SYSTEM REQUIREMENTS DOCUMENT FOR THE OVERALL DEPLETED URANIUM HEXAFLUORIDE CONVERSION PROJECT

U.S. Department of Energy
Portsmouth/Paducah Project Office
Portsmouth Site
Paducah Site

APPROVAL PAGE

Listed below are personnel responsible for the preparation, review, and approval of this plan. Signatures for each have been provided on DUF6 Form 4320, *Document Review & Approval Form.*

LEAD PREPARER:	Dustin Burkeen	Paducah System Engineer
REVIEWER:	Deena Kuntz	Paducah System Engineer
APPROVERS:	Kirk Barlow	Design Authority
	Jackie East	Nuclear Safety Manager
	Scott Nicholson	Program Director I - ESH&QA
	Adam Goldberg	Program Manager II - Implementation Process Technology Officer
	Fred Jackson	Program Director I - Chief Engineer

REVISION LOG			
Revision	**Effective Date**	**Description of Change**	**Pages Affected**
0	05/06/20	• Initial release. Replaces DUF6-BWCS-SRD-PROJ	All

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS

ACRONYM	DEFINITION
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	As Low As is Reasonably Achievable
BJC	Bechtel Jacobs Corp.
BWCS	BWXT Conversion Services, LLC
CFR	Code of Federal Regulations
CID	Cylinder Information Database
CRD	Contract Requirements Document
DOE	Department of Energy
DOE G	DOE Guide
DOE M	DOE Manual
DOE O	DOE Order
DOE-STD	DOE Standard
DOL	Department of Labor
DOT	Department of Transportation
DSA	Documented Safety Analysis
DUF_6	Depleted Uranium Hexafluoride
EPHA	Emergency Preparedness Hazard Analysis
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPC	Engineering, Procurement, and Construction
ETTP	East Tennessee Technology Park
FHA	Fire Hazard Analysis
FR	Federal Register
HC	Hazard Category
HF	Hydrofluoric Acid or Hydrogen Fluoride
ISMS	Integrated Safety Management System
KDEP	Kentucky Department for Environmental Protection
LEU	Low-Enriched Uranium
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NMC&A	Nuclear Materials Control and Accountability
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
ORO	Oak Ridge Operations
OSHA	Occupational Safety and Health Administration
PGDP	Paducah Gaseous Diffusion Plant
PL	Public Law
PPPO	Portsmouth Paducah Project Office
PQAP	Project Quality Assurance Plan
RFP	Request for Proposal
KDEP	Kentucky Department for Environmental Protection
NRC	U.S. Nuclear Regulatory Commission
OEPA	Ohio Environmental Protection Agency

ACRONYM	DEFINITION
PCB	Polychlorinated Biphenyls
RCRA	Resource Conservation Recovery Act
ROD	Record of Decision
RPMP	Regulatory Permitting and Management Plan
SER	Safety Evaluation Report
SRD	System Requirements Document
SSC	Structures, Systems and Components
TBD	To be determined
TBV	To be verified
TRU	Transuranics
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage and Disposal Facility
TSR	Technical Safety Requirement
U-235	Uranium 235
UF_6	Uranium Hexafluoride
UO_2F_2	Uranyl Fluoride
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USQ	Un-reviewed Safety Questions
WAC	Waste Acceptance Criteria
WAG	Waste Acceptance Guidelines

1 PROJECT BACKGROUND

Depleted uranium hexafluoride (DUF_6) is an end-product of uranium enrichment, the process of making uranium suitable for use as fuel for nuclear reactors or in national security applications. The use of uranium in these applications requires increasing the proportion of the uranium-235 (U-235) isotope found in natural uranium. Uranium enrichment by the U.S. Department of Energy (DOE) and its predecessor agencies had been accomplished using gaseous diffusion technology, in which gaseous uranium hexafluoride (UF_6) diffuses through a porous barrier, resulting in a stream of UF_6 enriched in U-235 and a stream of UF_6 depleted in U-235.

Large-scale uranium enrichment in the United States began as part of the Manhattan Project during World War II. Uranium enrichment activities continued under the U.S. Atomic Energy Commission (AEC) and its successor agencies, the Energy Research and Development Administration and the DOE. The K-25 Plant at Oak Ridge, Tennessee (renamed the East Tennessee Technology Park [ETTP]), was the first of three gaseous diffusion plants to produce enriched uranium. During the early 1950s, the Atomic Energy Commission also built gaseous diffusion plants at Portsmouth, Ohio, and Paducah, Kentucky. Decreasing demand for enriched uranium led to a DOE decision to cease operations at the K-25 Plant in 1985. Uranium enrichment activities at the Paducah site ceased in 2013, while the enrichment activities at the Portsmouth site ceased in 2001.

UF_6 poses potential health risks, and the material is handled accordingly. Uranium is radioactive, and UF_6 in storage emits low levels of gamma and neutron radiation. In addition, if UF_6 is released to the atmosphere, it reacts with water vapor in the air, forming hydrogen fluoride (HF) and uranyl fluoride (UO_2F_2). These products are chemically toxic. Uranium is a heavy metal that, in addition to being radioactive, can have toxic chemical effects (primarily on the kidneys) if it enters the bloodstream by means of ingestion or inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at high enough concentrations.

DOE stores DUF_6 (uranium hexafluoride depleted in the U-235 isotope, typically down to 0.2 -.4 percent) as a solid in large steel cylinders at Portsmouth and Paducah sites. Several different cylinder types are used for storage, but most of the DUF_6 is stored in 14-ton-capacity cylinders. Typically, the cylinders are stacked two layers high in outdoor areas called "cylinder storage yards." DOE also stores and maintains cylinders with “heels” (i.e., cylinders containing a small amount of residual material) and empty cylinders, in addition to cylinders containing “normal assay” (defined in the Cylinder Information Database [CID] as greater than or equal to 0.707% and less than or equal to 0.715% U-235), and low-enriched assay (with >0.715% up to less than 20% U-235) UF_6. “Normal assay” is equivalent to natural assay, as defined by ASTM STD C787-96. The 20% upper limit for low-enriched uranium (LEU) is based on the definition given in 10 CFR (Code of Federal Regulations) 74 - Material Control and Accounting of Special Nuclear Material. Natural and low-enriched UF_6 will not be converted. The cylinders at the Paducah and Portsmouth sites are stored with minimum risks to workers, the public, and the environment. DOE maintains an active cylinder management program to improve storage conditions in the cylinder storage yards, to monitor cylinder integrity by conducting routine inspections for holes or breaches, and to perform cylinder maintenance and repairs as needed.

On October 31, 2000, DOE issued its Request for Proposal (RFP) DE-RP05-01OR22717, Acquisition of Facilities and Services for Conversion of Depleted Uranium Hexafluoride (DUF_6),

for the design, construction, and operation of DUF_6 conversion facilities. In July 2002, Congress passed legislation (PL [Public Law] 107-206) that required DOE to build two facilities, one in Paducah, Kentucky and one in Portsmouth, Ohio, to convert the DUF_6 into a safer form. The legislation required DOE to award a contract for the project within a month of the President's signature and required construction to begin by July 31, 2004. On August 29, 2002, DOE signed Contract No. DE-AC-05-02OR22717 for the DUF_6 Project for the Conversion of Depleted Uranium Hexafluoride with Uranium Disposition Services, LLC (UDS). UDS was formed by AREVA NP, Inc. (formerly Framatome ANP), EnergySolutions Federal Services, Inc. (formerly Duratek), and Burns and Roe Enterprises, Inc.

At Portsmouth and Paducah, UDS completed constructing buildings to house the equipment required for a continuous conversion process, and offices and support areas for plant personnel. The DUF_6 conversion process involves vaporized DUF_6 being converted to uranium oxide in a fluidized bed conversion unit. The resulting powder is collected and packaged for disposition. The process equipment is arranged in parallel lines. Each line consists of autoclaves, conversion units, an HF Recovery System, and process off gas. The Paducah plant has four parallel conversion lines to meet its throughput requirements. The Portsmouth plant has three parallel conversion lines to meet its throughput requirements. Equipment is installed to collect and load-out the HF end-product. Construction of the Paducah facility was completed in December 2008, with the first years of operations ending in late 2011. Construction of the Portsmouth facility was completed in May of 2008, with the first year of operations completed in late 2011. It is anticipated that the Paducah facility will require approximately 25 years of operations to convert the material stored in cylinders at Paducah. It is anticipated that the Portsmouth facility will require approximately 18 years of operations to convert the material stored in cylinders at Portsmouth and the material in cylinders that was shipped to the Portsmouth site from ETTP.

On June 17, 2009, the DOE issued RFP DE-RP30-09CC40015, for DUF_6 Conversion Facilities operations at Paducah, Kentucky and Portsmouth, Ohio. On December 8, 2010, contract DE-AC30-11CC40015 was awarded to Babcock & Wilcox Conversion Services, LLC (BWCS). BWCS was formed by Babcock & Wilcox and URS Washington Division.

On September 8, 2015, contract DE-EM0004559 was awarded to Mid-America Conversion Services, LLC (MCS). MCS was formed by Atkins Nuclear Secured, LLC, Westinghouse Government Services, LLC, and Fluor Government Group International, Inc.

2 OVERALL MISSION, GOALS, AND OBJECTIVES

The mission of the DUF_6 Conversion Project is to safely and efficiently manage the DOE inventory of DUF_6 in its current form, provide facilities for converting DUF_6 to uranium oxide, and manage uranium oxide cylinders.

The goal of the DUF_6 Conversion Project is to complete the mission within 25 years. The objectives of the DUF_6 Conversion Project are to:

- Safely and efficiently manage the DOE's UF_6 inventory including the DUF_6 inventory
- Convert the DOE's DUF_6 inventory to uranium oxide using mature, proven technology and processes

- Process and package conversion products, co-products, or the empty cylinders, which are determined to be waste
- Dispose or reuse the end-products and wastes
- Meet all regulatory and other requirements for managing the DUF_6 inventory, including Congressional mandates, state agreements, and agreements with other site tenants.
- Protect the health and safety of workers, general public, and the environment
- Operate conversion facilities at Portsmouth, Ohio and Paducah, Kentucky in accordance with the authorization basis.

To facilitate successful completion of the project, three System Requirements Documents (SRDs) have been developed. The SRDs are listed and discussed below.

- DUF_6 Conversion Project Overall SRD – DUF6-SRD-PROJ
- DUF_6 Conversion Project SRD for Portsmouth – DUF6-SRD-PORT
- DUF_6 Conversion Project SRD for Paducah – DUF6-SRD-PADU

2.1 DUF_6 CONVERSION PROJECT OVERALL SRD

This SRD summarizes the requirements necessary to meet the overall mission of the project. It provides overall production and plant availability goals, identifies the need for various project-wide programs (Integrated Safety Management System, Cylinder Surveillance and Maintenance, etc.) and broader constraints affecting storage and transportation of cylinders and chemicals. The SRD also provides project duration objectives and the expected inventories at Portsmouth and Paducah.

2.2 PORTSMOUTH SRD

This SRD summarizes the requirements necessary to meet those aspects of the overall mission that affect the DUF_6 inventory at Portsmouth.

2.3 PADUCAH SRD

This SRD summarizes the requirements necessary to meet those aspects of the overall mission that affect the DUF_6 inventory at Paducah.

3 SYSTEM DESCRIPTION

The DUF_6 conversion and disposition approach taken by the DUF_6 Conversion Project integrates all project activities from cylinder management and transportation, through facility design, to material conversion and disposition. The primary goal of the DUF_6 Conversion Project is the safe and effective management of cylinders, disposition of DUF_6 cylinders, and conversion of DUF_6, and the management of waste materials.

Major activities within the scope of the DUF_6 Conversion Project include:

- Provide surveillance and maintenance (S&M) for the DUF_6 conversion facilities and associated equipment.
- Operate and maintain the conversion facilities to convert the DUF_6 from the inventory at Paducah and Portsmouth to uranium oxide at design throughput of the conversion facilities.
- Reuse and/or transport and dispose of the DUF_6 conversion process end-products and wastes.
- Sell the aqueous hydrofluoric acid (AqHF) product.
- Provide S&M services for the cylinder storage yards assigned to the DUF_6 Conversion Project.

A description of the facilities and activities planned at Portsmouth and Paducah can be found in the site-specific SRDs. In addition to differences in processing rates and years of expected operation, site differences include seismic criteria and the location of cylinders with respect to the conversion facility.

4 PERFORMANCE REQUIREMENTS

The DUF_6 Conversion Project manages DOE cylinders containing depleted, natural (normal per cylinder inventory database), low enriched UF_6 and cylinders with heel material and empty cylinders at both sites. Cylinders containing depleted, normal, and low enriched UF_6 at ETTP have been shipped to the Portsmouth plant. Cylinders with heel material and empty cylinders at ETTP have been shipped to the Portsmouth plant or elsewhere.

The contents of cylinders containing normal and low enriched UF_6 is managed by the DUF_6 contractor until disposition is directed by DOE. Natural UF_6 is made from uranium which has been mined but not processed. Normal UF_6 is natural uranium which has been processed by a feed converter. Therefore all UF_6 containing 0.711 wt% U235 at the gaseous diffusion plants is “normal UF_6”. The cylinders containing DUF_6 will be dispositioned via conversion in the conversion facilities at the Paducah and Portsmouth plants.

Conversion operations are defined by the conversion of DUF_6 cylinders in a routine manner using the full design capability of the conversion facilities. The DUF_6 contractor shall conduct conversion operations in accordance with the approved plans and conversion facility process design to meet the end point criteria specified by the DOE.

Cylinder management performance meets the requirements defined in the Cylinder Surveillance and Maintenance Plan (DUF6-PLN-011).

The DUF_6 Conversion Project manages the assigned DOE UF_6 cylinder inventory, including management of the Cylinder Information Database (CID) and the associated records, cylinder repair, required cylinder inspections, relocations, maintenance of the existing UF_6 cylinder storage yards, design and construction of new cylinder storage yards, if required, and disposition of empty cylinders and cylinders with heel. The cylinder data shown in Table 1 is the current status of DOE cylinders at both sites (current as of 12/30/19).

Table 1, Total Cylinder Quantities by Type and Site
(see individual site SRDs for cylinder types/contents)

Model	Paducah	Portsmouth	Total
1S	0	61	61
2S	0	21	21
4S	0	0	0
5A	0	15	15
5B	0	7	7
8A	0	11	11
8H	0	0	0
8S	0	0	0
10A	1	5	6
12A	61	53	114
12B	0	8	8
30A	1,824	680	2504
30B	1185	49	1234
48A	47	1,157	1204
48G	29,555	9,235	38790
48H	2,073	6	2079
48HX	775	6	781
48O	5,277	257	5534
48OH	0	22	22
48OHI	2	34	36
48OM	6,755	5,180	11935
48OMM	0	0	0
48T	604	3,605	4209
48X	2,394	313	2707
48Y	420	59	479
CV12	150	0	150
CV19	137	0	137
FAB3	0	2	2
SAM	0	23	23
UKN	1	2	3
Totals	**51,261**	**20,811**	**72,072**

* Cylinders <30” are under control of the Portsmouth GDP D&D Contractor. Portsmouth GDP D&D Contractor also has the contract to disposition cylinders less than 30” at Portsmouth (other than depleted). Depleted cylinders less than 30” will be processed by the DUF_6 contractor when the conversion facility is in operation.

** The Paducah cylinder count includes cylinders previously under the management of PGDP under their lease with the DOE.

Contract DE-AC05-11CC40015 Section C Paragraph VI C 1 and 2C.6.2.2: “Once cylinder S&M activities have been transitioned, the Contractor shall perform activities necessary to manage the DOE UF_6 cylinder inventory, including required cylinder inspections, maintenance of existing UF_6 cylinder yards, and disposition of empty and heel cylinders. Once cylinder S&M (Surveillance and Maintenance) activities have been transitioned, the Contractor shall perform all activities necessary to manage the DOE DUF_6 cylinder inventory, including required cylinder inspections, maintenance of the existing UF_6 cylinder storage yards, design and construction of new cylinder storage yards, if required, and disposition of empty and heel cylinders. At the direction of the DOE, the Contractor shall manage LEU or normal assay cylinders (e.g., transfer to other programs).”

The conversion facilities are designed to process the DUF_6 cylinders identified in the Cylinder Inventory Database (CID). The conversion facilities process DUF_6 at a rate such that the total DUF_6 inventory at both sites will be converted and dispositioned in no longer than 25 years after conversion operations start, subject to the constraints of projected funding levels.

The ETTP cylinders containing DUF_6 will be processed at the Portsmouth plant and all of the cylinders have been transported to the Portsmouth facility. Table 2, DUF_6 Processing Rates, identifies the contractual processing rates of DUF_6 at each facility and the number of years required to complete conversion of the inventory based on the design of each Conversion Facility.

Table 2, DUF_6 Processing Rates

Site	MT DUF_6	Plant Capacity	Time for Conversion
Portsmouth, OH Gaseous Diffusion Plant	250,000	13,500 mT/yr	18 years
Paducah, KY Gaseous Diffusion Plant	451,000	18,000 mT/yr	25 years

As there is nuclear material on site, it requires a method for controlling and accounting for the material. The Nuclear Material Control and Accountability Plan was developed to meet this requirement.

The DUF_6 Conversion Project is responsible for cylinder Surveillance and Maintenance (S&M) activities. This activity applies to the DOE inventory of DUF_6, low-enrichment uranium hexafluoride, normal UF_6, oxide-filled cylinders and heel and empty cylinders.

During the normal operations of the facility, various types of waste are generated. The types of waste include, but are not limited to: low-level waste (LLW), mixed low-level waste (MLLW), industrial waste, sanitary waste, and hazardous waste. The DUF_6 Conversion Project is responsible the proper disposition and disposal of the wastes. Waste is considered disposed of when the receiving Treatment, Storage and Disposal Facility (TSDF) provides the DUF_6 contractor with a certificate of disposal or certificate of destruction.

5 INTERFACES

5.1 ENVIRONMENTAL REGULATORY AGENCY INTERFACES

Primary state and federal regulatory agency interfaces include the Kentucky Department for Environmental Protection (KDEP), Ohio Environmental Protection Agency (OEPA), U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), and the U.S. Nuclear Regulatory Commission (NRC). Interfaces with the USEPA Region 4 (Kentucky) or Region 5 (Ohio) are with respect to the Toxic Substances Control Act (TSCA) as it applies to storage of UF_6 cylinders that have paint containing Polychlorinated Biphenyls (PCBs) in excess of regulatory limits. Kentucky and Ohio have regulatory authority for other environmental requirements affecting DUF_6 including compliance with the Resource Conservation Recovery Act (RCRA). The DUF_6 Conversion Project interfaces and provides reports, as required, with the Kentucky and Ohio State Emergency Planning Commissions, the Paducah and Portsmouth Local Emergency Planning Commissions, and the Ohio Department of Health.

5.2 WASTE DISPOSITION

The DUF_6 Conversion Project maintains liaison with the disposal sites that could be expected to receive waste materials for the operating life of each site with respect to Waste Acceptance Criteria (WAC) or Waste Acceptance Guidelines (WAG), performance criteria, licenses, and packaging requirements. The DOE shall be responsible for ensuring a waste disposition pathway exists for radioactive waste and/or the radiological component of any mixed wastes.

5.3 END-PRODUCTS TO CUSTOMERS

The DUF_6 Conversion Project maintains liaison with marketing entities to determine the market demand for the end products, particularly aqueous hydrofluoric acid.

The DUF_6 Conversion Project executes long-term agreements with customers for the sale of the product(s) to maintain a balance between production and by-product shipment.

In order for the conversion products to be sold, the DUF_6 Conversion Project has interfaced with DOE to obtain approval for the release of such products in accordance with DOE 5400.5, Chapter IV. This release approval has been received; the release limits are stated in the site-specific SRD for aqueous hydrofluoric acid.

5.4 PADUCAH/PORTSMOUTH

The Paducah and Portsmouth DUF_6 Conversion Facilities maintain a common database related to the material inventory and the Surveillance and Maintenance Program for the UF_6 cylinders stored at the two sites.

5.5 DOE, DUF_6 CONVERSION PROJECT

The DUF_6 Conversion Project interfaces with the DOE Portsmouth Paducah Project Office (PPPO). This interface is through the DOE Federal Project Manager along with DOE's Integrated Project Team (IPT) as defined by the DOE-PPPO Project Charter.

The DUF_6 Conversion Project acquires services and personnel as needed during the life of the project. Services and personnel are provided on a subcontract basis and/or DUF_6 Conversion Project direct hires. Services may include project management, project controls, design, procurement, construction management, process equipment installation, and start-up and operations support.

5.6 DUF_6 CONTRACTOR AND OTHER SUBCONTRACTORS

The DUF_6 contractor executes agreements with other subcontractors to provide services and personnel as needed during the life of this project. Areas where other subcontract services may be utilized include, but are not limited to, safety basis documentation, UF_6 cylinder and cylinder storage yard maintenance, laboratory services, equipment fabrication, construction services, regulatory (technical) services, and waste disposal.

6 CONSTRAINTS

This section cites authority documents that mandate legally binding requirements that affect technical decisions concerning the design of systems at each DUF_6 Conversion Project Facility. Only federal requirements are addressed. State and local requirements, which may implement the federal programs, will be addressed in the site-specific SRDs. The overall design of the facilities is to be based on the editions of the rules and regulations identified in the SRDs. Subsequent changes to rules and regulations in the updated editions is not implemented without specific direction from DOE under the configuration management provisions of the contract.

Pertinent DOE directives, which are consensus documents, are listed in Attachment J-2 to the contract, “List of Applicable DOE Directives,” and are enforced in the event of noncompliance by invoking contractual remedies such as contract cancellation. The project reviews all the directives listed in Attachment J-2 for their applicability to individual systems. The project identifies other directives (by EPA, state, and other agencies), as necessary, in addition to those identified in Attachment J-2 to the contract, and submit them to DOE for consideration.

Because the legally binding requirements contained within each authority document apply differently to each facility type, this section does not describe the requirements in detail. Also, this section does not identify specific systems to which the requirements contained within each authority document may apply.

6.1 CONSTRAINTS RELATED TO NUCLEAR SAFETY

DOE regulates nuclear safety at the DUF_6 Conversion Project Facilities, as authorized by Section 161.i (3) of the Atomic Energy Act of 1954 (AEA) (PL 83-703). To implement such regulation, DOE has promulgated nuclear safety standards in regulations and has adopted pertinent directives. The Department enforces its regulations, which have the power of law, by levying fines or by referring the offending contractor to the Department of Justice for other punishment.

6.1.1 **Statutes**

- Atomic Energy Act of 1954 (42 U.S.C. [United States Code] 2011 et seq.)

6.1.2 **Executive Orders**

None

6.1.3 **Regulations**

- 10 CFR (Code of Federal Regulations) Part 830, Subpart B, “Safety Basis Requirements”

6.1.4 **DOE Directives**

- DOE O 420.1C, Chg 2, “Facility Safety”
- DOE O 422.1, Chg 2, “Conduct of Operations
- DOE O 425.1D, Chg 1, Verification of Readiness to Startup or Restart Nuclear Facilities (Mod 54)
- DOE O 430.1B, Chg 2, Real Property and Asset Management (Mod 54)
- DOE O 470.4B, Chg 2, Safeguards and Security Program

6.1.5 **DOE Standards**

- DOE-STD-1020, “Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities” 2012
- DOE-STD-1021, “Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems and Components” July 1993, Change Notice No. 1 January 1996, reaffirmed with Errata April 2002
- DOE-STD-1023, “Natural Phenomena Hazards Assessment Criteria” March 1995, Change Notice No. 1 January 1996, reaffirmed with Errata April 2002
- DOE-STD-1027, “Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports” December 1992, Change Notice No. 1 September 1997
- DOE-STD-3009-94 CN3, “Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis”
- DOE-STD-1030-96, Guide to Good Practices for Lockouts and Tagouts
- DOE-STD-1090-2011, Hoisting and Rigging (Mod 54)
- DOE-STD-1098-2008, Radiological Control, Change Notice 1 (Mod 54)
- DOE-STD-1107-97, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities, Change Notice 1 (Mod 54)
- DOE-STD-3020-2015, Specification for HEPA Filters used by DOE Contractors
- DOE-STD-3025-2007, Qualities Assurance Inspection and Testing of HEPA Filters

A hazard analysis systematically identifies and assesses potential process-related hazards, hazards stemming from natural phenomena, and external hazards that can affect the public, the workers, and the environment due to single or multiple failures. The end result of the hazard analyses is to determine hazard categories of the various parts of the facility and to identify the bounding accident scenarios to be carried forward for specific safety analyses. Table 3 identifies the expected hazard categories for each area and facility.

Table 3, Hazard Category by Segment and Facility

Area	Hazard Category[2]	
	Paducah	**Portsmouth**
Cylinder Storage Yards	2	2
Full Cylinder Staging Area	3	3
Conversion Building	3	3
HF Load out Area (note 1)	Below 3	Below 3
Oxide Staging Area	3	3
Empty and Heel Cylinder Staging Area	3	3
Miscellaneous Support Areas (note 1)	Below 3	Below 3

Notes:
1) While segments have a categorization of Below 3, the overall facility categorized as Hazard Category 3.
2) Hazard categories (HCs) are defined in 10 CFR 830. HC 1 to HC 3 specifies the most hazardous to least hazardous nuclear facility. Below 3 refers to those facilities considered at most to be classified as Radiological Facilities. Hazard Category 1 applies to Nuclear Reactor Facilities. Hazard Category 2 applies to Non-reactor Nuclear Facilities/Areas that have a potential for off-site impact. Hazard Category 3 applies to Non-reactor Nuclear Facilities that have a potential for on-site impact only.

DOE safety basis documentation derived from 10 CFR 830 is the core of the authorization basis for the operation of the Paducah and Portsmouth cylinder storage yards, movement of all radiological materials, and the siting, design, and operation of the DUF_6 Conversion Project facilities at Paducah and Portsmouth. The safety analysis format and content for the siting, design, and operation of the DUF_6 Conversion Project facilities at Paducah and Portsmouth follows DOE-STD-3009. Technical Safety Requirements were developed following DOE guidance based on the results of the safety analysis. Individual structures, systems, and components (SSC) were graded based on the results of the hazard analyses. Grading directly affected Technical Safety Requirements and were performed during the design process. SSC's are graded into four categories – Safety Class, Safety Significant, Production Support, and General Service. Safety Evaluation Reports (SER) were prepared by DOE to approve the established safety basis for each facility.

In addition to the safety basis documentation referred to in the paragraph above, the DUF_6 Conversion Project considers the provisions of 40 CFR 68 and 40 CFR 355. Based on 40 CFR 68, a facility that stores 1,000 pounds or more of HF at a 50% or greater concentration shall, under worst-case release conditions (i.e., fire, explosion, total spill), limit the airborne concentration of HF to 0.016 mg/l (milligrams per liter) at a distance from the source that is less than the distance to any public receptor. 40 CFR 355 addresses Emergency Planning and Community Right to Know considerations that stipulates a threshold planning quantity and reportable quantity for hydrofluoric acid of 100 pounds.

As part of the Surveillance and Maintenance of the cylinder storage yards, DUF_6 Conversion Project maintains the existing safety documentation for these yards, including the Documented Safety Analyses, Fire Hazards Analyses, Emergency Preparedness Hazard Analyses, and any local agreements. DUF_6 Conversion Project developed and maintains specific programs for safety document updates, onsite cylinder movement, Unreviewed Safety Questions process, criticality safety, agreements with local security and fire departments, etc.

The design layout of the Paducah and Portsmouth Conversion Facilities limit the presence of radiological materials in the facilities, particularly the cylinders containing non-uranium contaminants, so the limits identified in the 10 CFR 830 safety basis documentation for the conversion facilities are not exceeded.

Quality Assurance requirements derived from 10 CFR 830 is the basis of the Project Quality Assurance Plan (PQAP).

6.2 CONSTRAINTS RELATED TO WORKER PROTECTION

6.2.1 **10 CFR 851**

Regulations supporting worker safety are implemented through 10 CFR 851, which specifies contractor actions to protect workers at DOE sites. The DOE Office of Enforcement is responsible for investigating potential 10CFR851 non-compliance issues. The DOE Office of Enforcement is also responsible for investigating potential security non-compliance issues as well as violations of Price-Anderson Act Amendment acts.

10 CFR 851 incorporates OSHA requirements found in 29 CFR 1910 by reference. It also incorporates a number of national standards including NFPA 70E.

Elements of 10 CFR 851 include:

- Construction Safety
- Fire Protection
- Explosives Safety
- Pressure Safety
- Firearms Safety
- Industrial Hygiene
- Biological Safety

- Occupational Medicine
- Motor Vehicle Safety
- Electrical Safety
- Nanotechnology Safety
- Workplace Violence Prevention

6.2.2 **Statutes**

- Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) Occupational Safety and Health Act (5 U.S.C. 5108 et seq.)

6.2.3 **Executive Orders:**

None

6.2.4 **Regulations**

- 10 CFR Part 835, “Occupational Radiation Protection”
- 10 CFR Part 851, “Worker Safety and Health Program”

6.2.5 **DOE Directives**

- DOE O 225.1B, Accident Investigation
- DOE O 231.1B, Environment, Safety, and Health Reporting

6.3 CONSTRAINTS RELATED TO WASTE MANAGEMENT AND POLLUTION PREVENTION

EPA and the States regulate or establish the relevant standards for most aspects of the management of hazardous waste at the DUF_6 Conversion Project facilities (under the Resource Conservation and Recovery Act) and for emergency planning and hazardous chemical reporting (under the Emergency Planning and Community Right-to-Know Act of 1986 and the Pollution Prevention Act of 1990). Under the authority of the Atomic Energy Act, DOE regulates radioactive waste management and is responsible for pollution prevention pursuant to Executive Order 13148, “Greening of the Government through Leadership in Environmental Management.”

6.3.1 **Statutes**

- Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6901 et seq.) Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U.S.C. 11001 et seq.)
- Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq.)
- Atomic Energy Act of 1954, as amended (42 U.S.C. 2011, et seq.)

6.3.2 **Executive Orders**

Executive Order 13148, “Greening of the Government through Leadership in Environmental Management” (65 FR [Federal Register] 24595; 04/26/2000)

6.3.3 **Regulations**

- 40 CFR Part 261, “Identification and Listing of Hazardous Waste”
- 40 CFR Part 262, “Standards Applicable to Generators of Hazardous Waste”
- 40 CFR Part 264, “Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities”
- 40 CFR Part 268, “Land Disposal Restrictions”
- 40 CFR Part 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs)”
- 40 CFR Part 355, “Emergency Planning and Notification”
- 40 CFR Part 370, “Hazardous Chemical Reporting: Community Right-to-Know ”
- 40 CFR Part 372, “Toxic Chemical Release Reporting: Community Right-to-Know”
- 40 CFR Part 761, “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions”

6.3.4 **DOE Directives**

- DOE O 435.1,Chg 1, Radioactive Waste Management

6.4 CONSTRAINTS RELATED TO PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT

The USEPA and the States regulate or establish the relevant standards for most aspects of protection of public health and the environment related to contaminant releases from DOE facilities. Non-radiological contaminant releases to water from DOE operating facilities are regulated under the Federal Water Pollution Control Act, as amended by the Clean Water Act (CWA), while radiological and non-radiological releases to air are regulated under the Clean Air Act (CAA). DOE controls radiological contaminant releases to water pursuant to the Atomic Energy Act of 1954.

6.4.1 **Statutes**

- Clean Air Act, as amended (42 U.S.C. 7401 et seq.)
- Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.) Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.) Executive Orders:
- Executive Order 11988, “Floodplain Management” (42 FR 26951; May 24, 1977) Executive Order 11990, “Protection of Wetlands” (42 FR 26961; May 24, 1977) Regulations:
- 40 CFR Part 50, “National Primary and Secondary Ambient Air Quality Standards”

- 40 CFR Part 60, “Standards of Performance for New Stationary Sources”
- 40 CFR Part 61, “National Emission Standards for Hazardous Air Pollutants”
- 40 CFR Part 68, “Chemical Accident Prevention Provisions”
- 40 CFR Part 112, “Oil Pollution Prevention”
- 40 CFR Part 141, “National Primary Drinking Water Regulations”

6.4.2 **DOE Directives**

- DOE 458.1, Chg 3, Radiation Protection of the Public and the Environment (Mod 54)

6.5 CONSTRAINTS RELATED TO TRANSPORTATION SAFETY

Transportation of UF_6 (depleted, normal, or slightly enriched) from one DOE facility to another is subject to DOE controls pursuant to the Atomic Energy Act of 1954. In general, DOE requires that each package and shipment of such radioactive materials be prepared in compliance with the Hazardous Materials Regulations (HMRs) adopted by the U.S. Department of Transportation (DOT) to implement the Hazardous Materials Transportation Act, as amended. These regulations are located in 49 CFR Parts 171 through 180.

6.5.1 **Statutes**

- Atomic Energy Act of 1954
- Hazardous Materials Transportation Act, as amended (49 U.S.C. 1501 et seq.)

6.5.2 **Executive Orders**

- None

6.5.3 **Regulations**

- 10 CFR Part 71, “Packaging and Transportation of Radioactive Material”
- 49 CFR 173.420, “Uranium Hexafluoride (fissile, fissile excepted, and non-fissile)”

6.5.4 **DOE Directives**

- DOE O 460.1C, Packaging and Transportation Safety
- DOE O 460.2A, Departmental Materials Transportation and Packaging Management

6.6 GENERAL CONSTRAINTS

6.6.1 **DOE Directives**

- DOE 458.1, Chg 3, Radiation Protection of the Public and Environment (Mod 54)

6.7 SAFEGUARDS AND SECURITY

The DUF_6 Conversion Project meets DOE's safeguards and security requirements and is addressed in PGDP-SS-PL-007, PGDP Site Security Plan.

6.8 MATERIAL SAFEGUARDS

Material control and accountability requirements are addressed in a Nuclear Materials Control and Accountability Plan, DUF6-PLN-009 for Piketon, OH and DUF6-PLN-067 for Paducah, and implemented accordingly.

6.9 INTEGRATED SAFETY MANAGEMENT SYSTEM (ISMS)

The ISM processes apply to all phases of the project in accordance with the Integrated Safety Management System Plan, DUF6-PLN-040.

The following DOE directives apply to ISMS.

6.9.1 **DEAR Clauses; Acquisition Regulation:**

Department of Energy Acquisition Regulation (DEAR) clauses promulgated in 48 Code of Federal Regulations:

- 970.1100-1 - Performance-based contracting
- 970.5204-2 - Laws, regulations, and DOE directives
- 970.5223-1 - Integration of environment, safety, and health into work planning and execution

6.9.2 **DOE Policies**

- DOE P 450.4, Integrated Safety Management Policy

6.9.3 **DOE Orders**

- DOE O 450.2, Integrated Safety Management

6.9.4 **DOE Guides and Manuals**

- DOE G 450.4-1C, Integrated Safety Management System Guide
- DOE M 411.1-1C, "Safety Management Functions, Responsibilities, and Authorities" (12/31/2003)

7 REGULATORY AND PERMITTING REQUIREMENTS

To assure that all applicable environmental permitting and regulatory requirements are met, the DUF_6 Conversion Project assures that the cylinders at Paducah, and Portsmouth are properly managed, and that the conversion facilities, and their associated infrastructures, are operated in conformance with all applicable DOE Directives, and Federal State, and local requirements. Sources for these requirements include the EPA, U.S DOT, NRC, KDEP, OEPA, USACE, various Executive Orders and Congressional Acts, and consent orders and compliance agreements. Details on the specific regulatory and permitting requirements, the manner in which their applicability was determined, and the means whereby they are integrated into the overall DUF_6 Conversion Project are described in the Project's Regulatory and Permitting Plan, DUF6-PLN-002.

7.1 PRINCIPAL REGULATORY REQUIREMENTS

The principal federal level regulatory requirements that affect conversion facility operation, and cylinder management are found in various DOE Directives and Titles 10 and 40 of the Code of Federal Regulations (CFR). In addition, Kentucky and Ohio have similar requirements that are analogous to the federal regulations found in 40 CFR. A listing and a brief description of each of the principal relevant DOE Directives and federal regulations follow.

7.1.1 **DOE Directives**

7.1.1.1 DOE Order 420.1C - "Facility Safety"

This order establishes facility safety requirements for the following:

- Nuclear safety design
- Criticality safety
- Fire protection
- Natural phenomena hazards mitigation
- A systems engineering program to ensure continual operational readiness

7.1.1.2 DOE Order 430.1B - "Real Property Asset Management"

This order states that the DOE, in partnership with its contractors, plan, acquire, operate, maintain, and dispose of physical assets as valuable national resources. Stewardship of these physical assets is accomplished in a safe and cost-effective manner to meet the DOE mission, and to ensure protection of workers, the public, and the environment. As such, appropriate industry standards, utilizing a graded approach with performance objectives, are incorporated into applicable project plans and design documents.

7.1.1.3 DOE Order 435.1B - "Radioactive Waste Management"

The objective of this order is to ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety, and the environment, in part through appropriate facility design and waste minimization. To meet this objective, DOE contractors systematically plan, document, execute, and evaluate the generation and management of DOE radioactive waste and assist the Government in planning, executing, and evaluating the generation and management of these wastes.

7.1.1.4 DOE Order 436.1 - "Departmental Sustainability"

This order, which replaces DOE Order 450.1, defines requirements and responsibilities for managing sustainability DOE to ensure that the Department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient and reliable energy for the future; institute wholesale cultural change to factor sustainability and greenhouse gas (GHG) reductions into all DOE corporate management decisions; and ensure that DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan.

7.1.2 **Code of Federal Regulations**

7.1.2.1 49 CFR 171 - "Packaging and Transportation of Radioactive Material

The regulations in this part set the requirements for packaging, preparation for shipment, and transportation of radioactive material and references the requirements found in 49 CFR 171 through 177 and 390 through 397. For example, under packaging, it is required that a package must be designed, constructed, and prepared for shipment so that, under the tests specified in §71.71 ("Normal conditions of transport"), there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging. Also, this regulation limits each individual package of radioactive materials, under conditions normally incident to transportation, to radiation levels that do not exceed 2 mSv/h (200 mrem/h) at any point on the external surface of the package, except under certain specific conditions when the external surface dose limits are 10 mSv/h (1000 mrem/h).

7.1.2.2 CFR 851 - “Worker Safety and Health Program”

The rules in this part establish standards for the protection of workers at DOE facilities. Standards include all aspects of worker safety except for radiation protection which is covered by 10 CFR 835. The standards included in 10 CFR 851 are applicable to anyone who works on a DOE site for 30 days or more in a 12-month period. It includes protection against chemical, biological, and industrial hazards. Enforcement responsibility is assigned to the DOE Office of Enforcement which also has enforcement responsibility for 10 CFR 830 non-compliances, and security non-compliances.

7.1.2.3 CFR 835 - "Occupational Radiation Protection"

The rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Among other requirements, it sets occupation dose limits for general employees to a total effective dose equivalent of 5 rems (0.05 Sv) per year, and requires that optimization methods be used to assure that occupational exposure is maintained as low as reasonably achievable (ALARA) in developing and justifying facility design and physical controls.

7.1.2.4 CFR 1021 - "National Environmental Policy Act Implementing Procedures"

The purpose of this part is to establish procedures that the DOE uses to comply with section 102(2) of NEPA and the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA. It stipulates, similarly to DOE Order 450.1B, that following completion of an environmental impact statement (EIS) and its associated ROD, DOE prepares a Mitigation Action Plan that addresses mitigation commitments expressed in the ROD that can include modifications to the proposed design, construction and operation of a facility. The Mitigation Action Plan explains how the corresponding mitigation measures, designed to mitigate adverse environmental impacts associated with the course of action directed by the ROD, will be planned and implemented. The Mitigation Action Plan is prepared before DOE takes any action directed by the ROD that is the subject of a mitigation commitment.

7.1.2.5 CFR 1022 - "Compliance with Floodplain-Wetlands Environmental Review Requirements"

This part establishes policy and procedures for discharging DOE's responsibilities with respect to compliance with Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands, including: DOE policy regarding the consideration of floodplain/wetlands; factors in DOE planning and decision making; and DOE procedures for identifying proposed actions located in floodplain/wetlands, providing opportunity for early public review of such proposed actions, preparing floodplain/wetlands assessments, and issuing statements of findings for actions in a floodplain/wetlands. Since there are known wetlands on the Paducah site building layout and road and rail construction will be affected.

7.1.2.6 40 CFR – “Protection of Environment"

Chapter 1 (Parts 1 - 799) of 40 CFR addresses numerous EPA rules and regulations, many of which are echoed or have analogous requirements in the Kentucky and Ohio environmental regulations, that are applicable to the DUF_6 Conversion Project. Principal federal requirements are found in:

- Subchapter C - Air Programs (Parts 50 - 99) which requires, for example, that: 1) emissions of radionuclides to the ambient air from DOE facilities do not exceed those amounts that would cause any member of the public to receive in any year an effective

dose equivalent greater than 10 mrem/yr (Part 61), and 2) a 99 weight-% removal of HF from process effluents prior to atmospheric release be achieved (Part 63).

- Subchapter D - Water Programs (Parts 100 - 149) which, for example, describes: 1) the National Pollutant Discharge Elimination System (NPDES) permitting process (Part 122), 2) the criteria, standards, and treatment requirements to meet the Best Practical Control Technologies for wastewater discharges (Part 125), and 3) the maximum allowable contaminant levels in potable water (Parts 141 and 143).
- Subchapter I - Solid Wastes (Parts 239 - 299) which, for example, 1) defines a waste as hazardous if it is ignitable, corrosive, reactive, toxic, or is a specific listed waste (Part 261), 2) requires generators of hazardous waste to obtain a generators number (Part 262), and 3) defines the "cradle to grave" management of hazardous wastes under the Resource Conservation Recovery Act (Parts 262 through 270).

7.1.2.7 49 CFR 173 - "Shippers-General Requirements for Shipments and Packaging":

This part sets forth requirements for the packaging and transportation of hazardous and radioactive materials. The requirements prescribed in this part are in addition to, not in place of, and generally more detailed, than the packaging and shipping requirements set forth by the EPA in 40 CFR 262 and 263, and the NRC in 10 CFR 71. For example, additional detailed requirements for the packaging, labeling, placarding, shipping, and quality assurance considerations for radioactive materials are found in 49 CFR 173.401.

7.2 PRINCIPAL PERMITTING REQUIREMENTS

The KDEP and OEPA are responsible for maintaining the quality of their respective State's land, air, water resources, and public and semi-public drinking water supplies. To accomplish this task, they regulate sources of air and water pollution, public and semi-public water treatment systems, public and semi-public wastewater treatment systems, sewage treatment plants, and the management of hazardous and non-hazardous wastes. Regulation of these sources is carried out through a series of state-enforced environmental quality requirements and permitting programs. Additionally, permits may be required from the USACE with respect to wetlands or stream encroachment, and the EPA, if the State has no specific enabling legislation or if the EPA has not delegated permitting and enforcement authority to them. The requirements found in these permits set forth performance, monitoring, sampling, and reporting requirements for the conversion facilities and their associated infrastructures, and thus require design and operational solutions to assure compliance.

A description of the environmental permitting process is found in the RPMP, which identified thirty potentially required permits or needed regulatory agency approvals for the construction and operation of the conversion facilities at Paducah and Portsmouth. The DUF_6 Conversion Project's overall permitting strategy, however, is to minimize the number of permits that will be required at the Paducah and Portsmouth facilities by making appropriate modifications to add the DUF_6 Conversion Project onto existing site permits. As a result of this approach, only a few permits or approvals are required by the Paducah and Portsmouth facilities, i.e., storm water plans, facility air permits, sewer and water line permits, and hazardous waste generator registrations. The specific permits and approvals needed, and the responsible regulatory authorities for each site are found in each respective site's SRD (DUF6-SRD-PORT AND DUF6-SRD-PADU). The Regulatory and Permitting Plan identifies the needed permits and approvals and their respective monitoring, sampling, and reporting requirements, while the site-specific SRDs enumerate the performance requirements and design constraints found in each permit.

7.3 POTENTIAL IMPACT OF NEW REGULATIONS

To assure that the DUF_6 Conversion Project is designed, constructed, and operated in compliance with all applicable regulations, and any new regulations promulgated during the contract period, DUF_6 Conversion Project personnel are on several e-mail notification lists, e.g., the EPA and the Bureau of National Affairs (BNA), and additionally maintains close contact with KDEP and OEPA. In this manner the DUF_6 Conversion Project becomes aware of potential new regulations in their formative stages, well in advance of their promulgation, and this affords the project time to analyze the impacts that these potential regulations have on the DUF_6 Conversion Project, and, as appropriate, comment upon or negotiate with the responsible regulatory authority. The DUF_6 Conversion Project is not aware, at this time, of any planned or on-going new regulation promulgation that would substantively affect the project's design and operations.

END OF DOCUMENT