



## SAFETY ANALYSIS REPORT



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### 10.3 TAILS DISPOSITION

The disposition of tails from the NEF is an element of authorized operating activities. It involves neither decommissioning waste nor is it a part of decommissioning activities. The disposal of these tails is analogous to the disposal of radioactive materials generated in the course of normal operations (even including spent fuel in the case of a power reactor), which is authorized by the operating license and subject to separate disposition requirements. Such costs are not appropriately included in decommissioning costs (this principle (in the 10 CFR 50 context) is discussed in Regulatory Guide 1.159 (NRC, 1990), Section 1.4.2, page 1.159-8). Further, the "tails" products from the NEF are not mill tailings, as regulated pursuant to the Uranium Mill Tailings Radiation Control Act, as amended and 10 CFR 40, Appendix A (CFR, 2003j), and are not subject to the financial requirements applicable to mill tailings.

Nevertheless, LES intends to provide for expected tails disposition costs (even assuming ultimate disposal as waste) during the life of the facility. Funds to cover these costs are based on the amount of tails generated and the unit cost for the disposal of depleted  $UF_6$ .

It is anticipated that the NEF will generate 132,942 MT of depleted uranium over a nominal 30 year operational period. This estimate is conservative as it assumes continuous production of tails over 30 years of operation. Actual tails production will cease prior to the end of the license term as shown in Figure 10.1-1, NEF – Conceptual Decommissioning Schedule.

Waste processing and disposal costs for  $UF_6$  tails are currently estimated to be \$5.50 per kg U or \$5,500 per MT U. This unit cost was obtained from four sets of cost estimates for the conversion of  $DUF_6$  to  $DU_3O_8$  and the disposal of  $DU_3O_8$  product, and the transportation of  $DUF_6$  and  $DU_3O_8$ . The cost estimates were obtained from analyses of four sources: a 1997 study by the Lawrence Livermore National Laboratory (LLNL) (Elayat, 1997), the Uranium Disposition Services (UDS) contract with the Department of Energy (DOE) of August 29, 2002 (DOE, 2002), information from Urenco, and the costs submitted to the Nuclear Regulatory Commission as part of the Claiborne Enrichment Center (CEC) license application (LES, 1993a) in the 1990s.

The four sets of cost estimates obtained are presented in Table 10.3-1, Summary Of Depleted  $UF_6$  Disposal Costs From Four Sources, below, in 2002 dollars per kg of uranium (kg U). Note that the Claiborne Energy Center cost had a greater uncertainty associated with it. The UDS contract does not allow the component costs for conversion, disposal and transportation to be estimated. The costs in the table indicate that \$5.50 per kg U (\$2.50 per lb U) is a conservative and, therefore, prudent estimate of total depleted  $UF_6$  disposition cost for the LES NEF. Urenco has reviewed this estimate and, based on its current cost for UBC disposal, finds this figure to be prudent.

In May 1997, the LLNL published UCRL-AR-127650, Cost Analysis Report for the Long-Term Management of Depleted Uranium Hexafluoride (Elayat, 1997). The report was prepared to provide comparative life-cycle cost data for the Department of Energy's (DOE's) Draft 1997 Programmatic Environmental Impact Statement (PEIS) (DOE, 1997) on alternative strategies for management and disposition of  $DUF_6$ . The LLNL report is the most comprehensive assessment of  $DUF_6$  disposition costs for alternative disposition strategies available in the public domain.

The technical data on which the LLNL report is based is principally the May 1997 Engineering Analysis Report (UCRL-AR-124080, Volumes 1 and 2) (Dubrin, 1997).

When the LLNL report was prepared in 1997, more than six years ago, the cost estimates in it were based on an inventory of 560,000 MT of  $\text{DUF}_6$ , or 378,600 MTU after applying the 0.676 mass fraction multiplier. This amount corresponds to an annual throughput rate of 28,000 MT of  $\text{UF}_6$  or about 19,000 MTU of depleted uranium. The costs in the LLNL report are based on the 20 year life-cycle quantity of 378,600 MTU. The LLNL annual  $\text{DUF}_6$  quantities are about 3.6 times the annual production rate of the proposed NEF.

The LLNL cost analyses assumed that the  $\text{DUF}_6$  would be converted to  $\text{DU}_3\text{O}_8$ , the DOE's preferred disposal form, using one of two dry process conversion options. The first --- the anhydrous hydrogen fluoride (AHF) option --- upgrades the hydrogen fluoride (HF) product to anhydrous HF (< 1.0% water). In the second option --- the HF neutralization option --- the hydrofluoric acid would be neutralized with lime to produce calcium fluoride ( $\text{CaF}_2$ ). The LLNL cost analyses assumed that the AHF and  $\text{CaF}_2$  conversion products are of sufficient purity that they could be sold for unrestricted use (negligible uranium contamination).

The costs in Table 10.3-1, represent the LLNL-estimated life-cycle capital, operating, and regulatory costs, in 2002 dollars, for conversion of 378,600 MTU over 20 years, of  $\text{DUF}_6$  to  $\text{DU}_3\text{O}_8$  by anhydrous hydrogen fluoride (HF) processing, followed by  $\text{DU}_3\text{O}_8$  long-term storage disposal in a concrete vault, or in an exhausted underground uranium mine in the western United States, at or below the same cost. An independent new underground mine production cost analysis confirmed that the LLNL concrete vault alternative costs represent an upper bound for underground mine disposal. The discounted 1996 dollar costs in the LLNL report were undiscounted and escalated to 2002 dollars. The LLNL life-cycle costs in 1996 dollars were converted to per kgU costs and adjusted to 2002 dollars using the Gross Domestic Product (GDP) Implicit Price Deflator (IPD). The escalation adjustment resulted in the 1996 costs being escalated by 11%.

On August 29, 2002, the DOE announced the competitive selection of Uranium Disposition Services, LLC to design, construct, and operate conversion facilities near the DOE enrichment plants at Paducah, Kentucky and Portsmouth, Ohio. UDS will operate these facilities for the first five years, beginning in 2005. The UDS contract runs from August 29, 2002 to August 3, 2010. UDS will also be responsible for maintaining the depleted uranium and product inventories and transporting depleted uranium from Oak Ridge East Tennessee Technology Park (ETTP) to the Portsmouth site for conversion. The DOE-UDS contract scope includes packaging, transporting and disposing of the conversion product  $\text{DU}_3\text{O}_8$ .

UDS is a consortium formed by Framatome ANP Inc., Duratek Federal Services Inc., and Burns and Roe Enterprises Inc. The DOE-estimated value of the cost reimbursement contract is \$558 million (DOE Press Release, August 29, 2002) (DOE, 2002). Design, construction and operation of the facilities will be subject to appropriations of funds from Congress. On December 19, 2002, the White House confirmed that funding for both conversion facilities will be included in President Bush's 2004 budget. However, the Office of Management and Budget has not yet indicated how much funding will be allocated. The UDS contract quantities and costs are given in Table 10.3-2, DOE-UDS August 29, 2002, Contract Quantities and Costs.

Urenco is currently contracted with a supplier for  $\text{DUF}_6$  to  $\text{DU}_3\text{O}_8$  conversion. The supplier has been converting  $\text{DUF}_6$  to  $\text{DU}_3\text{O}_8$  on an industrial scale since 1984.

The CEC costs given in Table 10.3-1, are those presented to John Hickey of the NRC in the CEC letter of June 30, 1993 (LES, 1993b) as adjusted for changes in units and escalated to 2002 (\$6.74 per kgU). The conversion cost of \$4.00 per kg U was provided to CEC by Cogema at that time. It should also be noted that this highest cost estimate is at least 10 years old and was based on the information available at that time. The value of \$5.50 per kgU used in the decommissioning cost estimate is 22% above the average of the more recent LLNL and UDS cost estimates, which is \$4.49 per kgU  $\{ (5.06 + 3.92) / 2 \}$ . The LLNL Cost Analysis Report (page 30) states that its cost estimate already includes a 30% contingency in the capital costs of the process and manufacturing facilities, a 20% contingency in the capital costs of the balance of plant; and a minimum of a 30% contingency in the capital costs of process and manufacturing equipment.

Also, the 1997 LLNL cost information is five years older than the more recent 2002 UDS cost information. The value of \$5.50 per kgU used in the decommissioning cost estimate for tails disposition is 40% greater than the 2002 UDS-based cost estimate of \$3.92 per kgU, which does not include offset credits for HF sales or proceeds from the sale of recycled products.

The costs in Table 10.3-1, indicate that \$5.50 is a conservative and, therefore, prudent estimate of total DU disposition cost for the NEF. Urenco has reviewed this estimate and, based on its current cost after tails disposal, finds this figure to be prudent.

In summary, there is already substantial margin between the value of \$5.50 per kgU being used by LES in the decommissioning cost estimate and the most recent information (2002 UDS) from which LES derived a cost estimate of \$3.92 per kgU.

Based on a computed tails production of 132,942 MTU during a nominal 30 years of operation and a tails processing cost of \$5.50/kgU or \$5,500 per MTU, the total tails disposition funding requirement is estimated at \$731,181,000. This sum will be included as part of the financial assurance for decommissioning (see Table 10.1-14, Total Decommissioning Costs). See Environmental Report Section 4.13.3.1.6, Costs Associated with  $\text{UF}_6$  Tails Conversion and Disposal, for additional details.

## 10.4 REFERENCES

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- CFR, 2003d. Title 10, Code of Federal Regulations, Part 20.2108, Records of waste disposal, 2003.
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NRC, 2003. Consolidated NM SS Decommissioning Guidance – Financial Assurance, Recordkeeping, and Timeliness, NUREG-1757, Volume 3, U.S. Nuclear Regulatory Commission, September 2003.

Table 10.3-1 Summary of Depleted UF<sub>6</sub> Disposal Costs from Four Sources  
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Source	Costs in 2002 Dollars per kgU			
	Conversion	Disposal	Transportation	Total
LLNL (UCRL-AR-127650) (a)	2.64	2.17	0.25	5.06
UDS Contract (b)	(d)	(d)	(d)	3.92
URENCO (e)	(d)	(d)	(d)	(d)
CEC Cost Estimate (c)	4.93	1.47	0.34	6.74

Notes:

- (a) 1997 Lawrence Livermore National Laboratory cost estimate study for DOE, discounted costs in 1996 dollars were undiscounted and escalated to 2002 by ERI.
- (b) Uranium Disposition Services (UDS) contract with DOE for capital and operating costs for first five years of Depleted UF<sub>6</sub> conversion and Depleted U<sub>3</sub>O<sub>8</sub> conversion product disposition.
- (c) Based upon Depleted UF<sub>6</sub> and Depleted U<sub>3</sub>O<sub>8</sub> disposition costs provided to the NRC during Claiborne Enrichment Center license application in 1993.
- (d) Cost component is proprietary or not made available.
- (e) The average of the three costs is \$5.24/kg U. LES has selected \$5.50/kg U as the disposal cost for the National Enrichment Facility. Urenco has reviewed this cost estimate, and based on its current experience with UF<sub>6</sub> disposal, finds this figure to be prudent.

Table 10.3-2 DOE-UDS August 29, 2002, Contract Quantities and Costs  
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		Target Million kgU
<b>UDS Conversion and Disposal Quantities:</b>		
	DUF6 (a)	U (b)
FY 2005 (August-September)	1.050	0.710
FY 2006	27.825	18.800
FY 2007	31.500	21.294
FY 2008	31.500	21.294
FY 2009	31.500	21.294
FY 2010 (October-July)	26.250	17.745
Total:	149.625	101.147
Nominal Conversion Rate (c) and Target Conversion Rate (Million kgU/Yr)		21.3
<b>UDS Contract Workscope Costs: (d)</b>		Million \$
Design, Permitting, Project Management, etc.		27.99
Construct Paducah Conversion Facility		93.96
Construct Portsmouth Conversion Facility		90.40
Operations for First 5 Years DUF <sub>6</sub> and DU <sub>3</sub> O <sub>8</sub> (e)		283.23
Contract Estimated Total Cost w/o Fee		495.58
Contract Estimated Value per DOE PR, August 29, 2003		558.00
Difference Between Cost and Value is the Estimated Fee of 12.6%		62.42
Capital Cost w/o Fee		212.35
Capital Cost with Fee		239.10
First 5 Years Operating Cost with Fee		318.92
<b>Estimated Unit Conversion and Disposal Costs:</b>		
Unit Capital Cost (f)		\$0.77/kgU
2005-2010 Unit Operating Costs in 2002 \$		\$3.15/kgU
Total Estimated Unit Cost		\$3.92/kgU

Notes:

- (a) As on page B-10 of the UDS contract.
- (b) DUF<sub>6</sub> weight multiplied by the uranium atomic mass fraction, 0.676.
- (c) Based on page H-34 of the UDS contract.
- (d) Workscope costs as on UDS contract pages B-2 and B-3.
- (e) Does not include any potential off-set credit for HF sales.
- (f) Assumed operation over 25 years, 6% government cost of money, and no taxes.