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Krich, Rod M.

From: Julian Steyn [steyn@energyresources.com]
Sent: Friday, January 03, 2003 12:11 PM
To: rod.krich@exeloncorp.com
Subject: Updated Cost Estimate Report Draft

NIRS/PC Prefiled Exhibit 114
Docketed 09/23/05

ERI-2129-0202 122002 Rev 1.do...

Rod:

Here is all that I could accomplish in the 30 minutes available. I took care of most of the kgU items (text & tables) and a few up front clarifications.

Please forward to Jim since I do not have his e-mail address. Send me the LeRoy to Hickey letter and the DUS contract. I will now proceed to take care of the other items.

Julian

EXHIBIT 11

PENGAD 800-631-6989

LES-01617

ENERGY
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ERI-2129-0202

Proprietary and Confidential

ESTIMATED LES-II APPLICABLE COSTS FOR DISTRIBUTION OF DUF6 BASED ON LLNL 1997 COST ANALYSIS FOR DOE DUF6 DISPOSITION

LES-01618

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ENERGY
RESOURCES
INTERNATIONAL, INC.

DRAFT ERI-2129-0202

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ESTIMATED LES-II APPLICABLE COSTS FOR DISTRIBUTION OF DUF6 BASED ON LLNL 1997 COST ANALYSIS FOR DOE DUF6 DISPOSITION

Prepared For:

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January 2003

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1. INTRODUCTION

In May 1997, the Lawrence Livermore National Laboratory published UCRL-AR-127650, *Cost Analysis Report for the Long-Term Management of Depleted Uranium Hexafluoride.* The report was prepared to provide comparative life-cycle cost data for the Department of Energy's (DOE) Draft 1997 Programmatic Environmental Impact Statement (PEIS) on alternative strategies for management of DUF_6. This report is the most comprehensive assessment of DUF6 disposition costs available in the public domain. The alternative strategies addressed in the report included: the no-action alternative, two long-term storage alternatives, two use alternatives, and a disposal alternative. The technical data on which the above report is based is principally the May 1997 Engineering Analysis Report (UCRL-AR-124080, Volumes 1 & 2). The final PEIS, which was completed in April 1999, identified conversion of DUF_6 to another stable chemical form as part of a DOE-preferred management alternative.

This ERI summary report presents LLNL cost estimates developed for DOE that might apply to the interim storage of DUF_6 at DOE conversion facilities, conversion of DUF_6 to DU_3O_8 at DOE facilities, ultimate disposal of DU_3O_8 at DOE sites, and general transportation of conforming cylinders. Costs for other alternatives were not addressed in this report since they were not considered as being applicable to LES. The ERI report is based on an analysis of the LLNL report, the publicly available literature, and available sources of information.

The estimates developed herein use the LLNL capital and operating life-cycle costs for the disposition of 378,600 MTU (560,000 MT of DUF6) over 20 years, as modeled in the LLNL Cost Report. The 20-year quantity analyzed corresponds to approximately 19,000 MTU per year, or approximately 2.4 times the expected annual tails output of the proposed Hartsville plant. The LLNL costs, which are reported in 1996 dollars (first quarter), were adjusted upward by 11% to 2002 dollars using the U.S. Gross Domestic Product (GDP) Implicit Price Deflator (IPD). The resulting estimates can be used to gauge the order of magnitude of potential costs that may apply to the Hartsville plant.

2. DUF_6 CONVERSION COSTS

The cost analysis assumed that the DUF_6 would be converted to DU_3O_8 using one of two dry process conversion options. The first --- the AHF option ---- upgrades the hydrogen fluoride (HF) product to anhydrous HF (<1.0% water).' In the second option --- the HF neutralization option --- the acid would be neutralized with lime to produce calcium fluoride (CaF2). The LLNL cost analyses assumed that the AHF and CaF2 conversion products are of sufficient purity that they could be sold for unrestricted use (negligible uranium contamination).

Table 1 presents the life-cycle capital, operating, and regulatory costs in 1996 dollars, for conversion of 378,600 MT over 20 years, of DUF_6 to DU_3O_8 by either anhydrous hydrogen fluoride (HF) or HF neutralization processing, followed by DU_3O_8 long-term storage

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disposal. The costs were extracted from the LLNL report by ERI. The LLNL life-cycle costs in 1996 dollars were converted to per kilogram unit costs and adjusted to 2002 dollars using the Gross Domestic Product (GDP) Implicit Price Deflator (IPD). This resulted in escalation of 11%.

TABLE 1
COST BREAKDOWN FOR DOE DUF6 TO DU3O8 CONVERSION, DISPOSAL, STORAGE & TRANSPORTATION
(MILLION DOLLARS FOR 378,600 MTU OVER 20 YEARS; 1996 DOLLARS)

	Anhydrous HF Conversion Option			HF Neutralization Conversion Option		
DUF6 TODU3O8 CONVERSION:						
Techology Development		9.84			5.74	
Process Equipment		22.36			20.88	
Process facilities		46.33			45.53	
Balance of Plant		29.20			30.25	
Regulatory Compliance		22.70			22.70	
Operations & Maintenance		134.76			198.40	
Decontamination & Decommissioning		1.76			1.73	
Conversion Totals:		266.95			325.23	
	DU3O8 Disposal Options			DU3O8 Disposal Options		
	Engineered Trench	Concrete Vault	Mined Cavity (UG Mine)	Engineered Trench	Concrete Vault	Mined Cavity (UG Mine)
BULK DU3O8 DISPOSAL:						
Waste Form Preparation						
Techology Development	6.56	6.56	8.20	6.56	6.56	8.20
Balance of Plant	26.43	26.43	26.43	26.43	26.43	26.43
Regulatory Compliance	2.02	2.02	2.02	2.02	2.02	2.02
Operations & Maintenance	33.23	33.23	33.23	33.23	33.23	33.23
Decontamination & Decommissioning	0.60	0.60	0.60	0.60	0.60	0.60
Waste Disposal						
Facility Engineering & Construction	12.22	96.08	409.02	12.22	96.08	409.02
Site Preparation & Restoration	0.89	1.68	19.21	0.89	1.68	19.21
Emplacement & Closure	30.61	39.2	248.88	30.61	39.2	248.88
Regulatory Compliance	40.35	40.35	40.35	40.35	40.35	40.35
Surveillance & Maintenance	2.29	2.86	2.21	2.29	2.86	2.21
Preparation & Disposal Totals:	155.20	249.01	790.15	155.20	249.01	790.15
Conversion + Bulk Disposal	422.15	515.96	1057.10	480.43	574.24	1115.38
Storage Until Conversion	197.00	197.00	197.00	197.00	197.00	197.00
Conforming Cylinder & DU3O8 Transportation	191.00	191.00	191.00	191.00	191.00	191.00
TOTAL (Million $)	810.15	903.96	1445.1	868.43	962.24	1503.38
TOTAL ($/KgU; 1996 Dollars)	2.14	2.39	3.82	2.29	2.54	3.97
TOTAL ($/KgU; 2002 Dollars per GDP IPD)	2.38	2.65	4.24	2.55	2.82	4.41

SOURCE: UCRL-AR-127650, Cost Analysis for the Long Term Management of Depleted Uranium Hexafluoride, May 1997.

AHF: Assumes sale of anhydrous hydrogen fluoride; $77.32 million credit assumed.
HF: Assumes sale of calcium fluoride (CAF2) produced from hydrogen fluoride (HF); $11.02 million credit assumed.

The unit costs in 2002 dollars given in the table range from $2.38 per kgU for the anhydrous HF conversion option with DU_3O_8 disposal in an engineered trench to $4.41 per kgU for the HF neutralization option with DU_3O_8 disposal in a high cost mined cavity based on available Yucca Mountain and WIPP project disposal cost data. All major buildings are assumed to be structural steel frame construction, except for the process building which is a two story reinforced concrete structure. Most of this building is assumed to be "special construction" with 1-foot thick concrete perimeter walls and ceilings , 8-inch concrete interior walls, and 2-foot thick concrete floor mat. The "standard construction" area walls are 8-inch thick concrete with 6-inch elevated floors and 8-inch

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concrete floors slabs on grade.

The operation and maintenance cost includes labor, materials, utilities, and waste management and waste disposal costs. It also assumes a credit for saleable by-product.

The anhydrous HF (AHF) conversion option costs assume that the AHF by-product is saleable, and that total revenues over the 20 years of operation would amount to $77.32 million. However, since the future market demand for AHF is very uncertain, it would be more prudent to assume that there will be no AHF by-product revenue. This would increase the operations and maintenance cost to $212.08 million, and the AHF conversion option to $344 million. Again, because of market uncertainty, it would be prudent to assume there would be no revenues from the sale of the by-product calcium fluoride (CaF2) obtained from neutralizing HF with lime; LLNL assumed that there might revenues of $11.02 million. Based on the assumption that there may be no by-product revenues, the HF conversion option operations and maintenance cost may be increased to $209.42 million and the total cost increased to $336.25 million, in 1996 dollars. The assumption of no by-product CaF2 revenue would approximately off-set the cost of disposing of the CaF2 as non-hazardous solid waste. In the unlikely event that the CaF2 had to be disposed as low level waste the cost could be high; LLNL estimated this possible cost as being $750 million over 20 years, in 1996 dollars.

Table 2 presents a summary of estimated capital, operating and regulatory costs for DUF_6 to DU_3O_8 conversion on a dollars per kgU basis, in both 1996 and 2002 dollars. The operating and maintenance estimates have been adjusted to account for the fact that there are no AHF or CaF2 revenues assumed. The total costs for the alternative processes are approximately the same if there are no saleable by-products. It can be seen that in either case the conversion process is operating and maintenance intensive.

TABLE 2

SUMMARY OF ESTIMATED CAPITAL, OPERATING, AND REGULATORY UNIT COSTS FOR DUF6 TO DU3O8 CONVERSION (DOLLARS PER KILOGRAM OF U as DUF6)

Cost Items	Anhydrous HF Option		HF Neutralization Option	
	1996$	2002$	1996$	2002$
Capital (a)	0.29	0.32	0.28	0.30
Operating & Maintenance (b)	0.56	0.62	0.55	0.61
Regulatory Compliance	0.07	0.07	0.07	0.07
Total:	0.91	1.01	0.89	0.99

(a) Technology development, process equipment, process facilities, balance of plant, and decontamination & decommissioning
(b) Assumes no by-product revenues.
Note: Summation may be affected by rounding.

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3. DU_3O_8 DISPOSAL COSTS

Table 1 presents estimated costs for three DU_3O_8 disposal options: shallow earthen structures (engineered "trenches"), concrete vaults, and a mined cavity (underground mine). For each option, the U_3O_8 would be packaged in 55-gal (208-L) drums.

All disposal options would include a central waste-form facility where drums of uranium oxide would be received from the conversion facility and prepared for disposal. The waste-form facility would include an administration building, a receiving warehouse, and short-term storage buildings (if necessary). Once prepared for disposal (if necessary), drums would be moved into disposal units. About 4 acres (1.6 ha) would be required.

The unique features of each of the DU_3O_8 disposal options are, as follows:

3.1 Disposal in Shallow Earthen Structures

Shallow earthen structures, commonly referred to as engineered trenches, are among the most commonly used forms of low-level waste disposal, especially in dry climates. Shallow earthen structures would be excavated to a depth of about 26 ft (8 m), with the length and width determined by site conditions and the annual volume of waste to be disposed of. Disposal in shallow earthen structures would consist of placing waste on a stable structural pad with barrier walls constructed of compacted clay. Clay would be used because it prevents the walls from collapsing or caving in, and it presents a relatively impermeable barrier to waste migration. The waste containers (i.e., drums) would be tightly stacked three pallets high in the bottom of the structure with forklifts. Any open space between containers would be filled with earth, sand, gravel, or other similar material as each layer of drums was placed. After the structure was filled, a 6 ft (2 m) thick cap composed of engineered fill dirt and clay would be placed on top and compacted. The cap would be mounded at least 3 ft (1 m) above the local grade and sloped to minimize the potential for water infiltration. Disposal would require about 42 acres (17 ha).

3.2 Disposal in Vaults

Concrete vaults for disposal would be divided into five sections, each section approximately 66 ft (20 m) long by 26 ft (8 m) wide and 13 ft (4 m) tall. As opposed to shallow earthen structures, the walls and floor of a vault would be constructed of reinforced concrete. A crane would be used to place the DU_3O_8 within each section. Once a vault was full, any open space between containers would be filled with earth, sand, gravel, or other similar material. A permanent roof slab of reinforced concrete that completely covers the vault would be installed after all five sections were filled. A cap of engineered fill dirt and clay would be placed on top of the concrete cover and compacted. The cap would be mounded above the local grade and sloped to minimize the potential for water infiltration. Disposal would require about 71 acres (28 ha).

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3.3 Disposal in a Mine

An underground mine disposal facility would be a repository for permanent deep geological disposal. A mined disposal facility could possibly use a previously existing mine, or be new one specially constructed for the sole purpose of waste disposal. For purposes of comparing alternatives, the conservative assumption of constructing a new costly mine was assessed for the PEIS. A mine disposal facility would consist of surface facilities that provide space for waste receiving and inspection (the waste-form facility), and shafts and ramps for access to and ventilation of the underground portion of the repository. The underground portion would consist of tunnels (called "drifts") for the transport and disposal of waste underground. The dimensions of the drifts would be similar to those described previously for the storage options, except that each drift would have a width of 21 ft (6.5 m). Waste containers would be placed in drifts and back-filled. Disposal would require about 228 acres (91 ha).

3.4 Disposal Option Costs

The LLNL estimated life-cycle disposal costs for the three disposal options just presented, in 1996 dollars, were as follows:

Engineered trench	$155.20 million
Concrete vault	$249.01 million
Mined cavity	$790.15 million

These costs include waste form preparation. ERI regards the mined cavity option costs as high because they are based on the sinking of a mine shaft with associated access drifts. The estimated disposal costs, particularly for a new "mine", are very dependent on the assumptions made regarding such key factors as soil characteristics, water infiltration rates, depth to underlying groundwater table, chemistry of different uranium compounds, and locations of future human receptors. These factors could vary widely depending on site-specific conditions. If an existing exhausted mine can be used the LLNL cost for the waste disposal portion of the DU_3O_8 mined cavity option might be reduced by as much as 50%, which could result in a total cost for this disposal option of about $430 million.

Table 3 presents the capital, operating, and regulatory costs on a per kgU basis for waste form preparation and waste disposal for each of the DU_3O_8 disposal options. It assumes that an existing exhausted mine can be used for the DU_3O_8 mined cavity option which would reduce disposal costs from $2.09 and $2.33 per kgU to $1.13 and $1.26 per kgU, in 1996 and 2002 dollars, respectively.

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TABLE 3 SUMMARY OF ESTIMATED CAPITAL, OPERATING, AND REGULATORY UNIT COSTS FOR DU3O8 DISPOSAL (DOLLARS PER kgU OF PRECURSOR DUF6)						
	Disposal Option (1996$)			Disposal Option (2002$)		
Cost Items	Engineered Trench	Concrete Vault	Mined Cavity	Engineered Trench	Concrete Vault	Mined Cavity
Waste Form Preparation						
Capital (a)	0.09	0.09	0.09	0.10	0.10	0.10
Operating & Maintenance	0.09	0.09	0.09	0.10	0.10	0.10
Regulatory & Compliance	0.01	0.01	0.01	0.01	0.01	0.01
Subtotal A	0.18	0.18	0.19	0.20	0.20	0.21
Waste Disposal						
Capital (b)	0.04	0.26	1.13	0.04	0.29	1.26
Emplacement, Closure, Surveillance & Maintenance	0.09	0.11	0.66	0.10	0.12	0.74
Regulatory & Compliance	0.11	0.11	0.11	0.12	0.12	0.12
Subtotal B	0.24	0.48	1.90	0.25	0.53	2.12
Preparation & Disposal (A+B)	0.42	0.66	2.09	0.45	0.73	2.33

(a) Technology development, balance of plant, and D & D.
(b) Facility engineering & construction, site preparation and restoration.

4. SUMMARY OF CONVERSION AND DISPOSAL COSTS

Table 4 presents the DUF_6 conversion and DU_3O_8 disposal costs already discussed on a dollar per kgU basis, in 2002 dollars. In addition it also includes the cost to DOE of

TABLE 4 SUMMARY OF TOTAL ESTIMATED CONVERSION AND DISPOSAL COSTS THAT MAY BE APPLICABLE TO LES (2002 DOLLARS PER kgU of DUF6)						
	Anhydrous HF Option			HF Neutralization Option		
Cost Items	Engineered Trench	Concrete Vault	Mined Cavity	Engineered Trench	Concrete Vault	Mined Cavity
DUF6 Conversion TO DU3O8	1.01	1.01	1.01	0.99	0.99	0.99
Waste Preparation & Disposal	0.45	0.73	1.26	0.45	0.73	1.26
DUF6 & DU3O8 Transportation	0.11	0.11	0.11	0.11	0.11	0.11
Total Cost	1.57	1.85	2.38	1.55	1.83	2.36

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truck transportation (including loading and unloading) of conforming DUF_6 cylinders to the conversion facility site and drummed DU_3O_8 to the disposal sites. It does not include storage costs since it may reasonably assumed that LES cylinders will be shipped straight to the conversion facility. If storage costs were to be included or demanded they might amount to about $0.58 per kgU, based on the storage costs given in Table 1.

The table indicates that the total costs for LES enrichment tails disposal in, in 2002 dollars, is likely to range from about $1.60 to $2.40 per kgU to be disposed. If the NRC mandates the use of an exhausted uranium mine for DU_3O_8 disposal, then the $2.40 cost is likely. If storage charges apply then the total upper bound cost may be about $3.00 per kgU as DUF_6.

It is of interest to note that USEC entered into an agreement with the DOE on June 30, 1998, entitled: "Memorandum of Agreement Between the United States Department of Energy and the United States Enrichment Corporation Relating to Depleted Uranium". According to the USEC Privatization S1 form, Exhibit 10.26, filed November 12, 1998 with the Securities and Exchange Commission, USEC agreed to pay the DOE $50,021,940 immediately prior to privatization for a commitment by the DOE "for storage, management and disposition of the transferred depleted uranium..." generated by USEC during the FY 1999 to FY 2004 time period. Under the terms of the agreement, the DOE also committed to perform "...research and development into the beneficial use of depleted uranium, and related activities and support services for depleted uranium-related activities". The agreement specifies that USEC will transfer title to and possession of 2,026 48-G cylinders containing approximately 16,673,980 kgU. Under this agreement, DOE effectively committed to dispose of USEC's DUF_6 at an average rate of approximately 3.0 million kgU per year between the middle of calendar 1998 and the end of 2003 at a cost of exactly $3.00 per kgU, in 1998 dollars.

On August 29, 2002, the DOE awarded a contract to Uranium Disposition Services to design and construct DUF_6 to DU_3O_8 conversion facilities at Portsmouth and Paducah, operate these facilities for the first five years, and transport DUF_6 in cylinders to the two facilities and drums to the DOE's DU_3O_8 disposal site, for a cost-reimbursement fee of $558 million. At the present time the DOE DU_3O_8 disposal site is understood to be the existing Nevada Test Site (NTS) near Las Vegas. Since the new conversion facilities will be the same total annual capacity as the model plant used in the LLNL cost study., the facilities' capital costs will be similar, about $127 million based on the data given in Table 1 after subtraction of the operating and maintenance costs. If the DOE storage and transportation costs ($197 and $191 million, respectively) given in Table 1 are added to the capital cost, and the operating and maintenance cost is adjusted to $50 million to account for the amount of tails (95,000 MTU) processed in the first five years, a total cost of $564 million can be obtained. The DOE costs of storage and transportation are expected to be substantial because of the large number of old and contaminated cylinders located at its three enrichment sites, and because on increasingly stringent regulations.

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While the foregoing calculation seem to be in very good agreement with the UDS contract price, this could be partly coincidental since the actual breakdown of the UDS contract prices have not so far as ERI is aware been made public yet. In addition, the Table 1 costs are in 1996 dollars whereas the UDS contract was executed in 2002. Again, it is assumed in this calculation that the DOE does not apply NTS charges to the UDS cost. It is believed that NTS storage costs, if applicable, would be less than $1.00 per kgU. It is important to note that the UDS contract price will provide for the necessary conversion facilities and process about one-fifth of the current accumulation of tails. It can be estimated that total cost of processing and disposing of all of the 476,000 MTU of DUF_6 might amount to about $760 million, which corresponds to about $1.60 per kgU. If NTS charges are assumed then the total cost of tails conversion and disposal would be about $2.60 per kgU of DUF_6.

5. CONCLUSIONS

The data in Table 4 suggest that LES tails conversion and disposal in the U.S. may cost in the range of $1.60 to $2.40 per kgU. This level of cost is partly substantiated by the UDS contract cost and DOE-USEC tails disposal agreement. While the subject has not been addressed in this report, the use of processing or enrichment facilities in Europe or Russia would add an additional cost of at least $1.00 per kgU because of transport costs, assuming the necessary export permits could be obtained from the NRC.

It is not clear whether the DOE-USEC unit cost of $3.00 was determined as a result of the LLNL study that was published in 1997 or whether it was driven by the funding needs of the DOE at the time of privatization. At any rate it is in general accord with the DUF_6 disposition costs just estimated based on the LLNL cost estimation study.

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