

## CALCULATION WORKSHEET

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1 OF 9

PROJECT

United States Enrichment Corporation Gaseous  
Diffusion Plants

CALCULATED BY

TC Johnson

DATE

2/1/07

DOCKET NUMBER

070-7001  
070-7002

SUBJECT

Decommissioning Funding Plan Depleted  
Uranium Disposition Unit Cost Estimate

CHECKED BY

T. FREDRICKS

DATE

2/2/07

Purpose:

The purpose of this calculation is to verify the United States Enrichment Corporation's (USEC's) unit cost basis for depleted uranium (DU) disposition from the Portsmouth and Paducah Gaseous Diffusion Plants (GDPs).

References:

1. Letter from S. Toelle(USEC) to J. Strosnider (NRC), "Transmittal of Proposed Changes to the Decommissioning Funding Program Description and Depleted Uranium Management Plan for Calendar Year 2007," November 17, 2006.
2. Letter from L. Brown (U.S. Department of Energy (DOE)) to P. Sewell (USEC), "Conversion and Disposal of Depleted Uranium Hexafluoride (DUF<sub>6</sub>) Generated by USEC at the American Centrifuge Plant in Piketon, Ohio," February 10, 2006.
3. M. Lindeburg; "Mechanical Engineering Review Manual," Professional Publications, San Carlos, California, 1984.
4. Bureau of Economic Analyses, National Income and Product Accounts Tables, Table 1.1.9, Implicit Price Deflators for Gross National Product, December 21, 2006.
5. Council of Economic Advisors, "Joint Press Release of the Council of Economic Advisors, the Department of Treasury, and the Office of Management and Budget, Updated Economic Forecast, June 8, 2006.

Summary:

The unit disposition costs for depleted uranium generated at the Portsmouth and Paducah GDPs are as follows:

Portsmouth GDP: \$4.73/kg DU  
Paducah GDP: \$4.25/kg DU

The unit costs including a 25 percent contingency factor are as follows:

Portsmouth GDP: \$5.91/kg DU  
Paducah GDP: \$5.31/kg DU

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Calculation:

Reference 1 provides the results of USEC calculations of DU disposition costs for DU generated by the Portsmouth and Paducah GDPs. These calculations are based on the approach developed by a DOE contractor, LMI, and provided to USEC in Reference 2. This approach is based on a requirement in the USEC Privatization Act (Act) that requires DOE to accept for disposal DU generated by uranium enrichment facilities licensed by NRC, at the request of the generator, if the depleted uranium is low-level radioactive waste. Under the Act, the generator is required to pay the DOE costs of disposition including a pro rata share of construction costs.

For the Portsmouth GDP, USEC has 360 metric tons (MT) of DU on site. It is assumed that this material would be deconverted to a uranium oxide at the deconversion facility being built at the Portsmouth GDP to process the inventory of DU from previous DOE operations. This amount of DU is equivalent to

$$\frac{360 \text{ MT DU}}{0.676 \text{ MT DU}} = 533 \text{ MT DUF}_6$$

USEC assumed that this DU would become part of the DU to be deconverted and disposed of with the 265,000 MT DUF<sub>6</sub> to be generated by USEC's planned American Centrifuge Plant to be also located at the Portsmouth GDP (Reference 1). To compute the pro rata share of the deconversion plant construction costs allocated to USEC, the approach used in the LMI report in Reference 2 is used. From Reference 2, the total estimated construction costs of the Portsmouth deconversion plant are \$134,000,000 in 2004 dollars. This amount includes a 20 percent contingency factor of \$22,300,000, which is being removed at this time (a 25 percent contingency factor will be applied later to the total costs). The construction costs in 2004 dollars are, therefore,

$$\$134,000,000 - \$22,300,000 = \$112,000,000$$

The total amount of DU to be processed at the Portsmouth deconversion plant includes 533 MT DUF<sub>6</sub> from the Portsmouth GDP, 265,000 MT DUF<sub>6</sub> from the USEC American Centrifuge Plant over its planned lifetime, and 246,000 MT DUF<sub>6</sub> from previous DOE operations. Including the American Centrifuge Plant generation increases the USEC pro rata cost and,

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therefore, the overall DU disposition cost to USEC. The total amount of  $\text{DUF}_6$  to be processed is

$$533 \text{ MT DUF}_6 + 265,000 \text{ MT DUF}_6 + 246,000 \text{ MT DUF}_6 = 512,000 \text{ MT DUF}_6 \quad \checkmark$$

This total amount would be processed at the Portsmouth deconversion plant at a capacity of 13,500 MT  $\text{DUF}_6$  per year. Therefore, it would take

$$\frac{512,000 \text{ MT DUF}_6}{13,500 \text{ MT DUF}_6} = 37.9 \text{ years (38 years)}$$

to process the entire amount of DU.

The pro rata investment cost for USEC in 2004 dollars would be

$$\$112,000,000 \times \frac{266,000 \text{ MT DUF}_6}{512,000 \text{ MT DUF}_6} =$$

$$\$112,000,000 \times (0.52) = \$58,200,000 \quad \checkmark$$

To annualize this amount over the processing lifetime of the Portsmouth deconversion plant, we use from Table 2.1 of Reference 3 the formula

$$A/P = \frac{i \times (1+i)^n}{(1+i)^n - 1} \quad \checkmark$$

where A is the annualized cost, P is the present worth amount, i is the discount rate, and n is the lifetime of the asset. In Reference 2, DOE assumed a discount rate of 3.5 percent. The annualized pro rata share of USEC's cost in 2004 dollars would be

$$A = \$58,200,000 \times \frac{(0.035) \times (1 + 0.035)^{38}}{(1 + 0.035)^{38} - 1}$$

$$A = \$58,200,000 \times \frac{(0.035) \times (1.035)^{38}}{(1.035)^{38} - 1}$$

$$A = \$58,200,000 \times \frac{(0.035) \times (3.70)}{3.70 - 1}$$

$$A = \$58,200,000 \times (0.048) = \$2,790,000$$

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Since the Portsmouth deconversion plant would be processing

$$(0.52) \times 13,500,000 \text{ kg DUF}_6 / \text{year} =$$
$$10^6 \times 7.02 \text{ kg DUF}_6 / \text{year}$$

of USEC material, the annualized cost per kg of DUF<sub>6</sub> in 2004 dollars is

$$\frac{\$2,790,000}{7,020,000 \text{ kg DUF}_6} = \$0.40 / \text{kg DUF}_6$$

To convert 2004 dollars to 2007 dollars, the gross national product (GNP) implicit price deflators (IPDs) are used from Reference 4. The most recent GNP implicit price deflator data covers up to 2005. To compute the implicit price deflator for 2005, we use information from Table 1.1.9 of Reference 4 as follows:

$$\frac{\text{Year 2005 IPD}}{\text{Year 2004 IPD}} = \frac{112.737}{109.426} = 1.03$$

To inflation for years 2006 and 2007, Council of Economic Advisors guidance (Reference 5) is used for the estimated GDP inflation indices.

$$\begin{aligned} \text{Year 2006 GDP Inflation Index} &= 2.9 \text{ percent} \\ \text{Year 2007 GDP Inflation Index} &= 2.3 \text{ percent} \end{aligned}$$

Therefore, to convert 2004 dollars to 2007 dollars, the cost is 2004 dollars is multiplied by the following factor:

$$1.03 \times 1.029 \times 1.023 = 1.08$$

Therefore, the USEC pro rata share of the annualized construction cost is

$$\$0.40 / \text{kg DUF}_6 \times 1.08 = \$0.43 / \text{kg DUF}_6$$

In Reference 2, the annual Portsmouth deconversion plant operating costs are \$1.76 / kg DUF<sub>6</sub> in 2004 dollars. This value includes a 10 percent contingency of \$0.16 / kg DUF<sub>6</sub>. Therefore, the annual operating cost in 2004 dollars without the contingency factor is

$$\$1.76 / \text{kg DUF}_6 - \$0.16 / \text{kg DUF}_6 = \$1.60 / \text{kg DUF}_6$$

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In 2007 dollars, the annual operating cost is ✓

$$\$1.60 / \text{kg DUF}_6 \times 1.08 = \$1.73 / \text{kg DUF}_6$$

Plant recapitalization costs in Reference 2 are \$0.33 / kg DUF<sub>6</sub> in 2004 dollars. This cost in 2007 dollars is

$$\$0.33 / \text{kg DUF}_6 \times 1.08 = \$0.36 / \text{kg DUF}_6 \quad \checkmark$$

DU disposal costs in Reference 2 in 2004 dollars is given as \$0.37 / kg DUF<sub>6</sub>. In 2007 dollars, this cost is

$$\$0.37 / \text{kg DUF}_6 \times 1.08 = \$0.40 / \text{kg DUF}_6 \quad \checkmark$$

Surveillance and maintenance costs for the DU cylinders in Reference 2 are given as \$0.003 / kg DUF<sub>6</sub> in 2004 dollars. Converting this cost to 2007 dollars, we have

$$\$0.003 / \text{kg DUF}_6 \times 1.08 = \$0.003 / \text{kg DUF}_6 \quad \checkmark$$

In Reference 2, the decommissioning costs for the Portsmouth deconversion plant are given as \$47,600,000 in 2004 dollars. The USEC share of this cost would be

$$\$47,600,000 \times 0.52 = \$24,800,000 \quad \checkmark$$

The annualized cost of the USEC pro rata share would be

$$\$24,800,000 \times 0.048 = \$1,190,000 \quad \checkmark \text{ or}$$

$$\frac{\$1,190,000}{0.52 \times 13,500,000 \text{ kg DUF}_6/\text{year}} = \$0.17 / \text{kg DUF}_6 \quad \checkmark$$

Reference 2 provides a Federal administrative charge for operating the Portsmouth deconversion plant of \$0.09 / kg DUF<sub>6</sub> in 2004 dollars. This cost in 2007 dollars would be

$$\$0.09 / \text{kg DUF}_6 \times 1.08 = \$0.10 / \text{kg DUF}_6 \quad \checkmark$$

The total cost in 2007 dollars for the disposition of the DU from USEC at the Portsmouth deconversion plant would, therefore, be:

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\$ / kg DUF<sub>6</sub>

Construction cost	0.43
Operating cost	1.73
Plant recapitalization cost	0.36
DU disposal cost	0.40
Surveillance/maintenance cost	0.003
Decommissioning cost	0.18
Federal administrative cost	0.10

Total 3.20 ✓

Converting from kg DUF<sub>6</sub> to kg DU, ✓

$$\frac{\$3.20 / \text{kg DUF}_6}{0.676 \text{ kg DU} / \text{kg DUF}_6} = \$4.73 / \text{kg DU}$$

Adding a 25 percent contingency factor to this amount gives

$$\$4.73 / \text{kg DU} \times 1.25 = \$5.91 \text{ kg DU} \quad \checkmark$$

For the Paducah GDP, USEC estimates that, in addition to the DU it now possesses, it will have a total of 50,300 MT DUF<sub>6</sub> through 2008 (Reference 1). This value is conservative based on its DU management plan, which projects ✓

$$\frac{31,900 \text{ MT DU}}{0.676 \text{ MT DU} / \text{MT DUF}_6} = 47,200 \text{ MT DUF}_6$$

to be generated through 2008.

This amount is assumed to be combined with the 421,000 MT DUF<sub>6</sub> from past DOE operations that will need to be processed by the Paducah deconversion plant. The Paducah deconversion plant has a capacity of 18,000 MT DUF<sub>6</sub> per year.

Therefore, the total amount of DU to be processed at the Paducah deconversion plant would be

$$421,000 \text{ MT DUF}_6 + 50,300 \text{ MT DUF}_6 = 471,000 \text{ MT DUF}_6 \quad \checkmark$$

The fractional USEC share of this amount is

$$\frac{50,300}{471,000} = 0.107 \quad \checkmark$$

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The total operating period of the Paducah deconversion plant would be

$$\frac{471,000 \text{ MT DUF}_6}{18,000 \text{ MT DUF}_6 / \text{year}} = 26.2 \text{ years or } 26 \text{ years}$$

The total construction cost of the Paducah deconversion plant is given in Reference 2 as \$152,000,000 in 2004 dollars. This amount includes a 20 percent contingency factor of \$25,300,000 (Reference 1). The total construction cost less the contingency is

$$\$152,000,000 - \$25,300,000 = \$127,000,000$$

The USEC pro rata share of the construction costs would be

$$\$127,000,000 \times \frac{50,300 \text{ MT DUF}_6}{472,000 \text{ MT DUF}_6} = \$13,500,000$$

The annualized construction cost would be

$$A = \$13,500,000 \times \frac{i \times (1+i)^n}{(1+i)^n - 1}$$

$$A = \$13,500,000 \times \frac{(0.035) \times (1+0.035)^{26}}{(1+0.035)^{26} - 1}$$

$$A = \$13,500,000 \times \frac{(0.035) \times (2.45)}{1.45}$$

$$A = \$13,500,000 \times 0.059 = \$796,000$$

The annualized cost per kg DUF<sub>6</sub> is

$$\frac{\$796,000}{(0.107) \times (18,000,000 \text{ kg DUF}_6)} =$$
$$\$0.413 / \text{kg DUF}_6$$

Converting to 2007 dollars, we have

$$\$0.413 / \text{kg DUF}_6 \times 1.08 = \$0.446 / \text{kg DUF}_6 \text{ or}$$
$$\$0.45 / \text{kg DUF}_6$$

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The annual operating costs for the Paducah deconversion plant in Reference 2 are \$1.45 / kg DUF<sub>6</sub> in 2004 dollars, which includes a 10 percent contingency cost of \$0.13 / kg DUF<sub>6</sub>. Subtracting out the contingency, we have

$$\text{\$1.45 / kg DUF}_6 - \text{\$0.13 / kg DUF}_6 =$$

$$\text{\$1.32 / kg DUF}_6 \checkmark$$

Converting to 2007 dollars

$$\text{\$1.32 / kg DUF}_6 \times 1.08 = \text{\$1.43 / kg DUF}_6 \checkmark$$

Plant recapitalization costs are given in Reference 2 as \$0.28 / kg DUF<sub>6</sub> in 2004 dollars. Converting to 2007 dollars, we have

$$\text{\$0.28 / kg DUF}_6 \times 1.08 = \text{\$0.30 / kg DUF}_6 \checkmark$$

Product disposal costs are given in Reference 2 to be \$0.37 / kg DUF<sub>6</sub> in 2004 dollars. Converting this to 2007 dollars, we have

$$\text{\$0.37 / kg DUF}_6 \times 1.08 = \text{\$0.40 / kg DUF}_6 \checkmark$$

Surveillance and maintenance costs for DU cylinders is provided in Reference 2 as \$0.003 / kg DUF<sub>6</sub> in 2004 dollars. Converting to 2007 dollars, we get

$$\text{\$0.003 / kg DUF}_6 \times 1.08 = \text{\$0.003 / kg DUF}_6 \checkmark$$

Paducah deconversion plant decommissioning costs are estimated to be \$57,200,000 from Reference 2 in 2004 dollars. The USEC pro rata share would be

$$\text{\$57,200,000} \times 0.107 = \text{\$6,120,000} \checkmark$$

The annualized USEC pro rata decommissioning cost would be

$$\text{\$6,120,000} \times 0.059 = \text{\$361,000} \checkmark$$

The annualized cost to USEC in kg DUF<sub>6</sub> would be

$$\frac{\text{\$361,000}}{0.107 \times 18,000,000 \text{ MT DUF}_6 / \text{year}} =$$
$$\text{\$0.187 / kg DUF}_6 \checkmark$$



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Converting to 2007 dollars

$$\$0.187 / \text{kg DUF}_6 \times 1.08 = \$0.20 / \text{kg DUF}_6$$

The Federal administrative charge in Reference 2 is \$0.08 / kg DUF<sub>6</sub> in 2004 dollars. Converting to 2007 dollars, we have

$$\$0.08 / \text{kg DUF}_6 \times 1.08 = \$0.09 / \text{kg DUF}_6$$

The total costs to USEC for DU dispositioning using the Paducah deconversion plant would be

	<u>\$ / kg DUF<sub>6</sub></u>
Construction costs	0.45
Operating costs	1.43
Plant recapitalization costs	0.30
DU disposal costs	0.40
Surveillance/maintenance costs	0.003
Decommissioning costs	0.20
Federal administrative costs	0.09
Total	2.87

Converting this amount to kg DU

$$\frac{\$2.87 / \text{kg DUF}_6}{0.676 \text{ kg DU} / \text{kg DUF}_6} = \$4.25 / \text{kg DU}$$

Applying a 25 percent contingency factor to this amount, we have

$$\$4.25 / \text{kg DU} \times 1.25 = \$5.31 / \text{kg DU}$$