CALCULATION WORKSHEET

PROJECT	CALCULATED BY	DATE
United States Enrichment Corporation American Centrifuge Plant	TC Johnson	2/22/07
DOCKET NUMBER: 070-7004 / SUBJECT: Decommissioning Funding Plan Depleted Uranium Disposition Unit Cost Estimate	CHECKED BY: TFREDRICKS	DATE: 4/4/07

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 its proposed American Centrifuge Plant (ACP) and to determine how the unit cost basis changes if the ACP capacity is 3.8 million, 7 million or 7.6 million Separative Work Units (SWU).

References:

1. Letter from S. Toelle(USEC) to J. Strosnider (NRC), "Submittal of Planned Changes to the License Application and Supporting Documents for the American Centrifuge Plant," June 30, 2006.

2. Letter from L. Brown (U.S. Department of Energy (DOE)) to P. Sewell (USEC), "Conversion and Disposal of Depleted Uranium Hexafluoride (DUF_6) Generated by USEC at the American Centrifuge Plant in Piketon, Ohio," February 10, 2006.

3. USEC Press Release, Business Wire, "USEC Updates Cost Estimate and Schedule for American Centrifuge Plant," February 12, 2007.

4. USEC "Environmental Report for the American Centrifuge Plant in Piketon, Ohio," Section 4.13.3.4, Revision 8, July 2006.

5. M. Lindeburg; "Mechanical Engineering Review Manual," Professional Publications, San Carlos, California, 1984.

6. Bureau of Economic Analyses, National Income and Product Accounts Tables, Table 1.1.9, Implicit Price Deflators for Gross National Product, June 29, 2006.

7. 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 USEC ACP and processed at the Portsmouth deconversion facility are as follows:

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ACP Capacity, Million SWU/year	Unit DU Disposition Cost, $/kg U	Unit DU Disposition with Contingency, $/kg U
3.5	4.64	5.80
3.8	4.62	5.78
7.0	4.51	5.64
7.6	4.50	5.62

Calculation:

Reference 1 provides the results of USEC calculations of DU disposition costs for DU generated by the ACP for a 3.5 million SWU plant. 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.

On February 12, 2007, USEC announced that, because its centrifuges are more efficient than previously thought, the ACP would be capable of producing 3.8 million SWU per year (Reference 3). USEC separately evaluated the environmental impacts for a 7 million SWU facility in the event that USEC decides at a future time to double the plant's capacity. Using the more efficient centrifuges, doubling the plant's capacity could produce an overall output of 7.6 million SWU per year. these new outputs would have the effect of increasing the plant's overall throughput and the amount of DU generated. Greater DU generation would increase USEC's pro rata share of the DOE costs and change the unit DU disposition costs calculated using the DOE cost estimating approach.

USEC estimated that 265,000 MT DUF_6 would be generated by USEC's planned American Centrifuge Plant operating at a 3.5 million SWU per year capacity (Reference 1). It is estimated that for a 3.8 million SWU plant, a total of

$$\frac{3{,}800{,}000 \text{ SWU}}{3{,}500{,}000 \text{ SWU}} \times 265{,}000 \text{ MT } DUF_6 =$$

288,000 MT DUF_6.

would be generated.

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For a 7 million SWU plant, USEC estimated that 513,000 MT DUF_6 would be produced (Reference 4).

Assuming a 7.6 million SWU plant would be built, USEC is assumed to produce

$$\frac{7{,}600{,}000 \text{ SWU}}{7{,}000{,}000 \text{ SWU}} \times 513{,}000 \text{ MT } DUF_6 =$$

557,000 MT DUF_6.

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 the amount estimated from the USEC American Centrifuge Plant over its planned lifetime and 246,000 MT DUF_6 from previous DOE operations. The total amount of DUF_6 to be processed for the ACP operating at 3.5 million SWU per year is

$$265{,}000 \text{ MT } DUF_6 + 246{,}000 \text{ MT } DUF_6 =$$

511,000 MT DUF_6

For 3.8 million SWU per year:

$$288{,}000 \text{ MT } DUF_6 + 246{,}000 \text{ MT } DUF_6 =$$

534,000 MT DUF_6.

For 7.0 million SWU per year:

$$513{,}000 \text{ MT } DUF_6 + 246{,}000 \text{ MT } DUF_6 =$$

759,000 MT DUF_6.

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For 7.6 million SWU per year:

$$557{,}000 \text{ MT } DUF_6 + 246{,}000 \text{ MT } DUF_6 =$$

$$803{,}000 \text{ MT } DUF_6.$$

These total amounts would be processed at the Portsmouth deconversion plant at a capacity of 13,500 MT DUF_6 per year. Therefore, it would take

$$\frac{511{,}000 \text{ MT } DUF_6}{13{,}500 \text{ MT } DUF_6} = 37.8 \text{ years (38 years)}$$

to process the entire amount of DU for the 3.5 million SWU per year plant;

$$\frac{534{,}000 \text{ MT } DUF_6}{13{,}500 \text{ MT } DUF_6} = 39.6 \text{ years (40 years)}$$

for a 3.8 million SWU per year plant;

$$\frac{759{,}000 \text{ MT } DUF_6}{13{,}500 \text{ MT } DUF_6} = 56.2 \text{ years (56 years)}$$

for a 7.0 million SWU per year plant; and

$$\frac{803{,}000 \text{ MT } DUF_6}{13{,}500 \text{ MT } DUF_6} = 59.5 \text{ years (60 years)}$$

for a 7.6 million SWU per year plant.

The pro rata investment cost for USEC in 2004 dollars for the 3.5 million SWU per plant would be

$$\$112{,}000{,}000 \times \frac{265{,}000 \text{ MT } DUF_6}{511{,}000 \text{ MT } DUF_6}$$

$$\$112{,}000{,}000 \times (0.519) = \$58{,}100{,}000$$

For the 3.8 million SWU per year plant, the pro rata investment cost would be

$$\$112{,}000{,}000 \times \frac{288{,}000 \text{ MT } DUF_6}{534{,}000 \text{ MT } DUF_6} =$$

$$\$112{,}000{,}000 \times (0.539) = \$60{,}400{,}000$$

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The pro rata investment cost for USEC in 2004 dollars for the 7.0 million SWU per plant would be

$$\$112{,}000{,}000 \times \frac{513{,}000 \text{ MT } DUF_6}{759{,}000 \text{ MT } DUF_6} =$$

$$\$112{,}000{,}000 \times (0.676) = \$75{,}700{,}000$$

The pro rata investment cost for USEC in 2004 dollars for the 7.6 million SWU per plant would be

$$\$112{,}000{,}000 \times \frac{557{,}000 \text{ MT } DUF_6}{803{,}000 \text{ MT } DUF_6} =$$

$$\$112{,}000{,}000 \times (0.694) = \$77{,}700{,}000$$

To annualize these amounts over the processing lifetime of the Portsmouth deconversion plant, we use from Table 2.1 of Reference 5 the formula

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

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

$$A = \$58{,}100{,}000 \times \frac{(0.035) \times (1+0.035)^{38}}{(1+0.035)^{38} - 1}$$

$$A = \$58{,}100{,}000 \times \frac{(0.035) \times (1.035)^{38}}{(1.035)^{38} - 1}$$

$$A = \$58{,}100{,}000 \times \frac{(0.035) \times (3.70)}{3.70 - 1}$$

$$A = \$58{,}100{,}000 \times (0.048) = \$2{,}790{,}000$$

With an asset lifetime of 40 years for a 3.8 million SWU per year plant:

$$A = \$60{,}400{,}000 \times \frac{(0.035) \times (1+0.035)^{40}}{(1+0.035)^{40} - 1}$$

$$A = \$60{,}400{,}000 \times \frac{(0.035) \times (1.035)^{40}}{(1.035)^{40} - 1}$$

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$$A = \$60{,}400{,}000 \times \frac{(0.035) \times (3.96)}{3.96 - 1}$$

$$A = \$60{,}400{,}000 \times (0.0468) = \$2{,}830{,}000$$

For an asset lifetime of 56 years for a 7.0 million SWU per year plant:

$$A = \$75{,}700{,}000 \times \frac{(0.035) \times (1 + 0.035)^{56}}{(1 + 0.035)^{56} - 1}$$

$$A = \$75{,}700{,}000 \times \frac{(0.035) \times (1.035)^{56}}{(1.035)^{56} - 1}$$

$$A = \$75{,}700{,}000 \times \frac{(0.035) \times (6.87)}{6.87 - 1}$$

$$A = \$75{,}700{,}000 \times (0.041) = \$3{,}100{,}000$$

For an asset lifetime of 60 years for a 7.6 million SWU per year plant:

$$A = \$77{,}700{,}000 \times \frac{(0.035) \times (1 + 0.035)^{60}}{(1 + 0.035)^{60} - 1}$$

$$A = \$77{,}700{,}000 \times \frac{(0.035) \times (1.035)^{60}}{(1.035)^{60} - 1}$$

$$A = \$77{,}700{,}000 \times \frac{(0.035) \times (7.88)}{7.88 - 1}$$

$$A = \$77{,}700{,}000 \times (0.0401) = \$3{,}120{,}000$$

For a 3.5 million SWU per year plant, the Portsmouth deconversion plant would be processing

$$\frac{265{,}000 \text{ MT } UF_6}{511{,}000 \text{ MT } UF_6} \times 13{,}500{,}000 \text{ kg } UF_6 \text{ / year} =$$

$$7{,}000{,}000 \text{ kg } UF_6 \text{ / year}$$

of ACP material, the annualized cost per kg of UF_6 in 2004 dollars is

$$\frac{\$2{,}790{,}000}{7{,}000{,}000 \text{ kg } UF_6} = \$0.40 \text{ / kg } UF_6$$

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For a 3.8 million SWU per year plant, the Portsmouth deconversion plant would be processing

$$\frac{288{,}000 \text{ MT } DUF_6}{534{,}000 \text{ MT } DUF_6} \times 13{,}500{,}000 \text{ kg } DUF_6 \text{ / year} =$$

7,280,000 kg DUF_6 / year

of ACP material, the annualized cost per kg of DUF_6 in 2004 dollars is

$$\frac{\$2{,}830{,}000}{7{,}280{,}000 \text{ kg } DUF_6} = \$0.39 \text{ / kg } DUF_6$$

For a 7.0 million SWU per year plant, the Portsmouth deconversion plant would be processing

$$\frac{513{,}000 \text{ MT } DUF_6}{759{,}000 \text{ MT } DUF_6} \times 13{,}500{,}000 \text{ kg } DUF_6 \text{ / year} =$$

9,120,000 kg DUF_6 / year

of ACP material, the annualized cost per kg of DUF_6 in 2004 dollars is

$$\frac{\$3{,}100{,}000}{9{,}120{,}000 \text{ kg } DUF_6} = \$0.34 \text{ / kg } DUF_6$$

For a 7.6 million SWU per year plant, the Portsmouth deconversion plant would be processing

$$\frac{557{,}000 \text{ MT } DUF_6}{803{,}000 \text{ MT } DUF_6} \times 13{,}500{,}000 \text{ kg } DUF_6 \text{ / year} =$$

9,360,000 kg DUF_6 / year

of ACP material, the annualized cost per kg of DUF_6 in 2004 dollars is

$$\frac{\$3{,}120{,}000}{9{,}360{,}000 \text{ kg } DUF_6} = \$0.33 \text{ / kg } DUF_6$$

To convert 2004 dollars to 2006 dollars, the gross national product (GNP) implicit price deflators (IPDs) are used from Reference 6. 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 6 as follows:

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

For inflation for year 2006, Council of Economic Advisors guidance (Reference 7) is used for the estimated GDP inflation index.

Year 2006 GDP Inflation Index = 2.9 percent

Therefore, to convert 2004 dollars to 2006 dollars, the cost is 2004 dollars is multiplied by the following factor:

1.03 x 1.029 = 1.06

Therefore, the USEC pro rata share of the annualized construction cost for the 3.5 million SWU per year plant is

$0.40 / kg DUF_6 x 1.06 = $0.42 / kg DUF_6

The USEC pro rata share of the annualized construction cost for the 3.8 million SWU per year plant is:

$0.39 / kg DUF_6 x 1.06 = $0.41 / kg DUF_6

The USEC pro rata share of the annualized construction cost for the 7.0 million SWU per year plant is:

$0.34 / kg DUF_6 x 1.06 = $0.36 / kg DUF_6

The USEC pro rata share of the annualized construction cost for the 7.6 million SWU per year plant is:

$0.33 / kg DUF_6 x 1.06 = $0.35 / kg DUF_6

In Reference 2, the annual Portsmouth deconversion plant operating costs are $1.76 / kg DUF_6 in 2004 dollars. This value includes a 10 percent contingency of $0.16 / kg DUF_6. Therefore, the annual operating cost in 2004 dollars without the contingency factor is

$1.76 / kg DUF_6 - $0.16 / kg DUF_6 = $1.60 / kg DUF_6

In 2006 dollars, the annual operating cost is

$1.60 / kg DUF_6 x 1.06 = $1.70 / kg DUF_6

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Plant recapitalization costs in Reference 2 are \$0.33 / kg DUF_6 in 2004 dollars. This cost is 2006 dollars is

\$0.33 / kg DUF_6 x 1.06 = \$0.35 / kg DUF_6

DU disposal costs in Reference 2 in 2004 dollars is given as \$0.37 / kg DUF_6 . In 2006 dollars, this cost is

\$0.37 / kg DUF_6 x 1.06 = \$0.39 / kg DUF_6

Surveillance and maintenance costs for the DU cylinders in Reference 2 are given as \$0.003 / kg DUF_6 in 2004 dollars. Converting this cost to 2006 dollars, we have

\$0.003 / kg DUF_6 x 1.06 = \$0.003 / kg DUF_6

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 x 0.519 = \$24,700,000

The annualized cost of the USEC pro rata share for a 3.5 million SWU per year plant would be

\$24,700,000 x 0.048 = \$1,190,000 or

$$\frac{\$1,190,000}{0.519 \times 13,500,000 \text{ kg } DUF_6/\text{year}} = \$0.17 / \text{kg } DUF_6$$

In 2006 dollars the cost would be

\$0.17 / kg DUF_6 x 1.06 = \$0.18 / kg DUF_6

The annualized cost of the USEC pro rata share for a 3.8 million SWU per year plant would be

\$25,700,000 x 0.0468 = \$1,200,000 or

$$\frac{\$1,200,000}{0.539 \times 13,500,000 \text{ kg } DUF_6/\text{year}} = \$0.16 / \text{kg } DUF_6$$

In 2006 dollars the cost would be

\$0.16 / kg DUF_6 x 1.06 = \$0.17 / kg DUF_6

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The annualized cost of the USEC pro rata share for a 7.0 million SWU per year plant would be

$$\$32{,}200{,}000 \times 0.041 = \$1{,}320{,}000 \text{ or}$$

$$\frac{\$1{,}320{,}000}{0.676 \times 13{,}500{,}000 \text{ kg } DUF_6\text{/year}} = \$0.14 / \text{kg } DUF_6$$

In 2006 dollars the cost would be

$$\$0.14 / \text{kg } DUF_6 \times 1.06 = \$0.15 / \text{kg } DUF_6$$

The annualized cost of the USEC pro rata share for a 7.6 million SWU per year plant would be

$$\$33{,}000{,}000 \times 0.0401 = \$1{,}320{,}000 \text{ or}$$

$$\frac{\$1{,}320{,}000}{0.694 \times 13{,}500{,}000 \text{ kg } DUF_6\text{/year}} = \$0.14 / \text{kg } DUF_6$$

In 2006 dollars the cost would be

$$\$0.14 / \text{kg } DUF_6 \times 1.06 = \$0.15 / \text{kg } DUF_6$$

Reference 2 provides a Federal administrative charge for operating the Portsmouth deconversion plant of \$0.09 / kg DUF_6 in 2004 dollars. This cost in 2006 dollars would be

$$\$0.09 / \text{kg } DUF_6 \times 1.06 = \$0.10 / \text{kg } DUF_6$$

The total cost in 2006 dollars for the disposition of the DU from USEC at the Portsmouth deconversion plant for a 3.5 million SWU per year plant would, therefore, be:

	\$ / kg DUF_6
Construction cost	0.42
Operating cost	1.70
Plant recapitalization cost	0.35
DU disposal cost	0.39
Surveillance/maintenance cost	0.003
Decommissioning cost	0.18
Federal administrative cost	0.10
Total	3.14

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Converting from kg DUF_6 to kg DU,

$$\frac{\$3.14 \text{ / kg } DUF_6}{0.676 \text{ kg DU / kg } DUF_6} = \$4.64 \text{ / kg DU}$$

Adding a 25 percent contingency factor to this amount gives

$$\$4.64 \text{ / kg DU} \times 1.25 = \$5.80 \text{ kg DU}$$

The total cost in 2006 dollars for the disposition of the DU from USEC at the Portsmouth deconversion plant for a 3.8 million SWU per year plant would be:

	$ / kg DUF_6
Construction cost	0.41
Operating cost	1.70
Plant recapitalization cost	0.35
DU disposal cost	0.39
Surveillance/maintenance cost	0.003
Decommissioning cost	0.17
Federal administrative cost	0.10
Total	3.12

Converting from kg DUF_6 to kg DU,

$$\frac{\$3.12 \text{ / kg } DUF_6}{0.676 \text{ kg DU / kg } DUF_6} = \$4.62 \text{ / kg DU}$$

Adding a 25 percent contingency factor to this amount gives

$$\$4.62 \text{ / kg DU} \times 1.25 = \$5.78 \text{ kg DU}$$

The total cost in 2006 dollars for the disposition of the DU from USEC at the Portsmouth deconversion plant for a 7.0 million SWU per year plant would be:

	$ / kg DUF_6
Construction cost	0.36
Operating cost	1.70
Plant recapitalization cost	0.35
DU disposal cost	0.39
Surveillance/maintenance cost	0.003
Decommissioning cost	0.15
Federal administrative cost	0.10
Total	3.05

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Converting from kg DUF_6 to kg DU,

$$\frac{\$3.05 \text{ / kg } DUF_6}{0.676 \text{ kg DU / kg } DUF_6} = \$4.51 \text{ / kg DU}$$

Adding a 25 percent contingency factor to this amount gives

~~$4.56~~ 4.51 / kg DU x 1.25 = $5.64 kg DU

The total cost in 2006 dollars for the disposition of the DU from USEC at the Portsmouth deconversion plant for a 7.6 million SWU per year plant would be:

	$ / kg DUF_6
Construction cost	0.35
Operating cost	1.70
Plant recapitalization cost	0.35
DU disposal cost	0.39
Surveillance/maintenance cost	0.003
Decommissioning cost	0.15
Federal administrative cost	0.10
Total	3.04

Converting from kg DUF_6 to kg DU,

$$\frac{\$3.04 \text{ / kg } DUF_6}{0.676 \text{ kg DU / kg } DUF_6} = \$4.50 \text{ / kg DU}$$

Adding a 25 percent contingency factor to this amount gives

$4.50 / kg DU x 1.25 = $5.62 kg DU