Enclosure to Letter,
Gustavson to Spence,
Dated: December 1, 1995

Y/LB-15,914

Y-12

**OAK RIDGE
Y-12
PLANT**

LOCKHEED MARTIN

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**FEASIBILITY STUDY
ON CONSOLIDATION OF
FERNALD ENVIRONMENTAL
MANAGEMENT PROJECT
DEPLETED URANIUM MATERIALS**

November 30, 1995

MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

UCN-13672 (28 6-95)

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DEPLETED URANIUM MATERIALS**

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

B-25 Box	Department of Transportation 7A Type A Package
CFR	Code of Federal Regulations
CFO	chief financial officer
D&D	decontamination and decommissioning
DOE	Department of Energy
DOT	Department of Transportation
DP	Defense Programs
DU	depleted uranium
DUCRETE	Concrete with uranium oxide aggregate
EA	environmental assessment
EH	Environmental Health
EIS	environmental impact statement
EM	Environmental Management
ER	Environmental Restoration
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FILO	first in last out
FMPC	Feed Materials Production Center
FONSI	finding of no significant impact
FTE	full-time employee
FY	fiscal year
HEU	highly enriched uranium
HLW	high-level waste
HQ	headquarters
LLW	low-level waste
LMES	Lockheed Martin Energy Systems, Inc.
LSA	low specific activity
MPC	multi-purpose canister
NEPA	National Environmental Policy Act of 1969
NFS	Nuclear Fuel Services
NMC&A	nuclear materials control and accountability
ORR	Oak Ridge Reservation
PCBs	polychlorinated biphenyl
RADCON	Radiological Control
RCRA	Resource Conservation and Recovery Act of 1976
RFP	request for proposal
S&M	surveillance and maintenance
SA	safety assessment
SAR	safety analysis report
SEG	Scientific Ecology Group, Inc.
SNF	spent nuclear fuel
SST	stainless steel
TBD	to be determined
TSR	technical safety requirements
USQD	Unreviewed Safety Question Determination

CHEMICAL NOTATIONS

U_3O_8	triuranium octaoxide
^{235}U	uranium isotope 235
^{238}U	uranium isotope 238
UO_2	uranium dioxide
UO_2F_2	uranium oxyfluoride
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UO_3	uranium trioxide

UNITS OF MEASUREMENT

cm^3	cubic centimeter
$^{\circ}\text{C}$	degrees Celsius or centigrade
\$	dollar
ft	foot
ft^2	square foot
g	gram
gal	gallon
in	inch
kg	kilogram
t	metric tons
lb	pound

ACKNOWLEDGMENT

We wish to extend our appreciation to the numerous organizations of LMES, the DOE, and the management and staff of FERMCO for their assistance in providing data for this study. Special thanks are extended to Shirley Kaushiva and Gerry Motl of FERMCO for their excellent support.

EXECUTIVE SUMMARY

The DOE Office of Nuclear Weapons Management, DP, requested LMES to assess the feasibility of consolidating the FEMP DU materials at the ORR for future DOE programmatic use. The following project phases were included in the study evaluation:

1. DU material value, potential uses, and sampling;
2. Packaging and transportation;
3. Material control and accountability;
4. Environmental, health and safety issues;
5. Storage;
6. Project management;
7. Noneconomic factors, schedule; and
8. Cost.

The FEMP DU material represents a potentially valuable DOE resource. The most probable use for the metal and UF_4 is radiation shielding in packages for SNF, HLW, and other radiological wastes from federal and commercially funded projects. The UO_3 could be used as an aggregate in concrete, or in a process to make silicate glass beads in a backfill system for containers for SNF. Based on these potential uses, all of the FEMP DU material is acceptable for consolidation at the ORR except for 274 kg (603 lb) of UF_4 heels contained in 16 T-Hoppers.

Because the quantity of material being considered for consolidation is substantial and could be considered a major federal action, a NEPA EA must be prepared. An EA may take from 12 to 17 months, after which the transfer of the DU material may begin. Depending on the selected storage option, a SAR may need to be prepared. A SAR may take from 9 to 12 months to complete but may be performed in conjunction with the EA.

Various packaging, sampling, transportation, and storage options are included in this study for the consolidation of the material to a location on the ORR. The DU should be repackaged at FEMP, at a licensed off-site location, or at the ORR into packages that are suitable for long-term storage. The transportation campaign should use certified hazardous material haulers and will require approximately 250 truck loads to transfer the DU material.

1. INTRODUCTION

In 1991, the DOE made a decision to close the FMPC located in Fernald, Ohio, (Figure 1.1) and end its production mission. The site was renamed FEMP to reflect Fernald's mission change from uranium production to environmental restoration. As a result of this change, the inventory of strategic uranium materials maintained at Fernald by DOE DP will need to be relocated to other DOE sites. Although considered a liability to the Fernald Plant due to its current D&D mission, the FEMP DU represents a potentially valuable DOE resource. Recognizing its value, it may be important for the DOE to consolidate the material at one site and place it in a safe long-term storage condition until a future DOE programmatic requirement materializes.

In August 1995, the DOE Office of Nuclear Weapons Management, DP, requested LMES to assess the feasibility of consolidating the FEMP DU materials at the ORR. This feasibility study examines various phases associated with the consolidation of the FEMP DU at the ORR. If useful short-term applications for the DU fail to materialize, then long-term storage (up to 50 years) would need to be provided. Phases examined in this report include DU material value; potential uses; sampling; packaging and transportation; material control and accountability; environmental, health and safety issues; storage; project management; noneconomic factors; schedule; and cost.

BACKGROUND

In July 1991, as part of the restoration activities, the FEMP initiated the Safe Shutdown Program to provide planning, engineering, and program control for the proper disposition of all uranium products and in-process residue materials. The Safe Shutdown Program represents an effort to mitigate potential sources of contamination to the environment and to stabilize, isolate, and/or treat any existing contamination to prevent migration or release. Transfer of materials from existing, previously operated, production-related equipment, and the proper disposition of the uranium product materials and recoverable residues has been an integral part of the Safe Shutdown Program. Recent contractor reorganization has placed this responsibility under Waste Programs Management.

As of September 1, 1995, FEMP maintained an inventory of 3,860,961 kg (8,511,874 lb) of DU product material at numerous locations on site (Figure 1.2). Unless the material is consolidated on site or dispositioned to an off-site location, the material will impact the successful completion of currently scheduled safe shutdown, utility reduction, and subsequent facility D&D programs. Significant funding reductions at the site require that either the material be expeditiously dispositioned from the site by October 1997, or the work scope currently scheduled will be delayed and the planned reduction of landlord costs will not be realized.

Figure 1.1 Fernald Site and vicinity.

The FEMP has recently increased efforts to disposition this nuclear material. The overall strategy for various classes of material include:

- transfer to other government sites for programmatically identified needs,
- transfer to other government sites for inventory consolidation,
- sale to the commercial market, or
- declaration as waste material and subsequent disposal.

The FEMP DU represents a potentially valuable resource for which firm DOE requirements may develop in the future, such as the DOE Office of Civilian Radioactive Waste MPC Program or related applications in shielding for radioactive waste. Currently, a number of potential designs that include DU are being evaluated.

Figure 1.2. Highlighted DU storage locations at the FEMP.

2. INVENTORY

2.1 MATERIAL DESCRIPTION

The DU contains less of the fissionable isotope ^{235}U than is found in natural uranium. Natural uranium contains approximately 0.7 percent ^{235}U and 99.3 percent ^{238}U . Nuclear criticality is not a concern with DU. DU nominally contains 0.2 percent ^{235}U . The DU inventory at the FEMP consists of two compounds (UO_3 and UF_4) and uranium metal in various shapes. Table 2.1 gives the quantities available for all of the DU at the FEMP.

Table 2.1. DU stored at the FEMP

Description	Quantity	
	kg	lb
UO_3 compound	42,861	94,491
UF_4 compound	1,945,223	4,288,438
Metal	1,872,877	4,128,945
Total net weight	3,860,961	8,511,874

2.1.1 UO_3

The UO_3 , also known as uranyl oxide, is a yellowish-reddish powder in the crystalline form with a density of 7.29 g/cm^3 that is insoluble in cold water. Essentially all the UO_3 in inventory came from the Savannah River Site and was used to produce UF_4 and to improve the conversion efficiency of UF_4 to metal. Less than 1 percent of the UO_3 came from the Paducah Gaseous Diffusion Plant. The oxide is stored primarily in 55-gallon and 85-gallon drums. Most of the 85-gallon drums serve as overpacks for 55-gallon drums or other smaller containers of oxide that are stacked inside the larger drum. The remainder of the oxide material is stored in large steel containers called T-Hoppers.

2.1.2 UF_4

The UF_4 , also referred to as green salt, is a green, nonvolatile crystalline powder having a density of 6.70 g/cm^3 and a melting point of $1,036^\circ\text{C}$. The UF_4 is insoluble in water and is an intermediate product that is reduced with magnesium to yield DU metal.

The UF_4 that was produced at the FEMP is stored primarily in 10-gallon drums. Some UF_4 has been placed into 55- and 85-gallon drums which, in some cases, are overpacks for the original packages.

In addition to the FEMP-produced material, the FEMP has 64 T-Hoppers, ninety-four 55-gallon drums, and 105 ten-gallon drums of UF_4 that were produced at the Paducah Gaseous Diffusion Plant for which there is no chemical analysis. There are also 16 T-Hoppers with heels, the small amount of UF_4 that was not released during processing. The T-Hoppers have been stored outside and the UF_4 may have degraded from potential exposure to moisture. Some of the 55- and 85-gallon drums contain small amounts of UF_4 that remain from batch material samples.

2.1.3 Metal

The DU metal is moderately strong and ductile and can be cast, formed, and machined using conventional methods. Its very high density (19 g/cm^3) makes DU metal an excellent choice for radiation shields and counterweights. The DU is a reactive metal and has a relatively high melting temperature of $1,138^\circ\text{C}$. Unalloyed DU oxidizes rapidly in air and corrodes rapidly in moisture. The DU can be alloyed to improve corrosion resistance and its mechanical properties. The DU is only mildly radioactive and is listed as an LSA material in shipping regulations. The DU is about as chemically toxic as other heavy metals such as lead. Finely divided uranium, such as machining chips and grinding residue, is pyrophoric and must be handled carefully. Solid pieces of DU do not present a fire hazard under normal conditions and only a very high temperature-sustained fire could ignite the metal.

The FEMP DU metal is in various forms from the different points in the production process. The large primary ingots and product ingots are stored on skids. A few product ingots are stored in 55- and 85-gallon drums. The finished fuel cores are stored in wooden boxes (Figure 2.1). The category of metal identified as recycle metal is stored in various size drums, wooden boxes, and on skids. This metal includes bulk scrap and in-stream products that were rejected for physical defects or chemical requirements.

Figure 2.1. Fuel cores stored in wooden boxes.

2.2 MATERIAL VALUE

Based on an October 1995 memorandum (Reid 1995) from the Deputy Controller, DOE-HQ, to the Acting CFO, Ohio Field Office, the write down (DOE book value) for the FEMP DU is zero. When determining material value, however, there are several additional factors to consider, such as the market value, which may be estimated by evaluating the cost of converting UF_6 to UF_4 and metal as an alternate means of providing these materials for the anticipated applications (Table 2.2).

Table 2.2. Value of the FEMP DU material

Material type	FEMP inventory (lb)	DOE book value		Market value		Conversion value		
		Cost (\$/lb)	Value (\$)	Cost (\$/lb)	Value (\$)	Operation	Cost (\$/lb)	Value (\$)
UO_3	94,491		0		N/A			N/A
UF_4	4,287,452		0		N/A	UF_6 to UF_4	1.05	4,501,825
Metal	4,128,913		0	0.11	454,180	UF_6 to metal	4.55	18,786,554
Total value			0		454,180			23,288,379

An estimated market value can be determined by the selling price of the material. In 1993 the FERMCO offered the total inventory of DU material for sale. A proposal for the purchase of 973,651 lb of DU metal was accepted for \$103,680 or \$0.11 per lb. The DU metal sold was in the form of derbies, which are ingots directly reduced from UF_4 . Derbies have a higher-quality chemical composition than the remaining DU metal in the FEMP inventory. No proposals for the UF_4 or the UO_3 were accepted; therefore, a market value for these materials is not shown in Table 2.2. Market values can be found for natural UF_6 and natural U_3O_8 , but are not applicable to DU since natural uranium contains a greater amount of ^{235}U and has a wider range of uses than DU.

The value of the DU material can also be determined based on replacement cost. Typical cost for production of average quality DU metal from UF_6 is cited as \$10/kg (\$4.55/lb). This cost does not include secondary low-level waste disposal, which continues to increase, and does not include a cost for the UF_6 , which is provided at no cost by DOE. The \$10/kg conversion cost has been used in various reports on DU recycling done for the Office of Technology Development in the DOE Office of EM. The majority of the cost (77 percent) is in the UF_4 to metal conversion \$7.70/kg (\$3.50/lb). The UF_6 to UF_4 conversion cost is estimated to be about \$2.31/kg (\$1.05/lb) to produce average quality DU metal (Hertzler 1994 and Kaplan 1995).

The DOE owns vast quantities of depleted UF_6 that was produced as part of the gaseous diffusion process to enriched uranium. This UF_6 can be used to produce UF_4 and subsequently DU metal. Commercial industry exists today that can convert UF_6 into UF_4 and metal. However, the industry has limited demand for DU metal production, and the long-term future for this industry is unknown.

3. POTENTIAL USES FOR DU

3.1 UO_3

The UO_3 at the FEMP was used to produce UF_4 . It was also used in the UF_4 to metal conversion process to enhance the conversion efficiency. This use was dependent on the FMPC equipment and process and is not used by the DU industry today.

The feasibility of using DU oxide as an aggregate in concrete is being explored at the Idaho National Engineering Laboratory and other DOE facilities (Haelsig 1994). Analysis has shown that concrete with UO_2 as an aggregate is significantly better at shielding gamma radiation and somewhat better at shielding neutron radiation than conventional concrete. Preliminary concepts for DUCRETE (concrete with uranium oxide aggregate) based storage casks for SNF are being evaluated. The DUCRETE containers could also be used for management of other radioactive wastes. The DUCRETE material is under development.

Another potential use for DU oxide is to make DU silicate glass beads or sand that could be used as a backfill system for containers of SNF. Preliminary analysis of the DU silicate material has shown it to offer potential benefits of lower radionuclide release rates from the SNF waste package over geological time, assured control of nuclear criticality for geological time frames, and lower radiation levels from the waste package. The DU silicate material would be formulated from DU oxide. This material is very early in development.

These potential uses for DU oxide are based on UO_2 or U_3O_8 . With additional processing steps, UO_3 can be converted to these oxide forms. Within the DOE complex are other large inventories of DU oxide which would also be candidates for these potential uses. The exact chemical and other quality requirements for the starting oxide for the uses described are unknown at this time. Conversion of DU oxide into metal is technically possible, but no commercial plant exists in the United States that can perform this conversion.

3.2 UF_4

There are no known uses for DU in the form of UF_4 . The UF_4 could be converted to metal as uses for DU metal develop and existing metal inventories are consumed. The chemical analysis provided by the FERMCO indicates that the majority of the UF_4 is high quality and could be used to produce high quality DU metal derbies for use in weapons production. However, at this time, no new derby quality metal is needed. The UF_4 in the 64 T-Hoppers, ninety-four 55-gallon drums, and 105 ten-gallon drums from the Paducah Gaseous Diffusion Plant does not have chemical analysis on record. Potential use of this UF_4 may depend on the physical and chemical quality.

3.3 METAL

The chemistry information has been reviewed for the DU metal stored at the FEMP. It is concluded that this metal does not meet the material specifications for DU metal used in DOE DP weapon production. The metal is suitable for other uses where strict chemical requirements are not necessary, such as in radiation shielding. The most recent and complete market study on potential uses of DU is found in the August 1995 report by Susan Arnold Kaplan, *Depleted Uranium Market Study*. This report concludes that the highest probable and largest use

radiological wastes.

The SEG may have shielding requirements for high dose rate residue from a waste reduction process. The SEG has proposed using DU metal shielding inside a package for storing and managing the residue from resin reduction. Each container uses an estimated 4,000 lb of DU metal. This operation could start in 1996 with approximately 100 containers per year and increase to 500 containers per year and continue as long as the waste was processed (indefinitely). On a cumulative basis, the FEMP DU metal would be consumed within five years. After the metal was exhausted, the UF_4 could be converted to metal as the next least expensive source of metal. At a rate of 500 containers per year, the UF_4 would be used within two years.

The most recent plan for DU use in packaging is in the MPC Program described in DOE/RW-0445 for Civilian Spent Nuclear Fuel Management. An analysis of the use of DU metal for the MPC Program is presented in an attachment to the DOE memorandum, *Final Draft Equity Sharing Proposal* (Collier 1995). Part of the following information is taken from this analysis.

The available DOE inventory of DU metal at the Oak Ridge Y-12 Plant and the FEMP is about 3,000 t ($6,614 \times 10^3$ lb) with additional DU metal (approximately 1,500 t [$3,306 \times 10^3$ lb]) at other sites in the DOE nuclear weapons complex. The Y-12 Plant and the FEMP DU metal will most likely be used first in packaging programs due to its ease of access and its form. Based on the delivery schedule in DOE/RW-0445, all of this DU metal can be used in MPC shield plugs in 15 years. The projected need for DU metal in the MPC Program is 16,000 t ($35,274 \times 10^3$ lb), 11,500 t over the current DOE metal inventory. All of the DOE DU metal stockpiles would be exhausted in 20 years. Additional metal would be procured on the world market or from conversion of existing UF_4 and UF_6 inventories.

As illustrated in Figure 3.1, the current supply of DU metal will be exhausted by the year 2013 if used only in the MPC Program. The SEG requirements alone would use the available material by the year 2003.

Figure 3.1. Potential utilization of DU metal.

The status of the Civilian Spent Nuclear Fuel Management program may change from the plans published in DOE/RW-0445. Several variations on the MPC Program have been proposed in current legislation. However, even if only half the amount of DU metal is used and if the program is stretched to twice as long, all of the DOE's inventory of DU metal will be used in less than 30 years.

Another potential utilization is the need for a similar packaging program for the DOE-owned SNF and HLW. It is anticipated that DOE will use a packaging system that would use DU metal as its radiation shield within the next 20 years in quantities that would exceed the available DOE inventory. The study in Y/NA-1801, *Depleted Uranium Market Study*, shows several scenarios where over 100,000 t ($220,460 \times 10^3$ lb) of DU metal may be needed for packaging.

Another potential use for DU that was not addressed in the DU market study is in the blending of surplus HEU for nonproliferation purposes. A possible purpose for blending HEU with DU may be for disposal of the HEU and not for producing reactor grade uranium. Processes that can mix DU and HEU in their metal form to produce lower assay enriched uranium potentially could use several thousand metric tons of DU.

4. SAMPLING

The FEMP Site has 331,091 kg (729,924 lb) of UF_4 that does not have available chemistry analysis. Based on information contained in the FEMP Depleted Uranium Green Book (FEMP 1995), this material was received from Paducah without a chemistry analysis and has not been analyzed while at the FEMP Site. For cost estimating purposes, this amount has been included in the 1,944,775 kg (4,287,452 lb) of UF_4 that has been determined as acceptable for receipt at ORR.

The consolidation of the 331,091 kg (729,924 lb) of unsampled UF_4 at ORR is dependent upon the physical condition of the material and the results of the chemistry analysis. Chemistry analysis will be conducted as a means of verifying the composition of the UF_4 and its suitability for use in future applications. An isotopic, spectrographic, percent UO_2F_2 , and gram-per-gram uranium analysis should be performed on the unsampled UF_4 . For the other DU materials, the historical analytical data is acceptable.

Prior to consolidation at the ORR, the UF_4 should meet the following criteria:

1. The UF_4 should not show signs of clumping or caking which would make the material unsuitable for the UF_4 to metal conversion process or interfere with the chemical sampling procedure. For the T-Hoppers, this would be determined during the repackaging; for the drums, checking one drum from each lot would be sufficient and could be done during the sampling process.
2. Chemistry results for the UF_4 shall be reviewed by the Y-12 Plant prior to shipment to verify that the material contains less than 0.21 percent of the ^{235}U isotope. Based on FEMP's past experience with the Paducah UF_4 , the Y-12 Plant does not anticipate that any of the material will exceed this requirement.

A representative sample shall be taken from each unsampled lot. Lot identities must be maintained throughout the sampling process to ensure material traceability. If a sample cannot be taken from a package (drum) due to unsuitable material conditions as described in Item 1, the package of material shall be rejected as not suitable for shipment to the ORR and another sample shall be taken from the lot.

For the purpose of this study, it is assumed that the sampling procedure will be performed during the repackaging of the unsampled T-Hoppers and drums. There are three repackaging/sampling options to consider:

1. repackaging/sampling at the FEMP,
2. repackaging/sampling at a licensed off-site facility, and
3. repackaging/sampling at the ORR.

4.1 REPACKAGING/SAMPLING AT THE FEMP

Table 4.1 details the FEMP inventory of unsampled UF₄, current container configuration, number of unique lots, and the estimated sampling cost if the sampling and lab analyses are performed at the FEMP. The sampling cost of \$1,100 per sample was provided by the FEMP site and includes labor, laboratory cost, and overhead for each sample. The total cost for the UF₄ sampling is \$82,500.

Table 4.1. Estimated sampling costs for unsampled UF₄

Packaging type	Number of packages	Net weight		Number of unique lots	Sample cost at \$1,100
		kg	lb		
T-Hoppers	64	256,477	565,429	64	\$70,400
Drums	95	63,932	140,946	6	6,600
10-gal drums	105	10,682	23,549	5	5,500
Totals	264	331,091	729,924	75	\$82,500

4.2 REPACKAGING/SAMPLING AT A LICENSED OFF-SITE FACILITY

If the repackaging is performed at a licensed off-site facility, a representative sample should be taken from each unique lot as previously described. However, since the identity of this licensed facility and its ability to perform lab analysis is unknown at this time, the assumption is made that the sampling cost will be comparable to the FEMP sampling cost. If the facility does not have laboratory analysis capabilities, then the samples may be sent to the Y-12 Plant Laboratory or the FEMP for the required analysis.

4.3 REPACKAGING/SAMPLING AT THE ORR

The unit sampling cost of \$1,413 (Table 4.2) is based on an individual sample being analyzed at the Y-12 Plant Laboratory. When dealing with a large quantity of samples, a savings of approximately 20 percent could be realized. The total sampling cost, using the discounted cost, is estimated at \$84,780. Shipping costs for the samples would not be incurred if the repackaging is performed at the ORR.

Table 4.2. Estimated Y-12 Plant Laboratory sampling costs for unsampled UF₆

Packaging type	Number of unique lots	Sample cost @ \$1,413	Less 20 percent quantity discount
T-Hoppers	64	\$90,432	\$72,346
Drums	6	8,478	6,782
10-gal drums	5	7,065	5,652
Total sampling	75	\$105,975	\$84,780
Shipping cost		70^a	70^a
Total sampling & shipping		\$106,045	\$84,850

^aShipping cost calculations:

75 samples X 15 g (max) each, DU (0.2 weight percent ²³⁵U) = 1,125 g of DU (~2.5 lb)

2.5 lb shipped as a limited quantity radioactive material, using a single, strong tight container to ship all of the samples

NOTE: If samples are shipped separately, shipping cost could escalate to \$5,250.

5. PACKAGING AND TRANSPORTATION

The DU is stored at the FEMP in a number of packaging configurations (Table 5.1).

Table 5.1. Current packaging configurations at the FEMP

Material description	Package (as stored)	Quantity	Package description
UO ₃ compound	10-gal drum	1	carbon steel
	55-gal drum	17	carbon steel
	85-gal drum	109	carbon steel
	T-Hopper	17	carbon steel
UF ₄ compound	5-gal drum	2	carbon steel
	10-gal drum	14,528	carbon steel
	55-gal drum	146	carbon steel
	85-gal drum	32	carbon steel
	T-Hopper	64	carbon steel
	T-Hopper (heels)	16	carbon steel
Metal, primary ingots	skids	169	wood
Metal, product ingots	55-gal drum	13	carbon steel
	85-gal drum	2	carbon steel
	skids	169	wood
Metal, product cores	box	1,512	wood
Metal, recycle	5-gal drum	8	carbon steel
	30-gal drum	108	carbon steel
	55-gal drum	1,017	carbon steel
	85-gal drum	79	carbon steel
	box	13	wood
	skids	198	wood
	miscellaneous	1	unknown
Metal, clad metal	55-gal drum	70	carbon steel

5.1 PACKAGING AND TRANSPORTATION REGULATIONS

The DU is packaged and shipped according to the DOE Order 460.1 that regulates the packaging transportation safety of hazardous materials, substances, and wastes. This order requires that all DOE shipments meet the regulations promulgated by the DOT in the CFR.

The DU is an LSA material that can be shipped according to the requirements of 49 CFR 173.425, paragraphs (a), (b), (c), or (d). These sections are paraphrased as follows:

- (a) ship the material in DOT Specification 7A Type A packagings,
- (b) ship the material in a strong tight container in an exclusive use vehicle,
- (c) ship the material as unpackaged (bulk) shipments in an exclusive use closed vehicle, or
- (d) ship as other hazardous materials when the material is in compliance with 10 CFR 20.

Shipments of materials to the ORR for storage at either the Y-12 Plant or K-25 Site should comply with either 49 CFR 173.425(a) or (b).

5.2 PACKAGING

5.2.1 Current Packaging

As described in Section 2, the DU forms include UO_3 compounds, UF_4 compounds, and metal. The material is presently stored at the FEMP in 18,323 packages that are an assortment of carbon steel drums (5-, 10-, 30-, 55-, and 85-gallon drums), wooden boxes (16 x 20 x 30 in), and wooden pallets (4 x 4 ft). The packages are staged both inside and outside of buildings.

Some of the drums (Figure 5.1) are overpacks which may have one or more drums inside. Other drums are stacked inside warehouses on wooden pallets (Figure 5.2). The wooden boxes (Figures 5.3 and 5.4) have aluminum liners with lids held in place by three to six metal bands. The large metal pieces are stored on wooden pallets. A portion of the UF_4 is in process containers (e.g., T-Hoppers) that are large (4 x 4 x 6 ft) steel receptacles that were used as bulk dispensers in the UF_6 -to-uranium metal process. The T-Hoppers are staged outside (Figures 5.5 and 5.6) in a storage yard.

Most of the packages have exhibited weathering or handling damage (Figures 5.7 and 5.8). Within two to ten years, this damage could lead to a corrosive breakthrough that would result in loss of containment of the materials. It would be necessary to repackage the material to satisfy long-term (fifty years) storage criteria.

Figure 5.1. Overpack drums that may have one or more drums packed inside.

Figure 5.2. Ten-gallon drums stacked in a FEMP warehouse.

Figure 5.3. Wooden box with aluminum liner.

Figure 5.4. Wooden boxes stacked in warehouse.

Figure 5.5. T-Hopper used to store UF_4 .

Figure 5.6. T-Hoppers stacked.

Figure 5.7. Drum exhibiting effects of exposure to weather.

Figure 5.8. Drum exhibiting handling damage.

5.2.2 Proposed Packaging

The present packages (drums, wooden boxes) are strong tight containers according to the DOT regulations; however, after 1996 the DOT may no longer authorize the use of a strong tight container. Instead, the United Nations authorized industrial packages (packing group 1, 2, or 3) would be required. A conservative approach would be to use a strong tight container that meets the requirements of a DOT Specification 7A Type A package. The 7A Type A package will meet the proposed DOT regulations that will go into effect in April 1996, and it provides an ample margin of safety for structural integrity. Furthermore, the marine-type coatings required for this packaging ensure that long-term metal oxidation is minimized. Another benefit is that as the stored materials are dispositioned to meet new demands, future costs would be avoided because the materials would not need to be repackaged.

It is proposed to store the materials in an area that is designated as a radioactive storage area. This area would be managed according to a Radiological Control Manual and other applicable Health and Safety procedures for radiological control. Such an area would allow personnel to enter without special clothing (although shoe scuffs and lab coats may be required in the future) and to exit without radiation monitoring. If the materials are stored in their present packagings, they would have to be stored in an area that is designated as a radioactive contamination area. Such an area would require personnel to don special anticontamination clothing when entering and to perform radiation monitoring when exiting. Furthermore, contamination control measures would be required for the storage building.

As indicated previously, the DU should be placed in a suitable form for long-term storage. Some of the scenarios evaluated include:

- place existing packages into DOT Specification 7A Type A packages (referred to in this report as B-25 boxes [Figure 5.9]),
- repack materials in 55-gallon stainless steel drums, or
- convert UF_4 to uranium metal and pack all metal into B-25 boxes.

B-25 boxes could be used for repacking the UO_3 and UF_4 . The box would contain twenty-four 5- or 10-gallon drums or six 55-gallon drums. Its exterior dimension would be 51 x 54 x 96 in (as a minimum). The box would weigh about 7,000 lb for a floor loading of about 195 lb/ft² and cost \$1,200 (unburdened). A number of the 55-gallon drums at the FEMP are in 85-gallon drum overpacks. For optimum storage, the 55-gallon drums should be removed from the overpacks and placed into B-25 boxes. It would be necessary to repackage all of the material presently in the T-Hoppers except for the heels into either 10- or 55-gallon drums.

Figure 5.9. Example of a B-25 box.

The UO_3 and UF_4 could be repacked into 55-gallon stainless steel drums. There is a 900 lb (net) limit on the drum content. Four drums would be strapped to a metal pallet (4 x 4 ft). The drums and pallet would weigh 3,750 lb for a floor loading of about 234 lb/ft². Each 55-gallon stainless steel drum would cost \$400 (unburdened) and each metal pallet would cost \$200 (unburdened).

Repacking the DU into drums will result in scrapping all of the carbon steel drums that presently contain the material. The total cost to scrap all drums contaminated with radioactive materials is approximately \$1,500,000 (\$100/drum). For the purpose of this study, scrapping was included in the initial costs. It is possible that a portion of the costs could be deferred if some of the drums could be used for waste burial.

Uranium metal ingots (8 to 10 in outside diameter x 20 to 30 in long, maximum) could be placed in a B-25 box with external dimensions of 20 x 45 x 45 in. Gross weight of the box should not exceed about 3,175 kg (7,000 lb). The floor loading would be about 498 lb/ft². At FEMP's option, the cores could be repacked into the steel box without the wooden box. Wood is not an acceptable outer box for storage since it introduces a fire fuel source in the storage facility. Alternatively, uranium metal cores (2.16 in outside diameter x 8.335 in long) in their wooden boxes (approximately 16 x 14 x 30 in) would be placed inside of a steel box such that the gross weight does not exceed 3,175 kg (7,000 lb).

5.2.3 Repackaging Options

It is important to note that the UF_4 in the T-Hoppers (representing less than 6 percent of the total DU) must be repackaged before consolidation in order to be stored. The DOE sites will not be able to receive the large T-Hopper physical structures for storage or for repacking. Although the T-Hoppers are strong tight containers and should contain the materials for a long period, they are rusted, have surface contamination, and present handling and storage problems due to their bulk. A storage rack would be needed to optimize storage space or a single-stacking layer would be used that would require more floor space. The anticipated radioactive storage area is not a contamination area. Thus, the T-Hopper material (UF_4) should be sampled and repacked at the FEMP prior to consolidation.

The organization that repacks the material is evaluated in the storage scenarios and includes the following options:

- converting UF_4 to metal at conversion facility and repack,
- repacking at the FEMP,
- repacking at the Y-12 Plant, or
- repackaging at a commercial vendor.

The option to ship the material to a commercial vendor for repacking was evaluated. The site license for uranium at several qualified vendors limits the quantity of uranium such that a campaign to repack the 3,860,961 kg (8.5 million lb) would be protracted. This would require a small shipment of material over a long period of time or require the vendors to request a change to their Nuclear Regulatory Commission site licenses. The NFS located in Erwin, Tennessee, declined our request to provide labor and storage space rate information for inclusion in this report.

Of the three material forms, DU metal presents the optimum storage configuration. At \$7.70/kg (\$3.50/lb), converting the 1,950,467 kg (4.5 million lb) of UF_4 to metal is very expensive (about \$15M) and requires an initial investment for conversion. Converting the 42,861 kg (94,491 lb) of UO_3 into metal is technically possible, but no commercial plant exists in the United States that can perform this conversion. Thus, converting the UF_4 and UO_3 to metal was not considered to be a cost-effective option. The storage options discussed earlier are adequate for compounds.

Long-term storage (up to 50 years) of hazardous materials require a structurally sound outer packaging that can withstand handling damage and weathering. It has been proven many times that carbon steel drum containment will fail in a short period of time. Thus, LMES would not place the existing drums into long-term storage anywhere on the ORR. Two long-term storage packages were evaluated: 55-gallon stainless steel drums and carbon steel, DOT Specification 7A, Type A packages (B-25 box) with protective coating (inside and outside). The cost to repack the material can be evaluated simply as the cost of the 55-gallon stainless steel drums (and a metal pallet per four drums) versus the cost of the B-25 box.

A total of 4,767 fifty-five-gallon stainless steel drums (\$400 each) and 1,191 metal pallets (\$200 each) would be needed to repackage all of the UF_4 at a cost of \$2,145,000 for just the hardware. About 740 B-25 boxes (\$1,200 each) would be needed to repackage all of the UF_4 at a cost of \$888,000 for just the hardware. Thus, repacking the UF_4 into B-25 boxes would be less expensive. This does not include costs associated with the transportation which should favor the B-25 box since fewer boxes are needed than pallets.

The most cost-effective repacking option is for the FERMCO to repack the packages into B-25 boxes at the FEMP. This would minimize the scrap wastes at the Y-12 Plant, facilitate shipment of the packages to ORR, and eliminate the necessity for the Y-12 Plant to develop procedures to repackage the materials. At the FEMP's option they may elect to have those materials that require repackaging shipped to an off-site licensed commercial facility for that purpose.

The cost to repackage the DU is a function of the packaging costs and the labor to repack the materials into the new packages (drums or boxes). The costs of the packages are considered to be the same whether the materials are repacked at the FEMP, the Y-12 Plant, or at a commercial vendor. Thus, the remaining cost difference in repacking is the labor costs. The labor rates for the options are listed below.

FERMCO	\$175/hour
Y- 12 Plant	\$335/hour

These costs combine the rates for two material handlers, a supervisor, a data clerk, and two health physics technicians. The difference between the FERMCO and the Y-12 Plant rate is based on the site's operating contract. FERMCO is managed under an environmental restoration management contract and their rate does not include overhead costs, such as site utilities, property protection, and other basic service costs. The Y-12 Plant operates under a maintenance and operator contract and includes all burden for plant operations in their rate, including central and DOE office services. The commercial vendor rates were not available, but their rates are expected to be about 30 percent more than the FERMCO rate.

Lockheed Martin Energy Systems, Inc., must conduct a readiness assessment before the DU can be received at the ORR. If the DU is repacked at the FEMP or an off-site licensed vendor,

the readiness assessment would cost about \$10,875. If the DU is repacked at the Y-12 Plant, the readiness assessment would cost about \$108,750. These are initial costs only. There are no recurring costs for the readiness assessment.

A rate of ten containers per hour to repack the existing containers into either new drums or boxes was used to estimate the labor costs. There is a total of 18,275 containers of DU to be repacked; thus, a total repacking time of 1,827.5 hours will be needed. Using the stated labor rates, the labor cost to repack the materials becomes:

FERMCO	\$319,813
Y- 12 Plant	\$612,213

5.3 TRANSPORTATION

The transportation campaign should use certified hazardous material haulers. The nominal cost to ship hazardous materials is about \$0.68/kg (\$1.50/lb) per truck mile. The over-the-road net weight limit for a truck is about 18,144 kg (40,000 lb). This limit would allow six to seven B-25 boxes per truck or forty to forty-four 55-gallon drums.

The following mileage estimates (Table 5.2) were used in the analyses for transportation costs:

Table 5.2. Mileage estimate used in determining transportation costs

Origin	Destination	Miles
FEMP	ORR	300
FEMP	LLW Site (South Carolina)	700
FEMP	Conversion facility	500
Conversion facility	ORR	300

The cost to load or unload trucks considered a rate of four containers per hour for box-type containers and 50 containers per hour for drum-type containers. The labor to load and unload the truck includes two material handlers, a supervisor, a data clerk, and two health physics technicians.

On the basis of DU weight, it would require about 250 truck loads to transport all of the repackaged DU from the FEMP to the consolidated storage site. On a daily basis for a single operating shift, four to five trucks could be received, surveyed, unloaded, and packages placed in the storage facility. This approach to move the DU to a consolidated site would take 60 to 70 work days. However, to prevent confusion and to level the work load, one truck a day should be received. This campaign would take approximately one year. Using a three-shift operation, the campaign could possibly be completed in about one month. Shift differentials and tripling the work staff would increase the transportation cost about 10 percent.

The rail transport mode costs were not developed for this study. The rail spur from the FEMP is under reconstruction and will not be ready for about two years. Had rail transportation been available, or if the project were to be delayed for two years, a reduction of about 5 percent in the transportation cost could be realized because of the increased load per shipment and the decreased cost per unit load available through rail transportation.

6. NMC&A PLAN

A shipper/receiver agreement will need to be established to document shipper measurements and receiver verification requirements for the DU. Prior to placing the DU packages into the B-25 boxes, each package must be weighed and the information recorded on the DOE/NRC Form 741. After the B-25 box is packed, it must be weighed and sealed. Upon arrival at the ORR, the B-25 box must be weighed again for comparison to the recorded shipping weight and the material packing lists must be verified against the DOE/NRC Form 741 for accuracy. Scales with an accuracy of ± 4.5 kg (10 lb) will be needed to weigh each B-25 box or drum. The scales are estimated to cost \$7,250 and will require annual calibration at a cost of \$1,450. The cost of the scales and the calibration is shown in Table 8.4 and is included in the initial and annual costs for each storage facility option.

After the material has been received at the designated storage site and verified against the DOE/NRC Form 741, NMC&A will determine identification numbers for the individual B-25 boxes or drums, the DU packages, and enter the data into a material control and accountability database system. A correlation between the B-25 box or drum and its DU packages will be established to allow for inventory of only the sealed B-25 boxes or drums.

As shown in Table 6.1, estimated NMC&A costs include \$362,500 by operations at the FEMP and the ORR for checking and weighing all of the FEMP material; \$181,250 for initial data entry into the material control and accountability database system, data handling and reconciling the inventory; and \$15,225 for the bimonthly reconciliation to book inventory, and the physical inventory and reconciliation that will be taken at the end of each two-year period.

Table 6.1. Estimated NMC&A costs

	Verification (\$)	Initial data entry (\$)	Annual inventory (\$)
UO ₃	2,700	1,350	203
UF ₆	276,200	138,100	11,470
Metal	83,600	41,800	3,552
Totals	362,500	181,250	15,225

For estimating purposes, the K-25 Site NMC&A Department has agreed that there will not be a significant change to this estimate if the material is stored at the K-25 Site. If the material is repackaged at a licensed, off-site facility, the cost for verifying the material against the DOE/NRC Form 741, and weighing the packages is included in Section 5.2.3.

7. ENVIRONMENTAL, HEALTH AND SAFETY ISSUES

7.1 NEPA PROCESS

The appropriate level of NEPA documentation for the relocation of 3,860,961 kg (8.5 million lb) of DU materials to the ORR would be an EA and would include public participation. An EA analyzes the environmental impacts of the proposed action and determines whether or not the federal undertaking would significantly affect the environment. If it is determined that the relocation of the DU would significantly affect the environment, the DOE prepares an EIS. If not, a FONSI would be issued. A flowchart of the NEPA process is shown in Figure 7.1.

Flowchart

Basic NEPA Process

Figure 7.1 NEPA process.

The EM Department at the selected storage site would initiate the NEPA process for the proposed project. The estimated costs include providing data, support analyses, public participation, draft EAs, and the final EA. The NEPA process for the preparation of an EA usually averages from 12 to 17 months with an estimated cost between \$72,500 to \$217,500. Breakdown of cost is dependent upon the scope of the project and the detail required to complete the NEPA process.

The DU Material cannot be shipped to the ORR until the EA has been completed.

7.2 FACILITY SAFETY

Storage of the quantity of DU material considered in this study would require development or modification of facility safety documentation to comply with DOE Order 5480.23, *Nuclear Safety Analysis Reports*. An initial facility hazard categorization, per DOE Standard 1027-92, for storage of the 8.5 million lb of DU material is Category 2 and would require a SAR. The threshold quantity for determination of a Category 2 facility is 710,000,000 g (1,565,280 lb) (the Category 3 facility threshold is 13,000,000 g [28,660 lb]).

The facility selected for storage of the DU material and the status of its facility safety documentation will dictate what additional documentation is required. If the facility has an existing SAR, it would be reviewed and modified to include the new storage activity. The review and modification may be accomplished with a USQD and a SA. If the addition of this quantity of DU material represents a significant change or introduces reviewed safety questions, a more extensive safety analysis will be required. A SAR would be required for any facility that does not have a current SAR.

The safety documentation must be complete and approved prior to initiating operations. This documentation requires support efforts by the Facility Safety Department, System Safety Engineering, facility operations, and other subject matter experts, such as Fire Protection Engineering and slight involvement from the Nuclear Criticality Safety Department. The SARs can be written by subcontractors, but support and involvement of the previously mentioned resources are still required. A SAR takes approximately 12 months to be written and approved, and is estimated to cost \$217,500. If the facility has a SAR, the USQD and SA may be done for as little as \$20,000 and take approximately 3 months.

An annual review of the SAR must be performed by the Facility Safety Department, System Safety Engineering, and operations to determine if the facility is in compliance with the SAR. The SAR and TSR are updated annually. The annual cost of the review and update is estimated at \$21,750.

7.3 RADIOLOGICAL CONTROL

Prior to shipment, the DU material will be checked by Radiological Control to ensure that the outside surface contamination of the packages meets the DOT requirements. Once the material arrives at the ORR, the outside surface of the packages will be checked to verify the absence of outside contamination prior to storage in the radiological storage area. After the packages have been unloaded, the inside of the transport trailer will be checked for contamination. The costs for the radiological control checks are included in the load and unload amounts in Section 5.2.3 of this report.

The recommended storage area at the ORR would be in an area that is designated as a radioactive material area. This area is managed according to a Radiological Control Manual and other applicable health and safety procedures for radiological control. Such an area allows personnel to enter without special clothing (although shoe scuffs and lab coats may be required in the future) and to exit without radiation monitoring. The initial cost for establishing this type of area to comply with applicable DOE and plant requirements is \$1,450, and an annual cost of \$5,220 for quarterly radiological surveillances as required by plant procedures.

If the material is stored at the ORR in its present packagings, it would need to be stored in an area that is designated as a radioactive contamination area. Such an area would require personnel to don special anticontamination clothing when entering and to perform radiation monitoring when exiting. Furthermore, contamination control measures would be required for the storage building. This type of area could increase the radiological cost to an initial cost of \$72,500 for the purchase of whole body monitor and the set up of the boundary control station, if none existed. The annual cost would increase to \$10,500 which would include the required monthly maintenance on the monitor, floor smears, and anticontamination clothing costs.

8. STORAGE

Consolidation of the FEMP DU at the ORR depends on meeting a number of physical, safeguards, security, safety, and compliance requirements. This study evaluated existing facilities at the Y-12 Plant and the K-25 Site and a new facility located at the Y-12 Plant. The evaluation of the candidate storage sites is discussed in the following subsections.

8.1 PHYSICAL REQUIREMENTS

A long-term storage facility for DU requires the following physical elements:

- floor area,
- floor loading capacity, and
- ceiling height.

The physical dimensions of the floor space are determined by the package dimensions, stacking height, aisle space, and other operational space requirements (scale, egress, ingress). The physical requirements for the two packaging options examined (i.e., 55-gallon stainless steel drums on metal pallets and B-25 boxes) are presented in Table 8.1.

Table 8.1. Package dimensions, weight, floor loadings, and stacking height

Package	Height x width x length (in)	Footprint (ft ²)	Weight (lb)	Floor loading per stack height (lb/ft ²)	Safe stacking height
Four 55-gal stainless steel drums and metal pallet with UF ₄ or UO ₃	40 x 48 x 48	16	3,750	235	3
B-25 box with UF ₄ or UO ₃	51 x 54 x 96	36	7,000	195	2
B-25 box with U metal	20 x 45 x 45	14.0625	7,000	498	3

The total storage space required to consolidate all of the DU is a function of the type of packaging used, the stacking height, aisle space, handling equipment, and storage options. The storage options represent the procedure for placing the packages into the storage facility and removing them. The most efficient method for storing the packages is to use FILO. This would require about 20 percent more space than the packages to allow for safe access to the NMC&A information on the outer surface of the packages. If random access to the packages is required, then the aisles would need to be as wide as the packages, or 100 percent of the package floor space. Since the materials can be segregated within the storage facility by material type (metal or compounds), then FILO would be preferred. The preferred handling equipment would be forklifts with a minimum lifting capacity of 3,629 kg (8,000 lb) and a minimum lifting height of 10 ft.

To establish a maximum floor space requirement, a one-high stacking height is used for the packaging options (Table 8.2). The number of packages, aisle space (at 20 percent package space), and the total floor space for the packaging options are included.

Table 8.2. Package and aisle floor area for a single stacking height

Package	Quantity of packages	Area (ft ²)	Aisle space (ft ²)	Total area (ft ²)
Four 55-gal stainless steel drums and metal pallet with UF ₄ or UO ₃	1,218	19,488	3,898	22,386
B-25 box with UF ₄ or UO ₃	758	27,288	5,458	32,746
B-25 box with U metal	646	9,084	1,817	10,901
Totals				
55-gal drum (UF ₄ , UO ₃) and B-25 box (U metal)	1,864	28,572	5,715	34,287
B-25 box (U metal, UF ₄ , UO ₃)	1,404	36,372	7,275	43,647

The maximum floor space required for the packages is less than 44,000 ft². Some space for loading/unloading access, facility access, and the scale is needed. If 10 percent floor space is added for the access areas and scale, then the maximum space needed to house the consolidation effort would be about 50,000 ft².

The storage space required for the packaging options if the optimum stacking height is achieved is tabulated in Table 8.3. Not all of the existing facilities can accommodate the optimum stacking height because either the ceiling height is too low or the floor loading is limited. The floor space selection is also dependent on the annual cost per square foot to maintain storage of the DU and the initial costs to meet the other operational requirements, such as access control, safety, safeguards, and security.

Table 8.3. Package and aisle floor area for optimum stacking heights

Package	Quantity of packages	Stacking height	Total floor and aisle space (ft ²)
Four 55-gal stainless steel drums and metal pallet with UF ₄ or UO ₃	1,218	3	7,796
B-25 box with UF ₄ or UO ₃	758	2	16,373
B-25 box with U metal	646	3	3,618
Totals			
55-gal drum (UF ₄ , UO ₃) and B-25 box (U metal)	1,864	-	11,414
B-25 box (U metal, UF ₄ , UO ₃)	1,404	-	19,991

8.2 INITIAL & ANNUAL STORAGE COSTS

The initial costs incurred with the DU consolidation, regardless of the selected storage option, are listed in Table 8.4. Because the sampling cost differences described in Section 4 varied by only \$2,500, the amount was rounded to \$85,000 to cover all sampling options. Also, the cost of the scales that will be required for weighing the material prior to being placed in storage has been added as an initial cost.

Table 8.4. Nonsite specific initial and annual storage costs^a

Cost element	Initial cost (\$)	Annual cost (\$)
EA	217,500	0
NMC&A	543,750	15,225
Project management	217,500	2,175
RADCON	1,450	5,220
Sampling (FEMP)	85,000	0
Scales	7,250	1,450
Total fixed costs	1,072,450	24,070

^aCosts are burdened using FY 1995 rate of 45 percent.

8.3 STORAGE OPTIONS AT THE Y-12 PLANT

The Y-12 Plant contains approximately 570 buildings with a total of 7,250,000 ft² of space. Of this total, about 425 buildings (4,742,000 ft²) are currently occupied by DP, with the remainder of the buildings being utilized by the DOE-EM Program, Johnson Controls World Services, MK-Ferguson, Oak Ridge National Laboratory at the Y-12 Plant, and by the DOE Transportation Safeguards Division.

8.3.1 D&D Buildings

A major Y-12 Plant initiative affecting the current and future uses of the large production buildings at the plant is the downsizing and consolidation of the footprint of the production area. Details of this initiative can be found in the *Reconfiguration Project Report, Y-12 2000* (Y-12 1993). This document states "... (downsizing) ... facilitates the possible D&D of retired production operations buildings (9206, 9204-4, and 9201-5) ..."

In 1994, the Y-12 Plant management declared through the EM-sponsored Surplus Facilities Inventory and Assessment projects that these buildings would be available for D&D within five years. In addition, the reduced DP footprint at Y-12 and associated cost avoidance is consistent with the future secondary plant mission defined by the *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (Y-12 1995).

There are currently four buildings at the Y-12 Plant slated for D&D. These buildings encompass approximately 1,425,000 ft² of floor space and are desirable storage areas. However, these buildings are old and are very expensive to maintain (Table 8.5).

Table 8.5. FY 1995 facility costs for D&D buildings

Cost element	Building 9201-4 cost (\$)*	Building 9201-5 cost (\$)	Building 9204-4 cost (\$)	Building 9206 cost (\$)
Utilities	230,112	3,909,870	1,218,840	801,317
Miscellaneous services	1,431,842	1,174,588	870,595	1,097,629
Total	1,661,954	5,084,458	2,089,435	1,898,946
FY 1995 ft² facility costs				
Building ft ²	561,900	531,400	273,305	58,055
Utility cost	\$0.41	\$7.36	\$3.19	\$18.91
Service costs	\$2.96	\$9.57	\$7.65	\$32.71

*In D&D process

Pre-D&D transition activities in Buildings 9201-4, 9201-5, 9204-4, and 9206 involving moving equipment and other materials out of the buildings have already begun, and continuing use of even part of the building for DP might jeopardize the transition to D&D. The use of these buildings for the storage of the FEMP DU would require DOE management decisions on allocation of building preparation costs as well as the ongoing cost of operations. Significant capital investment would be required to segment or compartmentalize the buildings, and a new utility service distribution center would be required. If the decision is made to store the FEMP DU in one of these buildings, it would be reasonable to assume that the DU storage mission would become the steward of the building and would be responsible for all costs to maintain the building.

The use of any one of the D&D buildings would include a \$10/ft² cost to isolate the major utilities, convert the wet sprinklers to dry sprinklers, and install emergency lighting. The possibility of DP sharing this expense with EM exists if one of these buildings was used for storage. Also, the D&D schedule would need to be accelerated. Additional costs of \$500,000 would be incurred to establish a stand-alone service center to provide required utilities and services, add or remove walls and doors, and to establish material control requirements. The cost to modify the D&D building for DU storage is shown in Table 8.6. The stand-alone service center could reduce the annual operating costs to \$3/ft². The cost elements for D&D Buildings at the Y-12 Plant are presented in the following subsections.

Table 8.6. D&D building modification costs

Cost element	Building 9201-4 (\$)	Building 9201-5 (\$)	Building 9204-4 (\$)	Building 9206 (\$)
Modify building (estimated \$10/ft ²) ^a	5,619,000	5,314,000	2,733,050	580,550
Establish a stand-alone service center	500,000	500,000	500,000	500,000
Total	6,119,000	5,814,000	3,233,050	1,080,550

^aPotential exist to share building modification cost with EM. D&D schedule would need to be accelerated.

8.3.1.1 Building 9201-4

Building 9201-4 has approximately 561,900 ft² of floor space with 161,000 ft² on the ground level. The building is further along in the D&D process; thus a low facility service cost of \$2.96/ft², as shown in Table 8.5, can be used in the evaluation.

There are large ventilation tunnels beneath the ground floor of this building which would limit the storage to a one-high stacking height for the packages. As primary building occupant, the entire facility service cost of \$1.66M/year for the next five years was applied, at which time a facility service center could be established and the cost could drop to \$3/ft². The building costs are shown in Table 8.7.

Table 8.7. Initial and annual cost for Building 9201-4

Cost element	Initial cost (\$)	Annual cost (\$) 1 to 5 years	Annual cost (\$) 6 to 50 years
SAR	217,500	21,750	21,750
Site preparation	500,000	0	0
Facility service cost	0	1,661,954	150,000
Initial & annual cost from Table 8.4	1,072,450	24,070	24,070
Total	1,789,950	1,707,774	194,195
Note: - Current annual facility cost used for the first 5 years. - After 5 years, the facility service cost is estimated at \$150,000 (\$3/ft ² for 20,000 ft ²). - Annual cost numbers do not include escalation.			

The report assumes that the building will be segmented for the DU storage in five years; thus, the annual facility service cost could be reduced to approximately \$150,000. This number is based on the maximum floor space requirement of 50,000 ft² due to the ventilation tunnels, at \$3/ft².

8.3.1.2. Building 9201-5

Of the 531,400 ft² of floor space in Building 9201-5, 169,000 ft² is located on the ground floor. This building has large ventilation tunnels beneath the ground floor which would require a one-high stacking height for the DU packages. Building 9201-5 currently supports operations that are to be phased out over the next several years. Large blocks of floor space are not readily available for DU storage in the near future. This building is not considered further in the study.

8.3.1.3. Building 9204-4

The basement area of Building 9204-4 contains 64,900 ft² of floor space, of which 28,000 ft² could be used for DU storage. The 1,400 lb/ft² floor loading capacity could accommodate two- or three-high stacking configurations. Space in this building could cost \$7.65 ft² for the first five years until the building is placed in D&D, afterwhich, the facility service cost could be reduced to approximately \$60,000, at \$3/ft². Building specific costs are shown in Table 8.8.

Table 8.8. Initial and annual cost for Building 9204-4

Cost element	Initial cost (\$)	Annual cost (\$) 1 to 5 years	Annual cost (\$) 6 to 50 years
SAR	217,500	21,750	21,750
Site preparation	500,000	0	0
Facility service cost	0	153,000	60,000
Initial & annual cost from Table 8.4	1,072,450	24,070	24,070
Total	1,789,950	198,820	105,829
Note: - Annual facility service cost for the first 5 years calculated at \$7.65/ft ² for 20,000 ft ² . - After 5 years, the facility service cost is estimated at \$60,000 (\$3/ft ² for 20,000 ft ²). - Annual cost numbers do not include escalation.			

8.3.1.4 Building 9206

Building 9206 is part of the decontamination program. The program could last for the next 10 years and result in this building being unavailable for the storage of the FEMP DU. Building 9206 will not be considered further in this study.

8.3.2 Other Y-12 Plant Buildings

Other existing buildings at the Y-12 Plant were selected on the basis of prior studies of potential storage spaces. For most buildings evaluated, only the ground-level floors were considered suitable due to floor loading requirements. Some of the buildings were not suitable for DU storage due to inadequate floor loading; space limitations; incompatibility with ongoing operations; the presence of fixed equipment; inadequate ceiling heights; or federal regulations requirements.

Buildings selected for further study (9720-24, 9720-38, and 9213) are discussed in the following subsections.

8.3.2.1 Building 9720-24

Building 9720-24 could be used for the storage of the FEMP DU, but additional storage area would be needed since this building only has 11,200 ft², and the ceiling height would only accommodate a two-high stacking configuration. This building currently contains equipment that was used in support of the press operations at Building 9204-4, and an old hydroform press. A portion of the equipment stored in this building will be relocated as part of the downsizing effort, but the majority will not be moved. The following actions would have to be taken before Building 9720-24 could be used for consolidation of the DU:

1. Remove equipment and other items from the building at an estimated cost of \$200,000.
2. Decontaminate the building at an estimated cost of \$62,000.

Removing the equipment and decontaminating the building are estimated to take approximately six months. Specific building costs are shown in Table 8.9.

Table 8.9. Initial and annual cost for Building 9720-24

Cost element	Initial cost (\$)	Annual cost (\$)
SAR	217,500	21,750
Site preparation	262,000	0
Facility service cost	0	33,600
Initial & annual cost from Table 8.4	1,072,450	24,070
Total	1,551,950	79,420
Assumptions: - Annual facility service cost is based on \$3/ft ² for 11,200 ft ² .		

8.3.2.2 Buildings 9213 and 9720-38

Either Building 9213 or 9720-38 could be used in conjunction with Building 9720-24 for additional storage space. Building 9213 is the former Nuclear Criticality Research and Testing Facility and is currently unoccupied, although a tenant may have been identified. The building contains floor space of 23,500 ft², of which 5,000 ft² could meet the minimum floor loading limit for the DU material.

Building 9720-38 contains 7,700 ft² and has a floor loading limit of 1,000 lb/ft². It is currently being used for empty drum storage, but it is possible that some space could be used in the building for storing DU. Building 9720-38 has been targeted for future storage of the Y-12 Plant material. Storage of the FEMP DU would conflict with these plans.

The use of either of these buildings would require a SAR. Since most of the information gathered for Building 9720-24 would be applicable to Buildings 9213 or 9720-38, duplicate SAR effort could be avoided and the costs reduced by 50 percent. Specific cost information for these buildings is provided in Tables 8.10 and 8.11.

Table 8.10. Initial and annual cost for Building 9213

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR	108,750	10,875
Site preparation	20,000	0
Facility service cost	0	15,000
Initial & annual cost from Table 8.4	1,072,450	8,670
Total	1,201,200	34,545
Assumptions: - Facility service cost based on \$3/ft ² for 5,000 ft ² . - NMC&A cost included in Building 9720-24 annual cost.		

Table 8.11. Initial and annual cost for Building 9720-38

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR	108,750	10,875
Site preparation	20,000	0
Facility service cost	0	23,100
Initial & annual cost from Table 8.4	1,072,450	8,670
Total	1,201,200	42,645
Assumptions: - Facility service cost based on \$3/ft ² for 7,700 ft ² . - NMC&A cost included in Building 9720-24 annual cost.		

8.3.3. New Facility at the Y-12 Plant

An additional storage option is the construction of a new facility to house the FEMP DU material. Two potential locations (Figure 8.1) at the Y-12 Plant were identified for a new prefabricated metal storage facility.

One site which is located west of Building 9723-16 comprises approximately 15,000 ft². It is the former site of a 1944 cafeteria. This location would be suitable for use by increasing the floor loading capacity to allow for higher stacking levels for some DU materials.

The other building location north of Building 9204-1 comprises 30,000 ft². It is the former site of a change house that was constructed during the 1940s. Both locations have fire lines and electrical service in close proximity and no major service relocation would be required. The site north of Building 9204-1 would require less site preparation since it is not located within the protected area of the Y-12 Plant.

Figure 8.1. Plan of the Y-12 Plant highlighting candidate building sites.

A new facility would require a number of safety features to meet the requirements of a Category 2 Facility (DOE Order 5480.23, *Nuclear Safety Analysis Reports*), since the quantity of consolidated DU will exceed the threshold for a Category 2 Facility of 719,000 kg (1,585,280 lb) of DU. The principle safety features include design to DOE Order 6430.1A:

- fire alarms
- emergency notification system
- area lighting

Meeting the requirements of the DOE orders translates to a \$200/ft² cost. A new building would take one to two years to plan, bid, procure, and erect. Table 8.12 provides specific cost information.

Table 8.12. Initial and annual cost for a new building at the Y-12 Plant

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR	217,500	21,750
Building cost	4,000,000	0
Facility service cost	0	60,000
Initial & annual cost from Table 8.4	1,072,450	24,070
Total	5,289,950	105,820
Assumptions: <ul style="list-style-type: none"> - Building cost based on \$200/ft² for 20,000 ft². - Annual facility service cost is based on \$3/ft² for 20,000 ft². 		

DOE could grant a waiver to reduce the Category 2 requirements and the new building could be designed and built in compliance with the less stringent uniform building code, which could substantially reduce the building cost.

8.4 STORAGE OPTIONS AT THE K-25 SITE

The K-25 Site has more than 250 buildings with a total of 13,000,000 ft² of floor space. About 10,500,000 ft² comprise the shut down gaseous diffusion production facilities. Four existing buildings at the K-25 Site were identified as candidate sites (Figure 8.2) for storage of the FEMP DU materials: K-25, K-31, K-33, and K-1065-E (Table 8.13). The Waste Management Division at the K-25 Site is the largest user of storage space in these buildings and plans to continue to use them for stored materials such as RCRA, PCBs, radioactive contaminated materials, and lithium materials. Buildings K-25, K-31, and K-33 are former process buildings and are currently ER-owned in the DOE-ER D&D program.

Figure 8.2. Plan of the K-25 Site highlighting candidate sites.

Table 8.13. Candidate buildings for storage at the K-25 Site

Building number	Size (ft ²)	Construction Type	Comments
K-25	4,451,065	Concrete and steel frame	Questionable long-term availability. May be scheduled for demolition within 15 years.
K-31	1,659,628	Concrete and steel frame	Long-term storage of DU not in K-25 Site mission.
K-33	2,780,104	Concrete and steel frame	Long-term storage of DU not in K-25 Site mission.
K-1065-E	48,000	Concrete and steel frame	Could be used for long-term storage of DU, but it would not be consistent with the K-25 Site mission.

The initial cost to store the material at the K-25 Site in Buildings K-25, K-31, or K-33 would be less than the Y-12 Plant storage cost. These buildings are already classified as Category 2 facilities and would not incur the full cost for the SAR. A USQD and a SA would need to be prepared, but this cost should not exceed \$20,000 and three months for completion. The storage areas for these buildings are located in radiological contamination areas, which would require anticontamination clothing be worn by the employees when performing periodic inspections and inventories. Site preparation cost is estimated at \$15,000 for all of the K-25 Site buildings included in this study. The cost elements are discussed in the following subsections.

8.4.1 Building K-1065-E

Building K-1065-E contains 48,000 ft² of floor space with a floor loading capacity of 1,200 lb/ft². It was licensed to house pond waste with the State of Tennessee as an F006 Mixed Waste Storage Facility and could be used to store DU without modification to the state license. The empty building is located outside of the K-25 Site protected area. However, K-25 Waste Management has expressed interest in using this building as a hazardous waste storage facility. The selection of this site as a storage building would require a SAR because the facility would become a Hazard Category 2 Nuclear Facility. Creating new nuclear facilities is not consistent with the current K-25 Site mission. Specific costs for Building K-1065-E are presented in Table 8.14.

Table 8.14. Initial and annual cost for Building K-1065-E

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR	217,500	21,750
Site preparation	15,000	0
Facility service cost	0	57,600
Initial & annual cost from Table 8.4	1,072,450	24,070
Total	1,304,950	103,420
Assumptions: - Annual facility service cost based on storage mission at \$1.20 per ft ² for 48,000 ft ² .		

Since the DU storage would only require approximately 20,000 ft², it could be possible to reduce the annual facility service cost by sharing the building with other tenants.

8.4.2 Building K-25

Storage space is available in Building K-25. However, its short-term demolition schedule and the storage space condition could eliminate this building from the list of long-term storage candidates. Building K-25 is scheduled for demolition within a 15-year time frame. This would require that the material either be utilized in other applications or moved to another facility for continued storage after 15 years. Based on the most optimistic use schedule described in Section 3, this would be a feasible option only if the DU material is used within the 15-year time frame. The storage space in Building K-25 is in the vault area and is subject to high humidity levels and is exposed to water leakage from other parts of the building. Both of these conditions would subject the packages to high moisture conditions which could lead to excessive weather damage of the packages.

Table 8.15 lists the initial and annual costs for Building K-25. Since this building is already a Category 2 facility, the cost for the safety analysis document would be minimal.

Table 8.15. Initial and annual cost for Building K-25

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR (USQD-TSR)	20,000	2,000
Site preparation	15,000	0
Facility service cost	0	28,560
Initial & annual cost from Table 8.4	1,072,450	24,070
Total	1,107,450	54,630
Assumptions: - Annual facility service cost based on available vault area of \$1.20 per ft ² for 23,800 ft ² .		

8.4.3 Buildings K-31 and K-33

Buildings K-31 and K-33 could be used for long-term (up to 50 years) storage. However, K-25 Site's mission does not include the long-term DU storage and would require a decision by DOE to redefine the mission before these buildings could be used. Present plans are to downgrade these buildings from Category 2 facilities. The storage of DU in these buildings would require the maintenance of their Category 2 status.

The K-25 Site Office personnel have had several discussions with DOE-ER personnel regarding the downgrade status of Buildings K-31 and K-33. Activities associated with the downgrade are a part of the proposed K-25 Site S&M Program Task Order. A benefit of reducing the hazard classification to a nonnuclear status would provide cost savings to the S&M Program. Strategies also include making these facilities available for reuse and/or privatization. DU storage could affect that effort.

Table 8.16 lists the building specific estimated initial and annual costs. Since these buildings are already Category 2 facilities, the cost for the SAR would be minimal.

Table 8.16. Initial and annual cost for Buildings K-31 and K-33

Cost Element	Initial cost (\$)	Annual cost (\$)
SAR (USQD-TSR)	20,000	2,000
Site preparation	15,000	0
Facility service cost	0	24,000
Initial & annual cost from Table 8.4	1,072,450	24,070
Total	1,107,450	50,070
Assumptions: - Annual facility service cost based on available vault area of \$1.20/ft ² for 20,000 ft ² .		

9. PROJECT MANAGEMENT

Project management support for the DU consolidation will be required to ensure all tasks involved with the consolidation of the material are implemented according to the required time schedule. It is not anticipated that one full-time project manager would be required, but the collective total support for project oversight; project management through the LMES Task Based Management System; Nuclear Materials Management and Storage support; procurement support; management support from the FEMP Site; and the K-25 Site management support (if that site is selected as a storage option) could equal 0.5 FTE per year.

The cost of the project management support will vary according to the selected storage option. If the material is stored in an existing building, then the support could be concluded within a 12 to 18 months, with an estimated cost between \$100,000 and \$163,000. However, if the decision is made to construct a new facility, the project management support would extend to two years and is estimated to cost \$217,500. The annual support for the materials management after the DU has been consolidated is estimated to cost \$2,000.

10. NONECONOMIC FACTORS

A number of factors affect project implementation that must be handled by senior project officials at DOE and each of these are addressed in the following subsections.

10.1 SITE MISSION VERSUS STORAGE LOCATION

The Y-12 Plant mission includes the stockpile stewardship of strategic materials, such as uranium, for DP. The K-25 Site mission includes the environmental restoration and waste management of the former gaseous diffusion plant. Placing the FEMP DU at the Y-12 Plant is consistent with their mission; placing FEMP DU at the K-25 Site is not.

10.2 OFFICIAL AND PUBLIC PERCEPTION

Storage of the DU at either the Y-12 Plant or the K-25 Site will require a NEPA review and an EA. Whenever possible, DOE will provide enhanced opportunities for public involvement in the EA process.

10.3 SCHEDULE

Completion of the EA will require about 12 to 17 months and presents a limiting factor for the start date of the consolidation effort. A SAR will require 9 to 12 months to complete, but it can be performed in conjunction with the EA and is not a limiting factor. Figures 10.1 and 10.2 illustrate a 12-month and 17-month EA completion time. In order for the DU to be removed from the FEMP Site by October 1997, the ORR would need to be prepared to receive the material by February 1997. Supporting the October 1997 date would require the available options be limited to a location where a minimum amount of site preparation is required, or the use of an interim off-site storage location.

Figure 10.1. Environmental assessment (12 months).

11/29/95

Task

Milestone ◆

Summary ◀────────▶

Figure 10.2. Environmental assessment (17 months).

11/29/95

Task

Milestone ◆

Summary ⇄

11. TOTAL LIFE CYCLE COSTS

The total life cycle costs (initial, annual, escalated) to consolidate the FEMP DU at the ORR is given in Table 11.1 for each option element evaluated. These elements are:

Material Form: The DU is in three material forms, UO_3 , UF_4 , and U-metal. Of the two options examined (e.g., storing the material as is or as metal), only the option to store the DU as is was included in the cost summary. (1 option)

Sampling: Sampling the DU in containers that do not have chemistry information at either the FEMP, the Y-12 Plant, or at an off-site facility all cost about the same; thus, only a single option for sample costs was included. (1 option)

Packages: The costs for the 50-year storage container considered two basic options: a combination of new 55-gallon stainless steel drums for compounds and B-25 boxes for metal, or B-25 boxes for all DU. (2 options)

Repacking: The costs to repack the DU at either the FEMP or the Y-12 Plant were considered. The two options for packaging (above) affect the costs for these two repacking options. (2 options)

Transportation Mode: Only the highway mode of transportation was included in the costs. (1 option)

Storage: The costs for 50-year storage of DU includes the Y-12 Plant and the K-25 Site. At the Y-12 Plant, existing buildings (9201-4, 9204-4, 9213, 9720-24, and 9720-38, or combinations of buildings) and a new building were evaluated. Only existing buildings were considered at the K-25 Site (K-25, K-31, K-33, K-1065-E). (9 options)

Table 11.1. Option elements cost

Option element	Initial cost (\$)	Annual cost (\$)	Escalated cost (\$)	Total cost (\$)
Repacking/packaging				
FEMP				
55-gal SST drums/B-25 boxes	4,506,761	0	0	4,506,761
B-25 boxes	2,018,112	0	0	2,018,112
Y-12				
55-gal SST drums/B-25 boxes	5,132,860	0	0	5,132,860
B-25 boxes	2,406,011	0	0	2,406,011
Transportation (highway)				
FEMP				
55-gal SST drums/B-25 boxes	236,423	0	0	236,423
B-25 boxes	281,707	0	0	281,707
Y-12				
55-gal SST drums/B-25 boxes	293,069	0	0	293,069
B-25 boxes	293,069	0	0	293,069
Storage				
Y-12 Plant				
Building 9201-4	1,789,950	1,707,774	29,700,152	31,490,102
Building 9204-4	1,789,950	198,820	12,259,982	14,049,932
Buildings 9720-24/9213	2,753,150	113,965	14,929,177	17,682,327
Buildings 9720-24/9720-38	2,753,150	122,065	15,990,260	18,743,410
New Building	5,289,950	105,820	13,862,199	19,152,149
K-25 Site				
Building K-25	1,142,450	54,630	7,156,416	8,298,866
Building K-31	1,107,450	50,070	6,559,065	7,666,515
Building K-33	1,107,450	50,070	6,559,065	7,666,515
Building K-1065-E	1,304,950	103,420	13,547,804	14,852,754

The initial cost includes the cost elements developed in the previous sections of the report and are given in Table 11.2. The cost includes EA; project management; NMC&A; radiation protection; sampling; safety analysis report; packaging; transporting; scraping waste containers; building occupancy; and site preparation. The annual costs include utilities; facilities maintenance; nuclear material control and accountability; management; and radiation control. The annual costs are escalated 3.5 percent per year for 50 years. The total costs for each of the elements combine the initial and yearly costs. A management reserve contingency of 15 percent should be added to the initial cost for the options selected in Table 11.1.

To evaluate the total life cycle costs, the costs for the option elements must be summed for the possible combinations. As discussed previously, of the six cost option elements (material form, sampling, packagings, repacking, transportation mode, and storage) only three resulted in more than one cost option, packagings (2 options), repacking (2 options), and storage (9 options). These options combine (2 x 2 x 9) for a total of 36 unique scenarios (Table 11.2). The costs for the DU consolidation scenarios are sorted by increasing total costs.

The decision to implement one of these DU consolidation scenarios will include other noneconomic factors, such as those discussed in Section 10. It may be possible to reduce some of these factors, such as ownership of buildings (DOE-EM versus DOE-DP), to economics.

Table 11.2. DU scenarios sorted by total cost

Repack DU at	DU storage container	Ship by	Storage location	Building	Initial cost (\$)	Annual cost (\$)	50-year escalated costs (\$)	Total cost (\$)
FEMP	B-25 boxes	Highway	K-25 Site	K-31	3,407,269	50,070	6,559,065	9,966,334
				K-33	3,407,269	50,070	6,559,065	9,966,334
Y-12	B-25 boxes	Highway	K-25 Site	K-31	3,806,530	50,070	6,559,065	10,365,595
				K-33	3,806,530	50,070	6,559,065	10,365,595
FEMP	B-25 boxes	Highway	K-25 Site	K-25	3,442,269	54,630	7,156,416	10,598,685
Y-12					3,841,530	54,630	7,156,416	10,997,946
FEMP	55-gal SST drums/B-25 boxes	Highway	K-25 Site	K-31	5,850,634	50,070	6,559,065	12,409,699
				K-33	5,850,634	50,070	6,559,065	12,409,699
				K-25	5,885,634	54,630	7,156,416	13,042,050
Y-12	55-gal SST drums/B-25 boxes	Highway	K-25 Site	K-31	6,533,379	50,070	6,559,065	13,092,444
				K-33	6,533,379	50,070	6,559,065	13,092,444
				K-25	6,568,379	54,630	7,156,416	13,724,795
FEMP	B-25 boxes	Highway	Y-12 Plant	9204-4	4,089,769	198,820	12,259,982	16,349,751
Y-12					4,489,030	198,820	12,259,982	16,749,012
FEMP	B-25 boxes	Highway	K-25 Site	K-1065-E	3,604,769	103,420	13,547,804	17,152,573
Y-12					4,004,030	103,420	13,547,804	17,551,834
FEMP	55-gal SST drums/B-25 boxes	Highway	Y-12 Plant	9204-4	6,533,134	198,820	12,259,982	18,793,116
Y-12					7,215,879	198,820	12,259,982	19,475,861
FEMP	55-gal SST drums/B-25 boxes	Highway	K-25 Site	K-1065-E	6,048,134	103,420	13,547,804	19,595,938
FEMP	B-25 boxes	Highway	Y-12 Plant	9720-24/9213	5,052,969	113,965	14,929,177	19,982,146
Y-12	55-gal SST drums/B-25 boxes	Highway	K-25 Site	K-1065-E	6,730,879	103,420	13,547,804	20,278,683
Y-12	B-25 boxes	Highway	Y-12 Plant	9720-24/9213	5,452,230	113,965	14,929,177	20,381,407
FEMP	B-25 boxes	Highway	Y-12 Plant	9720-24/9720-38	5,052,969	122,065	15,990,260	21,043,229
Y-12					5,452,230	122,065	15,990,260	21,442,490
FEMP	B-25 boxes	Highway	Y-12 Plant	New	7,589,769	105,820	13,862,199	21,451,968
Y-12					7,989,030	105,820	13,862,199	21,851,229
FEMP	55-gal SST drums/B-25 boxes	Highway	Y-12 Plant	9720-24/9213	7,496,334	113,965	14,929,177	22,425,511
Y-12					8,179,079	113,965	14,929,177	23,108,256
FEMP	55-gal SST drums/B-25 boxes	Highway	Y-12 Plant	9720-24/9720-38	7,496,334	122,065	15,990,260	23,486,594
				New	10,033,134	105,820	13,862,199	23,895,333
Y-12	55-gal SST drums/B-25 boxes	Highway	Y-12 Plant	9720-24/9720-38	8,179,079	122,065	15,990,260	24,169,339
				New	10,715,879	105,820	13,862,199	24,578,078
FEMP	B-25 boxes	Highway	Y-12 Plant	9201-4	4,089,769	1,707,774	29,700,152	33,789,921
Y-12					4,489,030	1,707,774	29,700,152	34,189,182
FEMP	55-gal SST drums/B-25 boxes	Highway	Y-12 Plant	9201-4	6,533,134	1,707,774	29,700,152	36,233,286
Y-12					7,215,879	1,707,774	29,700,152	36,916,031

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Mr. R. J. Spence, DOE-ORO

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December 1, 1995

Enclosure: As Stated

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December 1, 1995

Mr. R. J. Spence
Department of Energy, Oak Ridge Operations
Post Office Box 2001
Oak Ridge, Tennessee 37831

Dear Mr. Spence:

**Feasibility Study on Consolidation of Fernald Environmental
Management Project Depleted Uranium Materials**

In reference to your subject letter dated August 8, 1995, enclosed is the final report for the *Feasibility Study on Consolidation of Fernald Environmental Management Project Depleted Uranium Materials*. We endorse your initiative to evaluate options for improved planning and management of nuclear materials and we look forward to your future efforts toward ultimate disposition of surplus fissile materials.

If you have any questions or need additional information regarding this study, please contact S. B. Derrington of the Depleted Uranium Operations at 574-2476 or P. W. Hart of the Nuclear Materials Management and Storage Department at 574-1244.

Sincerely,

F. P. Gustavson
Vice President
Defense and Manufacturing

FPG:tml