1 INTRODUCTION

The U.S. Department of Energy (DOE) is analyzing strategies for the long-term management of the depleted uranium hexafluoride (UF_6) inventory currently stored at three DOE sites near Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. DOE has determined that the selection and implementation of a long-term management strategy for depleted UF_6 is a major federal action with the potential to significantly affect the natural and human environment; thus, preparation of an environmental impact statement (EIS) is required. Because selection of a management strategy is a broad agency action setting the course of a program, this EIS is a programmatic EIS (PEIS). It describes alternative strategies (including current management, storage, use, and disposal) that could be employed in the long-term management of depleted UF_6 and analyzes the potential environmental consequences of implementing each alternative strategy for the period from 1999 through 2039. The PEIS has been prepared in accordance with the *National Environmental Policy Act* of 1969 (NEPA), as presented in the *United States Code* (42 USC 4321 et seq.), and applicable NEPA implementing regulations listed in the *Code of Federal Regulations* (40 CFR Parts 1500-1508 and 10 CFR Part 1021). It is anticipated that one or more follow-on NEPA reviews will be conducted after the Record of Decision for this PEIS to address site selection, technology selection, and facility construction and operation activities.

1.1 BACKGROUND INFORMATION

Uranium is the fuel used in most nuclear reactors and is also a component of nuclear weapons. Uranium is a naturally occurring radioactive element consisting of several isotopes: uranium-238 (99.3%), uranium-235 (0.7%), and uranium-234 (0.005%). These isotopes differ in the number of neutrons in their nuclei. The use of uranium for nuclear weapons and as a fuel in light water nuclear reactors, such as the reactors used to produce electricity in the United States, requires increasing the proportion of the uranium-235 isotope found in natural uranium through an isotopic separation process called enrichment. An enrichment process called gaseous diffusion is currently used in the United States.

The gaseous diffusion process requires uranium in the form of UF_6. UF_6 is a chemical compound consisting of one atom of uranium combined with six atoms of fluorine. It can be a solid, liquid, or gas, depending on its temperature and pressure. (See Appendix A of the PEIS for additional information on the properties of UF_6.) It is used for the gaseous diffusion process primarily because it can conveniently be used as a gas for processing, as a liquid for filling or emptying containers or equipment, and as a solid for storage. At atmospheric pressure, UF_6 is a solid below a temperature of 134°F (57°C) and a gas at temperatures above 134°F. Solid UF_6 is a white, dense, crystalline material that resembles rock salt. Liquid UF_6 is formed only at temperatures greater than 147°F (64°C) and at a pressure somewhat greater than atmospheric pressure.

UF_6 does not react with oxygen, nitrogen, carbon dioxide, or dry air, but it does react with water or water vapor. (For this reason, UF_6 is always handled in leaktight containers and processing equipment.) When UF_6 comes into contact with water, such as water vapor in the air, the UF_6 and water react, forming hydrogen fluoride (HF) and a uranium-fluoride compound called uranyl fluoride (UO_2F_2).

The characteristics of UF_6 pose potential health risks, and the material is handled accordingly. Uranium is radioactive, and UF_6 in storage emits low levels of gamma and neutron radiation. The radiation levels measured on the outside surface of filled depleted UF_6 storage cylinders are typically about 2 to 3 millirem per hour (mrem/h), decreasing to about 1 mrem/h at a distance of 1 ft (0.3 m). In addition, if UF_6 is released to the atmosphere, the uranium compounds and HF that are formed by reaction with moisture in the air can be chemically toxic. Uranium is a heavy metal that, in addition to being radioactive, can have toxic chemical effects (primarily on the kidneys) if it enters the bloodstream by means of ingestion or inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at high enough concentrations. The potential health risks associated with these substances are discussed in further detail in Chapter 4, Sections 4.3.1 and 4.3.2.

The enrichment of uranium by gaseous diffusion requires several steps (Figure 1.1). In the first step, uranium oxide is extracted from natural uranium ore and sent to an industrial facility where it is combined with anhydrous HF and fluorine gas to form UF_6. The product UF_6 is placed into steel cylinders and shipped as a solid to a gaseous diffusion plant for enrichment. The gaseous diffusion process takes a stream of heated UF_6 gas and separates it into two parts, one "enriched" with uranium-235 (i.e., uranium that contains more than 0.7% uranium-235) and the other "depleted" of uranium-235 (i.e., uranium that contains less than 0.7% uranium-235). The enriched UF_6 is generally used to manufacture fuel for nuclear reactors. The depleted UF_6 is stored as a solid in large metal cylinders at the enrichment facility.

The first large-scale uranium enrichment effort in the United States began as part of the atomic bomb development by the Manhattan Project during World War II. Later, enrichment for both civilian and military uses continued under the auspices of the U.S. Atomic Energy Commission and its successor agencies, including DOE. Three large gaseous diffusion plants were constructed to produce enriched uranium, first at the K-25 site[1] on the Oak Ridge Reservation near Oak Ridge, Tennessee, and subsequently at the Paducah site near Paducah, Kentucky, and the Portsmouth site near Portsmouth, Ohio (Figure 1.2). The K-25 plant ceased operations in 1985; however, depleted UF_6 from past operations is currently stored there in large steel cylinders. Depleted UF_6 from past operations at the Paducah and Portsmouth sites is also stored at those two sites in cylinders.

Uranium is still enriched at the Paducah and Portsmouth sites by the United States Enrichment Corporation (USEC). In 1993, the U.S. government created USEC pursuant to the

[1] The K-25 site is now called the East Tennessee Technology Park but is referred to as the K-25 site throughout this PEIS.

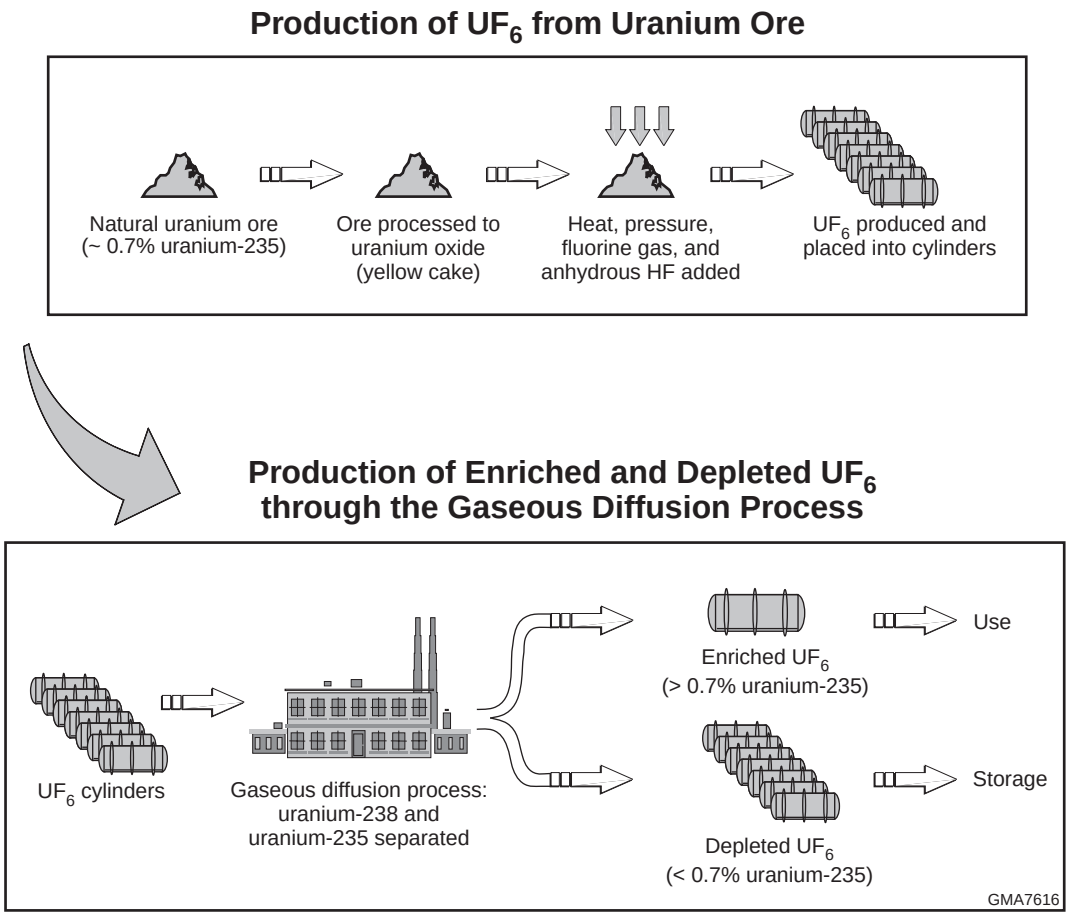

FIGURE 1.1 Schematic Depiction of UF_6 Production and Uranium Enrichment

Energy Policy Act of 1992 (Public Law 102-186) and began the process of privatizing the two operating gaseous diffusion plants. However, after the formation of USEC, DOE retained responsibility for 46,422 cylinders that contained depleted UF_6 produced before 1993 and were being stored at the three sites (28,351 at Paducah, 13,388 at Portsmouth, and 4,683 at K-25). The *USEC Privatization Act* (Public Law 104-134), signed into law on April 26, 1996, provides for the transfer of ownership of USEC from the government to private investors. This act provides for the allocation of USEC's liabilities between the U.S. Government (including DOE) and the new private corporation, including those liabilities for UF_6 cylinders generated by USEC before privatization. The allocation of responsibilities for this depleted uranium is described in a memorandum of agreement (MOA) between the USEC and DOE that was signed in May 1998 (DOE and USEC 1998a). This MOA transfers ownership of approximately 9,400 depleted UF_6 cylinders from USEC to DOE. A second MOA, signed in June 1998, transfers ownership of approximately 2,000 additional depleted UF_6 cylinders to DOE (DOE and USEC 1998b). The total cylinder inventory for which DOE currently has management responsibility consists of approximately 58,000 cylinders. (Additional details about the cylinder inventory are provided in Section 1.5.2).

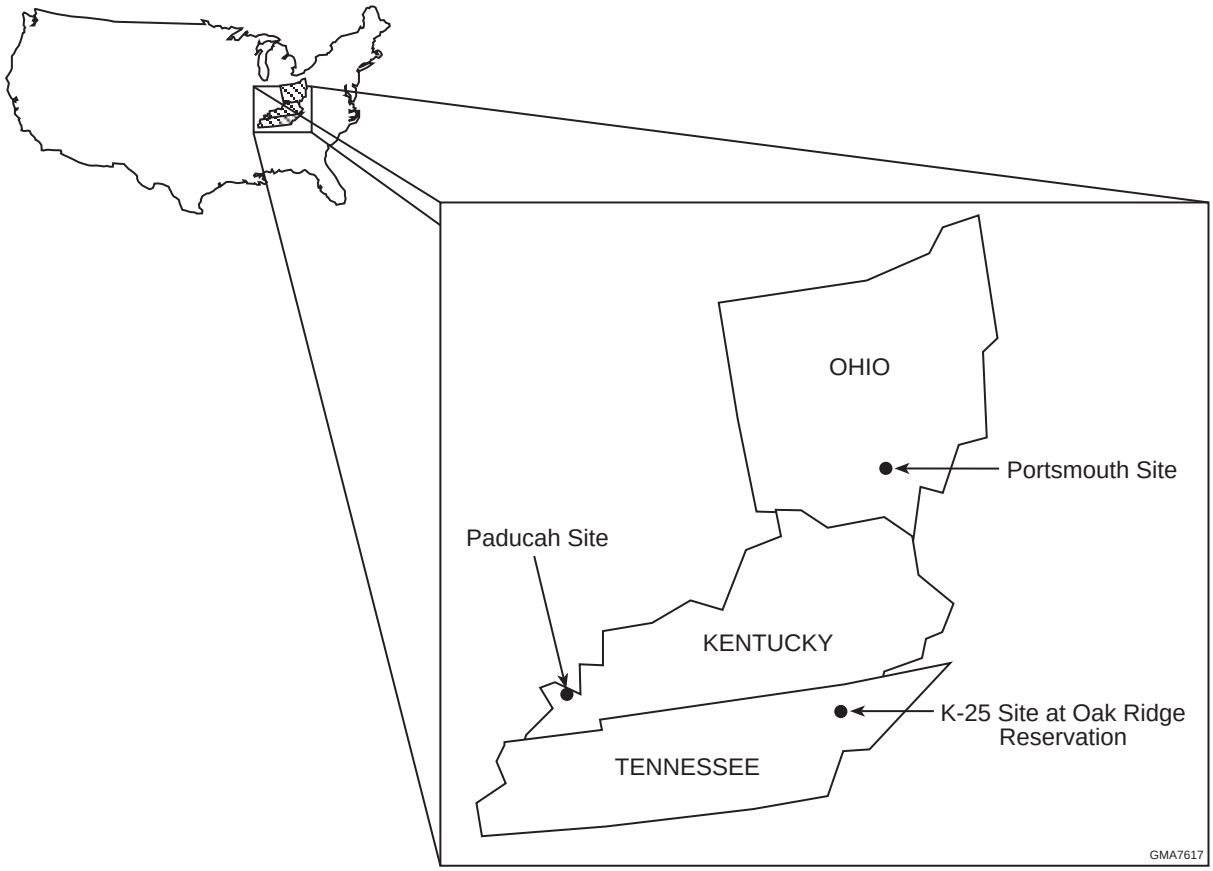

FIGURE 1.2 Depleted UF_6 Storage Locations

Depleted UF_6 has been stored at all three storage sites since the 1950s in large steel cylinders. Several different cylinder types are in use, although the vast majority of cylinders have a 14-ton (12-metric ton) capacity. Two typical cylinder types are shown in Figure 1.3. The 14-ton-capacity cylinders are 12 ft (3.7 m) long by 4 ft (1.2 m) in diameter, with most having a wall thickness of 5/16 in. (0.79 cm) of steel. The cylinders have external stiffening rings that provide support. Lifting lugs for handling are attached to the stiffening rings. A small percentage of the cylinders have skirted ends (extensions of the cylinder walls past the rounded ends of the cylinder), as shown in Figure 1.3. Each cylinder has a single valve for filling and emptying located on one end at the 12 o'clock position. Similar, but slightly smaller, cylinders with a capacity of 10 tons (9 metric tons) are also in use. Cylinders are manufactured in accordance with an American National Standards Institute standard (ANSI N14.1, *American National Standard for Nuclear Materials — Uranium Hexafluoride — Packaging for Transport*) as specified in 49 CFR 173.420, the federal regulations governing transport of depleted UF_6.

Cylinders are initially filled with liquid depleted UF_6, which is allowed to cool over several days. As the liquid UF_6 cools, it contracts, forming a solid that fills approximately 60% of the internal cylinder volume. During storage, a cylinder contains solid UF_6 in the bottom and UF_6 gas

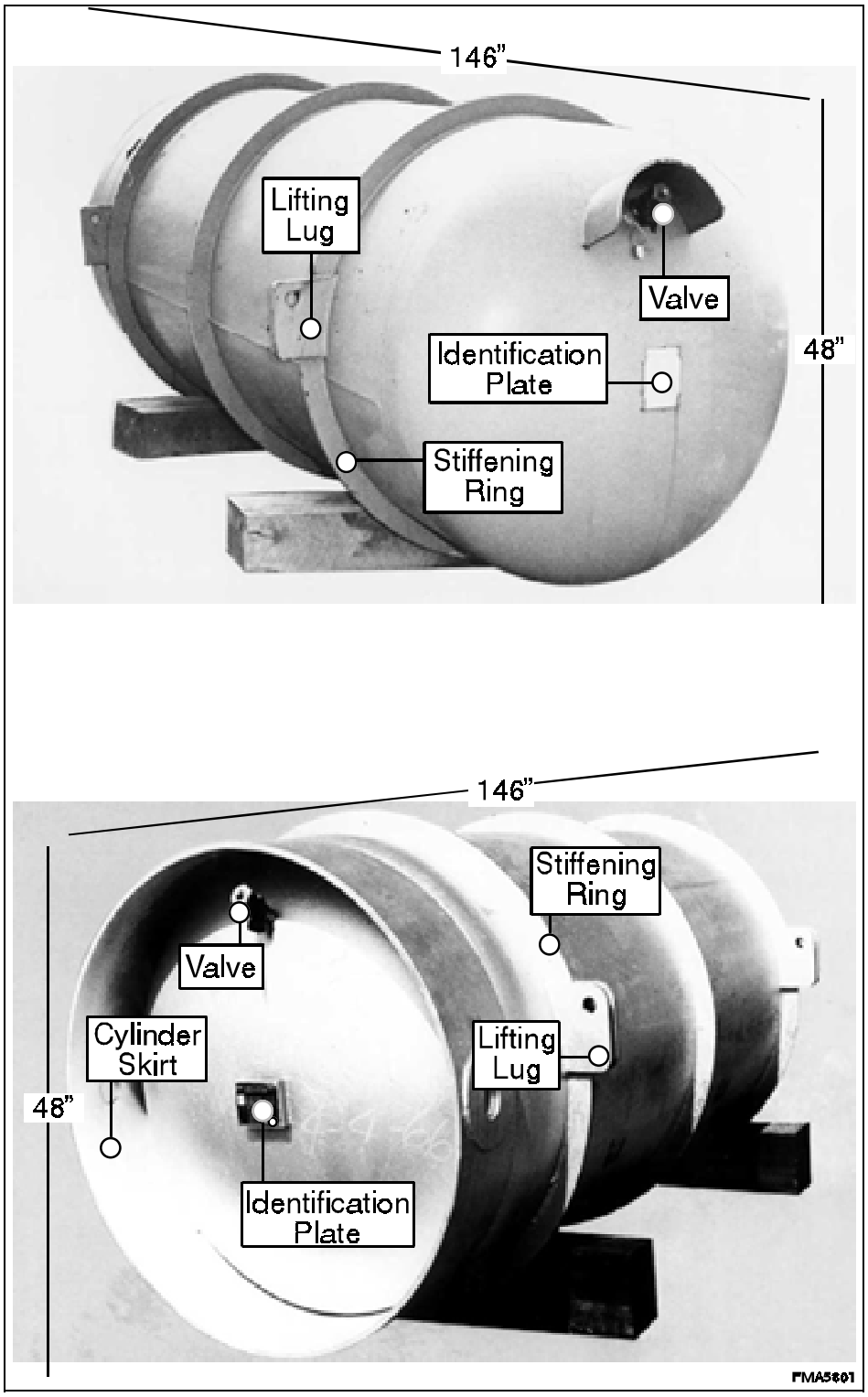

FIGURE 1.3 Typical Depleted UF_6 Storage Cylinders (Cylinders are constructed of steel, with the majority of cylinders having a 14-ton capacity. The bottom cylinder shows a "skirted" end.)

at less than atmospheric pressure in the top. The UF_6 inside the cylinder combines with the iron on the inner surfaces to form a surface layer of iron fluoride that inhibits internal corrosion. Because the pressure within the cylinders is less than atmospheric pressure, if a leak develops, air rushes into the cylinder until the pressure is equalized; UF_6 gas is not released initially, but HF gas is slowly released because moisture in the incoming air reacts with the UF_6.

The depleted UF_6 cylinders managed by DOE at the three sites are typically stacked two cylinders high in large areas called yards (Figure 1.4). Current management of this material requires safe storage, with minimum risks to workers, members of the general public, and the environment. Because storage began in the early 1950s, many of the cylinders now show evidence of external corrosion. Before 1998, seven cylinders (one at Paducah, two at Portsmouth, and four at K-25) had been identified to have developed holes (breaches), generally around spots previously damaged by handling activities. Because the depleted UF_6 is a solid at ambient temperatures and pressures, it is not readily released from a cylinder following a leak or "breach." When a cylinder is breached, moist air reacts with the exposed UF_6 solid and iron, resulting in the formation of a dense plug of solid uranium and iron compounds. The plug tends to block the breach for a period of time, so that release of uranium compounds and HF gas occurs very slowly. When the cylinder breaches are identified, either the breaches are repaired or the cylinder contents are transferred to new cylinders as soon as possible.

DOE maintains an active cylinder management program to improve storage conditions in the cylinder yards, monitor cylinder integrity, conduct routine inspections for breaches, and maintain and repair cylinders as needed. (Details of DOE's cylinder management program are provided in Appendix D.) In 1998, one additional cylinder breach occurred during the course of cylinder maintenance operations (i.e., cylinder painting); previous corrosion modeling had predicted that some additional cylinder breaches might be detected or occur during such activities. (Details on corrosion modeling predictions and breached cylinders are given in Appendix B.) The cylinder management program includes provisions for patching newly identified breached cylinders to eliminate releases of material.

DOE has responsibility for continued management of the depleted UF_6 cylinders stored at the Paducah, Portsmouth, and K-25 sites. The management plan in place during much of the preparation of this PEIS was to continue safe storage of the cylinders and, if no alternative uses for the depleted uranium were found to be feasible by about the year 2010, take steps to convert the UF_6 to triuranium octaoxide (U_3O_8) beginning in the year 2020. The U_3O_8, which is more chemically stable than UF_6,would be stored until there was a determination that all or a portion of the depleted uranium was no longer needed. At that point, the U_3O_8 would be disposed of as low-level radioactive waste (LLW). This plan was based on reserving depleted UF_6 for future defense needs and other potential productive and economically viable purposes, including possible reenrichment in an atomic vapor laser isotope separation plant, conversion of UF_6 to depleted uranium metal for fabrication of

penetrators (anti-tank weapons) for military use, and use as fuel in advanced liquid metal nuclear reactors.[2]

[2] Further details of the former management plan are described in Sewell (1992).

FIGURE 1.4 Depleted UF_6 Cylinders in Storage Yards

Since the former plan was put in place, several developments have occurred that suggest this plan should be revised. For example, the *Energy Policy Act of 1992* assigned responsibility for uranium enrichment and development of atomic vapor laser isotope separation to the USEC, the demand for penetrators has diminished, and the advanced liquid metal nuclear reactor program has been canceled. In addition, stakeholders near the current cylinder storage sites have expressed concerns regarding potential environmental, safety, health, and regulatory issues associated with the continued storage of the depleted UF_6 inventory. The Ohio Environmental Protection Agency issued a Notice of Violation to DOE (which has since been resolved), and the Defense Nuclear Facilities Safety Board (DNFSB) provided a recommendation to the Secretary of Energy regarding improvements in the management of depleted UF_6 (DNFSB 1995).

DOE also entered into a Consent Order with the Department of Environment and Conservation of the State of Tennessee with respect to the management of the depleted UF_6 stored at the K-25 site. DOE has agreed that if it chooses any action alternative as the outcome of this PEIS, it shall, subject to appropriate NEPA review, either remove all known depleted UF_6 cylinders from K-25 or complete the conversion of their contents by December 31, 2009.

In July 1998, the President signed Public Law 105-204 which provides, in part, the following (see Appendix N for the complete text of Public Law 105-204):

> *(a) PLAN. – The Secretary of Energy shall prepare, and the President shall include in the budget request for fiscal year 2000, a Plan and proposed legislation to ensure that all amounts accrued on the books of the United States Enrichment Corporation for the disposition of depleted uranium hexafluoride will be used to commence construction of, not later than January 31, 2004, and to operate, an onsite facility at each of the gaseous diffusion plants at Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle depleted uranium hexafluoride consistent with the National Environmental Policy Act.*

DOE provided its initial plan for the conversion of depleted UF_6, responsive to Public Law 105-204, to Congress on March 12, 1999. In addition, it issued a Request for Expressions of Interest for a Depleted Uranium Hexafluoride Integrated Solution Conversion Contract and Near-Term Demonstrations on March 4, 1999 (U.S. Department of Commerce 1999). Responses to this request will provide DOE with information to develop a detailed procurement strategy for an integrated approach to the management of DOE's depleted UF_6 inventory. A final plan, incorporating information from the private sector and other stakeholders, is expected to be issued later in 1999.

At this time, DOE has not recommended to the President that any additional legislation be proposed. Any proposal to proceed with the location, construction, and operation of a facility or facilities will involve additional review under NEPA.

1.2 PURPOSE AND NEED

The purpose of this PEIS is to reexamine DOE's management strategy for depleted UF_6 and alternatives to that strategy; DOE needs to take action in response to current economic, environmental, and legal developments. This PEIS examines the environmental consequences of alternative strategies of long-term storage, use, and disposal of the depleted UF_6 inventory. A long-term management strategy will be selected in the Record of Decision, which is scheduled to be issued no sooner than 30 days after the issuance of this PEIS.

1.3 PROPOSED ACTION

The proposed action assessed in this PEIS is DOE's selection of a long-term management strategy for depleted UF_6 that will be implemented following the Record of Decision. A strategy is a set of activities or steps for managing depleted UF_6, from its current storage at the three DOE storage sites to ultimate use, long-term storage, or disposal. The alternative strategies considered in the PEIS evaluate options for continued storage of cylinders, conversion of the UF_6 to other chemical forms, use of the uranium as a metal or an oxide, long-term storage, disposal, and/or transportation. The time period for which activities were assessed for all strategies was approximately 40 years: generally 10 years for siting, design, and construction of any required new facilities; about 26 years for operations; and, when appropriate, about 4 years for monitoring.[3] In addition, for the continued storage component of all alternatives and for the disposal alternative, long-term impacts (primarily from potential groundwater contamination) were estimated. The actual implementation schedule would depend on the ultimate strategy selected in the Record of Decision and on other considerations, and activities could continue beyond the 40-year period. DOE will conduct additional NEPA reviews for such activities as appropriate. The alternative management strategies assessed in this PEIS are described and compared in Chapter 2.

The PEIS provides a broad environmental analysis of the various programmatic management strategies available to DOE. DOE identified a preferred management strategy in the draft PEIS and modified the strategy in this final PEIS (see Section 2.5) on the basis of public comments received on the draft PEIS.

1.4 DEPLETED URANIUM HEXAFLUORIDE MANAGEMENT PROGRAM

The Office of Nuclear Energy, Science and Technology within DOE is responsible for the management of the depleted UF_6 generated by enrichment activities and currently stored at the Paducah, Portsmouth, and K-25 sites. To accomplish long-term management, a Depleted Uranium Hexafluoride Management Program was established that includes two sequential phases: (1) selection

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[3] These estimates were meant to provide a consistent analytical timeframe for the evaluation of all of the PEIS alternatives and do not represent a definitive schedule.

of a strategy for long-term management of depleted UF_6 followed by (2) implementation of the strategy selected, including selection of specific technologies, locations, facilities, and processes that may be required. The first program phase, strategy selection, is currently proposed and is the subject of this PEIS. A Record of Decision for this PEIS is expected to be published in the *Federal Register* (FR) no sooner than 30 days after the issuance of this PEIS. The Record of Decision for Phase I will be based on the results of this PEIS, as well as other information, including the information presented in a cost analysis report and an engineering analysis report (Figure 1.5). The Record of Decision will document the management strategy selected and will describe how it was selected from among several alternatives. One consideration in selecting a strategy is the assessment of potential environmental impacts associated with the alternatives.

A Two-Phased Approach: Two Levels of Decision Making

The Depleted Uranium Hexafluoride Management Program is pursuing a two-phased approach to long-term management of depleted uranium hexafluoride (UF_6).

Phase I is the subject of this PEIS and concerns the selection of a long-term management strategy. A strategy is a general approach to managing depleted UF_6, such as long-term storage, use, or disposal of some or all of the material. The strategy selected in Phase I will be announced in a Record of Decision to be issued no sooner than 30 days after the issuance of this PEIS. The selected strategy will identify major management activities required for ultimate disposition of depleted UF_6. Specific sites or technologies to be used would be identified in the next phase.

Phase II will begin following the Record of Decision and will involve the evaluation and selection of specific sites and technologies necessary to implement the strategy selected in Phase I. Phase II will include appropriate NEPA reviews for site and technology selection activities.

To support the evaluation of alternative management strategies for Phase I, DOE conducted engineering analyses to identify the technical characteristics associated with various potential management alternatives. The engineering analyses resulted in the preparation of two reports: the technology assessment report, *Technology Assessment Report for the Long-Term Management of Depleted Uranium Hexafluoride*, which was released on June 30, 1995 (Lawrence Livermore National Laboratory [LLNL] 1995); and the engineering analysis report, *Depleted Uranium Hexafluoride Management Program; Engineering Analysis Report for the Long-Term Management of Depleted Uranium Hexafluoride* (LLNL 1997a), which was released in May 1997.

Prior to preparing these two reports, DOE issued a Request for Recommendations (59 FR 56324) on November 10, 1994, soliciting suggestions for potential uses of depleted UF_6 and for any technologies that could facilitate the long-term management of depleted UF_6. The responses were evaluated by independent technical reviewers and documented in the technology assessment report. The technology assessment report evaluates the potential feasibility of uses for the depleted UF_6 and of technologies for converting the material to other chemical forms, and provides a consolidation of

the reviewers' evaluations of all recommendations received. These evaluations, along with other considerations, were used to develop representative technology options considered in this PEIS. |

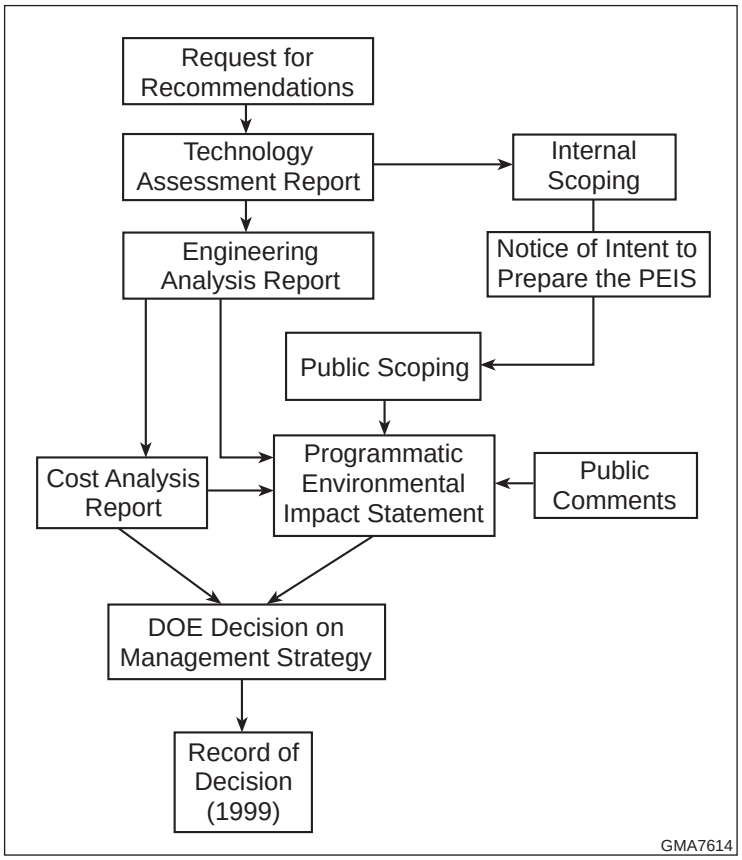

FIGURE 1.5 First Phase of the Depleted Uranium Hexafluoride Management Program

The engineering analysis report (LLNL 1997a) provides a more detailed, in-depth technical analysis of representative management options identified in the technology assessment report. It provides design and operational data for several different types of activities, including options for the preparation of UF_6 cylinders for shipment, conversion of UF_6 to other chemical forms, long-term storage of uranium material, manufacture and use of products containing uranium, and disposal. The engineering analysis report is the primary source of technical data and information for the alternatives evaluated in this PEIS and is incorporated by reference. The engineering analysis report includes descriptions of facility layouts, resource requirements, and construction requirements; estimates of effluents, wastes, and emissions during operations; and descriptions and estimated frequencies for a range of potential accident scenarios. These facility design data, as well as environmental setting information, were used as input to the calculational models or "tools" for estimating potential environmental impacts that could result under each alternative. LLNL's summary of the engineering analysis report is included in its entirety in Appendix O.

DOE also initiated a separate study of the costs of various technology options. The engineering analysis, including the technology assessment report and engineering analysis report, serves as the basis for the cost analysis, which provides estimates of the life-cycle costs associated

with long-term management strategies for depleted UF_6. The cost analysis report (LLNL 1997b) was released in May 1997.

Following publication of its Record of Decision, DOE plans to begin a process for selecting sites and technologies necessary to implement the selected strategy. This latter activity is referred to throughout this PEIS as the "second tier," or "Phase II," of DOE decisions regarding depleted UF_6 management. The second tier will include the appropriate NEPA analyses and reviews needed for decisions on site selection, selection of specific technologies for management activities, type and design of facilities, and vendors' industrial processes, as required by the selected alternative.

1.5 SCOPE OF THIS PEIS

Scope refers to the range of actions, alternatives, and impacts to be considered in an EIS. An agency generally determines scope through a two-part process: internal scoping and public scoping. Internal scoping refers to efforts within the agency to identify potential alternatives, identify important issues, and determine the analyses to be included in an EIS. Public scoping refers to the request for public comments on the proposed action and on the results of internal scoping. Public scoping includes consultation with federal, state, and local agencies as well as requests for comments from stakeholder organizations and members of the general public.

On the basis of input received during the public scoping process, the federal agency responsible for the proposed action (DOE) prepares a draft EIS and makes it available to the public for their review and comment. The "public" is broadly defined and includes any and all interested or affected parties, including interested or affected private citizens; state, local, and tribal governments; environmental groups; and civic and community organizations. The responsible agency evaluates the comments received and revises the EIS before issuing it as a final document. The public scoping process for this PEIS is summarized in Section 1.5.1.1. The public review of the draft PEIS and major changes made to the draft before the issuance of the final PEIS are outlined in Section 1.5.1.2.

1.5.1 Public Participation

1.5.1.1 Summary of Public Scoping for the Draft PEIS

DOE published a Notice of Intent to prepare this PEIS, entitled *Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride*, on January 25, 1996 (61 FR 2239), beginning a 60-day scoping period. The Notice contained DOE's preliminary results of internal scoping, including a description of the proposed action, alternatives, and approach to EIS preparation. In addition to providing information on the PEIS, the Notice of Intent invited public participation in determining the scope of the PEIS. Comments were requested by correspondence and by participation in one or more public scoping meetings.

Three PEIS public scoping meetings were held between February 13 and February 20, 1996 — one near each depleted UF_6 storage site. A total of 300 persons attended the meetings, and 169 comments were received. DOE also provided several alternative means for public involvement. A fact sheet titled "Overview of the Programmatic Environmental Impact Statement" was mailed to more than 3,800 individuals and organizations identified by the three current storage sites and through the DOE stakeholder mailing list as parties potentially interested in the PEIS. The fact sheet requested comments and gave directions on how comments should be sent to DOE. In addition, a World Wide Web site was developed, which included an overview of the project, fact sheets, links to other useful Internet sites (e.g., DOE's NEPA Internet site), and directions on how to comment.

The public scoping process generated a total of 235 comments on the proposed scope of the PEIS. These comments were examined to finalize the proposed scope of the PEIS. Comments were related primarily to nine major issues: (1) general environmental concerns, (2) current management, (3) storage, (4) conversion, (5) use, (6) cost, (7) disposal, (8) transportation, and (9) policy issues. Appendix L of this PEIS provides a summary of these comments and a discussion of the comments' effects on the scope of the PEIS, including where scope was changed and where change in scope was inappropriate.

1.5.1.2 Public Review of the Draft PEIS

The draft PEIS was mailed to stakeholders in mid-December 1997, and a notice of availability was published by the U.S. Environmental Protection Agency (EPA) in the *Federal Register* on December 24, 1997. In addition, the entire PEIS was also made available on the World Wide Web at the same time. Stakeholders were encouraged to provide comments on the draft PEIS during a 120-day review period, from December 24, 1997, until April 23, 1998. Comments could be submitted by a toll-free number, by fax, by letter, by e-mail, or through the World Wide Web site. Comments could also be submitted at four public hearings held during a period from February 19, 1998, to March 10, 1998. Public hearings were held near each of the three current storage sites (Paducah, Kentucky; Oak Ridge, Tennessee; and Portsmouth, Ohio) and another in Washington, D.C.

A total of about 600 comments were received during the comment period. The comments received and DOE's responses to those comments are presented in Volume 3 of this PEIS. Several revisions were made to the draft PEIS on the basis of the comments received. A summary of the major issues raised by the reviewers of the draft PEIS and DOE's resolution of these issues are as follows:

- *Comments related to the preferred alternative.* Many of the reviewers questioned DOE's preference for beginning to convert the depleted UF_6 inventory to uranium oxide or uranium metal only as uses for these materials became available. Several reviewers expressed a desire for DOE to start conversion as soon as possible. Conversion to U_3O_8 was the option most often cited as preferred, although several reviewers thought conversion to metal

would be more advantageous. In addition, many reviewers expressed doubt about the prospects for any widespread uses for depleted uranium now or in the future.

After careful consideration of comments, DOE revised the preferred alternative for the final PEIS. The preferred alternative, as stated in Section 2.5 of this final PEIS, calls for prompt conversion of the depleted UF_6 inventory to U_3O_8 and long-term storage of that portion of the U_3O_8 that cannot be put to immediate use. Under this revised preferred alternative, conversion to depleted uranium metal would take place only if uses for the metal products become available. The impacts of the preferred alternative are discussed in Sections 2.5.2, 5.7, and 6.3.7 of the PEIS.

- *Comments related to seismic hazards at the Paducah site.* Several reviewers commented that the draft PEIS did not adequately address the seismic hazards at the Paducah site. They requested that DOE review new information that came to light very recently and reevaluate the risks associated with potential earthquakes at Paducah.

  In response, DOE reviewed those references that were available at the time this final PEIS was prepared. DOE determined that the analyses performed as part of the safety analysis reports recently completed at the three current storage sites (including Paducah) and for this PEIS were adequate. However, one reference identified in a comment from the State of Kentucky was not available in time to be considered in the preparation of the final PEIS. DOE will review that reference and any other data when they become available and take appropriate action to maintain the safety basis of its cylinder management program. In addition, if new facilities are to be constructed at Paducah or any other site, the latest information concerning seismic hazards at that site would be factored into the design of the new facilities.

- *Comments related to potential life-cycle impacts.* Several reviewers stated that depleted uranium and products made from using depleted uranium in various chemical forms would eventually need to be disposed of. They requested that the PEIS include a discussion of impacts for the disposal of these materials following long-term storage and use. The draft PEIS had included a discussion of potential impacts from management activities through the year 2039 for all alternatives and evaluation of long-term impacts (primarily from groundwater contamination) from the continued storage component of all alternatives and for the disposal alternative.

  In response to commentors' requests for life-cycle impact analysis, a new section was added to this PEIS (Section 5.9) to discuss issues related to the potential impacts of the long-term (beyond 2039) management of materials

containing depleted uranium under all alternatives. However, because of the uncertainties associated with the events that would occur far into the future and with the regulatory atmosphere at that time, the discussion is limited to issues that would need to be considered and the options that would be available for managing the material beyond 2039.

- *Comments related to the cylinder inventory.* Several reviewers questioned the accuracy of the reported number of DOE-owned cylinders of depleted UF_6 (46,422) considered in the draft PEIS. Other reviewers requested that USEC-generated cylinders also be included within the scope of the PEIS.

  Upon review, confusion related to the size of the DOE cylinder inventory appears to have resulted because the numbers published in various DOE reports sometimes included only the full cylinders of depleted UF_6 and other times included not only the full cylinders but also heel cylinders and cylinders containing natural UF_6. Although the number 46,422 that is used in the draft PEIS was accurate at the time the document was published, subsequent privatization of USEC and transfer of some cylinders from USEC to DOE changed the inventory of depleted UF_6 that falls within the scope of the PEIS (see Section 1.5.2). Chapter 6 has been added to the PEIS and Chapter 2 and the Summary have been revised so the PEIS includes the impacts associated with the management of additional USEC-generated cylinders. The heels cylinders are also included in the scope of the PEIS (see Section 1.5.2).

- *Comments related to current cyclinder management.* Several reviewers raised questions and concerns about the current management of the cylinders at the three DOE locations.

  In response to these concerns, it has been emphasized that DOE's current cylinder management program provides for safe storage of the depleted UF_6 cylinders. DOE is committed to the safe storage of the cylinders at each site during the decision-making period and also through the implementation of the decision made in the Record of Decision. DOE has an active cylinder management program that involves upgrading cylinder storage yards, constructing new yards, repainting cylinders to arrest corrosion, and regular inspection and surveillance of the cylinders and storage yard conditions.

The changes made in response to public comments, including the inclusion of up to 15,000 USEC cylinders, did not affect the types or overall significance of the environmental impacts presented in the draft PEIS. Although the estimated impacts did increase by up to 30% in some assessment areas, this increase was generally not significant because the impacts were typically small to begin with. Many impacts did not change at all as a result of including the USEC cylinders because these impacts were related to factors that were unaffected by the inventory increase. For example,

the consequences of potential accidents did not increase, because accidents generally involve only a limited amount of material that would be available, regardless of the overall inventory. In addition, other impacts did not change because they were related to the annual material processing rates, which were assumed to remain the same when the USEC cylinders were included. Consequently, it was not necessary to recirculate the draft PEIS for additional public review. The nature and magnitude of changes in environmental impacts resulting from the addition of USEC cylinders are discussed in Sections 2.4, 2.5, and Chapter 6 of this PEIS.

1.5.2 Cylinder Inventory

This PEIS considers the depleted UF_6 inventory stored at the Paducah site, Portsmouth site, and K-25 site on the Oak Ridge Reservation for which DOE has management responsibility. This inventory includes depleted UF_6 generated by DOE before the formation of USEC in July 1993 as well as depleted UF_6 generated by USEC that has been or will be transferred to DOE. Specifically, the PEIS considers the management of 46,422 cylinders generated by DOE and up to 15,000 cylinders generated by USEC.

The depleted UF_6 inventory generated by DOE before July 1993 consists of 46,422 cylinders that contain approximately 560,000 metric tons of UF_6; of these, 28,351 cylinders are located at Paducah (342,000 metric tons), 13,388 are at Portsmouth (161,000 metric tons), and 4,683 are at K-25 (56,000 metric tons).

In addition to the DOE cylinder inventory, management responsibility for approximately 11,400 depleted UF_6 cylinders (about 137,000 metric tons) was transferred from USEC to DOE by the signing of two MOAs. The MOA between DOE and USEC related to depleted uranium generated before the privatization date was signed in May 1998 (DOE and USEC 1998a). It transferred management responsibility for approximately 9,400 cylinders (about 6,600 cylinders stored at Paducah and about 2,800 stored at Portsmouth) from USEC to DOE. A second MOA between DOE and USEC related to depleted uranium, signed in June 1998, transfers approximately 2,000 depleted UF_6 cylinders from USEC to DOE between 1999 and 2004 (DOE and USEC 1998b). (The locations of these cylinders are not specified in this second agreement.)

To account for uncertainties related to the management of depleted UF_6 generated by USEC in the future, the analysis in the PEIS considers management of up to 15,000 USEC-generated cylinders (approximately 180,000 metric tons). For the purposes of analysis, it was assumed that 12,000 of the USEC-generated cylinders would be managed at Paducah and 3,000 would be managed at Portsmouth.

Also included in the scope of this PEIS is a total of approximately 200 cylinders at the three sites that contain small amounts of material. These cylinders, which are termed “heels” cylinders, contain a total of about 2,300 lb of depleted UF_6, less than 0.0002% of the inventory. A cylinder heel is defined as the residual amount of nonvolatile material remaining in a cylinder after removal of the

depleted UF_6. For this PEIS, it has been assumed that the heels cylinders will continue to be safely stored under the cylinder management program. If a management strategy that involves conversion is selected, these existing heels cylinders will be treated in the same way as the heels cylinders that would be generated from the conversion process. Details on the treatment of heels cylinders are given in Appendix F, Section F.2.

1.5.3 Alternative Management Strategies and Types of Activities

The alternatives that are evaluated and compared in this PEIS represent the consensus of both DOE and the general public regarding reasonable strategies for the long-term management of depleted UF_6. The alternative management strategies were developed and announced in the Notice of Intent to prepare this PEIS. The following alternatives are assessed in the PEIS: the no action alternative, which considers continuation of current cylinder storage and management practices indefinitely; two long-term storage alternatives; two use alternatives; and one disposal alternative. These alternatives, as well as DOE's preferred alternative, are described in detail in Chapter 2.

In addition to the management strategies considered in this PEIS, the use of some depleted UF_6 is being considered pursuant to other DOE programs, such as the disposition of surplus plutonium. Uses being considered by other DOE programs, which are subject to future decisions and other NEPA reviews, would generally involve only a small fraction of the depleted UF_6 inventory currently in storage and would not affect the selection of a long-term management strategy.

At the time of public scoping, the no action alternative was based on the course of action outlined by Sewell (1992) (Section 1.1). This course of action included chemical conversion of depleted UF_6 to the oxide U_3O_8, beginning in the year 2020 and continuing for 20 years, followed by storage of the U_3O_8. After public scoping and based on internal DOE reviews, the no action alternative was modified to be the continued storage of UF_6 cylinders indefinitely at the three current storage sites.

Each alternative consists of several management activities. The types of management activities included in the alternatives have been grouped into seven major categories, as shown in Figure 1.6. Within each category, several representative options, consisting of either design or technology variations, were considered. It is important to note that the options are representative in nature and were selected to provide a basis for comparing broad, programmatic management strategies. These seven categories of activities formed the main building blocks for evaluating all of the alternatives in the PEIS — each alternative strategy is composed of a combination, or series, of several of these management activities. The following categories of activities were included:

- ***Continued Cylinder Storage:*** Depleted UF_6 cylinders would continue to be stored in yards at the three current storage sites for some period of time for all alternatives. During that time, current cylinder management practices would continue to ensure that cylinders were maintained in a safe condition.

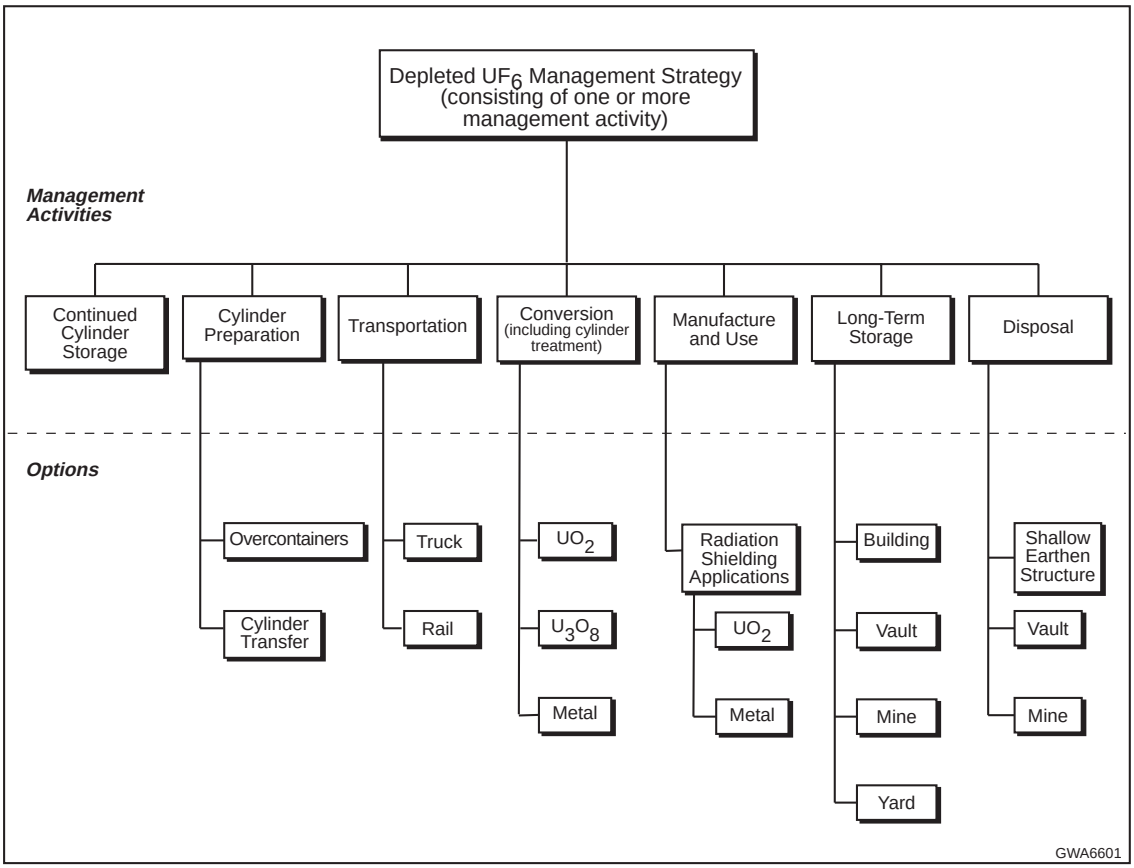

FIGURE 1.6 Options for Depleted UF_6 Management Activities (All alternative strategies consist of some combination of these activities.)

- ***Cylinder Preparation Options:*** If depleted UF_6 cylinders were to be shipped from the current storage sites, some cylinders might require preparation to make them suitable for transportation. Two options were considered for these activities: (1) use of overcontainers, which are large metal containers certified to meet U.S. Department of Transportation (DOT) shipping requirements, into which cylinders could be placed, and (2) use of a cylinder transfer facility, which could be used to transfer the UF_6 contents from old cylinders to new cylinders.

- ***Transportation Options:*** It is possible that the cylinders might have to be transported from the current storage sites, depending on the ultimate locations selected for conducting future management activities. Therefore, the transport of cylinders by both truck and rail was evaluated. Also considered was the transport of all other materials that might be required for or produced by the different alternative strategies.

- ***Conversion Options:*** Some alternatives would involve the conversion of depleted UF_6 into another chemical form prior to long-term storage, use, or disposal. The different chemical forms of uranium considered include two uranium oxides — U_3O_8 and uranium dioxide (UO_2) — and uranium metal. The treatment of emptied cylinders is also considered.

- ***Manufacture and Use Options:*** Depleted UF_6 could potentially be used to manufacture products with beneficial applications. The analysis in this PEIS considered, as a representative application, the use of a converted form of depleted UF_6 to manufacture a dense material to be used for shielding against gamma radiation. The selection of shielding as a representative use option is not intended to imply that the PEIS will be used to select a specific end-use or will preclude other uses.

- ***Long-Term Storage Options:*** Depleted UF_6 cylinders or uranium oxide (following conversion) could be placed into long-term storage. Four different long-term storage options were considered: buildings, belowground vaults, mines, and yards.

- ***Disposal Options:*** Depleted UF_6 could be disposed of as LLW following conversion to an oxide form. Three disposal facility options were considered: shallow earthen structures, belowground vaults, and mines.

Impacts resulting from the decontamination and decommissioning of any required facilities are expected to be relatively small when compared with the impacts resulting from the construction and operation of these facilities. Inclusion of the decontamination and decommissioning impacts would not affect the comparison of the programmatic alternatives analyzed and the conclusions reached in this PEIS. The decontamination and decommissioning impacts would be considered in the follow-on site-specific and facility-specific environmental planning and analysis documents.

1.5.4 Environmental Setting Considerations

Because this PEIS is an analysis of programmatic strategies, rather than specific siting alternatives, certain impacts have been assessed using representative or generic environmental settings. In particular, impacts associated with potential conversion, long-term storage, manufacturing, transportation, and disposal activities were assessed assuming representative or generic site environmental conditions. The purpose of this approach was to provide as substantive an assessment as possible and to allow for a comprehensive comparison of alternative management strategies. The activities that would normally take place at the current storage sites (Paducah, Portsmouth, and K-25) were assessed using site-specific data. These activities include continued cylinder storage and cylinder preparation for off-site shipment.

After the Record of Decision, DOE would evaluate potential facility locations and whether the facilities would be owned or operated by the private sector or the federal government. Depending on the strategy selected, DOE would evaluate a range of reasonable alternatives to select the sites for potential conversion, long-term storage, manufacturing, and disposal facilities. These subsequent analyses would be performed using site-specific environmental data.

Site selection activities would include an evaluation of site characteristics, such as the site's potential response to seismic events, potential for flooding, and geology, to ensure that suitable locations were chosen. Following site selection, any new facilities would be designed and built to meet engineering and construction standards and requirements appropriate for the selected location and the mission of the facility.

Environmental Settings Used in the PEIS Analysis

Existing site environmental settings were used for analysis of continued cylinder storage activities for all alternatives. Site-specific data were also used for analysis of cylinder preparation activities for off-site shipment of cylinders. The depleted UF_6 cylinders are currently located at the Paducah site, Portsmouth site, and K-25 on the Oak Ridge Reservation.

Generic environmental settings were used for analysis of manufacturing, disposal, and long-term storage in mines. These settings were selected on the basis of generalized environmental characteristics — such as a wet (or eastern United States) location and a dry (or western United States) location.

Representative environmental settings were used for analysis of conversion and long-term storage in yards, buildings, and vaults. These settings were selected on the basis of conditions at sites that, although not proposed for that activity, might be somewhat similar to an eventual site. In this PEIS, the conditions at the current storage sites were used to define a range of representative environmental settings. For the transportation analysis, representative route characteristics were based on national-average data.

1.5.5 Human Health and Environmental Issues

This PEIS evaluates and compares the potential impacts on human health and the environment for the alternative management strategies considered. In general, the PEIS emphasizes those impacts that may differentiate among alternatives or are of special interest to the general public (such as potential radiation effects). The assessment of potential environmental impacts is based primarily on the preliminary engineering data included in the engineering analysis report (LLNL 1997a). That report contains data on cylinder preparation and transportation, conversion, manufacturing, long-term storage, and disposal. The report includes descriptions of facility layouts; discussion of resource requirements; estimates of effluents, wastes, and emissions; and descriptions of potential accident scenarios for the depleted UF_6 management options considered in this PEIS (see Appendix O for a summary of the engineering analysis report).

The PEIS includes the assessment of impacts to human health and safety, air, water, soil, biota, socioeconomics, cultural and archeological sites, site waste management capabilities, resource requirements, and environmental justice. Issues judged by DOE to be of greatest concern or public

interest, and receiving more detailed analysis, include impacts to human health and safety, air and water, waste management capabilities, and socioeconomics. These issues are consequently treated in greater detail in the PEIS.

The environmental impacts for each alternative were determined by combining, as appropriate, the potential impacts associated with each of the individual activities that would be required to implement the alternative. The level of analysis conducted depended on the specific activity considered. The potential impacts during continued cylinder storage and cylinder preparation for shipment activities were evaluated for the environmental settings at the three current storage sites; potential impacts of conversion, manufacture and use, long-term storage, transportation, and disposal activities were evaluated for representative or generic environmental settings (see Chapter 3 for descriptions of the affected environments of these settings). The intent of the analysis at representative or generic environmental settings was to estimate a reasonable range of potential impacts to allow for a meaningful comparison of alternative strategies. Subsequent analysis with site-specific environmental data will be performed during the Phase II studies and NEPA reviews.

Estimating environmental impacts for alternative approaches to depleted UF_6 management is subject to uncertainty, primarily as a consequence of the (1) preconceptual nature of facility designs, (2) unknown location of future facilities, and (3) characteristics of the methods used to estimate impacts. This impact assessment was designed to ensure — through selection of assumptions, models, and input parameters — that impacts would not be underestimated and that relative comparisons among the alternatives would be valid and meaningful. This approach was developed by uniformly applying common assumptions to each alternative and by choosing assumptions intended to produce conservative estimates of impacts — that is, assumptions that would lead to overestimates of the expected impacts. Although uncertainty may characterize estimates of the absolute magnitude of impacts, a uniform approach to impact assessment enhances the ability to make valid comparisons among alternatives. This uniform approach was implemented in the analyses conducted for the PEIS to the extent practicable.

1.6 RELATIONSHIP TO OTHER NEPA REVIEWS

DOE has prepared, or is in the process of preparing, other NEPA reviews that are related to the management of depleted UF_6 or to the three current depleted UF_6 storage sites. These NEPA reviews are as follows:

- *Disposition of Surplus Highly Enriched Uranium, Final Environmental Impact Statement* (DOE 1996a): This EIS addresses the disposition of a nominal 200 metric tons of highly enriched uranium declared surplus to the national security needs of the United States. Alternatives include several approaches for blending down the highly enriched material to make it nonweapons-usable and suitable for fabrication into fuel for use in commercial nuclear reactors. Commercial use alternatives included transferring up to

50 metric tons of highly enriched uranium to USEC facilities for blending with natural uranium. The draft EIS was issued in October 1995 and the final EIS in June 1996. The Record of Decision (August 5, 1996) calls for blending, over time, as much material as possible (up to 85%) for commercial use, and blending the remainder for disposal as low-level waste. This EIS is related to the Depleted UF_6 PEIS in that USEC facilities are located at two of the current storage sites for depleted UF_6, Paducah and Portsmouth. The cumulative impacts analysis in the Depleted UF_6 PEIS takes into account the results of this EIS on disposition of highly enriched uranium.

- *Proposed Sale of Radioactively Contaminated Nickel Ingots Located at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Environmental Assessment* (DOE 1995b): This environmental assessment evaluates the impacts of the sale of radioactively contaminated materials, primarily nickel, that have potential value as a resource. These materials are stored at the Paducah Gaseous Diffusion Plant on the Paducah site. The final environmental assessment and Finding of No Significant Impact were issued in October 1995. This environmental assessment is related to the Depleted UF_6 PEIS because Paducah is currently a storage site for depleted UF_6. The cumulative impacts analysis in the Depleted UF_6 PEIS takes into account the results of this environmental assessment.

- *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a): This EIS comprises a complexwide evaluation of reasonable alternatives for managing existing and reasonably foreseeable amounts of spent nuclear fuel within the DOE inventory through the year 2035. This inventory includes the spent nuclear fuel currently stored at Oak Ridge National Laboratory on the Oak Ridge Reservation. This EIS contains an analysis of the transportation of spent nuclear fuel. That analysis has been referenced where relevant to the transportation analysis for the Depleted UF_6 PEIS. It is also related to the Depleted UF_6 PEIS because if a use alternative were selected, uranium-shielded casks could be used to store spent nuclear fuel. The final EIS was issued in April 1995, and a Record of Decision selecting three regionalized DOE locations for management of spent nuclear fuel (Hanford, Idaho National Engineering Laboratory, and the Savannah River Site) was issued in June 1995.

- *Refurbishment of Uranium Hexafluoride Cylinder Storage Yards C-745-K, L, M, N, and P and Construction of a New Uranium Hexafluoride Cylinder Storage Yard (C-745-T) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Environmental Assessment* (DOE 1996e): This environmental

assessment addresses improvements to depleted UF_6 cylinder storage conditions at the Paducah site. It includes both refurbishment of existing storage yards and construction of a new storage yard. A Finding of No Significant Impact has been issued for these activities. In the Depleted UF_6 PEIS, the upgrades planned to occur prior to 1999 are considered to be part of the affected environment for the Paducah site.

- *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996c): This EIS evaluates the potential environmental impacts resulting from activities associated with nuclear weapons research, design, development, and testing, as well as assessing and certifying their safety and reliability. The stewardship portion of the document analyzes the development of three new facilities to provide enhanced experimental capability. The stockpile management portion of this EIS concerns producing, maintaining, monitoring, refurbishing, and dismantling the nuclear weapons stockpile at eight possible sites, including the Oak Ridge Reservation. The final PEIS was released in November 1996, and the Record of Decision was issued on December 26, 1996 (61 FR 68014). A decision was made to downsize certain facilities at the Y-12 Plant on the Oak Ridge Reservation. This EIS is related to the Depleted UF_6 PEIS only because the K-25 site is part of the Oak Ridge Reservation. The cumulative impacts analysis in the Depleted UF_6 PEIS takes into account the results of this EIS on stockpile stewardship.

- *Storage and Disposition of Weapons-Usable Fissile Materials, Final Programmatic Environmental Impact Statement* (DOE 1996d): This EIS evaluates the environmental impacts of alternative approaches for the long-term storage and disposition of weapons-usable fissile materials — that is, highly enriched uranium and weapons-usable plutonium. Alternatives for long-term storage included the no action alternative, upgrade at multiple sites, consolidation of plutonium at one site, and colocation of plutonium or highly enriched uranium at one site. In a Record of Decision issued in January 1997, DOE decided, in part, to store highly enriched uranium in upgraded and consolidated facilities at the Y-12 Plant on the Oak Ridge Reservation. This EIS relates to the Depleted UF_6 PEIS because the K-25 site is also located on the Oak Ridge Reservation. The cumulative impacts analysis in the Depleted UF_6 PEIS takes into account the results of this EIS on storage and disposition of weapons-usable fissile materials.

- *Environmental Assessment for the DOE Sale of Surplus Natural and Low Enriched Uranium* (DOE 1996b): This environmental assessment reviews DOE's proposed action for the sale of about 35.7 million lb (16.2 million kg) U_3O_8 of uranium for subsequent enrichment and fabrication into commercial

nuclear reactor fuel. The uranium is currently in the forms of natural and low-enriched UF_6, which is stored at the Paducah and Portsmouth sites (the material considered in this environmental assessment is different than the depleted UF_6 considered in the Depleted UF_6 PEIS). The natural and low enriched UF_6 would be sold to various entities, which could include USEC, currently the only domestic provider of uranium enrichment services; over 60 electric utilities in the United States and abroad; converters; traders; and uranium producers. This environmental assessment is related to the PEIS because of potential cumulative impacts at the Paducah and Portsmouth sites, which are also current depleted UF_6 storage sites. The cumulative impacts analysis of the Depleted UF_6 PEIS takes into account the results of this environmental assessment.

- *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a): This EIS (referred to herein as WM PEIS) evaluates the impacts of different approaches to the treatment, storage, and disposal of the existing and projected DOE inventory of certain types of waste management programs wastes over the next 20 years. The WM PEIS considers radioactive low-level, high-level, transuranic, and mixed wastes, as well as toxic and hazardous wastes. The amounts of wastes analyzed for treatment, storage, or disposal range from thousands to millions of cubic meters and include wastes generated at the DOE sites in Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. The WM PEIS does not evaluate management of depleted UF_6 because that material is considered a source material, not a waste. The draft PEIS was issued in September 1995 and the final PEIS in May 1997.

  The WM PEIS considers the impacts of waste management at Paducah, Portsmouth, and the Oak Ridge Reservation based on the existing and projected inventories of waste generated during site operations. The three sites are also considered as candidate sites for regionalized waste management sites, and waste management impacts are evaluated for these scenarios as well. Cumulative impacts of current operations, waste management, and proposed future operations are also assessed for the three sites in the WM PEIS. Both the waste management analysis and cumulative impacts analysis in the Depleted UF_6 PEIS take into account the results of the WM PEIS.

- *Surplus Plutonium Disposition Draft Environmental Impact Statement* (DOE 1998a). This EIS examines reasonable alternatives and potential environmental impacts for the proposed siting, construction, and operation of three types of facilities for plutonium disposition. One of the facilities would fabricate plutonium oxide and depleted uranium oxide into mixed oxide fuel. The mixed oxide fuel fabrication facility would be located at either Hanford,

Idaho National Engineering and Environmental Laboratory, Pantex, or the Savannah River Site.

This EIS analyzes the use of approximately 1,000 tons of existing DOE stocks of depleted UF_6. The depleted UF_6 would be shipped from current locations to a commercial facility for conversion to uranium oxide. This material would then be shipped to the mixed oxide fuel fabrication plant. Mixed oxide fuel would be used in existing commercial light water reactors in the United States, with subsequent disposal of the spent fuel in accordance with the *Nuclear Waste Policy Act*. This EIS is related to the PEIS in that it could possibly use a small portion of the depleted UF_6 inventory.

- *Final Environmental Assessment for the Lease of Land and Facilities within the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 1997b). This environmental assessment was issued in November 1997 and evaluates the potential environmental impacts of leasing land and facilities at the K-25 site in Oak Ridge, Tennessee. The leasing program examined represents a reindustrialization effort by DOE, making vacant, underutilized, and/or inactive facilities available to private sector firms or other organizations for industrial, commercial, office, research and development, and manufacturing uses. In addition to increasing the use of DOE-owned resources, the program assessed in this document would reduce costs to DOE by lessening surveillance and maintenance requirements and, in some cases, by having lessees decontaminate facilities on the site. This environmental assessment is related to the PEIS because of potential cumulative impacts at the K-25 site, currently also a depleted UF_6 storage site. The cumulative impacts analysis of the PEIS takes into account the results of this environmental assessment.

- *Draft Environmental Assessment for the Proposed Treatment of Mixed Wastes at the Paducah Gaseous Diffusion Plant Using the Vortec Vitrification System* (DOE 1998b). This environmental assessment, issued as a draft in March 1998, evaluates the potential environmental impacts of building and operating a facility for the Vortec Cyclone Melting System™ at the Paducah site. This system may treat some portion of the LLW, low-level mixed waste (LLMW), and wastes regulated under the *Toxic Substances Control Act* (TSCA) that are stored at the Paducah Gaseous Diffusion Plant, thereby enabling their removal from storage to disposal. This environmental assessment is related to the PEIS because of potential cumulative impacts at the Paducah site, currently also a depleted UF_6 storage site. The cumulative impacts analysis of the PEIS takes into account the results of this environmental assessment.

1.7 OTHER DOCUMENTS AND STUDIES RELATED TO DEPLETED UF_6 MANAGEMENT

The management of the depleted UF_6 inventory has been independently reviewed by several other agencies and organizations external to the DOE Office of Nuclear Energy, and reports have been released by these groups summarizing their findings. The following is a list of the reports reviewed as a part of the preparation of this PEIS; the results of these reports were included in the PEIS analyses, as appropriate.

- *Defense Nuclear Facilities Safety Board Recommendation 95-1* (DNFSB 1995): In May 1995, the DNFSB issued Recommendation 95-1 regarding the storage of the depleted UF_6 cylinders. This recommendation addressed three items: (1) start of an early program to review the protective coating of cylinders containing the tails (i.e., depleted UF_6) from the historical production of enriched uranium, (2) exploration of the possibility of additional measures to protect these cylinders from the damaging effects of exposure to the elements as well as any additional handling that might be called for, and (3) institution of a study to determine whether a more suitable chemical form should be selected for long-term storage of depleted uranium.

  DOE accepted Recommendation 95-1 in June 1995 and emphasized the following focus areas for its response: removing cylinders from ground contact and keeping cylinders from further ground contact, relocating all cylinders into adequate inspection configurations, repainting cylinders as needed to avoid excessive corrosion, updating handling and inspection procedures and site-specific safety analysis reports (SARs), and completing an ongoing study that would include an analysis of alternative chemical forms for the material. Since 1995, actions have been taken to address each of these focus areas. Several cylinder yards have been reconstructed or newly constructed, and many of the cylinder relocations required to achieve adequate inspection configurations and removal from ground contact have been completed. A cylinder painting program has been initiated; the site-specific SARs have been updated (Lockheed Martin Energy Systems, Inc. [LMES] 1997a,b,c); and a Cylinder Project Management Plan with updated cylinder handling and inspection procedures has been completed (LMES 1997i). In addition, this PEIS, which analyzes alternative management strategies, including various chemical forms of depleted uranium, has been prepared partially in response to the DNFSB recommendation. This PEIS incorporates the information provided in the Cylinder Project Management Plan in its analysis of the impacts of continued cylinder storage and incorporates the results of the SARs in its cylinder accident impact analyses.

The DNFSB reviews DOE's progress in achieving the objectives of Recommendation 95-1 regularly. Additionally, the Board visits the storage sites on a regular basis and has a resident member in Oak Ridge.

- "Disposition of the DUF_6" (National Research Council 1996): A chapter in a book addressing opportunities for cost reduction in the decontamination and decommissioning of the nation's uranium enrichment facilities was devoted to the problems associated with management of the depleted UF_6 inventory. The main conclusion of the report was that if significant new uses had not been identified by 1998, the conversion of the depleted UF_6 inventory to U_3O_8 for long-term storage should begin, and that conversion should start with cylinders in poor condition. The report also concluded that use of a process in which "recyclable" HF would be produced would be the most feasible approach to liquidation of the large inventory. This PEIS addresses questions similar to those examined in the National Research Council report, but it addresses them in the form of alternative management strategies and in the context of the affected environment, as required under NEPA.

- *Depleted Uranium: A DOE Management Challenge* (DOE 1995c): This report examines the technical feasibility and costs of using depleted uranium for shielding in the form of either metal or a concretelike oxide aggregate. It also addresses the alternative recommending disposal of the inventory.

- *The Ultimate Disposition of Depleted Uranium* (Lemmons et al. 1990): This document concludes that it is desirable to maintain working inventories in the form of depleted UF_6 as long as there is a potential for it to be used and as long as cylinders and storage facilities are adequately monitored and maintained. However, at the time the report was written, it appeared that it would be viable to use only a small portion of the inventory, so the report recommended that the majority of the inventory be converted to U_3O_8 for long-term storage or disposal.

In addition to the above documents, the *Final Environmental Impact Statement for the Construction and Operation of Claiborne Enrichment Center, Homer, Louisiana* (U.S. Nuclear Regulatory Commission [NRC] 1994b) was reviewed for its applicability to analyses conducted for this PEIS. The purpose of the NRC document was to assess the impacts of a gaseous centrifuge uranium enrichment facility. Of interest with respect to this PEIS, the NRC document included an analysis of the impacts from a generic facility for converting depleted UF_6 to U_3O_8, and an analysis of the impacts from disposing of the U_3O_8. The findings of the NRC analysis were similar to the findings of the analyses for this PEIS; specifically, that (1) environmental impacts from the construction and operation of a generic uranium conversion facility would be small; (2) external doses from airborne releases would be about one million times less than internal doses; (3) disposal of the U_3O_8 in a near-surface facility in a wet environment could lead to radiological exposure doses that

exceed the 25 mrem/yr limit given in DOE Order 5820.2A and 10 CFR Part 61 ("Licensing Requirements for Land Disposal of Radioactive Waste"); and (4) disposal of the U_3O_8 in a generic deep disposal site (such as a mine) would not lead to radiological exposure doses that exceed the 10 CFR Part 61 limit. However, the NRC disposal analyses differed from those in this PEIS with respect to environmental conditions at the sites; the NRC analysis did not differentiate between disposal facilities in wet and dry environmental settings. In this PEIS, analyses were conducted separately for disposal in dry and wet environments. Under the assumptions used in this PEIS, disposal in near-surface and deep disposal facilities in a wet environment was found to lead to radiological doses in excess of 25 mrem/yr; disposal in near-surface and deep disposal facilities in a dry environment did not lead to doses in excess of 25 mrem/yr. Further details on the potential long-term impacts of disposal of uranium oxide are given in Section 5.6 and in Section I.4 of Appendix I.

1.8 ORGANIZATION OF THIS PEIS

The Depleted UF_6 PEIS consists of 11 chapters, 15 appendices, and comments/responses from the public review. Brief summaries of the main components of the PEIS are as follows:

1.8.1 Volume 1 — Main Text

- Chapter 1 introduces the PEIS, discussing pertinent background information, purpose and need for the DOE action, scope of the assessment, related NEPA reviews, other related reports and studies, and EIS organization.

- Chapter 2 defines the alternative management strategies considered in the PEIS and presents a summary comparison of the estimated environmental impacts. The DOE preferred alternative is identified and discussed.

- Chapter 3 discusses the environmental setting at the three DOE facilities currently storing depleted UF_6. Chapter 3 also presents the environmental characteristics of representative and generic environmental settings assumed for the assessment of long-term storage, manufacture and use, conversion, and disposal activities.

- Chapter 4 addresses the assumptions on which the PEIS and its analyses are based, defines the approaches to environmental impact assessment taken in development of the PEIS, and describes the methods of analysis.

- Chapter 5 presents the environmental impacts of the alternatives, including the no action alternative, from managing the inventory of DOE-generated cylinders. This chapter also discusses potential cumulative impacts at the Paducah, Portsmouth, and K-25 sites; issues related to potential life-cycle impacts associated with the alternatives; possible mitigation of adverse impacts

that are unavoidable; irreversible commitment of resources; the relationship between short-term use of the environment and long-term productivity; and pollution prevention and waste minimization.

- Chapter 6 presents the environmental impacts associated with the management of up to 15,000 USEC-generated cylinders.

- Chapter 7 identifies the major laws, regulations, and other requirements applicable to implementing any of the alternatives.

- Chapter 8 is an alphabetical listing of all the references cited in the PEIS. All cited references are available to the public.

- Chapter 9 lists the name, education, and experience of persons who helped prepare the PEIS. Also included are the subject areas for which each preparer was responsible.

- Chapter 10 presents brief definitions of the technical terminology used in the PEIS.

- Chapter 11 is a subject-matter index for Volumes 1 and 2 that provides page numbers where important terms and concepts are discussed.

1.8.2 Volume 2 — Appendices

- Appendix A discusses the chemical forms and characteristics of uranium and its compounds.

- Appendix B examines the issues of corrosion of depleted UF_6 cylinders and material loss from breached cylinders, including causes of corrosion and the experience with corrosion at the three current storage sites.

- Appendix C presents a detailed description of the analytical methods used to conduct the impact assessments for the PEIS.

- Appendices D through J address the impacts of options for the activities that make up the alternative management strategies. The impacts are presented for the following:

  - Continued cylinder storage — Appendix D,

  - Preparation of cylinders for shipment — Appendix E,

  - Conversion of UF_6 to an oxide or metal and treatment of heels cylinders and empty cylinders — Appendix F,

  - Long-term storage — Appendix G,

  - Manufacture and use — Appendix H,

  - Disposal — Appendix I, and

  - Transportation — Appendix J.

- Appendix K provides the results of the parametric analysis, which examines the differences in potential environmental impacts if facilities were smaller than full-sized. Appendix K also includes a summary of impacts for several combinations of alternative strategies.

- Appendix L summarizes the comments received during public scoping and discusses how these comments affected the scope of this PEIS.

- Appendix M contains the contractor disclosure statement.

- Appendix N provides the full text of Public Law 105-204.

- Appendix O contains the summary of the engineering analysis report.

1.8.3 Volume 3 — Responses to Public Comments

- Chapter 1 provides an overview of the public participation and comment process.

- Chapter 2 contains copies of the actual letters or other documents that transmitted public comments on the draft PEIS to DOE.

- Chapter 3 lists DOE's responses to written comments received through the mail or electronic media.

- Chapter 4 lists DOE's responses to comments received verbally at the public hearings.

- Chapter 5 consists of two indexes for Volume 3 that provide page numbers where comments and responses are located. One index is organized by commentor name and the other by document number.