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Office of Fissile Materials Disposition

United States Department of Energy

Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials

November 29, 1996

Rev. 1

PREFACE

This report summarizes representative technical, cost, and schedule data for the reasonable alternatives being considered for the storage of weapons-usable fissile materials in the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (MD-PEIS). (A companion report entitled *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* is being issued in parallel with this document to address the disposition issues). Revision 0 of this report was issued on July 17, 1996, with a request for comments by August 31, 1996. A number of comments were received and the report has been revised accordingly. The data reported in this document were developed and compiled principally by the Department of Energy's Field Operations Offices and an Architect-Engineer, and were reviewed by the Department. The data were extracted from more exhaustive documents prepared by these organizations. Since the data are predicated on pre-conceptual and conceptual designs of the alternatives, they are subject to revision when new or better data become available. The data will be useful to:

- Facilitate comparison between alternatives for decision-making.

- Provide information for follow-on implementation.

The technical, cost, and schedule data will be considered by the Secretary of Energy in conjunction with: the Programmatic Environmental Impact Statement; *the Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Materials Storage and Plutonium Disposition Alternatives*; input from other Federal agencies; and national policy criteria to render a Record of Decision on long-term storage of weapons-usable fissile materials. The analyses in the two documents and this Report are appropriate to the intended scope of the documents as environmental, nonproliferation policy, and conceptual engineering documents, respectively. The programmatic Record of Decision will identify the configuration and the siting for the storage of weapons-usable fissile materials.

For storage alternatives, the MD-PEIS assesses all weapons-usable fissile materials in the Department of Energy's stockpile, including strategic reserves. The MD-PEIS also includes subalternatives which exclude strategic reserve storage. The *Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, February 1996) assesses three sites (the Oak Ridge Reservation, Pantex, and the Nevada Test Site) potentially involved in the storage of strategic reserve materials. The alternatives reviewed in this assessment focus on the alternatives in the MD-PEIS.

Revisions to facts/data are noted with sidebars. Editorial revisions are not marked.

EXECUTIVE SUMMARY

E.1 Introduction

The national policy, outlined by the President in September 1993, is to seek to eliminate, where possible, the accumulation of stockpiles of surplus highly enriched uranium (HEU) or plutonium, and to ensure that where these materials already exist they are subject to the highest standards of safety, security and international accountability. The Department plans to provide a storage system (up to 50 years) for plutonium and highly enriched uranium that meets the Stored Weapons Standard[1] and applicable environmental, safety, and health standards, while reducing storage and infrastructure cost, and accommodates the disposition of the surplus of these materials.

The Department has prepared a *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (MD-PEIS) (Reference 1) to analyze various long-term storage and disposition alternatives and to provide the necessary background, data, and analyses to help decision makers and the public understand the potential environmental impacts of each alternative. The results of the environmental analyses, together with information from technical and economic studies and national policy objectives, will form the basis for DOE's decisions, which will be given in a Record of Decision (ROD).

This report provides technical, cost, and schedule information for storage alternatives analyzed in the MD-PEIS. The cost information for each alternative is presented in constant 1996 dollars and also as a present value. It identifies both capital costs and life cycle costs. The level of detail supporting the cost estimates is at the conceptual design and planning levels. Schedules are presented for the implementation of each alternative.

E.2 Background and Requirements

The Department's inventories of plutonium and highly enriched uranium are located at a number of DOE sites. The United States declared 38.2 metric tons (MT) of weapons-grade plutonium surplus to national security needs. Additional inventories of non-weapons-grade plutonium bring the total amount of surplus plutonium to approximately 50 metric tons. These plutonium inventories would be comprised of pits[2] and non-pit forms (metals and oxides). Two alternatives, upgrade at multiple sites and the consolidation, were evaluated,

[1] A high standard of security and accounting for storage of nuclear weapons that would be maintained for the dismantlement and storage of weapons-usable fissile materials, as suggested by the National Academy of Sciences, Committee on International Security and Arms Control, "Management and Disposition of Excess Weapons Plutonium," National Academy Press, Washington, DC, 1994.

[2] A pit is the encased central core of a nuclear weapon made of special nuclear materials, primarily plutonium-239.

collectively, at six sites: Pantex Plant, Savannah River Site (SRS), Hanford Site, Idaho National Engineering Laboratory (INEL); Nevada Test Site (NTS), and Oak Ridge Reservation (ORR). A combination alternative, wherein the Rocky Flats Environmental Technology Site (RFETS) pits would be stored at Pantex and the non-pit materials at Savannah River Site, and the remaining inventories of plutonium would remain at the sites, pending disposition, was also evaluated.

Safeguards and security requirements dictate that access to weapons-usable fissile materials be restricted and that the materials be stored in a vault-type structure that provides a physical barrier for protection from theft and other security threats. Furthermore, nuclear safety requirements dictate that the materials need to be protected from external hazards such as seismic events and tornados and internal hazards such as fires, nuclear criticality, and other operational accidents. Because plutonium decays, some capability to remove the decay heat must be provided. The materials would need to be housed in hardened structures, i.e., concrete structures with walls and roofs several feet thick.

To carry out the storage mission, many functions would need to be performed in addition to storage: the materials would need to be received (or shipped), confirmed, and inventoried; a baseline configuration of each container containing the materials would need to be established and documented prior to the placement of the container into storage; the materials would need to be periodically examined against the baseline to ensure that a safe configuration was maintained; undesired changes in configuration would need to be corrected; and analytical services and waste management would need to be provided to support the above functions.

The key functional criteria for the design concepts developed to carry out the storage mission were: weapons-usable fissile materials would need to be maintained secure and safe; the impact to the public and workers from operations would need to be reduced compared to current operations; and surplus materials would need to be placed under International Agency for Atomic Energy (IAEA) inspections as required. The storage concepts developed incorporate these functions and criteria and also considered the use of existing facilities to the extent possible, as well as the construction of new facilities, for executing the storage mission.

E.2.1 Upgrade At Multiple Sites Alternative

Under the upgrade at multiple sites alternative, the Department would either modify existing or build new facilities, depending on the site's existing facilities' capability to meet standards for long-term storage of nuclear materials. Plutonium materials at a site would remain at the site and HEU would remain at Oak Ridge Reservation (Y-12). The Pantex Plant, the Savannah River Site, the Hanford Site, and the Idaho National Engineering Laboratory were evaluated. One or more sites would be selected to store the materials transferred from the Rocky Flats Environmental Technology Site, in addition to the weapons-usable plutonium currently located at that site. For this alternative, an aggregate of approximately 24,000 storage positions would be required to store the surplus plutonium. An additional 5,000 storage positions are allotted at Pantex to store the strategic reserves (non-surplus plutonium reserved for national security needs).

E.2.2 Consolidation Alternative

Under the consolidation alternative, plutonium at existing sites would be removed, and the entire DOE inventory of weapons-usable plutonium, except for plutonium used for research and development and other ongoing program needs, would be consolidated at one or more sites, while HEU would remain at ORR. In addition to the sites under consideration for the upgrade at multiple sites alternative, Nevada Test Site and Oak Ridge Reservation were evaluated.

Approximately 20,000 storage positions would be required for the surplus weapons-usable plutonium[3] and an additional 5,000 storage positions would be allotted to store the strategic reserves. Under this alternative, the Department also analyzed a storage facility with a capacity of 40,000 storage positions that would be capable of storing additional surplus plutonium that could be made available in the future as a result of agreements on disarmaments, changes in the stabilization program, and other program activities. This plutonium storage facility would represent a bounding storage configuration for analysis. Under this plutonium storage configuration, the Department would construct the storage facility in phases. The first phase would involve construction of a 20,000 position storage facility, and the second phase would involve construction of up to an additional 20,000 storage positions in units of approximately 5,000 storage positions, if required.

E.2.3 Combination Alternative

Under the combination alternative, separated and stabilized plutonium (consisting of pits and non-pit forms) residing at Rocky Flats Environmental Technology Site would be removed from the site and stored at two sites, pending disposition. The pits would be stored at Pantex, along with other pits residing at the site, and the non-pit forms would be stored at Savannah River, along with other non-pit forms at the site. The plutonium residing at other sites would remain at those sites pending disposition. This alternative could provide certain advantages in positioning the Department with respect to implementing disposition technologies. In any case, the combination alternative could include a staging approach involving the sites for pits and non-pit forms over time.

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[3] The difference in the number of storage positions between the upgrade at multiple sites (24,000 storage positions) and the 20,000 storage positions is caused by the sum of additional storage positions that are provided by the sites to allow for operational contingencies and the storage of other materials.

E.2.4 Storage Variables

There are a wide range of storage configurations that could be analyzed to determine the costs of plutonium storage. The cost of long-term storage of plutonium is affected by a number of variables, such as the amount of material to be stored, the form of the plutonium (pit or non-pit), how the material is stored, the start time and duration of storage, whether the facility is below-ground or above-ground, the means by which the facility design, construction and operation would need to meet nuclear safety requirements, and the extent to which existing facilities and capabilities can be used. The amount of materials to be stored and the start time and duration of storage would depend on the start date and rate of disposition of plutonium. The most significant variable in determining the capital cost of long-term storage of plutonium is the extent to which existing facilities can be used. The most significant variables that determine the operating costs are the extent to which existing infrastructure capabilities, such as security and safeguards, laboratory analyses and other support functions, can be shared with the storage mission, and how long the plutonium would be stored before being disposed of. In addition, the number of sites at which plutonium is stored would affect both the capital cost and the operating cost.

Of the range of storage configuration scenarios that could be analyzed to determine the cost of plutonium storage under the consolidation alternative, this report presents the costs of a 35,000 storage position configuration at a single site in two phases. In the first phase, the facility would become operational with 20,000 storage positions for surplus plutonium. The strategic reserve pits would be stored at Pantex in upgraded facilities. Under this scenario, approximately 12,000 storage positions would be allotted to pits and 8,000 storage positions allotted to non-pit forms. If a 35,000 storage position facility were to be required, approximately 20,000 storage positions would be allotted for pits and 15,000 storage positions for non-pit forms to accommodate potential future weapon disassemblies and potential increases in the amount of plutonium that would need to be stored as a result of stabilization activities and to meet other program needs. An additional 5,000 position vault would be added if the strategic reserve pits were to be relocated from Pantex. The facility is assumed to be operated for 50 years, although the operating time would depend on how fast surplus plutonium could be disposed of.

(moved to section E.2.3.)

E.3 Summary

E.3.1 Cost

The cost analyses show that the combination alternative for the storage of plutonium is the least expensive compared to the other alternatives. The analyses also show that for the consolidation alternative, Pantex and the Savannah River Site (SRS) would have the lowest cost compared to the other sites under consideration because existing and planned site infrastructure and support facilities could be shared.

Figure E-1 presents the costs for the upgrade at multiple sites alternative, consolidation alternative, and the combination alternative for storage of plutonium in constant 1996 dollars by capital (investment) and operating cost elements.

> The cost of the upgrade at multiple sites alternative is derived by summing the cost of storing the plutonium existing at each site over the four sites and adding the cost of storing the RFETS plutonium at one of the four sites. A total of 24,000 storage positions are provided. The capital cost is estimated to be approximately $380 million and the operating cost for 50 years of operation at approximately $3.2 billion ($64 million per year). The costs are insensitive to where the RFETS plutonium is stored at any one of the four sites.
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> The costs of the consolidation alternative for the first phase (20,000 storage positions) are shown to range from approximately $40 million to $360 million for capital costs and $600 million ($12 million per year) to $1.1 billion ($22 million per year) for operating costs. The incremental costs of adding 15,000 positions for the second phase are estimated to be approximately $70 million in capital cost and range from $70 million ($1.4 million per year) to $220 million ($4.4 million per year) in operating costs for 50 years of operation. The range of the cost estimates for the consolidation alternative reflects the extent to which existing facilities can be used and capabilities can be shared with other program missions at a site, as well as differences in storage design and operations.
>
> The costs of the combination alternative would be approximately $30 million capital and $360 million operating. The operating cost is based on storing plutonium at SRS for up to 7 years and pits at Pantex for up to 20 years.

For the case where the strategic reserve would not remain at Pantex, an additional 5,000 storage positions would be required to be collocated with the consolidated storage of surplus plutonium. In that event, the capital costs at each of the remaining sites would increase by about $25 million (the cost of a 5,000-position vault storage module, with contingency) and the total life operating cycle cost by about $120 million dollars ($2.4 million per year).

Figure E-2 presents the costs of the upgrade at multiple sites alternative, consolidation alternative, and combination alternative in terms of net present value of total life cycle costs. The combination alternative would provide the least cost compared to the other alternatives.

The capital cost for the storage of the non-surplus highly enriched uranium for the upgrade alternative is estimated at approximately $20 million and the present value total life cycle at approximately $190 million. If a new facility were to be constructed, the capital cost is estimated to be approximately $210 million and the present value total life cycle at approximately $420 million. These costs would be incurred in fulfilling a Defense Program mission.

Figure E-3 presents the costs for the consolidation of the non-surplus highly enriched uranium for an upgrade of existing facilities at ORR (Y-12) and for new construction.

E.3.2 Schedule

Long-term plutonium storage facilities for both pit and non-pit forms of plutonium could be operational in about 5 to 6 years from the time the project is authorized for the upgrade at multiple sites and consolidation alternatives. The earlier start of operation is attainable under the upgrade at multiple sites alternative. The upgrade for the storage of the non-surplus highly enriched uranium could be completed in about 6 years (prior to 2004).

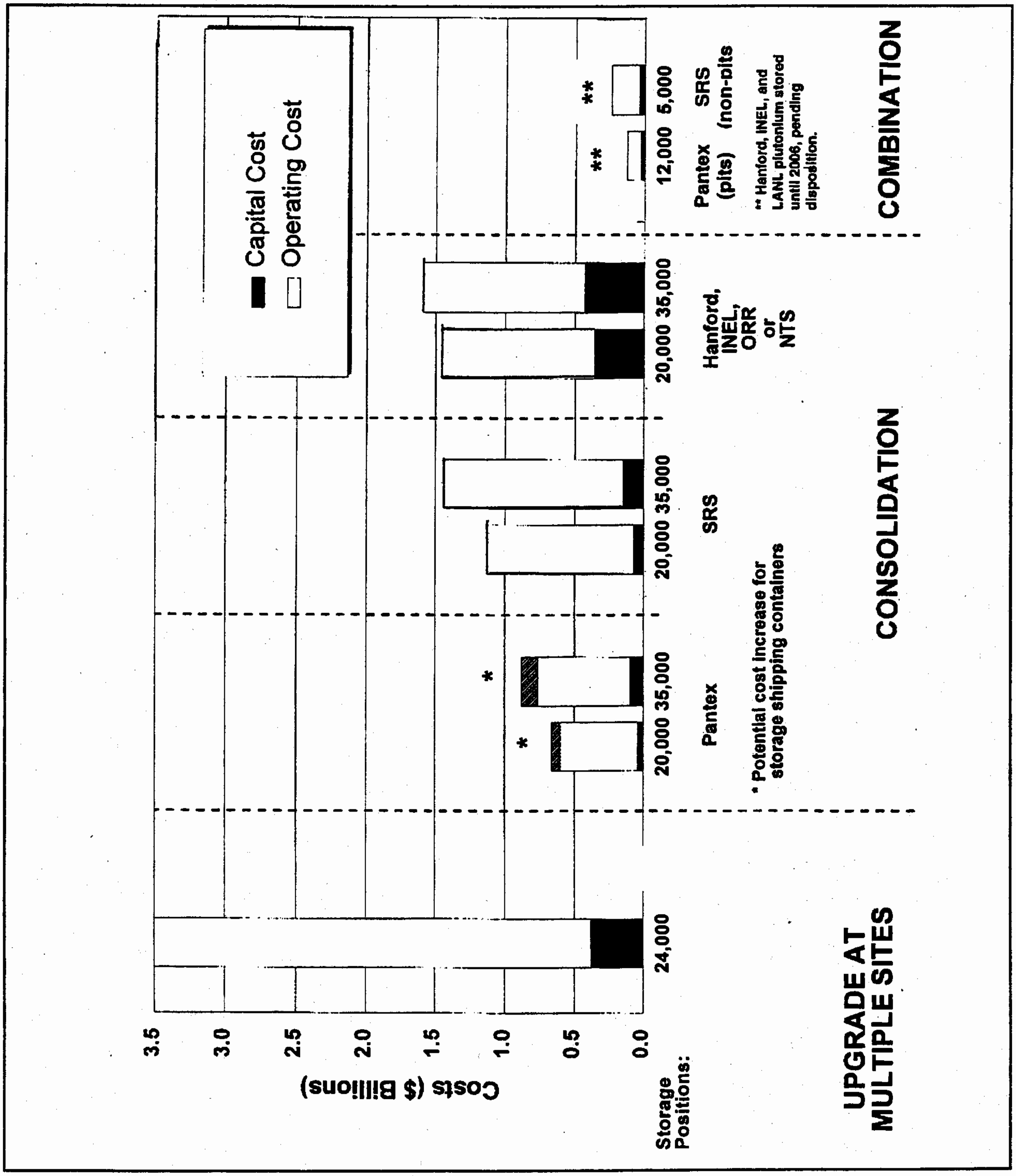

FIGURE E–1.— *Total Life Cycle Costs (Undiscounted) for Upgrade at Multiple Sites, Consolidation, and Combination Alternatives for Plutonium.*

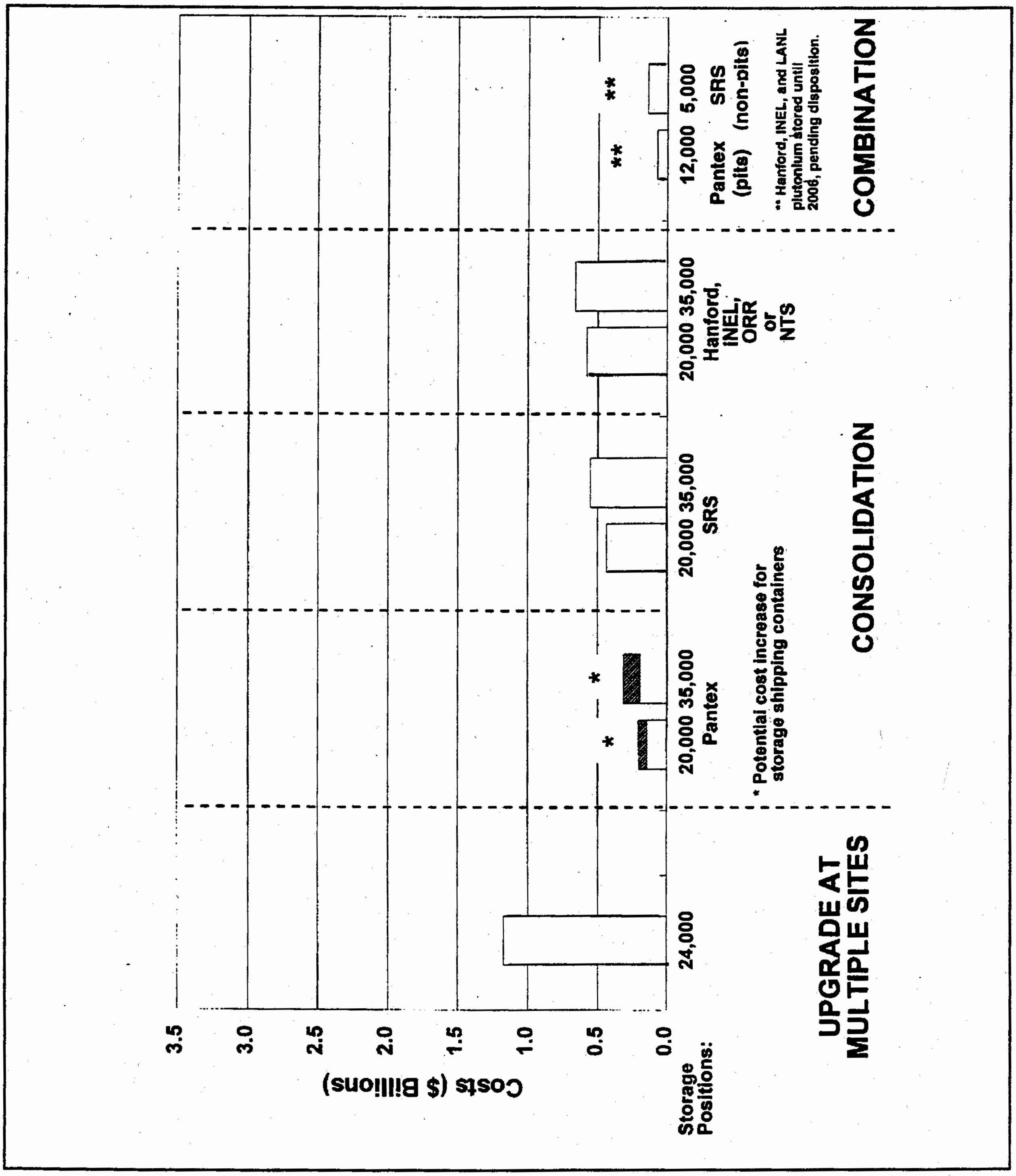

FIGURE E-2.— *Net Present Value of Total Life Cycle Costs for Upgrade at Multiple Sites, Consolidation, and Combination Alternatives for Plutonium.*

1996 dollars and also as a present value. It identifies both capital costs and life cycle costs. The level of detail supporting the cost estimates is at the conceptual design and planning levels. Schedules are presented for the implementation of each alternative.

1.3 Summary Description of Storage

Safeguards and security requirements dictate that access to weapons-usable fissile materials be restricted and that the materials be stored in a vault or vault-type structure that provides a physical barrier for protection from theft and other security threats. Furthermore, nuclear safety requirements dictate that the materials need to be protected from external hazards such as seismic events and tornados and internal hazards such as fires and other operational accidents.

In order to place and maintain plutonium in storage many services need to be performed. For example, the incoming and outgoing plutonium needs to be confirmed and accounted for, the plutonium needs to be monitored to assure that it remains in a stable configuration, and the plutonium may need to be repackaged if a package were to degrade. All of these operations need to maintain the plutonium in a safe nuclear configuration (prevent nuclear criticality). The storage facility functions are illustrated in figure 1-1, Overall Block Flow Diagram. The plutonium is processed through a material handling area before placement in a vault. If an incoming package is contaminated, or if off-normal conditions arise during storage, the plutonium is sent to be repackaged or overpacked. Under these circumstances, waste management activities would need to be conducted. In addition to these primary functions, a host of support functions also would need to be provided, such as analytical services, security, health physics, procurement, and administrative. Similar services would be needed to place and maintain HEU.

A storage facility is divided into three functional areas: material handling, material storage, and support. The material handling area, a hardened structure, receives and unpackages material containers for storage and performs material accountability verifications on all incoming material. It has separate areas to perform periodic safety evaluations (baseline and condition examinations) and international verification of surplus material, and an area for repackaging or overpacking of off-normal containers, if required. Material handling can also perform all functions necessary for shipping material to an off-site location.

The material storage area is a hardened storage vault or vault-like structure. The plutonium is stored as an unpackaged container, except for a Pantex Plant concept, where the plutonium would be stored in the shipping package. In all cases the metals and oxides package would meet DOE Standard 3013-94 (Reference 2). The plutonium is moved in and out of storage by remote means to reduce the radiation exposure to workers. The vault would need to be cooled to remove the heat generated by radioactive decay of the plutonium. For HEU, the material would be stored in cans or drums meeting a Y-12 standard (Reference 3). Remote means of handling would not be required and the storage area would not need to be cooled to remove the heat generated by the radioactive decay of HEU. For plutonium, the repackaging and overpacking area includes gloveboxes and associated ventilation systems for confinement of contaminants resulting from plutonium remediation activities. The ventilation system for these gloveboxes may require them to be classified as safety-related based on safety analyses.

The support area would be a nonhardened structure using commercial construction methods and materials. The support area houses an analytical laboratory, a waste holding area, a general maintenance area, and personnel support areas.

1.4 Approach

The Department's inventories of plutonium and highly enriched uranium are located at a number of DOE sites. The Department is currently in the process of stabilizing and repackaging weapons-usable plutonium metal and oxide materials and placing them in a safe, secure storage condition awaiting a decision on long-term storage and/or disposition. Plutonium materials (except plutonium in pits) received for storage will meet the "Criteria for Safe Storage of Plutonium Metals and Oxides" (Reference 2), a DOE standard for long-term storage (at least 50 years) of these materials. Similarly, the HEU materials requiring long-term storage will meet criteria for safe storage of HEU metals and oxides after being received by Oak Ridge Reservation (Reference 3).

The Department's inventories of plutonium and highly enriched uranium are divided into two categories--surplus and non-surplus. Surplus materials are those the President has declared surplus in response to recommendations from the Nuclear Weapons Council. Because only surplus materials are to be placed under IAEA inspection, design and operational concepts accommodate the separation of the surplus materials from the non-surplus materials. For purposes of these cost analysis, for plutonium, strategic reserve plutonium was assumed to require about 5,000 storage positions, and for surplus plutonium, about 20,000 storage positions was estimated to be required to store 50 MT[4]. For the consolidation of plutonium alternative, a facility having a total of 40,000 storage positions is expected to be sufficient to store plutonium that could be made available in the future. The additional 15,000 storage positions is an allowance for potential future storage needs resulting from further agreements on disarmament between the United States and the former Soviet Union, stabilization activities, and other activities. For the plutonium consolidation alternative, to allow for the uncertainty in the actual number of positions that may be needed, the cost and schedule is based on constructing the storage vault modules in units of 5,000 and constructing the facility in two phases. The first phase would provide 20,000 storage positions and the second phase would construct the remaining 20,000 storage position vault in units of 5,000. For HEU, the baseline quantity of HEU requiring long-term storage has been determined to be 6,000 cans and 8,500 drums.

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[4] Metric Ton = 1000 kilograms

Under the upgrade at multiple sites or consolidation alternative, the Department plans to transport the separated and stabilized plutonium materials at Rocky Flats Environmental Technology Site (RFETS) designated for disposition to one or more of the storage sites under consideration. These plutonium materials are in the forms of pits, metals, and oxides. Plans would be to ship the pits in FL or AT400A shipping containers and the metals and oxides in SAFKEG or equivalent shipping containers in the DOE safe, secure trailer (SST) system. RFETS could be in a position to start shipment of pits in 1997 to a designated receiver site and complete shipment in late 1998. In regard to metals and oxides, the earliest shipment from RFETS could be about 1998, with completion about 2002.

The earliest date by which RFETS materials could be received is 1997 at Pantex or Hanford. Pantex may be capable of receiving pits in Zone 4 on a temporary basis until Zone 12 upgrades or new facilities are completed by 2003. Hanford could begin receiving metals, oxides, and pits for temporary storage in the 2736-Z storage complex until completion of upgraded or new facilities about 2003. Finally, SRS may be capable of receiving metals, oxides, and pits on a temporary basis in 235F or P reactor about 2002. The early acceptance of RFETS materials would depend on the completion of environmental reviews for these actions at the cited sites. These early activities are not included in the schedules and cost estimates are not provided. However, these initial activities are expected to be a small incremental cost to the storage costs presented.

In DOE's Stockpile Stewardship and Management PEIS, a portion of the non-surplus weapons-usable fissile materials, namely the strategic reserve materials and the Pu-242 materials used for weapons Research and Development, is being analyzed for long-term storage at only Oak Ridge Reservation (ORR), Pantex, and Nevada Test Site (NTS). The Department's preferred alternative, to best meet the nuclear weapons program goals cited in the Stockpile Stewardship and Management PEIS, is to store the strategic reserve plutonium at Pantex. The cost estimates for the consolidation of plutonium are presented with and without this strategic reserve.

The Department's plans are to disposition surplus HEU in 15 to 20 years. The Department plans to store the remaining HEU required for various national security missions, except for HEU residing in the nuclear weapons stockpile or possession of the U.S. Navy. Other HEU not considered for the long-term storage mission includes irradiated uranium and HEU contaminated with plutonium levels higher than background, which would be stored in the plutonium storage facility, if required.

The capital costs and schedules presented in this report are based on conceptual designs or planning estimates. The designs are based on criteria and guidance that was developed to define the design and functional requirements. Operational costs are based on estimates of how the facilities would be operated. No significant technical issues that needed resolution prior to implementation were determined to impact either the cost or schedule, although container certifications would need to be completed prior to the shipment of materials. The cost estimates include investment, operating, total life cycle costs and discounted, present value costs. Cost estimates have been prepared that are site-specific and for consolidation at a reference site.

There is a wide range of storage configurations that could be analyzed to determine the costs of plutonium storage. The cost of long-term storage of plutonium is affected by a number of variables, such as the amount of material to be stored, the form of the plutonium (pit or non-pit), how the material is stored, the start time and duration of storage, whether the facility is below-ground or above-ground, the means by which the facility design, construction and operation would need to meet nuclear safety requirements, and the extent to which existing facilities and capabilities can be used. The amount of materials to be stored and the start time and duration of storage would depend on the start date and rate of disposition of plutonium.

The most significant variable in determining the capital cost of long-term storage of plutonium is the extent to which existing facilities can be used. The most significant variables that determine the operating costs are the extent to which existing infrastructure capabilities can be shared with the storage mission, such as security and safeguards, laboratory analyses and other support functions and how long the plutonium would be stored before being disposed of. In addition, the number of sites at which plutonium is stored would affect both the capital cost and the operating cost.

Of the range of storage configuration scenarios that could be analyzed to determine the cost of plutonium storage under the consolidation alternative, this report presents the costs of a 35,000 storage position configuration at a single site in two phases. In the first phase, the facility would become operational with 20,000 storage positions for surplus plutonium. The strategic reserve pits would be stored at Pantex in upgraded facilities. Under this scenario, approximately 12,000 storage positions would be allotted to pits and 8,000 storage positions allotted to non-pit forms. If a 35,000 storage position facility were to be required, approximately 20,000 storage positions would be allotted for pits and 15,000 storage positions for non-pit forms to accommodate potential future weapon disassemblies and potential increases in the amount of plutonium that would need to be stored as a result of stabilization activities and to meet other program needs. An additional 5,000 position vault would be added if the strategic reserve pits were to be relocated from Pantex. The facility is assumed to be operated for 50 years, although the operating time would depend on how fast surplus plutonium could be disposed of.

In addition to the single site consolidation storage configuration scenario, a two site combination alternative that takes into account the experience of sites in managing specific plutonium forms could provide certain advantages in positioning the Department with respect to implementing disposition technologies. In any case, consolidation could include a staging approach involving one or more storage locations for pit and non-pit forms over time.

(moved to Chapter 5.)

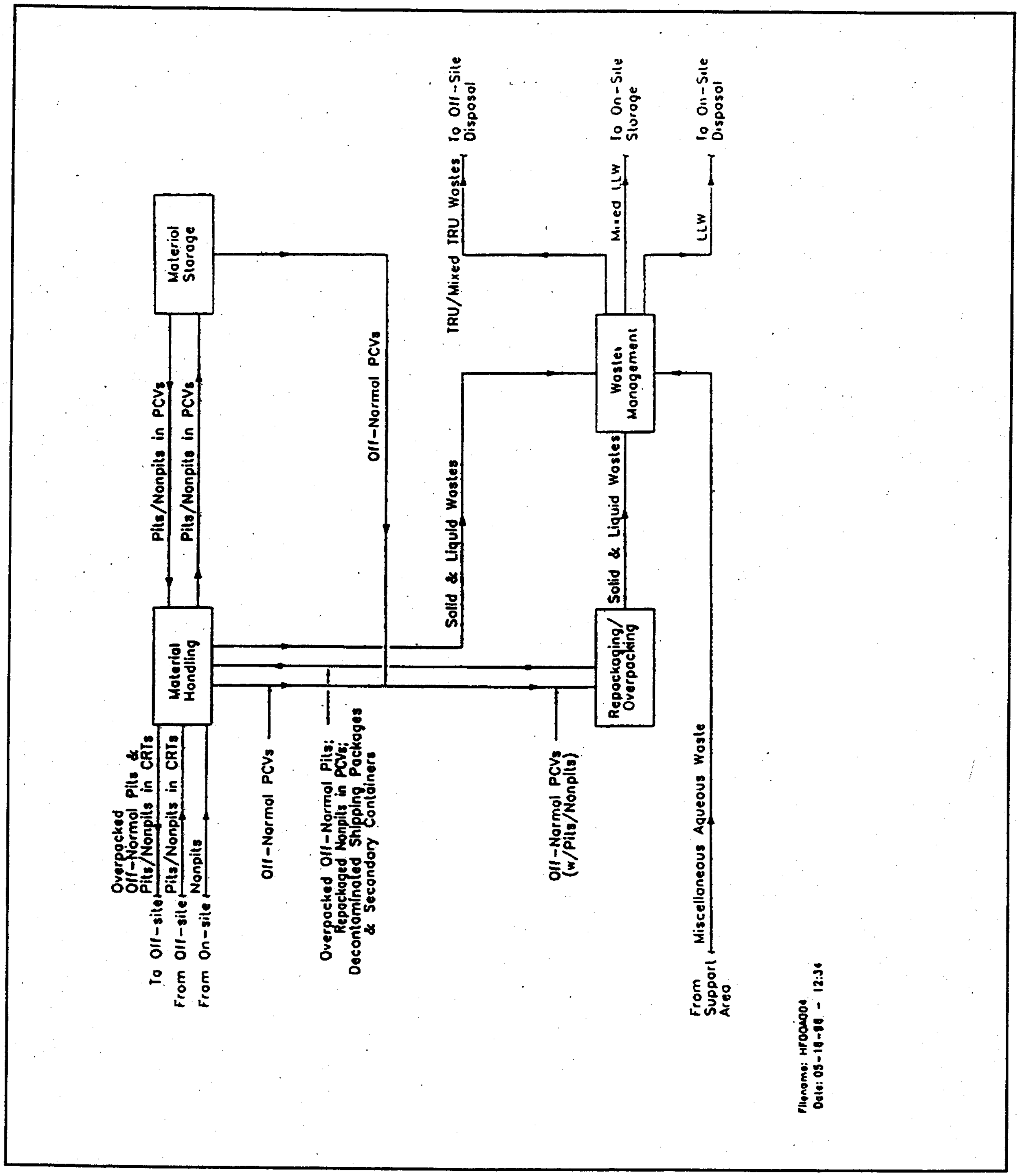

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FIGURE 1-1.— *Overall Block Flow Diagram.*

CHAPTER 2: UPGRADE AT MULTIPLE SITES ALTERNATIVE

This chapter provides a summary of the evaluations of the upgrade at multiple sites alternative. The summary for the consolidation alternative is provided in chapter 3.0, and the combination alternative in chapter 4.0.

Under this alternative, the Department would either modify certain existing or build new facilities, depending on the site's existing facilities' capability to meet standards for long-term storage of nuclear materials storage facilities; existing site infrastructure would be used to the extent possible. Plutonium materials stored at the Hanford site (Hanford), Idaho National Engineering Laboratory (INEL), Pantex Plant, (Pantex), and Savannah River Site (SRS) would remain at those four sites, and HEU would remain at Oak Ridge Reservation (ORR). One or more sites would be selected to store the material transferred from the Rocky Flats Environmental Technology Site (RFETS) and Los Alamos National Laboratory (LANL) in addition to the weapons-usable plutonium material currently located at that site.

2.1 Hanford Plutonium Storage Facility Upgrade

2.1.1 Description

There are about 11 MT of plutonium at the Hanford Site not associated with sites wastes. The amount to be stored includes the 1.7 MT of weapons-grade plutonium declared surplus and about 2.3 MT of the balance that is not irradiated. There are 4,000 storage positions allotted for this material. Additional capability of 3,600 positions would be provided to accept RFETS plutonium and approximately 500 positions more for Los Alamos National Laboratory (LANL) plutonium. One storage vault with a capacity to accommodate 8,100 positions would be provided.

Two subalternatives were considered for the upgrade alternative: for only the Hanford plutonium, either modify and upgrade the existing Fuel and Materials Examination Facility (FMEF) in the 400 Area or build a new facility in the 200 West Area; and for all of the RFETS and LANL plutonium, in addition to the Hanford plutonium, extend modifications and upgrades to FMEF or build a larger new facility in the 200 West Area.

Under the first subalternative, the existing FMEF, which has never been used, would need to be modified as a plutonium storage facility. The Hanford plutonium would be stored in the modified main cell of the FMEF process building. The FMEF process building is a safety class structure, and encloses approximately 5,300 square meters of operating area. The main cell of the process building would be modified to produce about 4,000 storage positions. This would include cutting new passages for material movement and adding shielding walls for radiation protection. Modifications to the ground floor would include adding various material handling functions such as accountability measurement, long-term safety evaluation, unpackaging/packaging, and a shielded AGV corridor. A loading dock for SST unloading would be added at the shipping and receiving bay. Lower floor modifications would include adding additional material handling functions such as shipping package staging, CRT handling, and abnormal package handling. Vault storage racks would be added to the main cell of FMEF to provide an additional 4,100 storage positions for the RFETS and LANL materials.

The allocated areas for material handling and vault storage and support are approximately 2,000, 400, and 1,600 square meters, respectively. The concept for using FMEF appears in figure 2-2. The material handling concept for this subalternative is to receive an SST in the shipping/receiving bay and unload it with a shielded fork lift. An overhead crane is used to lift the entire CRT and lower it through a hatch to a lower elevation. The CRT is disassembled at the lower elevation and material confirmation is performed on the shipping packages. For unpackaging, the shipping packages are brought up to the ground floor using an overhead crane. The storage container is moved to the accountability area using an AGV, and is then moved to long-term safety evaluation. It is then moved by an AGV to a rack loading station. The loaded rack is moved inside the vault area through the transfer tunnel. The overhead vault crane moves the rack from the transfer tunnel to the rack support structure in the vault.

The Hanford Plutonium Storage Facility (PSF) Upgrade carried forward in the conceptual design would be a new storage facility in which all primary functions are accomplished, and a number of new and existing facilities would provide required support functions. The new storage facility would be located just north of Building 234-5Z in the existing Plutonium Finishing Plant (PFP) protected area in the 200 West Area (See figure 3-2 for location). The facility design is based on the design developed for the new consolidated facility (CSNMSP) (See chapter 3.0 for description), and includes material handling, material storage, and support areas. The general arrangement of the storage facility is shown in figure 2-1, which shows the overall configuration of the three major areas of the facility. The allocated floor space for the three areas is 4,400, 1,700, and 1,700 square meters, respectively. The storage vault employs vertical sleeves that are serviced from above by an automated, remotely-controlled crane. The vault contains 106 sleeves for storing pits and 690 sleeves for non-pit materials. Detailed descriptions of the storage building areas are given in the Hanford PSF Upgrade Conceptual Design Report (CDR) (Reference 4).

In general, Balance of Plant (BOP) services and facilities required to support the storage mission would use existing Hanford infrastructure. These services and facilities include administration offices, security and training, environmental, safety, and health, support laboratories and offices, emergency facilities, and vehicle and facility maintenance shops. These structures and facilities would be upgraded and modified, as necessary, to meet new functional requirements and comply with new code requirements. Some new BOP facilities would be required; these facilities include (for example) a utility building, an emergency generator building, and a fire water storage tank and pumphouse.

2.1.2 Schedule and Cost

The proposed schedule for constructing the Upgrade PSF at Hanford is shown in figure 2-3. The facility would be operational in about 6 years from project authorization. With project authorization in the start of 1997, the facility would be ready to receive material in 2003. Construction would be phased to start as soon as sufficient design was available. The upgrade of FMEF could be completed approximately one year earlier than the upgrade PSF. The cost estimates are presented in section 2.5.

2.2 ANL-W Plutonium Storage Facility Upgrade at INEL

2.2.1 Description

There is a total of 4 MT of plutonium at Argonne National Laboratory-West (ANL-W) and another 0.5 MT at INEL. The plutonium at INEL would be moved to ANL-W. These materials would be stored in an existing storage vault. Additional new capacity would need to be provided to accommodate the RFETS plutonium.

Two subalternatives were considered for the ANL-W upgrade alternative. The first subalternative accommodates only the plutonium at INEL and ANL-W and would consist of modifying existing facilities for storage and support functions and constructing a new material handling building. The second subalternative considers the addition of RFETS plutonium and would add a new storage vault for the RFETS to the new material handling building of the first subalternative.

The ANL-W PSF Upgrade consists of a combination of new facilities and an upgrade of existing facilities, in which all material handling and storage functions would be accomplished, and a number of new and existing facilities that would provide required support functions. The storage facilities would be in the ANL-W Area of the INEL located in close proximity to the existing Zero Power Plutonium Reactor (ZPPR) Building. The general arrangement of the storage facility is shown in figure 2-4, which shows the new storage vault that would be provided for the RFETS material. The new storage vault employs the vertical sleeve design with access to the storage positions from an operating floor at the upper end of the sleeves where an automated, remotely-controlled crane places the storage containers into, and removes them from, the storage positions. The ZPPR fuel is stored in drawers located in concrete bins in the existing structure. Other materials on the INEL site would be placed in PCVs and stored in cavities in the vault walls of the existing building.

The storage facility upgrade design would use as many of the existing complex facilities as is practical. The ANL-W ZPPR complex consists of six main buildings; the Fuel Manufacturing

2.2.2 Schedule and Cost

The schedule for constructing the Upgrade PSF at INEL is shown in figure 2-5. The facility is operational in about six and one half years from project authorization. With project authorization in the start of 1997, the facility would be ready to received material in 2003. Construction would be phased to start as soon as sufficient design were available.

The cost estimate is presented in section 2.5.

2.3 Savannah River Site Upgrade Plutonium Storage Facility

2.3.1 Description

There are about 2 MT of plutonium at SRS, of which 1.3 MT have been declared surplus weapons-grade plutonium. The plutonium to be stored includes the weapons-grade plutonium declared surplus plus the balance of the plutonium not in irradiated form or reserved for national security needs. In addition, the facility will also store plutonium-238 and other actinides. The storage of these materials requires 2,000 positions. The Department committed in the Implementation Plan for the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-1 to meet the DOE criteria, DOE-STD-3013-94, for storage of plutonium metals and oxides by May 2002. The Department determined that a new Actinide Packaging and Storage Facility is the safest and most economical option compared to the major modification and refurbishment of existing SRS facilities. The new storage facility would be located north of the 235-F building and east of the 247-F building.
The upgrade alternative would be to construct a larger storage vault in the Actinide Packaging and Storage Facility. The facility's vault would need to be increased by 4,100 positions, or about 400 square meters, to accommodate the RFETS and LANL plutonium, and the material handling area would need to handle pits.

A detailed description of the Actinide Packaging and Storage Facility is given in Reference 6.

2.3.2 Schedule and Cost

The Upgrade PSF at SRS would require about 5 years from project authorization to construction completion. Based on the project being authorized early in 1997, the facility would be ready to receive RFETS material in 2002. The cost estimate is presented in section 2.5.

2.4 Pantex Upgrade Plutonium Storage Facility

2.4.1 Description

There are about 21 MT of weapons-grade plutonium declared surplus at Pantex. Two subalternatives were considered for the upgrade alternative: for the Pantex plutonium, modify existing buildings in Zone 12 South; and for the RFETS plutonium, in addition to the Pantex plutonium, increase modifications of existing buildings in Zone 12 South. Building 12-066 would be upgraded for the storage of the surplus plutonium for both alternatives. The upgrades would consist of increasing wall thicknesses to provide radiation shielding, upgrading existing ventilation systems, adding equipment required to perform material handling functions, and for the RFETS material, adding repackaging and analytical capabilities. In regard to the strategic reserve materials, the upgrade for the storage of these materials in Building 12-116 in Zone 12 South is already underway as part of another program and is expected to be completed as early as May 1998. In the Pantex design, the materials would be stored in shipping containers. The shipping containers would be mounted in frames in groups of 4 or 6 and placed remotely in the storage vault. These frames would act as racks in the vault.

A detailed description of the Pantex Upgrade PSF is given in Reference 7.

2.4.2 Schedule and Cost

The schedule for constructing the Upgrade PSF at Pantex is similar to that presented for the Upgrade at Hanford PSF. The cost estimate is presented in section 2.5. The bases for the cost estimates and definitions of terms are presented in Appendix A.

2.5 Summary of Upgrade at Multiple Sites Alternative

2.5.1 Cost Summary

The cost of each of the upgrades at a site appears in table 2.5-1 for the storage of the plutonium at the site and with the addition of RFETS materials for each site. The capital cost for the upgrade is estimated at no cost at SRS, $10 million at Pantex, $160 million at INEL, $190 million for the FMEF upgrade, and $240 million for new construction at Hanford. In the case of SRS, the Actinide Packaging and Storage Facility, which is planned to be completed before the start of the long-term storage mission, would provide long-term storage for the plutonium at SRS. The addition of RFETS plutonium ranges from $10 to $20 million. The capital cost for implementing the upgrade at multiple sites alternative would be less at Pantex or SRS because significantly less new construction would be needed to accomplish the mission.

TABLE 2.5-1.— *Cost of Upgrades at Sites*
In Millions, 1996 Dollars
(rounded to the nearest 10 million dollars)

Site	Capital Cost		50-Year Operating Cost		50-Year Total Life Cycle Cost (TLCC)		Present Value TLCC	
	W/O	With	W/O	With	W/O	With	W/O	With
	RFETS Pu		RFETS Pu		RFETS Pu		RFETS Pu	
INEL	160	180	750	780	910	960	340	360
HANFORD*	190/240	200/250	1000/940	1000/960	1190/1180	1200/1210	390/450	390/470
PANTEX	10†	20‡	340†	430‡	350†	450‡	100†	160‡
SRS	0**	20**	1040	1050	1040	1070	320	340

* Cost element entries are FMEF upgrade/new construction.

** Credit is given for the Actinide Packaging and Storage Facility, which is still to be constructed and is planned to be operational by 2002. Capital cost of the APSF is estimated to be approximately $140 million.

† The capital cost is based on taking credit for pits stored in improved shipping containers (AT400 or equivalent) that provide superior confinement and crush-resistance capabilities relative to prior-used containers. The effect of the use of the improved containers would be to reduce the extent of building improvements for plutonium storage. For 12,000 containers, the incremental cost could be approximately $40 million. This cost would be incurred as part of the program to upgrade the storage containers for pit storage.

‡ The capital cost is based on taking credit for non-pit material stored in shipping containers (modified AT400, SAFKEG, or equivalent). The effect of the use of the shipping containers is to reduce the extent of building improvements for plutonium storage. These containers are estimated to cost $8,000 each. For approximately 2,500 extra containers, the cost of operation could increase by approximately $20 million, in addition to the incremental cost of containers for pits ($40 million).

The total life cycle cost without RFETS plutonium ranges from $350 million at Pantex to approximately $1.2 billion at Hanford. The variability in life cycle costs reflects each site's mode of operation. For example, at Pantex the operating cost estimate does not include security costs because the surplus plutonium would be located in the same zone (Zone 12) as the strategic reserve. Were the surplus to be located in Zone 4, about $4 million per year would need to be added to the operating cost for security. The additional capital cost for storing RFETS plutonium ranges from $14 to $24 million and is a few percent of the total life cycle cost. The costs of transporting the RFETS materials to a site is included in the operating cost, and is $1.7 million for ANL-W, $2.1 million for Hanford, $0.9 million for Pantex, and $2.9 million for SRS, all in 1996 dollars.

The cost of the upgrade at multiple sites alternative consists of summing the cost at each site without the RFETS materials and adding the cost of the storage of RFETS at one site. Table 2.5-2 shows the cost of storing the plutonium currently at each of the four sites and adding the cost of storing the RFETS at ANL-W, or Hanford, or Pantex or SRS. The table shows that the total capital cost and total life cycle cost are not sensitive to where the RFETS plutonium is stored. The capital cost of the upgrade at multiple sites alternative is estimated at about $380 million, the total life cycle cost at about $3.5 billion, and the present value total life cycle cost at about $1.2 billion.

TABLE 2.5-2.— *Cost of Upgrade at Multiple Sites Alternative*
In Millions, 1996, Dollars
(rounded to the nearest 10 million dollars)

Site Taking RFETS Material	Capital Cost	50-Year Operating Cost	50-Year Total Life Cycle Cost (LCC)	Present Value TLCC
INEL	380	3160	3540	1170
HANFORD	370	3130	3500	1150
PANTEX	370	3310	3680	1210
SRS	380	3140	3520	1170

2.5.2 Schedule Summary

The schedules for all of the upgrades at multiple sites are approximately the same except for SRS. It takes about 6 years from project authorization until the facility is fully operational. For SRS about 5 years would be required to bring the expanded storage vault operational.

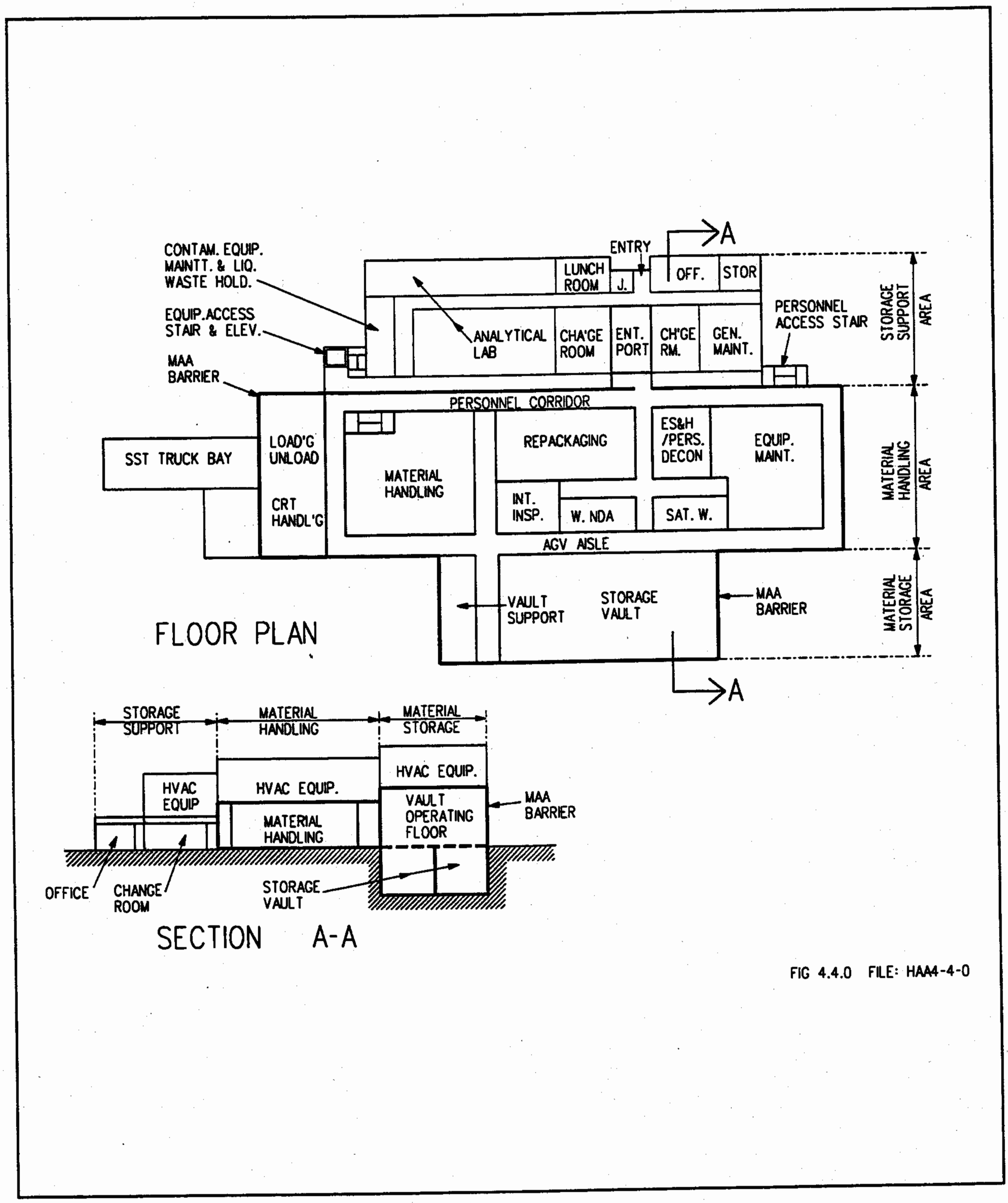

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FIGURE 2-1.— ***Hanford Upgrade Plutonium Storage Facility.***

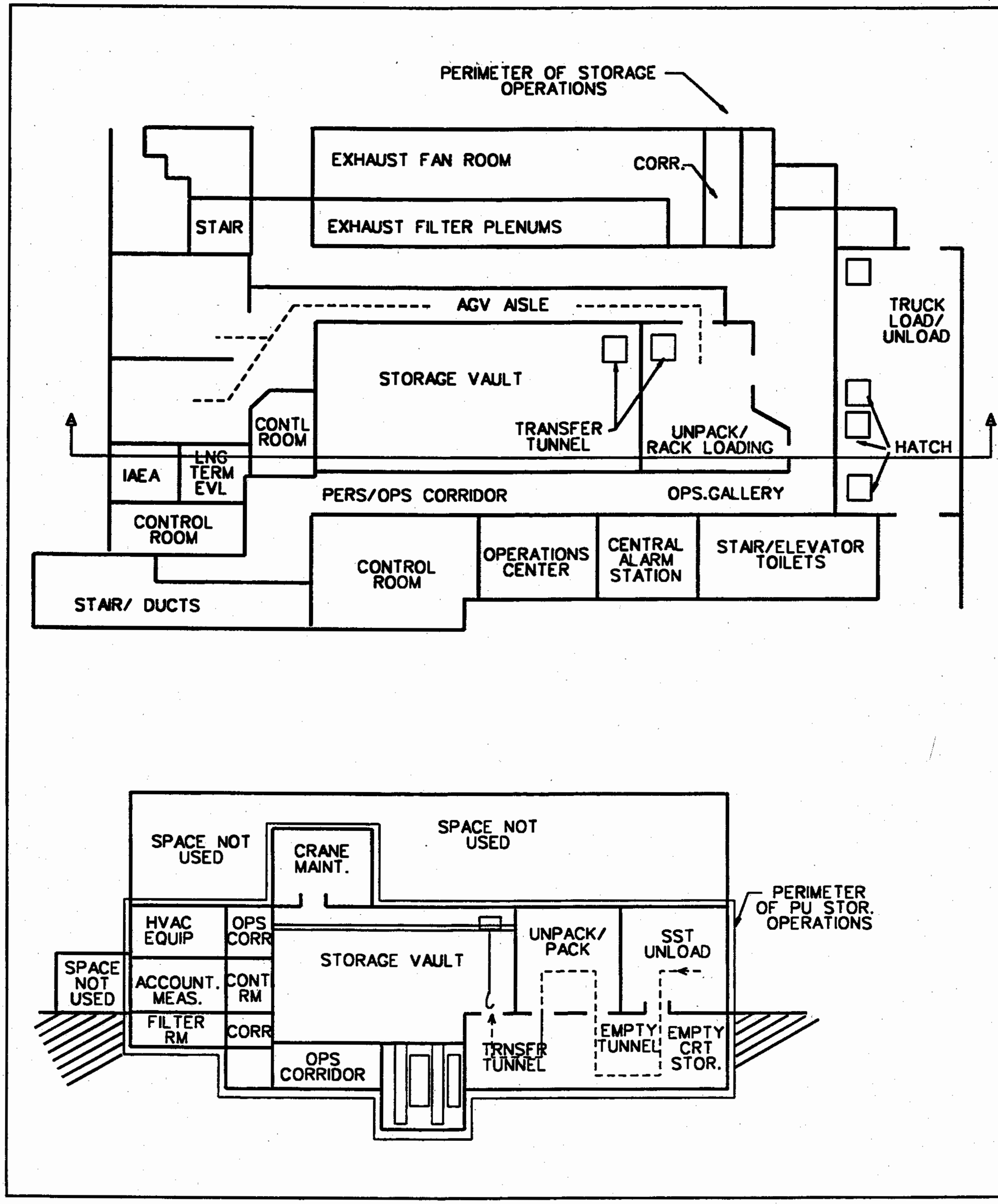

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FIGURE 2-2.— *Existing Fuel and Materials Examination Facility at Hanford.*

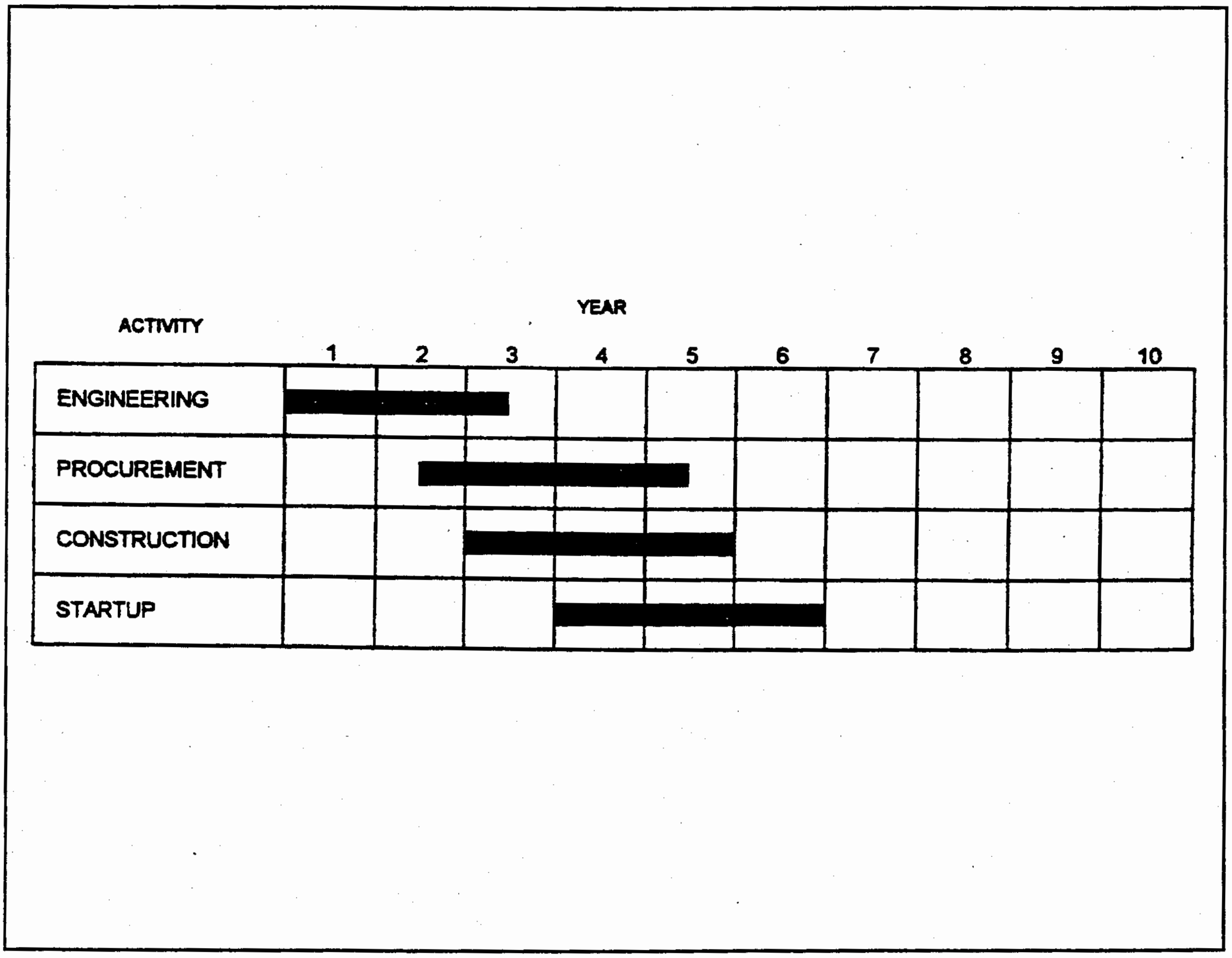

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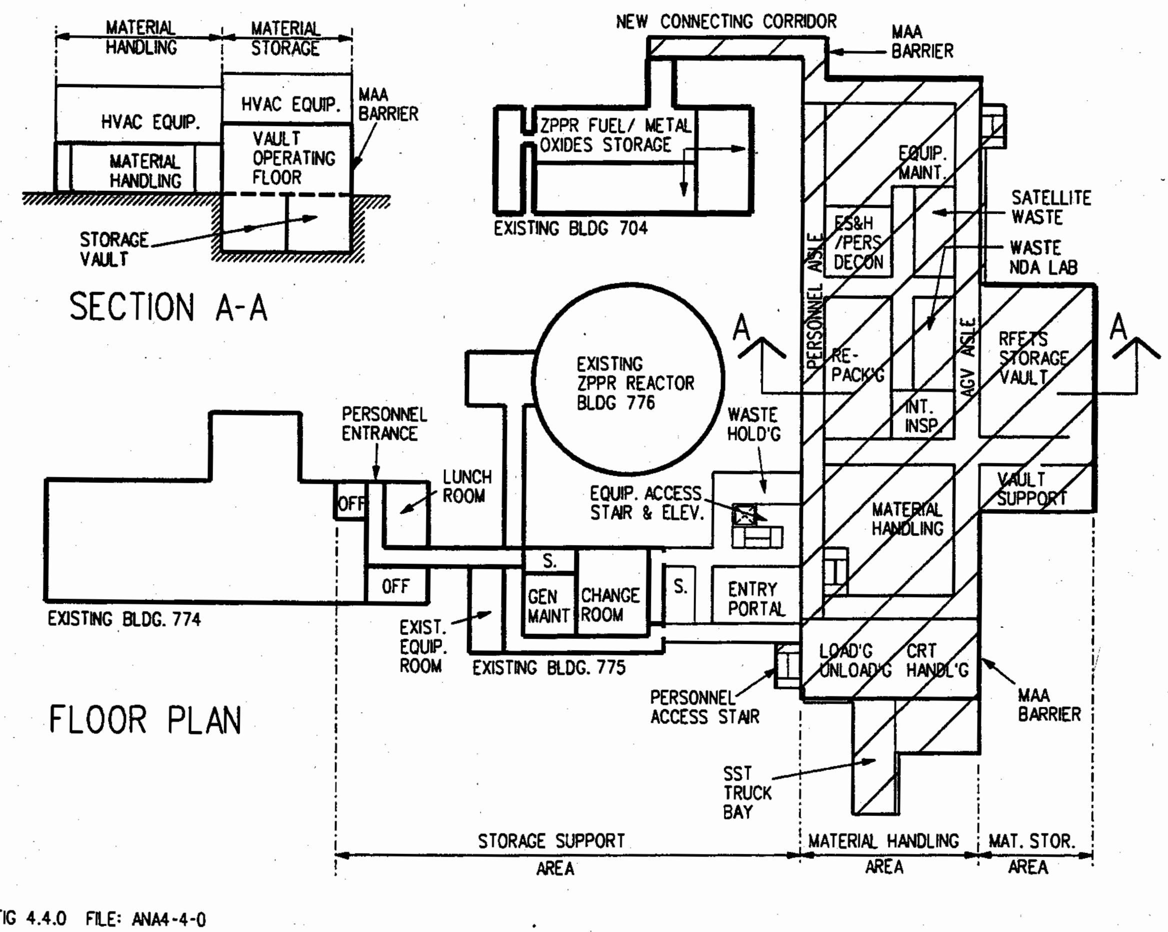
FIGURE 2-3.— ***Hanford Upgrade Summary Schedule.***



Note: Diagonal hatching indicates new area.

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FIGURE 2–4.— ***ANL-W Upgrade Plutonium Storage Facility.***

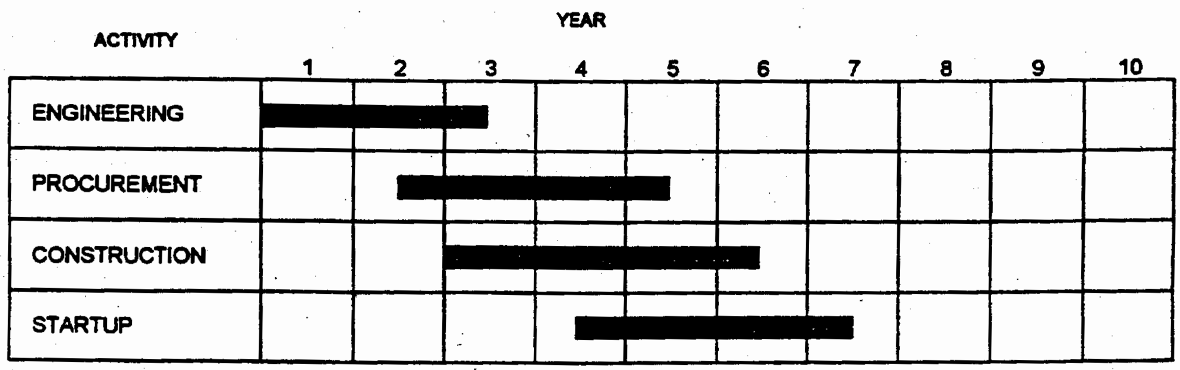

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FIGURE 2-5.— *ANL-W Upgrade Summary Schedule.*

CHAPTER 3: CONSOLIDATION OF PLUTONIUM ALTERNATIVE

Under this alternative, plutonium materials at existing sites would be removed, and the entire DOE inventory of plutonium except for plutonium used for research and development and other program needs would be consolidated at one or more sites, while the HEU inventory would remain at ORR. In addition to the candidate sites considered for the upgrade at multiple sites alternative, Nevada Test Site (NTS) and ORR are candidate sites considered for this alternative.

Existing facilities at Pantex, NTS, and Hanford were considered to implement this alternative as well as the to-be-constructed Actinide Packaging and Storage Facility at SRS. At Pantex, a number of buildings that had been recently constructed but not used because of the decrease in the number of weapons being assembled were considered. At NTS, the P-tunnel was considered for a storage vault. At Hanford, the Fuel and Materials Examination Facility was considered. Under the consolidation alternative, plans would include expanding the Actinide Packaging and Storage Facility at SRS to accommodate the larger quantity of plutonium that would need to be handled and stored.

In addition, the construction of a new facility was considered at each site. The conceptual design for the Consolidated Special Nuclear Materials Storage Plant (CSNMSP) (Reference 8) is based on use of a reference site that is representative of DOE sites having a plutonium support infrastructure. The reference site is defined by a set of data that is typical of the candidate DOE sites for the consolidated storage facility. Many of the CSNMSP utilities and support functions, such as administrative facilities, security portals, warehouse, fire station and fire water supply, would be available at the selected site.

The CSNMSP consists of a single storage facility, in which all primary functions are accomplished, and a number of new and existing facilities that provide required support functions. New facilities are located within a contiguous area of approximately 20 hectares. The general arrangement of the CSNMSP is presented in figure 3-1. The material handling area is a hardened concrete structure designed to receive and unpackage 4,000 shipping packages annually. The material storage area is a hardened concrete structure containing up to eight, 5,000-position storage vaults. Seven vaults are for storage of weapons-usable surplus material and one vault is for storage of strategic reserve material, if required. The material storage area is designed to be constructed in two, 4-vault phases to provide the flexibility in accommodating the range of plutonium storage needs from 20,000 storage positions up to 40,000 storage positions. The material handling area, the material storage area, and the support area would require about 5,800, up to 11,000, and 4,050 square meters, respectively.

3.1 Consolidation of Plutonium at Hanford

3.1.1 Description and Location

The consolidation alternative considered was the construction of a new facility in the 200 East Area. The CSNMSP design, described previously, would be the design option deployed for this alternative. There are existing facilities that could be upgraded to meet most of the CSNMSP design requirements. These were not analyzed in detail because they would not specifically meet all requirements. The proposed location on the Hanford site is adjacent to the 200 East Area as shown in figure 3-2.

FMEF was reviewed with respect to its capability to store 20,000 or 40,000 storage positions. The determination was that FMEF did not have the capacity to store 40,000 storage positions. While FMEF could store 20,000 storage positions consisting of metals and oxides, it would not have the capacity to store 12,000 pits and 8,000 non-pit forms because of the larger volume required for the storage of pits.

3.1.2 Schedule and Cost

The schedule for constructing the new facility for the consolidation of plutonium at Hanford is the same as the schedule for any of the other candidate sites and is shown in figure 3-3. The first phase has the first four modules operational in 6 years. The second phase has the remaining four modules operational one year later. The cost estimate is presented in section 3.7.

3.2 Consolidation of Plutonium at Savannah River

3.2.1 Description and Location

Two alternatives were considered for the consolidation alternative: construct a new facility east of Z-Area; and modify the new Actinide Packaging and Storage Facility and add additional new storage vaults in the F-Area.

The Actinide Packaging and Storage Facility material handling capability would need to be increased by the addition of a material handling line and up to seven additional modular vaults. A total of up to approximately 9,700 square meters would need to be added. Figure 3-4 shows how the vault capacity could be added in the F-Area. The new vaults would be of the CSNMSP design.

The new facility would be the CSNMSP design. The proposed location on the SRS site adjacent to the Z-Area is shown in figure 3-5.

3.2.2 Schedule and Cost

The schedule for constructing the facility for consolidation of plutonium at SRS using the CSNMSP design is the same as that presented for consolidation of plutonium at Hanford. For the other option, the facility could be made operational about the same time. The cost estimate is presented in section 3.7.

3.3 Consolidation of Plutonium at Pantex

3.3.1 Description and Location

There are two optional designs being considered for consolidation of plutonium at Pantex. The first option would be the deployment of the CSNMSP, at the location shown in figure 3-6. The second option, designated the Consolidated Plutonium Storage Facility (CPSF), would use existing facilities.

The Consolidated Plutonium Storage Facility (CPSF) consists of an upgrade of existing facilities. Building 12-66 is proposed for storage of surplus materials having a capacity of up to 35,000 storage positions and located in Zone 12 South. It would have a storage vault floor area up to 5,800 square meters. The materials would be stored in shipping containers mounted in frames in groups of 4 or 6 and placed remotely in the storage vault. The material handling operations would be accommodated in Building 12-116.

For strategic reserve material, Building 12-116 would be upgraded to provide 5,000 storage positions, and Building 12-117 would be used for loading dock operations. These buildings have a gross floor area of about 6,000 square meters.

A detailed description of the consolidated storage facility at Pantex is given in Reference 7.

3.3.2 Schedule and Cost

The schedules for constructing either the CSNMSP or the second option described above at Pantex is the same as that shown for consolidation of plutonium at Hanford. The cost estimate is presented in section 3.7.

3.4 Consolidation of Plutonium at the INEL

3.4.1 Description and Location

The consolidation alternative under consideration is the construction of a new facility near the Idaho Chemical Processing Plant.

The CSNMSP design described previously is the technical option for consolidation of plutonium being considered for deployment at the INEL because no existing facility is adequate for the consolidated storage mission. The location of the candidate site is shown on figure 3-7. The ANL-W area is too small to accommodate the consolidated storage facility. As noted in the upgrade at multiple sites, the Fuel Processing Restoration Building had capacity to store only the plutonium currently at the INEL site.

3.4.2 Schedule and Cost

The schedule for constructing the facility for consolidation of plutonium at the INEL is the same as that shown for consolidation of plutonium at Hanford. The cost estimate is presented in section 3.7.

3.5 Consolidation of Plutonium at the Nevada Test Site

3.5.1 Description and Location

The consolidation alternative considered two options: extend and modify the existing P-tunnel; or construct a new facility near the Device Assembly Facility (DAF).

Use of the Device Assembly Facility in conjunction with new facilities was initially considered but was found to be impractical due to the cost of adapting the blast-resistant structures of the existing facility to a new mission.

An expansion of the P-Tunnel facility at NTS was considered for consolidated storage of plutonium. The P-Tunnel is an existing excavation located at Rainier Mesa near the north edge of the NTS. The tunnel is about 2,500 feet long and about 800 feet below the surface. A new material handling facility would be built at the entrance of the P-Tunnel. This option would include upgraded and expanded drifts. The difference in estimated cost for this option compared to the CSNMSP is small. The CSNMSP, which would present less risk in cost and schedule, was preferred because there is no significant cost advantage for the P-tunnel option.

The CSNMSP design is the option for consolidation of plutonium being considered for deployment at the NTS. The location proposed for this facility on the NTS is shown in figure 3-8.

3.5.2 Schedule and Cost

The schedule for constructing the facility for consolidation of plutonium at the NTS is the same as that for Hanford. The cost estimate is presented in section 3.7.

3.6 Consolidation of Plutonium on the Oak Ridge Reservation

3.6.1 Description and Location

The consolidation alternative considered was the construction of a new facility. The CSNMSP design is the option for consolidation of plutonium being considered for deployment at the ORR because no existing facility is suitable for this purpose. The location proposed for this facility on the ORR is shown in figure 3-9.

3.6.2 Schedule and Cost

The schedule for constructing the facility for consolidation of plutonium at the ORR is the same as for consolidation of plutonium at Hanford. The cost estimate is presented in section 3.7.

3.7 Summary of Consolidation of Plutonium Alternative

3.7.1 Cost Summary

The cost estimates for the consolidation of plutonium alternative are presented in table 3.7-1. Bases and definitions for the cost estimate are presented in Appendix A, Cost Estimate Information.

Table 3.7-1 presents the costs for the consolidation alternative for two phases. In the first phase, the existing inventory of surplus plutonium would be consolidated in a 20,000 storage position facility. In the second phase, surplus plutonium that could become available in the future would be consolidated in up to 15,000 additional storage positions. For the case where the strategic reserve would not remain at Pantex, an additional 5,000 storage positions would be required to be co-located with the consolidated storage of the surplus plutonium.

The first option on table 3.7-1 presents the costs for essentially all new construction at a site. These costs would apply to Hanford, NTS, INEL and ORR. Although, existing facilities could be used at Hanford, NTS and INEL for the plutonium storage mission, the assessment was that new construction would be more cost-effective. The capital cost for a new 20,000 storage position facility is estimated to be $360 million and the increment to add another 15,000 storage positions is estimated to cost $70 million. The operating cost is estimated at $1.09 billion and approximately $1.16 billion for the 20,000 and 35,000 storage position facilities, respectively. The increment in operating costs is approximately $70 million or $1.4 million per year and is attributed to additional maintenance and replacement costs and decontamination and decommissioning costs.

TABLE 3.7-1.— *Consolidation of Plutonium Alternative Storage Facility Costs*
In Millions, 1996 Dollars
(rounded to the nearest 10 million dollars)
cost for 20,000 storage positions/cost for 35,000 storage positions

Consolidated Plutonium Storage Option	Capital Cost	50-Year Operating Cost	50-Year Total Life Cycle Cost (TLCC)	Present Value TLCC
All Sites Except Optional SRS and Pantex Design	360/430	1090/1160	1450/1590	580/660
SRS Option	70/150*	1060/1280	1130/1430	430/550
PANTEX Option	40/100**	600/670***	640/770	200/260

* Credit is given for the Actinide Packaging and Storage Facility, which is still to be constructed and is planned to be operational by 2002. Capital cost of the APSF is estimated to be approximately $140 million.

** The cost shown in the table for the 35,000 storage position facility is based on the methodology used for other site estimates. The capital cost is based on taking credit for pits stored in improved shipping containers that provide superior confinement and crush resistance capabilities relative to prior-used containers. The effect of the use of the improved containers would be to reduce the extent of building improvements for plutonium storage.

*** The cost of storing 8,000 to 15,000 shipping containers for non-pit materials could increase the cost of storage by as much as $60 million to $120 million for consolidation with 20,000 and 35,000 storage positions, respectively, in addition to the incremental cost of containers for pits, $40 million, which would be incurred as part of the program to upgrade the storage containers for pit storage.

The second option presents the costs for consolidation at SRS. These costs are incremental to the costs to the use of the Actinide Packaging and Storage Facility (APSF), which is planned to be completed before the start of the long-term plutonium storage mission. The incremental costs are for the addition of storage vaults and modifications to the APSF. The incremental capital cost is estimated at $70 million for the first phase and $150 million for the second phase. The operating cost is approximately $1.1 billion and $1.3 billion for the first and second phases, respectively. The difference in operating costs over 50 years is approximately $220 million, or $4.4 million per year. The increase in operating costs for the second phase relative to the first phase is attributed to additional maintenance, replacement, operating personnel, and decontamination and decommissioning.

The third option presents the costs for consolidation at Pantex. For Pantex, the costs are based on using an existing building and existing infrastructure. The current plans are to store the surplus plutonium in shipping containers, AT400A for pits and undefined shipping containers for metals and oxides. The shipping containers for metals and oxides could cost from approximately $1,000 to $10,000 per container, with a cost in the higher range more likely. The capital cost for the first phase is estimated at $40 million and the second phase at $100 million. The increment in capital cost is attributable to the additional storage area and storage racks that would be required. The operating costs are $600 million and $670 million for the first and second phases, respectively. The increment in operating costs over 50 years is approximately $70 million, or $1.4 million per year, and is attributed to additional maintenance and replacement and decontamination and decommissioning costs.

For the case where the strategic reserve would not remain at Pantex, an additional 5,000 storage positions would be required to be collocated with the consolidated storage of surplus plutonium. In that event the capital costs at each of the remaining sites would increase by about $25 million (the cost of a 5,000 position vault storage module, with contingency), and the total life cycle operating cost by about $120 million dollars.

The operating cost estimates include the cost of transportation of the plutonium materials to the site for long-term storage. These cost estimates are $6 million to Pantex, and $24 million to all other sites. The difference in transportation cost reflects that much of the plutonium (in pits) is already located at Pantex.

3.7.2 Schedule Summary

The construction schedule is essentially the same for all of the candidate sites.

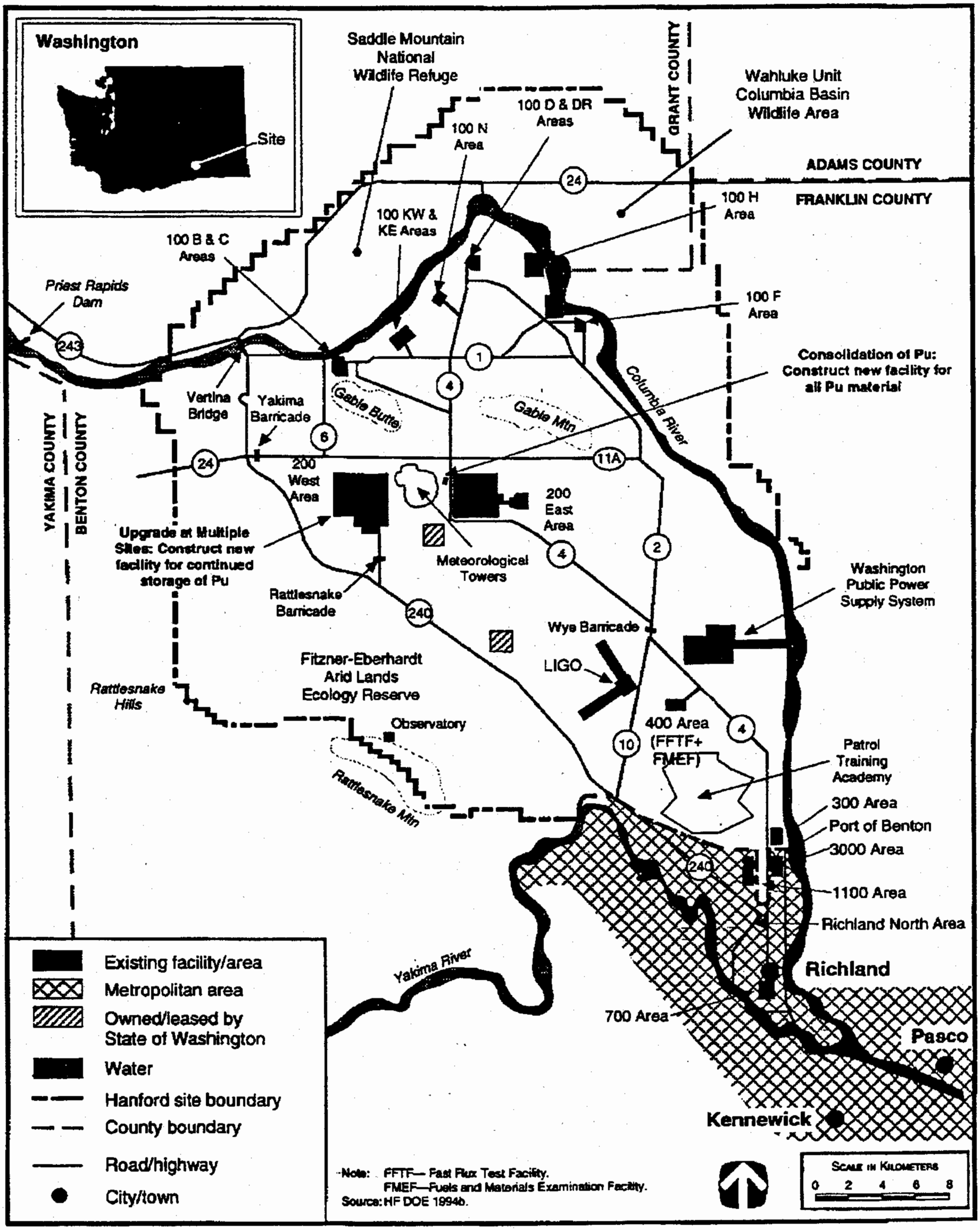

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FIGURE 3-2.— ***Conceptual Facility Locations for the Long-Term Storage Alternatives at Hanford Site.***

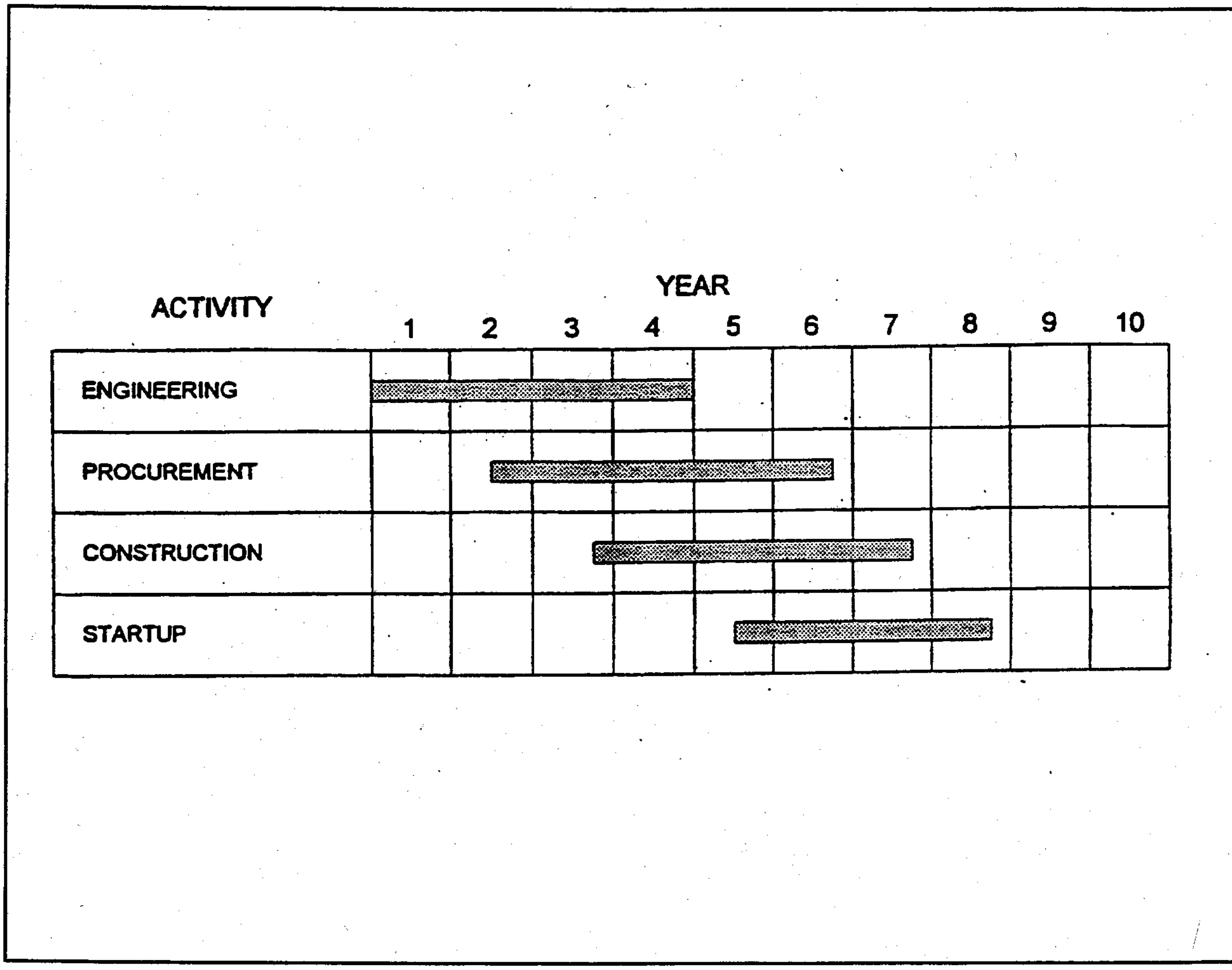

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FIGURE 3-3.— ***Hanford CSNMSP Summary Schedule.***

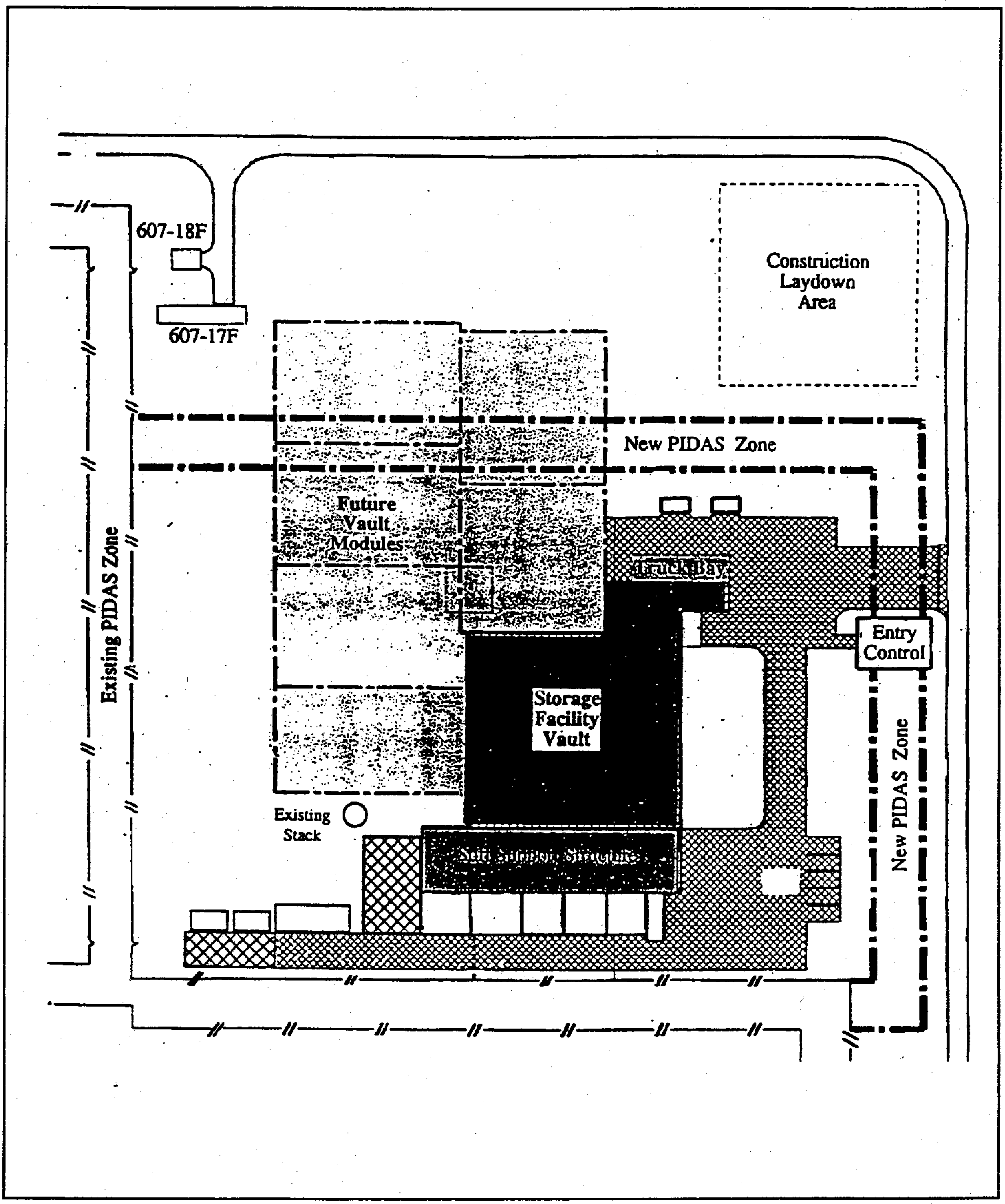

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FIGURE 3-4.— ***SRS Future Expansion Plan for Consolidation of Plutonium***

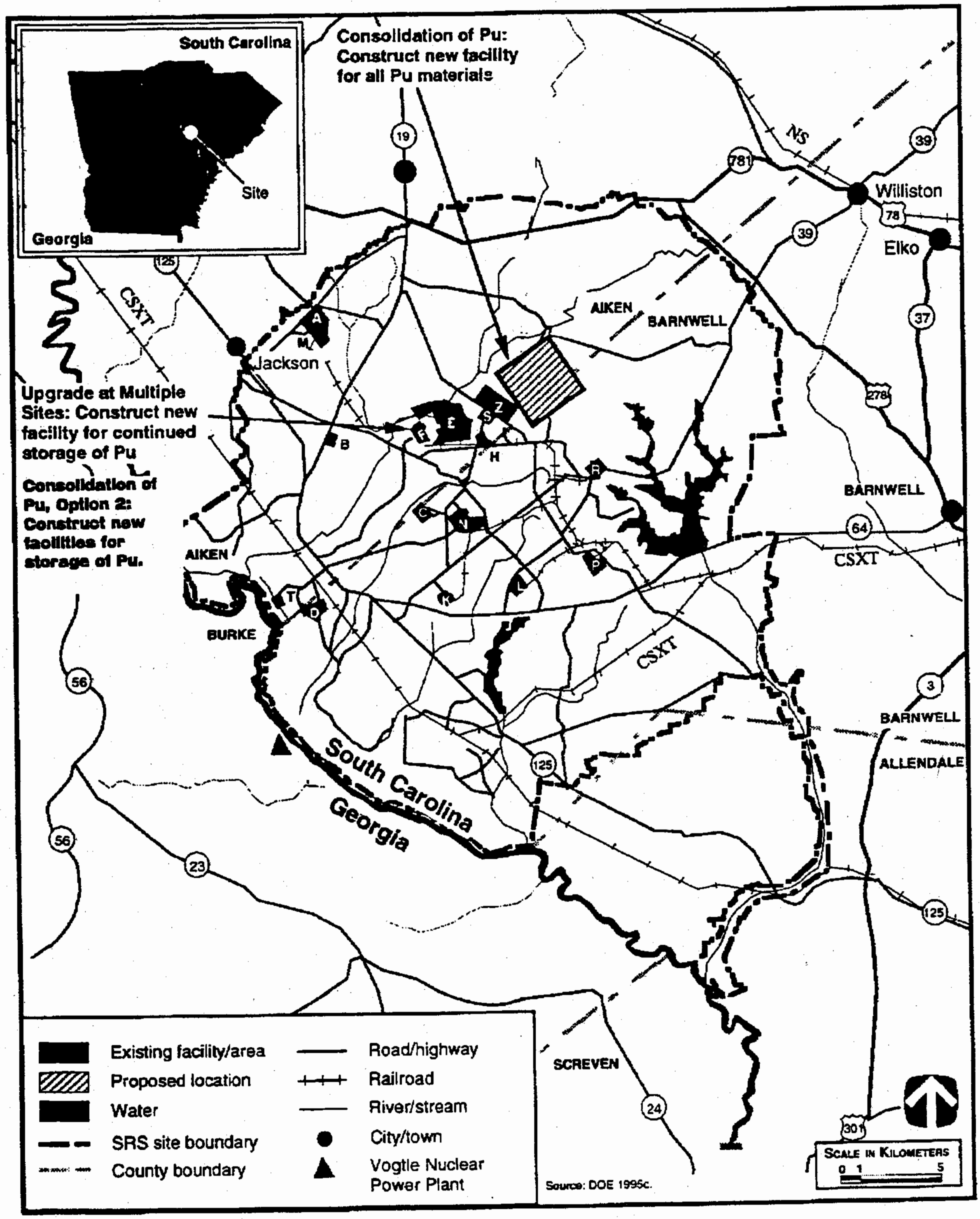

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FIGURE 3-5.— ***Conceptual Facility Locations for the Long-Term Storage Alternative at Savannah River Site.***

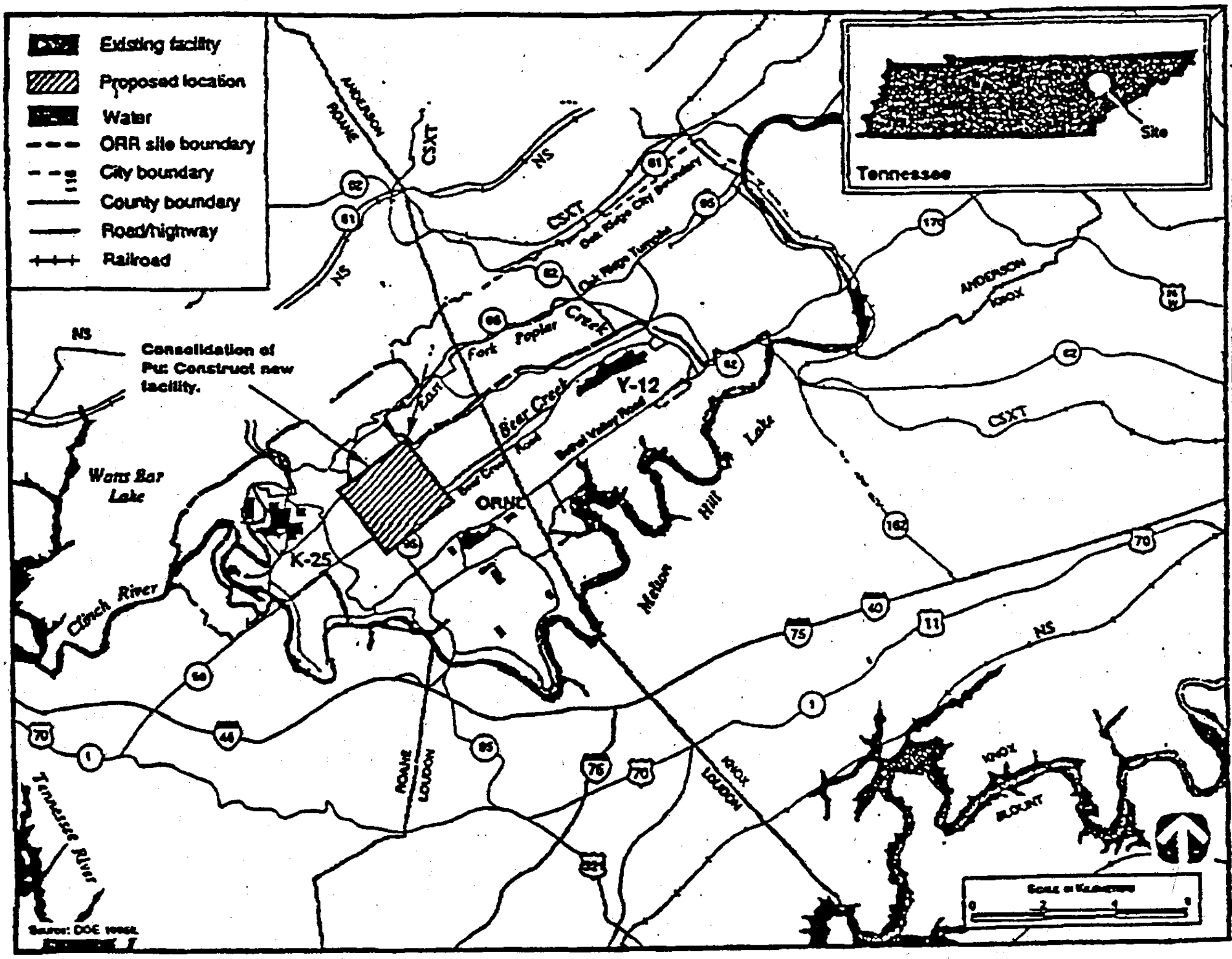

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FIGURE 3–9.— *Conceptual Facility Locations for the Long-Term Storage Alternatives at Oak Ridge Reservation.*

CHAPTER 4: COMBINATION ALTERNATIVE

Under this alternative, the plutonium forms residing at Rocky Flats Environmental Technology Site (RFETS) would be removed and stored at two sites, Pantex Plant and Savannah River Site (SRS), pending disposition. The pit forms from RFETS would be stored at Pantex Plant along with all the other surplus pits, and the non-pit forms would be stored at SRS. The plutonium residing at Hanford, Idaho National Engineering Laboratory (INEL), and Los Alamos National Laboratory (LANL) would remain at those sites, also pending disposition (or movement to lag storage at the disposition facilities). HEU would remain at Oak Ridge Reservation (Y-12), and the non-surplus (strategic reserve) plutonium would remain at Pantex.

Under this alternative, surplus plutonium would be stored only as long as required to support disposition alternatives. The *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* provides descriptions and estimated schedules for disposition technologies. Based on this report, pit forms could be converted to plutonium oxide as feed material to the disposition technologies as early as 9 years and could take about 19 years to complete the conversion, after a Record of Decision on disposition technologies. For non-pit forms, the plutonium could be converted to plutonium oxide as feed material to the immobilization technology as early as 7 years and could take about 14 years to complete after a Record of Decision on disposition technologies.

4.1 Storage at Pantex

Pit forms residing at Pantex, surplus and non-surplus, are currently stored in Zone 4 in magazines. Pit forms from RFETS would be stored initially in Zone 4 along with the other pits. Upon completion of upgrades in Zone 12 (see section 2.4), the surplus pits would be moved to Zone 12 and the surplus pits stored in Building 12-066, and the non-surplus pits in Building 12-116. Modifications to Building 12-066 would allow the storage of approximately 12,000 pits. Operations associated with the storage of the surplus pits would take advantage of the infrastructure that would be in place for the storage of the non-surplus pits.

4.2 Storage at Savannah River Site

SRS plans are to stabilize, repackage as necessary, and store plutonium in the to-be-constructed Actinide Packaging and Storage Facility (APSF) starting in approximately 2002. Design activities for this facility are planned to start in fiscal year (FY) 97. The APSF storage vault would be expanded from about 2,000 positions to store the SRS plutonium to about 5,000 positions to accommodate the RFETS non-pit forms. The RFETS plutonium could be stored in the APSF vault starting about 2002, pending disposition.

4.3 Storage at Other Sites

Plutonium residing at Hanford would be stored at the Plutonium Finishing Plant. Plutonium residing at INEL would be stored in Building 704 at Argonne West and in the 200 West Area of the Idaho Chemical Processing Plant at INEL. Plutonium residing at LANL would be stored in the upgraded Nuclear Material Storage Facility. The description of the storage of these materials appears in the MD-PEIS under the no action alternative.

4.4 Summary of Combination Alternative

4.4.1 Cost

The cost estimates for the combination alternative are presented in table 4.2-1. Bases and definitions for the cost estimate are presented in Appendix A, Cost Estimate Information.

The capital cost of the combination alternative is estimated to be $30 million and consists of the cost of upgrading the 12-066 facility at Pantex and the expansion of the to-be-constructed APSF at SRS. Any modifications to plutonium storage facilities at Hanford, INEL, and LANL that would be required prior to about 2003 would be dictated by other program needs. The operations cost is estimated to be $330 million and consists of the costs of operating the 12-066 facility and the APSF, pending disposition. The costs of operating the storage facilities at Hanford, INEL, and LANL are not included because the time that the plutonium would reside at these sites pending disposition would not be substantially different than if they were to be moved to a consolidated storage site (see schedule following).

The capital cost at Pantex is based on upgrading Building 12-066 and using the material handling and support capabilities that would be provided for the strategic reserves (non-surplus pits) in Zone 12, estimated to be available sometime in FY 98. The capital cost also includes the packaging and repacking costs of moving the RFETS pits from Zone 4 to Zone 12. The operational costs at Pantex are based on the costs of operating Building 12-066. Other infrastructure costs would be paid as part of maintaining Defense Program missions and are not included in the cost estimate. Although storage time could range from about 12 to 20 years, a conservative storage period of 20 years is used to establish the operating cost. The capital cost is estimated to be $10 million and the operating cost $130 million.

The capital cost at SRS is based on the incremental cost of adding an expanded storage vault for the to-be-constructed APSF. The material handling and support area capital costs would be paid as part of establishing the environmental management capability to stabilize and package the SRS plutonium. The operational costs represent the cost of operating and maintaining the APSF facility. While opportunities exist for cost sharing with other program missions, the costs appearing on table 4.2-1 are conservative in that they represent all Department mission costs. In any case, most of the plutonium stored in the APSF would be stored awaiting disposition. The storage time is assumed to be 7 years before the plutonium could be disposed of. The capital cost is estimated to be $20 million and the operating cost $200 million.

4.4.2 Schedule

The upgrade to Building 12-066 at Pantex could be completed as early as 1999 and the transfer of pits from Zone 4 could start in about the 2000 - 2001 time frame. Alternatively, depending on Defense Program mission priorities at Pantex, the transfer of pits from Zone 4 to Building 12-066 could start by about 2004. The pits would remain in storage in Building 12-066, pending disposition, until the start of disposition, which could range from 7 to 11 years (2006 to 2010), after which the pits would be removed over time for disposition. Disposition would take from about 5 to 9 years; therefore, the storage mission could last up to 2019.

The plutonium at SRS would be placed in storage in the APSF about 2002. The non-pit forms would remain in storage, pending disposition, until about 2004, and then be removed over time. The storage mission would end about 2011.

The plutonium at Hanford, INEL and LANL would reside in existing facilities at these sites, pending disposition. The plutonium at these sites could be removed to a disposition site for lag storage or to be disposed of starting as early as 2004, and all plutonium could be removed in about 2 years.

TABLE 4.2-1.— *Combination Alternative Plutonium Storage Facility Costs*
In Millions, 1996 Dollars
(rounded to the nearest 10 million dollars)

Consolidated Plutonium Storage Option	Capital Cost	Operating Cost	Total Life Cycle Cost (TLCC)	Present Value TLCC
PANTEX	10*	130	140	70
SRS	20**	200	220	140
TOTAL	30	330	360	210

* The capital cost is based on taking credit for pits stored in improved shipping containers that provide superior confinement and crush resistance capabilities relative to prior-used containers. The effect of the use of the improved containers would be to reduce the extent of building improvements for plutonium storage. For 12,000 pits, the incremental cost could be approximately $40 million. This cost would be incurred as part of the program to upgrade the storage containers for pit storage.

** Credit is given for the APSF, which is still to be constructed and is planned to be operational by 2002. Capital cost of the APSF is estimated to be approximately $140 million.

CHAPTER 5: HIGHLY ENRICHED URANIUM

The Y-12 plant (ORR), designated by the Department as the interim storage site for highly enriched uranium (HEU) stores much of the United States' inventory of HEU[5]. The *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant* (Reference 9) analyzed the environmental impacts of the interim storage of HEU. The *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* analyzed the environmental impacts of extending the current storage mission at Y-12 into the long-term HEU storage mission, in addition to relocating the HEU from Y-12 to a consolidated plutonium storage site.

The inventory of non-surplus HEU would be stored in stainless steel cans (approximately 6 inches in diameter and 9 inches long) and in drums of various sizes. The assumed quantity is 6,000 cans and 8,500 drums.

HEU would be stored in material access areas, or other secure locations within the Y-12 Plant Perimeter Intrusion Detection and Alarm System controlled area. All storage configurations would meet criticality safety, environmental, and security requirements. HEU would be stored in vault-like cages, tube vaults, vaults, or modular storage vaults.

A vault-like cage is a structure having a combination locked door and protected by an intrusive alarm system that is activated by any penetration of walls, floors, ceilings, or openings, or by motion within the room. Tube vaults have concrete floors, ceilings, and walls. Matrices of steel tubes are constructed in two opposing walls in these vaults, and the spaces between the steel tubes are filled with concrete. Trays with fixed spacers are used in the tubes to maintain criticality safety when canned components are stored. The trays are pulled out horizontally from the tube vault and loaded with containers. A vault is a windowless enclosure with a built-in combination locked steel door and walls, floors, and ceiling substantially constructed of materials that afford penetration resistance at least equal to that of 8-inch thick reinforced concrete. Modular storage vaults are concrete blocks approximately six feet by six feet and 2 feet high containing 20 storage positions for cans. The modular storage vaults are structurally equivalent to tube vaults. Each container would be loaded by hand into a storage cavity. The loaded modular storage vaults may be stacked on each other up to eight vaults by means of a forklift. The uppermost vault would be covered with a lid.

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[5] HEU is uranium enriched in the isotope U-235 to greater than or equal to 20 percent.

5.1 Upgrade Alternative

Under this alternative HEU would be stored in five facilities at Y-12. These facilities would be upgraded to improve the resistance to natural phenomena hazard events such as tornado winds and earthquakes as part of the Defense Program mission. These facilities, Building 9212 Complex, Building 9204-2E, Building 9204-2 and Building 9215/9998 Complex, would be used for continued storage of the non-surplus HEU.

5.2 Collocation Alternative

Under this alternative, the HEU would be moved from Y-12 and collocated with a new consolidated plutonium facility. Because the radiological and nuclear characteristics of HEU are different from plutonium, HEU would require different handling and storage protocols. A new HEU facility was analyzed that would provide the material handling, storage and support functions. Some administrative support functions could be shared with the plutonium storage facility.

5.3 Schedule and Cost

The cost estimate is based on a preliminary analysis and review by an Architect Engineer. The cost estimate for the upgrade alternative was prepared from conceptual bills of materials and man-hour estimates. The cost of this project is estimated to be about $20 million. The total life cycle cost is estimated at $720 million and the net present value total life cycle cost at $186 million. These costs would be incurred as part of the Defense Program mission.

The project schedule was estimated to take approximately five years, with conceptual design activities starting approximately two years prior to the start of Title 11 design. Title II Design would start in early FY 99 and construction would end in FY 2004.

The long-term storage alternative for the collocation of plutonium and highly enriched uranium would require construction of new facilities for HEU. The need to construct a new facility for HEU would make the collocation alternative less cost-effective relative to the upgrade alternative because the costs of a new facility for the storage of HEU is estimated to cost $220 million in capital costs, $1.2 billion in total life cycle costs, and $420 million net present value total life cycle costs.

CHAPTER 6: REFERENCES

1. U.S. Department of Energy, *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement*, 1996.

2. U.S. Department of Energy Standard, "Criteria for Safe Storage of Plutonium Metals and Oxides," DOE-STD-3013-94, December 1994.

3. U.S. Department of Energy, "Criteria for the Safe Storage of Enriched Uranium at the Y-12 Plant," Y/ES-015, July 1995.

4. Fluor Daniel, Inc., *Hanford Plutonium Storage Facility Upgrade Conceptual Design Report*, Revision A, May 1996.

5. Fluor Daniel, Inc., *Argonne National Laboratory-West Plutonium Storage Facility Upgrade Conceptual Design Report*, Revision A, May 1996.

6. Westinghouse Savannah River Co., *PEIS Upgrade Data Report on Plutonium Storage at the Savannah River Site*, Revision 3, Document No. NMP-PLS-940288, August 1, 1994.

7. Mason & Hanger-Silas Mason Co., Inc., *Preliminary Cost Estimate Report on Upgrade Alternative for the Pantex Plant Pu Storage Operations*, Revision 1, Report No. RPT16, December 1995.

8. Fluor Daniel, Inc., *Consolidated Special Nuclear Material Storage Plant Reference Site Conceptual Design Report*, Volumes 1-3, February 1996.

9. U.S. Department of Energy, *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee*, DOE/EA-0929, September 1994.

APPENDIX A - COST ESTIMATE INFORMATION

A.1 Basis of Cost Data

The basic cost data were extracted from existing cost estimates. The cost estimates used as data sources for each storage alternative are listed in table A-1.

Table A-1 Cost Data Sources

Storage Alternative	Data Source (A.2 Cost References below)	Remarks
Pantex Consolidated Option	C1	FMEF estimate with repackaging and analytical lab capabilities added, cost of 20,000 racks added, and all costs escalated to 1996 June
Pantex Upgrade	C2, C10	Added cost of additional shielding; adjusted all costs to 1996 dollars
CSNMSP Reference Site	C3	Delete strategic reserve storage; escalated all costs to 1996 dollars
SRS Upgrade	C4	Escalated to 1996 dollars
SRS Upgrade Consolidated Option	C5	Adjusted to 1996 dollars
INEL Upgrade	C6	Escalated to 1996 dollars
Hanford Upgrade	C7, C11	Escalated to 1996 dollars
HEU Upgrade	C8	Escalated to 1996 dollars
New HEU Storage Facility	C9	Used Main Storage building from C9 and labor rates, other factors from C3, escalated to 1996 dollars

In order to provide a valid cost comparison between candidate alternatives, all cost estimates are in 1996 dollars.

Escalation of source data to 1996 dollars, when required, was calculated in accordance with DOE FM-20's *Economic Escalation Indices for DOE Construction and Environment Project* (Jan. 1996). Contingency identified in the estimate is included as part of the costs presented in this section.

Packing of material for shipment from the present location to long-term storage at another DOE site and the shipping containers are not included in the costs, but the cost of the transportation is included.

A.2 COST REFERENCES

C1. Mason and Hanger-Silas Mason Co., Inc., *Preliminary Cost Estimate Report on Upgrade Alternative for the Pantex Plant Pu Storage Operations*, RPT16, Rev. 1, December 1995.

C2. Mason & Hanger-Silas Mason Co., Inc., *Pit Storage Bldg.12-66 Planning Estimate*, May 22, 1996.

C3. Fluor Daniel, Inc., *Reference Site Conceptual Design Report Consolidated Special Nuclear Material Storage Plant Cost Estimate*, Revision A, February 1996.

C4. Westinghouse Savannah River Co., *Conceptual Design Documentation for the RFETS Material Upgrade at SRS*, NMP-PLS-960071, April 18, 1996.

C5. D.N. Bridges to Andre Cygelman, Subject: Consolidated Storage Facility at SRS, dated July 1996.

C6. Fluor Daniel, Inc., *Conceptual Design Report ANL-W Plutonium Storage Facility Upgrade*, Revision A, May 1996.

C7. Fluor Daniel, Inc., *Conceptual Design Report Hanford Plutonium Storage Facility Upgrade*, Revision A, May 1996.

C8. Martin Marietta Energy Systems, Inc., PEIS Data and Cost Estimating Report: *Upgrading the Y-12 Plant for Long-Term HEU Storage*, February 1995.

C9. Fluor Daniel, Inc., *Final Feasibility Design Cost Estimate for Collocated Highly Enriched Uranium/Special Nuclear Material Storage Plant*, Revision B, October 1995.

C10. Mason & Hanger-Silas Mason Company, Inc., Operating Cost Estimates for Storage of Plutonium Options, Letter, W.A. Weinreich to G.W. Johnson, dated July 12, 1996.

C11. U.S. Department of Energy, Richland Office, *Hanford Site Data for the Weapons Complex Reconfiguration Programmatic Environmental Impact Statement*, DOE/RL-93-0100, Rev. 1, July 1994.

A.3 Definitions

Construction	Construction labor, plant materials and equipment, indirect costs and taxes.
Construction Management	Management of all construction and procurement activities.
End-of-Life Decontamination & Decommissioning (D&D)	Decontamination, demolition and removal of materials and structures, and restoration of the site to a "greenfield" condition.
Engineering, Design, & Inspection	Preliminary design (Title I), detailed design (Title II), and inspection/engineering support services during construction (Title III).
Operations & Maintenance (O&M)	Staffing, consumables, utilities, waste management, and capital upgrades and replacements during the 50-year operational life of the plant.
Other Project Costs (OPC)	Pre-Title I design (e.g., conceptual), pre-Title I program management and administration, pre-Title I safety and environmental review and permitting, research and development, and start-up operations prior to full-scale operations.
Operating Cost	O&M + D&D
Project Management	Management and administration of the project by the contractor tasked with project oversight and control.
Stand-alone	The term "stand-alone" refers to a facility or plant that contains all the support, utility and infra-structure functions required to operate (i.e., functions are not shared with other new or existing plants).
Start-up Operations	Hiring, start-up and operations training, start-up procedure development, operational readiness reviews and start-up.
Total Estimated Cost (TEC)	Engineering and design, construction, construction management and project management.
Total Project Cost (TPC) or Capital Cost	TEC + OPC.
Total Life Cycle Cost (TLCC)	TPC + O&M + D&D.

A.4 Reference Site

The Consolidation of Plutonium alternatives will be facilities located at a reference site on existing DOE property. The reference site is defined by a set of data that is typical of the DOE sites that could be selected for these facilities. The reference site is described in FDI's Task Directive 005, Revision 5, dated February 22, 1996 (Reference C).

A.5 Development of Present Value Cost

In order to examine the time value of money, a present value analysis was performed for each alternative. The present value analysis is a means of evaluating future cash flow outlays or investments in a long-term project in present day dollars. To determine the present value of the life-cycle expenditures (TEC, OPC, O&M costs, and D&D costs) incurred over the project life and the effect of activity schedules, these costs have been discounted to the end of fiscal year 1996. The real discount rate of 5 percent was used to discount the total life-cycle costs. The real discount rate is the difference between the nominal interest rates on treasury notes and bonds percent and the estimated annual escalation rate of (Reference A-1: OMB Circular No. A-94, Appendix C, Revised January 1995).

The schedules presented for each alternative served as the reference to distribute the estimated costs over time. The OPC (including Pre-Title I and Start-up), O&M (50 years of operation) and D&D (spread over 5 years at the end of useful life) costs were included in the present value analysis. Since the Pre-Title I costs are approaching completion, these costs were not discounted.