12/17/01

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Primary Document

Engineering Evaluation/Cost Analysis for the C-410 Complex Infrastructure at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

I-05112-0018

DECEMBER 2001

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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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Primary Document

Engineering Evaluation/Cost Analysis for the C-410 Complex Infrastructure at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

December 2001

Prepared for the
U.S. Department of Energy
Office of Environmental Management

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
managed by
Bechtel Jacobs Company LLC
for the
U.S. Department of Energy
under contract DE-AC05-98OR22700

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FIGURES

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ACRONYMS AND ABBREVIATIONS

ACM	asbestos-containing material
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BJC	Bechtel Jacobs Company LLC
BRE	Baseline Risk Evaluation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
cm	centimeter
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
dpm	disintegrations per minute
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
ft	foot
ha	hectares
HEPA	high-efficiency particulate air
HF	hydrogen fluoride
km	kilometer
kPa	kilopascal
LDR	land disposal restriction
LLW	low-level waste
m	meter
min	minute
mrad	millirad
mrem	millirem
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act of 1969
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
ppm	parts per million
psi	pounds per square inch
RmAO	removal action objective
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act of 1976
S&M	surveillance and maintenance
SER	Site Evaluation Report
SNM	special nuclear material
T&E	Threatened and Endangered
TBC	To be considered
TSCA	Toxic Substances Control Act of 1976
WAC	waste acceptance criteria

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EXECUTIVE SUMMARY

The C-410 Complex at the Paducah Gaseous Diffusion Plant (PGDP) received uranium oxide (UO_3 and other oxide forms) and converted it in successive steps to uranium tetrafluoride (UF_4) and then to uranium hexafluoride (UF_6) for use as feed material for the diffusion cascades. The complex is comprised of C-420, which converted UO_3 to UF_4, C-410 which converted UF_4 to UF_6, C-411 where fluorine cell maintenance was conducted, and a number of surrounding support facilities. This document addresses the decontamination and decommissioning (D&D) of the equipment and infrastructure in these facilities. The evaluation incorporates National Environmental Policy Act of 1969 values into the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process to the extent practicable consistent with U.S. Department of Energy (DOE) policy.

Headquarters policy is to conduct decommissioning under CERCLA as non-time critical removal actions (DOE and EPA 1995). This action is proposed to be undertaken as a non-time-critical removal action under CERCLA consistent with the Program Plan for D&D of facilities at the PGDP, which specifies that D&D activities should be carried out in three phases. These include a site evaluation phase; an infrastructure D&D phase, which is carried out as a non-time-critical removal action; and a facility structure D&D, which is carried out as a remedial action.

While the scope of the C-410 D&D Project will cover the entire C-410 Complex, this engineering evaluation/cost analysis (EE/CA) only covers the removal, disposal, or reuse/recycle of process and ancillary equipment inside the C-410 Complex buildings. The removal action does not address the primary building utilities, the building structure, or the underlying soil. These will be addressed in a later phase of the remedial actions for the C-410 Complex. The removal action supports the long-term remediation of the C-410 Complex. Alternatives for the complex could include: (1) no action, (2) long-term surveillance and maintenance (S&M), (3) demolition of the C-410 Complex and the remediation of the underlying soil that is above industrial scenario action thresholds, or (4) free-release of the building. The infrastructure removal will remove the materials causing the highest potential risks (e.g., transferable radioactive materials, asbestos, and other hazardous materials such as polychlorinated biphenyls); thereby, significantly reducing the risk to current employees and potential off-site receptors in the event of building failure or further degradation. The risk of a release from the facility will be greatly reduced by the removal of the equipment and infrastructure. The building utilities, building shell, and lagoons would be left to later remedial actions.

The major radiological contaminants of concern are uranium and the associated daughter products. The uranium is present as oxide and fluoride compounds. Some other radionuclides including Tc-99, Np-237, Cs-137, and Pu-239 are present in small quantities as a result of the processing of reactor return material. Uranium contamination is present in and on nearly all parts of the facility and equipment.

Other materials that were used extensively include the asbestos-containing materials that were used throughout the plant to provide thermal insulation, polychlorinated biphenyls that were used in electrical and hydraulic equipment, refrigerants, hydrogen fluoride, and other chemicals used to generate fluorine. Metals such as lead in paint and chrome in cooling water are also likely to be present. Much of the asbestos material is damaged and not contained.

A Level 3 Baseline Risk Evaluation (BRE) was performed for the C-410 Complex to assess the potential risks to human health and the environment posed by current and future potential releases. The BRE evaluation indicated that long-term exposures to contaminated media inside the building pose a potential health risk to site workers and the general public. The risk is primarily due to the potential for contaminant migration and catastrophic releases.

A site evaluation report was prepared. The document describes the feed plant facilities to be addressed by the infrastructure removal action, presents information on the complex history, and summarizes the nature and extent of contamination.

The objectives for this removal action include the following:

1. reduce the potential for a release of contaminants from the equipment and stored materials contained in the C-410 Complex due to deterioration of the aging buildings,

2. reduce the potential for public and environmental exposure to radioactive and hazardous substances that could be caused by any uncontrolled releases from the buildings, and

3. remove the infrastructure and stored materials from the C-410 Complex buildings in preparation for structure D&D.

A variety of technologies were evaluated as potentially applicable to the activities to be conducted under the alternatives to be considered. The technologies evaluated included methods of contamination removal, waste stabilization, size reduction, waste treatment and disposal, and recycling and reclamation. The waste materials generated from actions under the alternatives considered would be disposed of at appropriate on-site and off-site facilities. The plan for waste management will be included in the work plans.

This EE/CA analyzes six alternatives for accomplishing the removal action objectives. The six alternatives are as follows:

1. no action;

2. continue S&M;

3. remove stored materials, infrastructure and equipment, and dispose;

4. remove stored materials, infrastructure and equipment, decontaminate, recycle, treat, and dispose;

5. remove stored materials, infrastructure and equipment, reduce size, stabilize and contain, and dispose; and

6. remove stored materials; infrastructure and equipment; segregate materials; selectively decontaminate; reuse or recycle selected materials; reduce size; and dispose.

These alternatives were evaluated for their effectiveness, implementability, and cost. Alternative 1, no action, does not achieve the removal action objectives. The no action alternative would not comply with the applicable or relevant and appropriate requirements (ARARs) and would not provide overall protectiveness. The no action alternative is technically readily implementable. Because the no action alternative would discontinue monitoring and surveillance, the no-action alternative could cause undesirable impacts on other facilities at the PGDP as the buildings deteriorate. There is no cost for implementing no action.

Alternative 2, continue S&M for an extended period, does not achieve the removal action objectives. It would comply with ARARs. However, continued protectiveness would require continuous vigilance on the part of maintenance workers. This alternative is readily implementable since it only involves extending the maintenance program already in place. Maintenance personnel would receive long-term exposure to contaminants in the building. The cost over a 30-year period is estimated to be $28 million.

Alternative 3, remove stored materials, infrastructure and equipment, and dispose, would achieve the removal action objectives. Wastes would be appropriately characterized and disposed at appropriate on-site or off-site disposal facilities. This alternative would provide long-term protection, but it would result in short-term exposures to personnel engaged in the removal action. There would be no reduction in toxicity, mobility, or volume through treatment. Alternative 2 is readily implementable. Alternative 3 is estimated to cost $61 million. The cost for this alternative and for alternatives 4, 5, and 6 could increase or decrease depending on which disposal facilities are available at the time of the action. The costing assumes that most of the material is disposed of off-site.

Alternative 4, remove stored materials, infrastructure and equipment, decontaminate, recycle, treat, and dispose, would meet the removal action objectives. Alternative 4 would comply with the ARARs and achieve long-term protectiveness. Short-term exposures would be greater than in Alternative 3 because of the increased effort required to decontaminate and segregate materials. The number of shipments would be reduced in this alternative, and therefore, the transportation risk from potential accidents would also be reduced. The statutory preference for treatment would be achieved because mobility and volume of contaminated materials would be reduced by treatment. This alternative is implementable, but would require additional effort to decontaminate equipment and prepare materials for recycling. Recycling options are limited by current DOE policy, but the stored materials and recycled metals could be used within the DOE complex (for example, they could be used as stainless steel for disposal containers or retained for future use in the high level waste repository). While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily. Alternative 4 is estimated to cost $51 million.

Alternative 5, remove stored materials, infrastructure and equipment, reduce size, stabilize and contain, and dispose, would achieve the removal action objectives. Alternative 5 would comply with the ARARs and provide long-term protectiveness. Size reduction technologies (e.g., cutting and compaction) would be used to reduce the volume of material. The use of grout-like materials to provide additional containment is also evaluated as part of this alternative. Volume would be reduced, but weight would be increased for the material being disposed of at appropriate disposal facilities. This alternative is readily implementable. The addition of grout might conflict with the waste acceptance criteria at some disposal facilities. The size reduction would result in a savings in disposal costs because some facilities charge a premium for large bulk items. Alternative 5 is estimated to cost $59 million.

Alternative 6, remove stored materials, infrastructure and equipment, segregate materials, selectively decontaminate, reduce size, reuse or recycle selected materials, and dispose would achieve the removal action objectives. Alternative 6 recognizes that each of the other action alternatives contains elements that could be effectively used for one or more categories of waste, but none of these other alternative would be best for all of the waste. Alternative 6 groups the waste and matches the features that are most advantageous for each grouping. This alternative reduces the amount of material that is transported and disposed of at remote locations. Therefore, the risk from potential transportation accidents is reduced. This alternative provides treatment for some of the waste groupings. This alternative is implementable but would require additional effort to decontaminate materials for reuse of items, recycle of metals, or on-site disposal. Size reduction technologies would be used to reduce the volume of material. Any recycle would honor the DOE policies for recycle including any changes to the policies. Alternative 6 is estimated to cost $49 million.

Alternatives 3, 4, 5, and 6 all would achieve the removal action objectives, provide overall protectiveness, and comply with ARARs. Alternative 3 would reduce the cost and short-term exposure because waste materials would be disposed with minimal processing or segregation. This alternative would not meet the statutory preference for treatment. The costs for Alternatives 3, 4, 5, and 6 would be reduced if a local disposal facility such as the C-746-U Landfill or a potential on-site disposal cell for CERCLA wastes were available. CERCLA-derived waste would be disposed in the C-746-U Landfill only after it has been demonstrated that disposal in the landfill provides long-term protectiveness of human health and the environment. Any CERCLA-derived wastes disposed in the landfill would also have to comply with applicable requirements in the landfill permit and any additional appropriate waste acceptance criteria. The largest savings would likely be for Alternative 3 because of the larger volume of material. Alternatives 4, 5, and 6 would include treatment. These alternatives would result in extra short-term exposure and expense due to decontamination, characterization for disposal, and treatment. The reduced cost of disposal could offset the cost increase. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily. The actual cost savings would vary depending upon the waste stream. Some items such as the fluorine cells might result in a positive cost savings, while other streams such as the recycling of carbon steel would likely result in a net cost increase.

Overall, the no action alternative would not meet the removal action objective and Alternative 2, continue S&M, does not provide a permanent solution. Alternatives 3, 4, 5, and 6 would be effective in meeting the removal action objectives. Alternatives 4, 5, and 6 would satisfy the statutory preference for treatment. Alternative 3 would dispose of materials with minimal processing, resulting in lower short-term exposures but greater volumes of material disposed of. Alternative 4 would increase the amount of material returned to useful service, but cost savings from recycle are offset by the increased costs due to the need for extensive characterization and decontamination. Alternative 5 would provide for volume reduction that would reduce disposal cost. The addition of grout in Alternative 5 as an additional barrier would have a small positive impact in terms of reducing the potential for migration of contaminants, but it would result in an increase in costs and shipping weights. Costs for Alternatives 3, 4, and 5 range from $51 million to $61 million (year 2001 dollars). The cost for Alternative 6, the recommended removal action, is $49 million (year 2001 dollars). Overall, Alternative 6 is the most effective because it applies the best features of the other alternatives to those waste groupings where the features are most appropriate.

Alternative 6, the recommended removal action, uses elements of Alternatives 3, 4, and 5 to apply to the following different waste groupings:

- reusable equipment,
- high-value metals,
- large bulky components, and
- the remainder of the infrastructure and equipment.

The first group is defined as equipment for which the cost for reuse (including decontamination and preparation) is less than or equal to the cost of disposal. This equipment would be offered for sale with a minimum bid level set at the estimated break-even point. Items for which the minimum bid is not received would be placed in one of the other groups for disposal. This grouping includes only a small amount of the material.

Grouping 2 includes components constructed of high-value metals such as inconel or monel. These components would be separated and held long enough to evaluate whether progress in the metal recycling programs will allow beneficial reuse of these materials. If approved, these metals would be decontaminated and recycled; otherwise, they would be placed in one of the remaining two groupings for disposal. This grouping includes only a small amount of the material.

Grouping 3 includes large, bulky components and components that could be easily decontaminated. The size reduction technologies described in Alternative 5 would be used to reduce large, bulky items in order to reduce shipping and disposal costs. Grout would not be added. Components that could be easily decontaminated (e.g., flat metal plates with surface contamination) would be decontaminated only enough to meet the waste acceptance criteria of the other appropriate disposal facilities if such facilities are available at the time of the action. Otherwise, the material would be sent to off-site facilities.

Grouping 4 consists of all remaining infrastructure and equipment. These materials would be disposed as described in Alternative 3.

The cost of the recommended action is estimated to be $49 million. The cost could increase or decrease depending on which of the potential disposal facilities are available and used at the time of the action. All appropriate disposal facilities are included as viable options for this removal action.

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1. INTRODUCTION

The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA) and Kentucky regulators have agreed to conduct decontamination and decommissioning (D&D) activities under the existing Federal Facilities Agreement (FFA) for the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky (DOE 1997). Facilities planned for D&D will be treated as D&D operable units. The C-410 Complex is the first facility to undergo D&D at PGDP. The three phases specified in the D&D Program Plan for D&D of facilities at PGDP are (1) documentation process (site evaluation phase), (2) non-time-critical removal action (infrastructure removal phase), and (3) facility structure D&D and environmental media characterization and remediation.

This engineering evaluation/cost analysis (EE/CA) document evaluates alternatives to address the potential for migration and release of hazardous substances that are present in the process buildings associated with the C-410 Complex (feed plant) at PGDP. The C-410 Complex, located in the central portion of the plant at the intersection of Tennessee Avenue and 11th Street, is comprised of three main process buildings, which are attached to one another, and several auxiliary facilities as shown in Fig. 1.1. These buildings and facilities include those listed below.

- C-410 Original Feed Plant and East and West Expansion
- C-410-A Second East Expansion of Feed Plant
- C-410-B hydrogen fluoride (HF) Neutralization Lagoon
- C-410-C HF Neutralization Building
- C-410-D Fluorine Storage Building
- C-410-E Emergency HF Holding Pond
- C-410-F HF Storage Building (North)
- C-410-G HF Storage Building (Center)
- C-410-H HF Storage Building (South)
- C-410-I Ash Receiver Shelter
- C-410-J HF Storage Building (East)
- C-411 Cell Maintenance Building
- C-420 Green Salt Plant

C-410-B and -E are excluded from this removal action because the lagoon and holding pond contain no equipment or infrastructure. The soil-like sludge and structures will be addressed during the facility structure and soil remedial actions. C-410-D is excluded from this removal action because it is leased to the U.S. Enrichment Corporation and is still in use.

While the scope of the C-410 D&D project will cover the entire C-410 Complex, this EE/CA only covers the removal and disposal or reuse of process and ancillary equipment inside the C-410 Complex buildings. The removal action does not address the primary building utilities, the building structure, or the underlying soil. These will be addressed in a later phase of the remedial actions for C-410. The removal action supports the long-term remediation of the C-410 complex. Alternatives for the complex could include: (1) no action, (2) long-term surveillance and maintenance (S&M), (3) demolition of the C-410 Complex and the remediation of the underlying soil that is above industrial scenario action thresholds, or (4) free-release of the building. The infrastructure removal will remove the materials causing the highest potential risks [e.g., transferable radioactive materials, asbestos, and other hazardous materials such as polychlorinated biphenyls (PCBs)]; thereby, significantly reducing the risk to current employees and potential off-site receptors in the event of building failure or further degradation. The risk of a release from the facility will be greatly reduced by the removal of the equipment and infrastructure. The building utilities, building shell, and lagoons would be left to later remedial actions.

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DOCUMENT No. DOE/OR/07-1952&D2R1

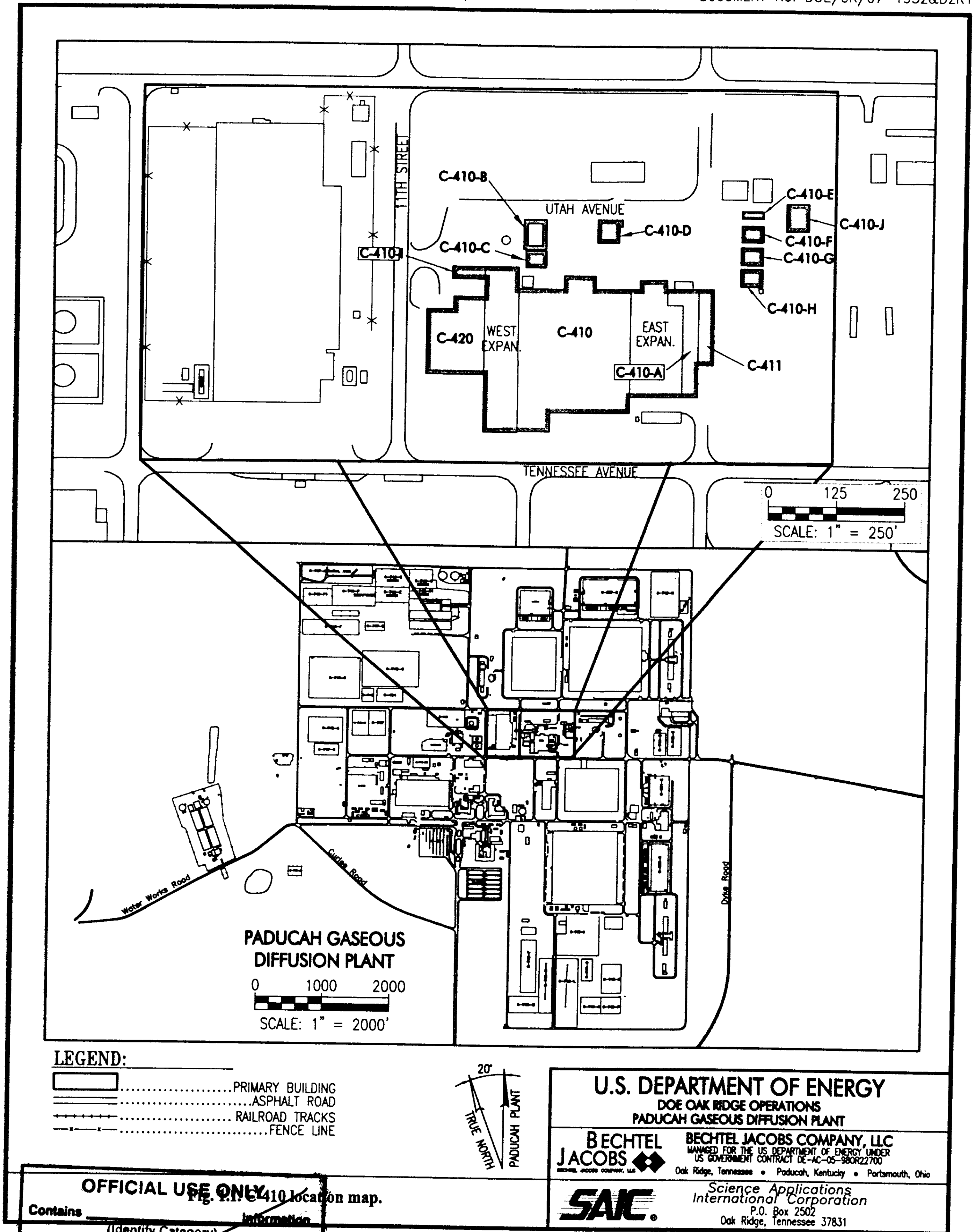

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Fig. 1.1. C-410 location map.

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1.1 D&D PROCESS

This EE/CA supports the decision-making process for a removal action to address the stored materials, infrastructure, and equipment (including process equipment, piping, wiring, etc.) in the building. Most of the material stored in the buildings was placed there after the process was shut down. Much of the material in storage was brought from other areas of the plant. Actions to address the foundations, walls, roofs, and underlying or surrounding soils remaining after completion of the removal action will be determined by future Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) documentation. Some of the materials, such as combustibles, are being removed from the complex as part of a separate removal action and are being staged for further action. The water in the basement that is suspected to be leaking out of the basement is currently being removed as part of a separate emergency removal action.

1.1.1 Regulatory Setting

Many of the PGDP facilities that will undergo D&D are located on or near sites being remediated under CERCLA authority. With this in mind, DOE decided in 1994 that D&D efforts would be governed by CERCLA regulations and carried out under the CERCLA regulatory framework for facilities where a known release of hazardous substances had occurred or that pose a threat of release of hazardous substances to the environment.

On May 22, 1995, a memorandum entitled "Policy on Decommissioning Department of Energy Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act" (DOE and EPA 1995) established an approach agreed upon by DOE and EPA for conducting decommissioning activities as non-time-critical removal actions, unless circumstances made such an approach inappropriate. This policy built upon the foundation established in an earlier guidance document issued by EPA/DOE/U.S. Department of Defense, "Guidance on Accelerating CERCLA Environmental Restoration at Federal Facilities" (August 22, 1994).

The action would comply with the applicable or relevant and appropriate requirements (ARARs) discussed in Section 2 and more details in Appendix C.

DOE issued a Secretarial Policy Statement on the National Environmental Policy Act of 1969 (NEPA) (DOE 1994b) stating that DOE will address and incorporate NEPA values into CERCLA documents to the extent practicable. Such values may include analysis of socioeconomic, cultural, ecological, and cumulative impacts, as well as environmental justice and land use issues, and the impacts of off-site transportation of wastes. NEPA values have been incorporated into this document in accordance with Secretarial policy.

The process for regulatory review and approval by EPA and Kentucky regulators defined in the FFA will be followed.

1.1.2 Phases of the D&D Process

The D&D process encompasses activities that take place after a facility has been deactivated and placed in an ongoing S&M program by DOE. Decontamination includes the removal or reduction of radioactive or hazardous contamination from facilities. Decommissioning can entail decontamination and dismantlement. Dismantlement involves disassembly or demolition and the disposal of waste materials in compliance with applicable requirements.

The D&D process at PGDP has been broken down into three primary phases, as shown by the D&D operable unit flowchart in Fig. 1.2. The flowchart identifies the specific tasks within each phase and correlates these tasks to the CERCLA process.

The following is a summary of the purpose of each document (e.g., what decisions it must support and the information that will be provided) in the context of the C-410 Complex:

1. Removal Notification/Justification – Decision to conduct a removal action. This document should include the preliminary Site Evaluation Report (SER).

2. EE/CA – Identification and evaluation of alternatives consistent with likely endpoints for C-410 Complex.

3. Action Memorandum – Decision to implement selected alternative.

4. Removal Action Work Plan (RAWP) – Details for approach to implement the selected alternative.

DOE has submitted the Removal Notification with SER and the EE/CA to EPA and KDEP. The Action Memorandum and RAWP will be developed and submitted following finalization of the EE/CA and completion of the public review and comments period for the EE/CA.

This EE/CA is part of the infrastructure D&D phase. The objective of the infrastructure D&D phase is to prepare for demolition of a facility and disposal of the associated debris. In the infrastructure phase, the building contents are removed so that only the building structure remains. To facilitate removal of the building contents, efforts may be required to abate asbestos. Decontamination may be required. Further characterization activities may also be performed to profile the removed materials for proper disposal.

Infrastructure D&D represents an intrusive operation that will be conducted as a non-time-critical removal action where the facilities to be addressed present the threat of release of hazardous substances to the environment and present a risk to human health or the environment appropriate to be addressed in this manner. At a minimum, an EE/CA, Action Memorandum and Waste Management Plan must be prepared and approved before the physical D&D work begins. In addition, a Removal Action Work Plan will be submitted; this plan must be approved by the regulatory agencies prior to beginning fieldwork. Following approval, the FFA requires fieldwork to begin within 15 days.

1.1.3 Schedule

The EE/CA and Action Memorandum are FFA milestones for 2001 and 2002. Mobilization is an FFA milestone for FY 2002. Infrastructure D&D is a multi-year project. The final length of time for the project is funding dependent. The primary work activities undertaken as a part of the infrastructure removal will take place inside of the C-410, C-411, and C-420 buildings. Known floor drains in the building have been plugged, and water lines entering the building are currently being cut and capped in an effort to control water entering or leaving the building. As a result, activities that will take place outside of the primary buildings, for example at the Ash Receiver Shed or at the tank farm, will be sequenced later in the removal action. This will allow for implementation of integrated sediment controls, such as sediment control structures, or systemic controls, such as sedimentation basins, to be in place prior to these potential sediment or runoff generating activities. Additionally, during these activities outside the building, localized sediment controls, such as silt fences, will be installed to control migration of sediment.

1.2 SCOPE AND PURPOSE

The purpose of this EE/CA is to evaluate alternatives to reduce the potential for future contaminant releases from the equipment and infrastructure in the C-410 Complex (excluding the lagoon, C-410-B, and holding pond, C-410-E) in a manner that protects both human health and the environment.

This action is being documented with an EE/CA under CERCLA in accordance with the *Policy on Decommissioning of Department of Energy Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act* (DOE and EPA 1995). This policy states that unless the circumstances at a facility make it inappropriate, decommissioning activities will be conducted as non-time-critical removal actions. The FFA (DOE 1997) for PGDP authorizes DOE to develop and perform removal actions to abate, minimize, stabilize, mitigate, or eliminate a release or the threat of a release of hazardous substances, pollutants, or contaminants or hazardous wastes and hazardous constituents at or from PGDP. Based on past usage, the C-410 Complex represents a threat of a release of contaminants into the environment. Uranium was processed in the facility and is deposited on internal and external surfaces. Asbestos insulation is deteriorating and has fallen off pipes and equipment. Lead-based paint and piping are deteriorating. The contaminants are present in building equipment, construction materials of the buildings themselves, and stored materials. Because no imminent danger is known to exist that would necessitate an early cleanup, the removal action is categorized as non-time-critical.

During the implementation of this removal action, releases to other environmental media will be controlled through various mechanisms, including but not limited to sequencing of work, work practices, and physical controls or barriers. For example, activities that take place outside of the C-410, C-411, and C-420 buildings will apply both localized sediment controls, and will also be sequenced after the completion of implementation of sediment controls under the Site Wide Sediment Runoff Control response action, to take advantage of those controls being in place. Personnel will enter and exit the facility through boundary control stations to ensure radiological contamination is not carried out of the area. Physical controls, such as sealing building vents to the extent practicable, plugging floor drains, cutting and capping water lines that enter the building, and routine vacuuming and housekeeping inside the building will be applied to minimize the potential for contaminant migration. Additionally, certain activities, such as removal of asbestos, will be performed in enclosures to contain contaminants. Additional discussion for the approach to contain contaminants will be provided in the RAWP.

1.3 SITE DESCRIPTION

PGDP is located in western Kentucky, on the lower end of the Ohio River Valley. The site occupies approximately 1439 ha (3556 acres) in McCracken County approximately 19 km (12 miles) west of Paducah, Kentucky (DOE 1993) (Fig. 1.3). The Ohio River runs 5.8 km (3.6 miles) north of the site. The C-410 Complex is located in the central portion of PGDP.

1.3.1 Topography

PGDP and the surrounding area are flat with elevations across the site ranging from about 107 m (350 ft) to 119 m (390 ft) above mean sea level. The ground surface slopes at a rate of about 5.1 m/km (27 ft/mile) toward the Ohio River. Two main features dominate the landscape in the surrounding area: the loess-covered plains and the Ohio River floodplain dominated by alluvial sediments. The terrain is slightly modified by the dendritic drainage systems associated with the two principal streams in the area, Bayou Creek and Little Bayou Creek. These streams have eroded small valleys, which are about 6 m (20 ft) below the adjacent plain.

D&D operable unit

Document Process	Phases	Typical Tasks
• Site Evaluation Report/RA Notification • DOE Orders and Regulations	**RA Notification and Site Evaluation**	• Building Surveys and Records Search • Inventory Facility Contents • Preliminary Characterization • Waste and Debris Removal/Vacuuming • Corrective Maintenance
Non-Time-Critical Removal Action • EE/CA • Public Comment • Action Memo • RAWP • RA Report	**Infrastructure D&D**	• Flush Process System • Removal of Equipment and Interior Infrastructure • Characterization • Decontamination as needed • Disposal
Remedial Action • FS • Proposed Plan • Public Comment • ROD • RD/RA	**Facility Structure D&D**	• Characterization • Facility Demolition • Waste Disposal
	Environmental Media	• Characterization and Remediation of Residual Soil Contamination

62-112701-020e

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
Bechtel Jacobs Company LLC

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

SAIC
Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. 1.2. D&D operable unit flowcart.

Figure No. 1.2
DATE 11/27/01

Fig. 1.2. D&D operable unit flowcart.

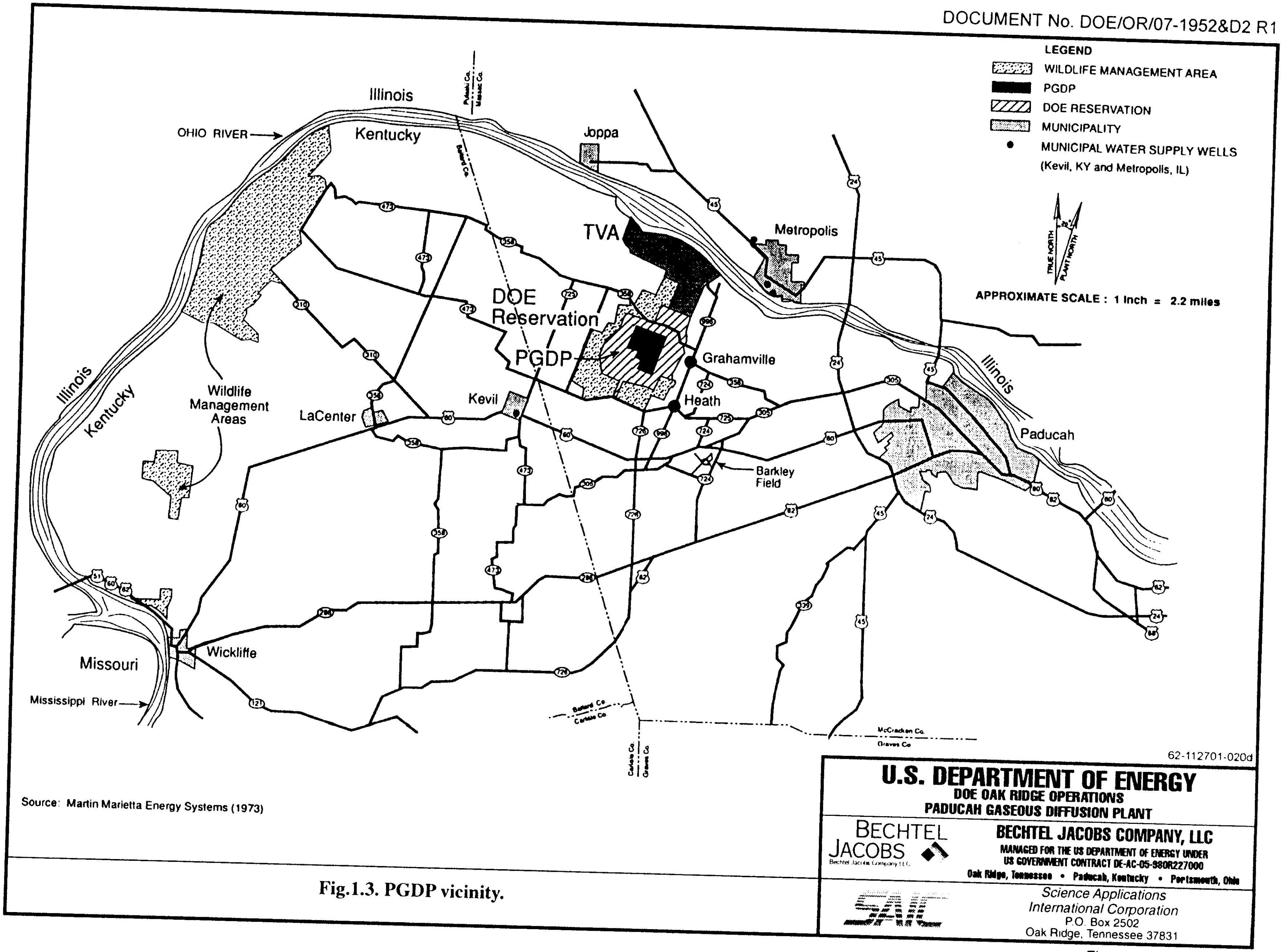

Fig.1.3. PGDP vicinity.

Fig.1.3. PGDP vicinity.

1.3.2 Population and Land Use

The primary C-410 buildings are locked and inside of a fenced reservation. Some external facilities such as the HF tanks and the lagoon are not locked, but they are still within the fenced reservation. PGDP surrounding the C-410 Complex is heavily industrialized; however, as is evident from Fig. 1.3, the land surrounding the DOE Reservation is sparsely populated and rural. Within an 8-km (5-mile) radius of PGDP, 75% of the land is in agricultural use or is dedicated to open space (DOE 1993). The West Kentucky Wildlife Management Area bordering PGDP is popular among quail and deer hunters. The nearest communities are Grahamville and Heath (Fig. 1.3).

1.3.3 Climate

Prevailing winds are from the south to southwest at a mean annual speed of 3.5 m/s (7.9 mph). The 13-year average monthly precipitation is 10 cm (3.96 inches), varying from an average of 6.58 cm (2.59 inches) in August to an average of 12.0 cm (4.72 inches) in February. The 13-year average monthly temperature is 14.4 °C (57.9 °F), varying from 4.0 °C (34.5 °F) in January to 26.4 °C (79.5 °F) in July (DOE 2000a).

1.3.4 Hydrology and Stormwater

PGDP is located in the western portion of the Ohio River drainage basin. The plant is within the drainage areas of Bayou Creek and Little Bayou Creek, situated on the divide between the two creeks. Man-made drainages receive storm water and effluent from PGDP. The plant monitors 17 outfalls, which have a combined average daily flow of 4.9 million gallons per day.

The regional groundwater flow system occurs within the Mississippian Bedrock, Cretaceous McNairy Formation, Eocene Sands, Pliocene Terrace Gravel, Pleistocene Lower Continental Deposits, and Upper Continental Deposits (Fig. 1.4) (DOE 2000a). Gravel and sand lenses within the Lower Continental Deposits, at a depth of approximately 55 to 90 ft bgs, comprise the uppermost aquifer, termed the Regional Gravel Aquifer. The overlying sediments of the Upper Continental Deposits, comprised mainly of silts and clays with thin sand and gravel lenses, have been designated the Upper Continental Recharge System.

The flow from the C-410 Complex HF neutralization process discharges to an HF neutralization lagoon. There is also an HF emergency holding pond, C-410-E, that has never received waste. The HF neutralization lagoon is a 1,940 ft^2 at-grade impoundment that is about 2-ft-deep with an earth/clay floor and wire reinforced grout walls. It was used for the lime neutralization of HF cell electrolyte. The electrolyte was neutralized in an adjacent tank, C-410-C, prior to discharge to the lagoon. The HF emergency holding pond is a 600 ft^2 below-grade impoundment. It was constructed in the 1950s, but never received wastes. Stormwater drainage from the Neutralization Lagoon area and the remainder of the north side of the C-410 Complex goes through outfall ditch 001. Stormwater drainage from the south side of C-410 Complex enters the stormwater system and flows west through Outfall 8.

1.3.5 Geology

The Mississippian limestone bedrock under the fenced area of the plant lies from 107 to 137 m (351 to 449 ft) below the ground surface. Overlying soils are poorly stratified layers of clay, silt, gravel, and sand. A geologic cross section is illustrated in Fig. 1.4.

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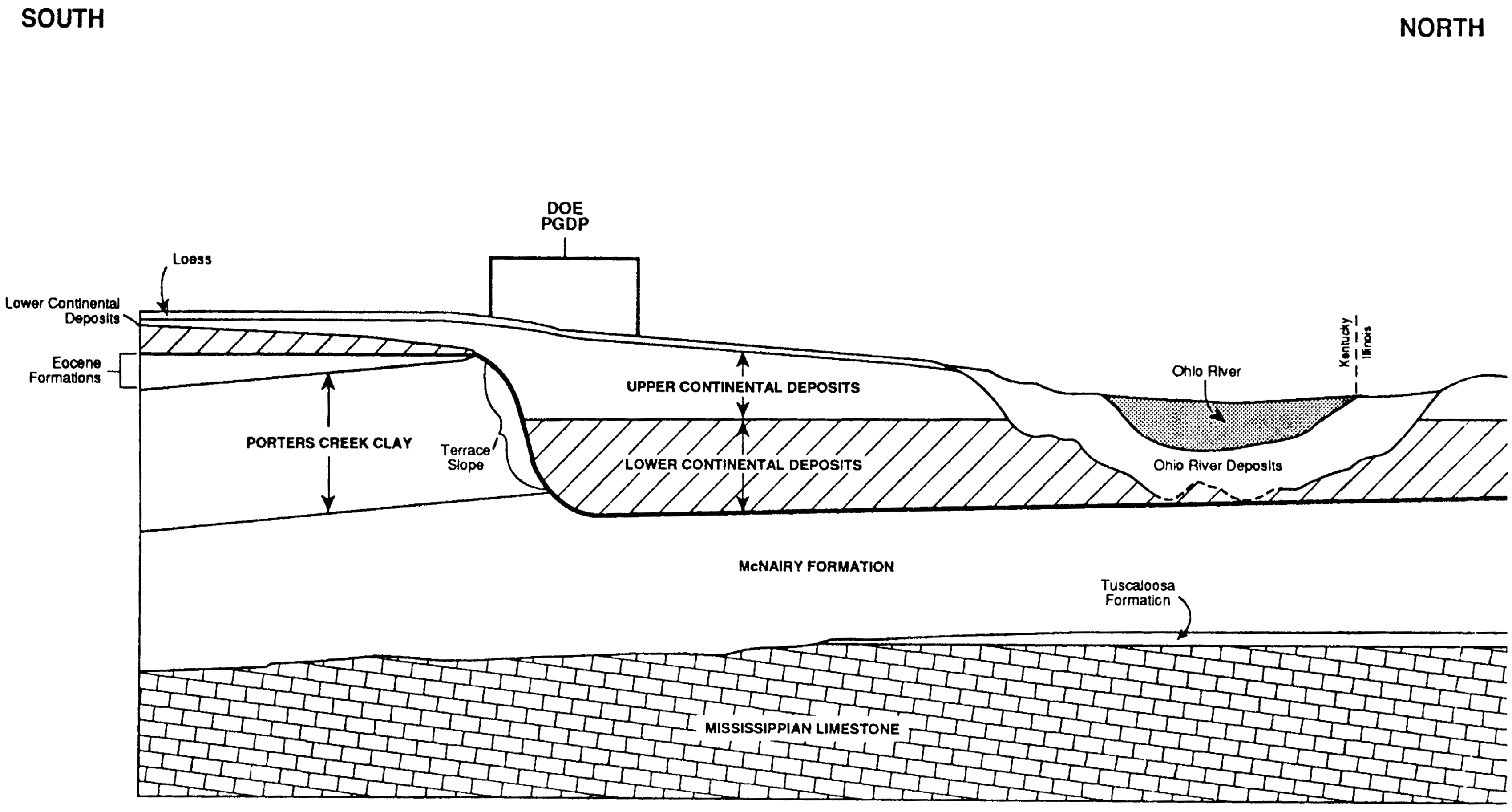

62-112701-020c

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
Bechtel Jacobs Company LLC

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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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Fig. 1.4. Schematic of stratigraphic and structural relationship near the PGDP.

Figure No. 1.4
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Fig. 1.4. Schematic of stratigraphic and structural relationship near the PGDP.

Three major fault systems are recognized in the PGDP area. These include New Madrid, Rough Creek, and Saint Genevieve. The Rough Creek fault system appears to be inactive. The St. Genevieve fault system is active from south of St. Louis into western Kentucky. Historically, a large number of earthquakes associated with the New Madrid fault system have occurred in northeastern Arkansas and southeastern Missouri. Several earthquakes have occurred in the New Madrid seismic zone that would have had a major impact on the Paducah area. The most significant of these, with estimated Richter magnitudes as high as 8.7, occurred in 1811 and 1812. Since 1950, 16 earthquakes have occurred within a 161-km (100-mile) radius of Paducah, and 4 within an 80-km (50-mile) radius (DOE 1994a). These earthquakes have ranged in intensity from V to VIII on the Modified Mercalli Scale, with a reported Richter scale magnitude up to 5.5.

1.4 SITE BACKGROUND

The following sections contain descriptions of the buildings, equipment and processes of the C-410 Feed Plant complex. A description of the present inventory is available in the table in Appendix A.

1.4.1 General Description of Buildings

The C-410 Feed Plant complex was constructed in 1953 with its primary mission being the production of UF_6 from UO_3. The process involved the conversion of UO_3 to UO_2 and then to UF_4 (green salt) in the C-420 Green Salt Plant. The UF_4 was then converted into UF_6 in the C-410 Feed Plant. This EE/CA addresses all infrastructure in the entire complex excluding the lagoon (C-410-B) and holding pond (C-410-E), which currently fall under other remedial units.

The original feed plant consists of the central portion of C-410, the HF neutralization building (C-410-C), and three HF storage tank areas (C-410-F, G, and H) (Fig. 1.5). The original building was a two-story, rectangular, mill-type structure. The building has a structural steel frame with walls of reinforced concrete, corrugated asbestos, and steel sash. The roof consists of metal decking, insulation, and built-up tar and slag roofing. The approximate dimensions of the original C-410 building (excluding the later extensions) are 71 × 65 × 12 m (232 × 212 × 39 ft) with a total floor area of 7000 m^2 (75,800 ft^2) [approximately 4600 m^2 (50,000 ft^2) on the first floor].

The east expansion consists of a one-story, rectangular structure approximately 61 × 30 × 5 m (201 × 99 × 16 ft) with a total floor area of about 1900 m^2 (20,000 ft^2). The construction is similar to the original facility except that the walls are concrete block. The west expansion is a rectangular structure, partly one story and partly two story, that is approximately 94 × 18 × 12 m (310 × 60 × 39 ft) with a floor area of about 2500 m^2 (27,100 ft^2). Construction is the same type as the original facility.

The second phase east expansion is a one-story structure approximately 61 × 9 × 5 m (201 × 30 × 16 ft) with a total floor area of approximately 600 m^2 (6000 ft^2). Construction is the same type as the first east expansion.

The cell maintenance building (C-411) was added after 1956. Footprint dimensions of the building are approximately 43 × 9 m (140 x 30 ft) with a total floor area of approximately 400 m^2 (4200 ft^2).

The C-420 facility was added in 1956. The building consists of a 22-m-(73-ft)-high, steel-framed, multi-story structure [approximately 37 m (120 ft) long and 24 m (79 ft) wide] abutting the west side of Building C-410, a 7 × 15 m (24 × 48 ft) wing of similar height at the northeast portion, and a single-story west wing. The exterior walls are concrete block to the height of the west wing. The remaining walls are

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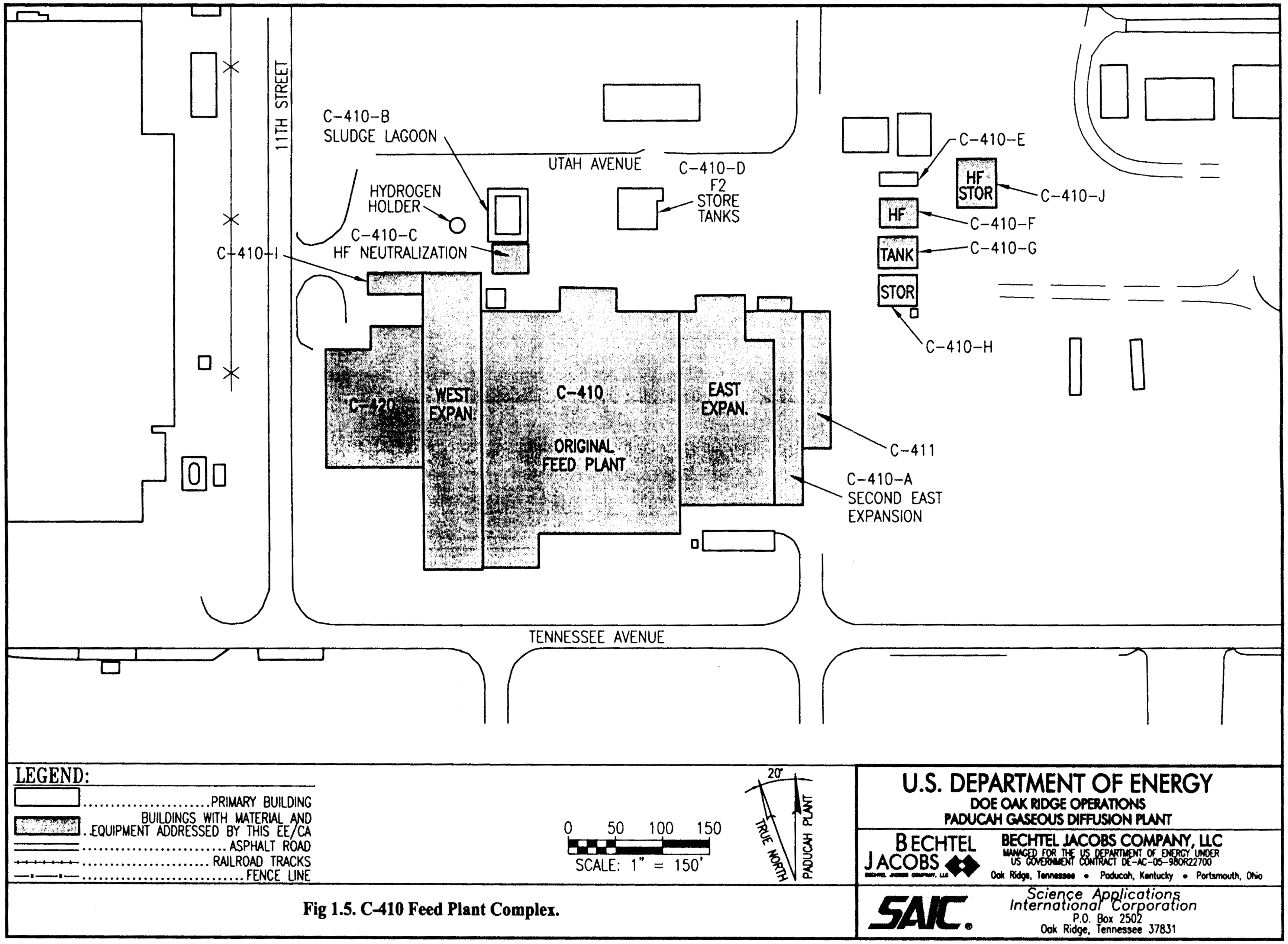

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Fig. 1.5. C-410 Feed Plant Complex.

corrugated cement asbestos siding. The roofs are built-up roofing with gravel coating applied over an insulated metal deck. The main area consists of five main floors with intermediate platform or mezzanine levels. The ground floor has a concrete floor slab and, except for a concrete slab for the third-floor toilet room, all upper floors and platforms are raised-pattern sheet steel. Figure 1.6 shows the overall floor plan for the contiguous buildings.

1.4.2 Process Description

A simplified process flow diagram is provided as Fig. 1.7. The C-410 Complex was operated to convert UO_3 to UF_6 by a series of reactions involving gaseous hydrogen, HF, and fluorine. When uranium was received in the form U_3O_8, some preprocessing was required before introducing the material to the process (BJC 2000). The conversion of UO_3 to UO_2 by reduction followed by the conversion of UO_2 to UF_4 by hydrofluorination using hydrogen fluoride gas occurred in the C-420 Green Salt Plant. The conversion of UF_4 to UF_6 by fluorination with fluorine gas occurred in the C-410 Feed Plant. Prior to 1956, when the C-420 facility was constructed, the entire process was performed in the C- 410 facility.

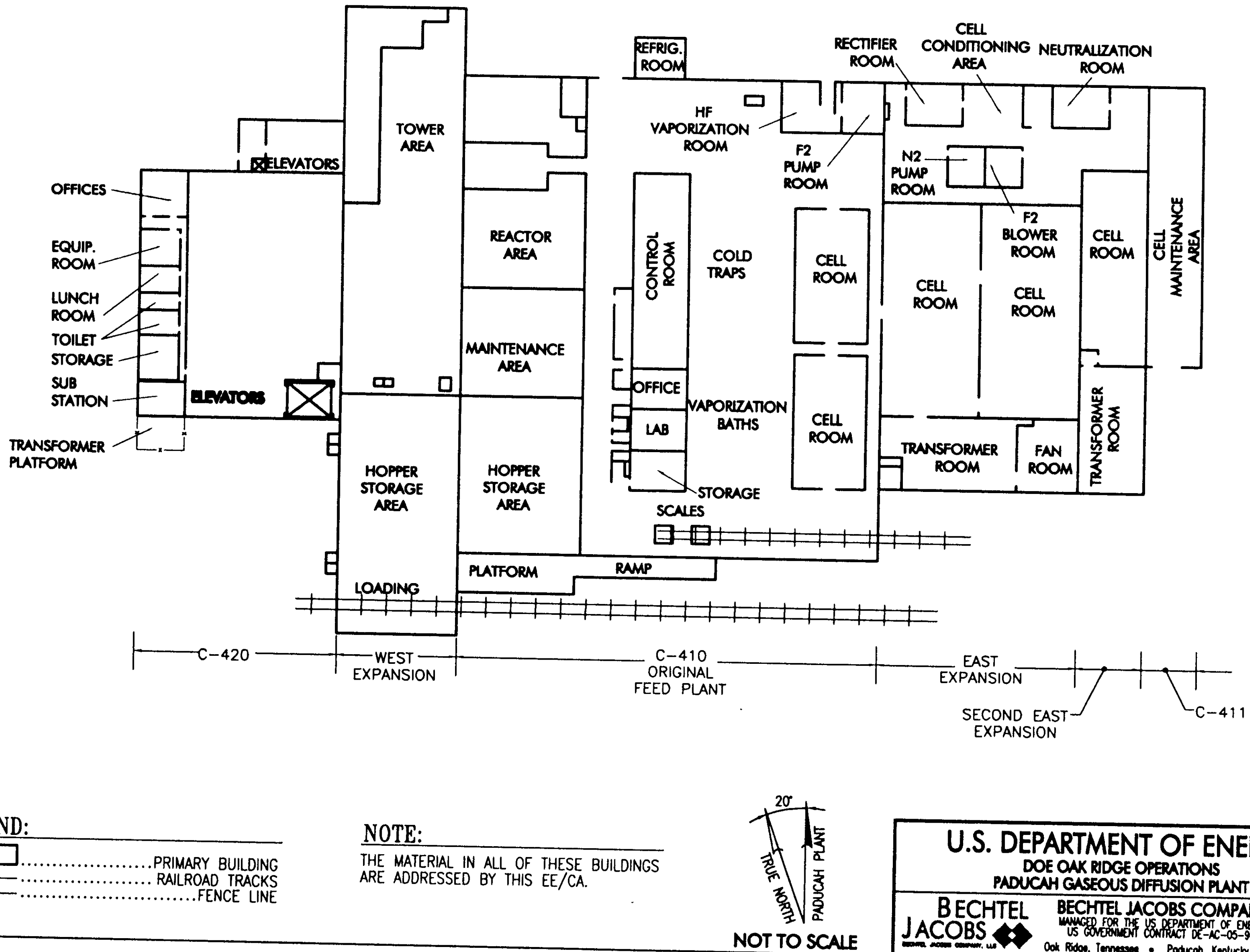
UO_3 was received as a powder in 4.5-metric-ton (5-ton) containers, unloaded from railcars by a crane in C-410, and transferred by carts via a freight-elevator to the top floor of C-420. The UO_3 powder was discharged into feed hoppers. The reduction of UO_3 to UO_2 was accomplished by reacting the UO_3 with hydrogen gas in a screw reactor. The UO_2 was collected in a seal hopper for further processing. The off-gas from the screw reactor was fed to a burner to remove the hydrogen gas. It was then sent to a settling chamber and a bag dust collector, from which it was discharged to the atmosphere.

The hydrofluorination of UO_2 to UF_4 (green salt) was conducted in C-420 in horizontal-screw reactors. The UO_2 powder was fed from the seal hopper to three screw reactors operating in series. HF gas was fed countercurrent to the flow of UO_2. The off-gas was diverted to a cyclone separator, a carbon tube dust filter, and then to an HF recovery system. The HF recovery system consisted of two cooling systems used to condense the HF vapor to a liquid. The condensed HF was drained to rubber-lined storage tanks. The HF that remained in the vapor stream was sent to a scrubber, and the inert gases were discharged to the atmosphere through a fume stack. The UF_4 powder was collected in a seal hopper, transferred to a weigh hopper, and then discharged into a closed conveyor. The conveyor carried the UF_4 powder into a large hopper in C-410 for further processing.

The conversion of UF_4 to UF_6 by fluorination in tower reactors was accomplished in C-410. UF_4 and fluorine gas were fed counter currently to tower reactors. The UF_6 gas that was produced was sent through two cyclone dust separators operating in series and then through a filter. The dust-free gas from the filter flowed into cold traps to condense the UF_6. The liquid in the cold traps was drained into cylinders mounted on scales. The cylinders were used to transfer the UF_6 to the cascade feed facilities.

The off-gas from the UF_4 to UF_6 conversion was sent to a fluorine clean-up reactor, where additional UF_4 was fed to react with any remaining fluorine gas. The ash from the clean-up reactor was sent back to the storage hopper for reprocessing, and the gas was vented through another set of cold traps to recover additional UF_6. The off-gas was then vented to a final cold trap to remove the last traces of UF_6. The off-gas from this cold trap was sent to a UF_6 absorber, a cyclone separator, and a filter before being discharged to the atmosphere.

The fluorine gas used in the process was generated within C-410. Liquid HF was received in railcars, then transferred to the C-410 HF storage tanks outside of the east end of C-410. Liquid HF was vaporized for use in the C-420 $UO_2 \rightarrow UF_4$ process and was routed to the fluorine production cells for conversion into fluorine gas and hydrogen gas via electrolysis. The fluorine gas was used to convert UF_4 into UF_6 (Energy Systems 1994a).



LEGEND:

PRIMARY BUILDING

RAILROAD TRACKS

FENCE LINE

NOTE:

THE MATERIAL IN ALL OF THESE BUILDINGS ARE ADDRESSED BY THIS EE/CA.

Fig 1.6. C-420, C-410 and C-411 floor plan.

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Figure No. 99049/DWGS/N46FLRPLAN

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Fig. 1.6. C-420, C-410 and C-411 floor plan.

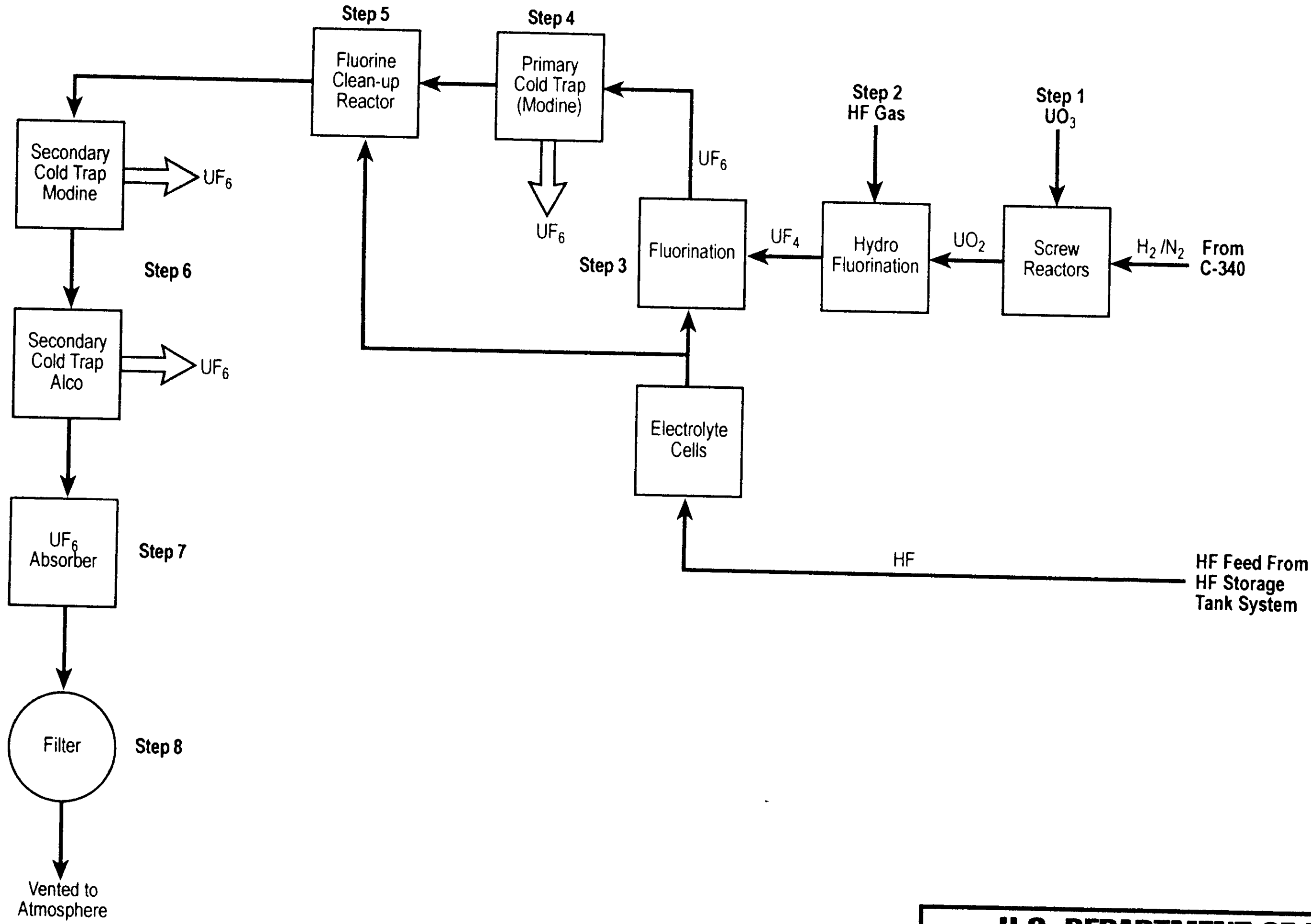

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Fig. 1.7. UF_6 production from UO_3 flow diagram.

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Fig. 1.7. UF_6 production from UO_3 flow diagram.

1.4.3 Auxiliary Systems

Auxiliary systems include water, electrical, steam, ventilation, lighting, refrigeration, and sewage systems.

Water was supplied to the facility from the plant water system. Both sanitary water, for human consumption and use, and cooling water, for process and work area cooling, were supplied by the C-611 water plant.

Electrical power was provided by two 2000-kVA, 13.8-kV transformers powering a 400-A, 4-kV direct current bus. Two double-ended substations provided power at 13.8-kV primary and 480-V secondary voltages. Each of the four transformers were dual rated at 1500/2000 kVA.

The entire facility was heated using 100% outside air, steam-heated make-up air units. Air was exhausted by roof-mounted exhaust fans. Outside air entered the area through wall-mounted auto damper intake louvers. During the winter months the dampers were closed in some areas, and air was recirculated to conserve heat and prevent the occurrence of cold spots in process areas. Steam tracing and steam-heated air were used to heat process piping.

Air exhausted from the fluorine cell rooms and HF vaporizer room, all of which were kept at a slight negative pressure with respect to atmosphere, was discharged above the adjacent roof level through stacks located north of the fluorine plant.

The feed plant control room, change house, lunch room, and laboratory were air conditioned by a chilled water unit. Office areas on the west side of C-420 were cooled by individual window-mounted air conditioners.

Explosion-proof incandescent lighting fixtures were used in hazardous areas, and vapor-tight incandescent lighting was used in other process areas. Fluorescent lighting was used in office areas.

Refrigeration systems were used for condensing UF_6 product and HF and fluorine in off-gases from the reaction systems. Cold traps cooled by Freon™-12 were used to remove HF and fluorine from off-gases. A two-stage ammonia refrigeration system provided cooling to the Freon™-12 system. The ammonia system also cooled glycol used in the Modine cold traps to condense UF_6 (Energy Systems 1995; Energy Systems 1994a; Energy Systems 1994b).

A sewage system was also provided in the building.

1.4.4 Related Facilities

The C-410 Building is connected via overhead piping to the HF storage tanks. The HF tanks are connected via overhead piping to the C-340 facility. During the operation of C-340, liquid HF was produced in C-340 and was transferred to C-410 for use in the fluorination of UO_2 to UF_4.

1.5 HISTORICAL SUMMARY OF FACILITY OPERATIONS

The facility began operations in 1952 and continued to operate through the mid-1960s. The facility was then placed in standby for a period of several years. The facility was restarted in the mid-1970s and operated for a brief period until its final shutdown in 1977. During the operational period of the plant, uranium oxides recovered from spent fuel from nuclear reactors were intermittently processed. The recovered oxides (reactor returns) accounted for an average of about 17% of the material fed to the cascade during the periods spent fuel was used (BJC 2000). It is assumed that all of the cascade feed was processed in C-410, although some of the reactor returns were received in the form of UF_6. This had the effect of introducing limited quantities of other radioactive products into the plant. Four of the fluorine generating cells continued operating into 1994 to provide fluorine for cascade use. All production at the complex ceased in 1994.

The presence of the transuranic elements, neptunium and plutonium, in the cascade was confirmed by radiochemical analysis in 1957. In 1958, a neptunium recovery program was implemented at C-410 to extract the radionuclide from the receiver ash and cylinder heels, where it was most concentrated.

Technetium, a fission product, was also discovered and a program to recover this element was implemented beginning in 1960 and ending in 1963. Much of these materials were removed before the feed was sent to Paducah. As a result, the percentage of transuranics, such as neptunium and plutonium, and fission products such as technetium, in the reactor tails material sent to C-410 was very small, estimated at approximately 0.2 ppm neptunium, 4 ppb plutonium, and 7 ppm technetium.

Available documents indicate that, during final shutdown, the process systems were purged and isolated (Energy Systems 1995; Energy Systems 1994b). Since shutdown of the facility, the C-420 offices have been used for a variety of other purposes, including an electrical shop, training space, and health physics offices. During the cascade upgrading and improvement programs, large valve rebuilding was performed in part of the original C-410 structure. Small laboratory facilities were also established in the facility, as was a computer maintenance shop. The only activities in the complex today are minimal maintenance activities and the storage of various plant materials, many of them not related to C-410/420 operations. These materials include spare parts, and discarded equipment and materials from other areas of the plant.

The facility was formally accepted into the D&D Program through a Memorandum of Understanding between the DOE Office of Environmental Restoration and Waste Management and the Office of Uranium Enrichment (Energy Systems 1995; Energy Systems 1994a).

1.6 CURRENT STATUS OF FACILITY

The facility is currently in shutdown status with only a few utilities in operating condition. Access to the facility is controlled.

During the mid-1990s, waste drums that were being stored in the facility were characterized and a small percentage were found to contain hazardous waste; the drums were subsequently removed from the facility. Oil spills were cleaned up, and residual oil was drained from refrigeration systems. The PCB–containing transformers located in the outdoor bays at the south side of C-410 were removed and disposed (Energy Systems 1995).

Process systems were investigated to determine the presence of hazardous or other materials. The investigations focused on (1) determining the physical status of the system by evaluating whether documentation existed, or if it could be determined from visual inspection that the systems had been drained or purged since process shutdown; (2) evaluating the potential for the presence of residual material if it could not be determined that the system had been drained or purged; and (3) developing sampling procedures to collect and characterize residual materials.

It was determined during that investigation that the fluorine surge tank and the tanks in the HF storage tank farm were empty. Oil was drained from the ammonia refrigeration system and Freon™ was removed from the Freon™ refrigeration system. Ethylene glycol from the modine cold trap coolant system was drained and managed with other wastes. Some housekeeping activities were also conducted (Energy Systems 1995; Energy Systems 1994b).

Since the initial cleanup in the mid-1990s, activities within the building have been restricted due to worker health and safety concerns associated with the presence of airborne and other contaminants and the deteriorated condition of the structure (Energy Systems 1994b).

1.7 PREVIOUS INVESTIGATIONS AND ACTIONS

Data on the conditions within the C-410 facility complex are available from a number of sources. Previous characterizations include the following:

- Characterizations performed in support of a Resource Conservation and Recovery Act of 1976 (RCRA)/Toxic substances Control Act of 1976 (TSCA) walkthrough survey (DOE 1994),
- An asbestos survey conducted by Lee Wan & Associates (1990),
- The C-410 Feed Plant complex status investigations reports conducted and compiled by CDM (1994), and
- The 1995 summary report of environmental noncompliance closure activities (LMES 1995), and various response action characterizations conducted as part of the S&M of the complex.
- A May 2000 survey of contamination levels and dose rates (OREIS database).

1.7.1 Radiological Investigations

The major radiological contaminant of concern is uranium and other associated daughter products. The uranium is present as oxide and fluoride compounds. Some other radionuclides including Tc-99, Np-237, Cs-137, and Pu-239 are present in small qualities as a result of processing reactor return material. Uranium and other radionuclides present potential hazards from inhalation, ingestion, and skin contact from contamination on building and equipment surfaces.

Results from radiological surveys conducted in 1991, 1992, and 1993 are summarized in Tables 1.1, 1.2, and 1.3, respectively (Energy Systems 1994a). Table 1.1 presents the results from measurement of transferable contamination levels for both alpha and beta/gamma-emitting radionuclides, while Table 1.2 presents the results from measurements taken to assess the total transferable and fixed contamination. Table 1.3 presents dose rate measurements taken at one location inside C-410 and a location outside of C-410.

The residual radioactive material on the surfaces is thought to be primarily uranium. DOE guidelines for residual uranium surface contamination are 1000 disintegrations per minute (dpm)/100 cm^2 transferable contamination and 5000 dpm/100 cm^2 average total contamination with a maximum of 15,000 dpm/100 cm^2 over an area not to exceed 100 cm^2 (DOE Order 5400.5). It is clear from Table 1.1 that these guidelines are exceeded in C-410 for transferable contamination throughout the building except in the control room. Measurements in C-420 were below transferable guidelines. Some total surface

Table 1.1. Summary of results from transferable contamination measurements in the C-410 Complex (Energy Systems 1994a)

Location	Surface	Number of samples	Range of results (dpm/100 cm^2)	
			Alpha	Beta/gamma
C-410/C-411, Ground floor, northeast corner	Floor	25 to 135[a]	<2 to 394	<3 to 3331
C-410, Ground floor, boundary control stations step-off pads	Floor	4 to 7[b]	<3 to 308	<104 to 2046
C-410, Ground floor, control room	Floor	2[a]	<2 to 6	<6 to 108
	Office equipment	1[a]	<2 to 3	<6 to 22
C-410, Ground floor, northwest corner	Floor	202	<2 to 2,831	<6 to 53,377
C-410, Ground floor, southwest corner	Floor	166	<13 to 607	<147 to 2000
	Wall	4	184 to 272	1500 to 2100
	Equipment	9	<13 to 120	<104 to 1100
C-410, Ground floor, HF system area	Floor	18	120 to 7,328	562 to 160,000
C-410, Fluorine Plant area	Floor	[c]	450[c]	2900[c]
C-410, Corridor to C-420	Floor	[c]	930[c]	1855[c]
C-410, Equipment	Equipment	50	0 to 620	0 to 2740
C-420, First floor	Floor	11 to 14[a]	<2 to 25	<6 to 138
	Office equipment		<2	<6 to 18
C-420, First-floor equipment room	Floor	16	3 to 103	8 to 486

[a]Number of routine samples collected on a weekly basis.
[b]Number of routine samples collected on a daily basis.
[c]Number of samples not reported; only maximum values are provided.

Table 1.2. Summary of results from total contamination measurements in the C-410 Complex (Energy Systems 1994a)

Location	Surface	Number of samples	Range of results (dpm/100 cm^2)	
			Alpha	Beta/gamma
C-410, Ground floor, HF system area	Floor	18	3240 to 1,728,000	630,000 to 14,000,000
C-420, First-floor equipment room	Floor	16	720 to 5728	1700 to 25,000

Table 1.3. Summary of results from dose rate measurements in the C-410 Complex (Energy Systems 1994a)

Location	Surface	Number of samples	Dose rate	
			Beta (mrad/h)	Gamma (mrem/h)
C-410, Ground floor, Fluorine Plant area	Walls/equipment	[a]	11	<0.1
C-410 Spot Outside on South Side	Ground	[a]	15	1

[a]Number of samples not reported; only maximum values are provided.

measurements exceeded the guidelines in both C-410 and C-420 as shown in Table 1.2. The maximum dose rates shown in Table 1.3 exceeded DOE Order 5400.5 guidelines of 1 millirad (mrad)/h at 1 cm for beta/gamma emitters in both the indoor and outdoor measurements.

Data collected during a May 2000 survey have been analyzed. Results from this sample collection are available through the OREIS database. Measurements of total and removable contamination were reported for 128 samples. Total contamination levels ranged from less than the minimal detectable activity to over 7,000,000 dpm/100 cm^2 for beta/gamma and over 66,000 dpm/ 100 cm^2 for alpha and exceeding the DOE guidelines for surface contamination. Removable contamination levels were up to over 8,000 dpm/100 cm^2 for beta/gamma and over 1500 dpm/100 cm^2 for alpha and exceeding the DOE guidelines for total removable contamination. Removable levels were generally only a small fraction of the total contamination levels. Levels of total contamination for process equipment was generally in the millions of dpm/100 cm^2.

Dose rate measurements were also reported for 128 measurements. Measurements ranged from 5 to 1200 μR/h at contact. The highest areas ($\geq$ 500 μR/h) were in Zone 28 near a pipe, Zone 31 at the vacuum in the hopper storage room, Zone 22 the ash receiver, and Zone 12 piping.

Isotopic sample results were reported for 41 samples. The results included pCi/sample for Am-241, Cs-137, Co-60, Np-237, U-234, U-235, and U-238. No Co-60 was detected. Results for other radioisotopes were much less than the results for uranium. Since these results are per swipe sample only relative abundance is indicated. There were some results that indicated uranium enrichments above the natural enrichment level of 0.711% that was expected based on process knowledge. Areas with the potential to contain enriched uranium are being further evaluated.

1.7.2 Chemical Investigations

Process knowledge of facility operations has identified several sources of potential chemical hazards. Large quantities of HF in liquid form were used in the facility. The HF was used to convert UO_3 to UF_4 and to generate fluorine for use in the production of UF_6. Potassium bifluoride and lithium fluoride were also known to be present in the fluorine cells. The process cooling water was treated with chromate. PCBs were used in electrical and hydraulic equipment. Mercury was present in instruments and electrical equipment. Ethylene glycol, ammonia, methanol, and Freon™ were present in refrigeration systems. Lead (in paint) and other metals, such as silver, may also be present in the building and cadmium has been detected in the C-410 Complex. Methanol and a variety of organic solvents were used for cleaning and degreasing throughout the facility. In addition to these and other chemicals used in the process, the facility has been inactive for more than 20 years and has been used for the storage of equipment and materials not associated with the original mission of the facility. For this reason, contaminants may be present that are unrelated to the C-410 operations.

RCRA and TSCA investigations. In 1994 DOE contracted for a series of RCRA and TSCA assessments by means of walkthrough surveys of facilities. The objectives of these assessments were to review historical data, conduct interviews with former employees, and perform walkthroughs in order to identify known RCRA/TSCA concerns and to identify materials and processes that were not adequately characterized. No sampling or analysis of identified materials was conducted. (DOE 1994).

1.7.2.1 Non-uranium process systems status reports

In 1994, DOE investigated the status of "non-uranium process" systems in the C-410 Feed Plant complex. The investigation determined the physical status of each system by evaluating if documentation exists or if it can be reasonably determined from visual observation that each system was drained or purged since process shutdown, evaluated the potential for the presence of residual material if it could be determined that the systems had been drained or purged, and developed general sampling procedures to collect and characterize residual materials that were present or likely to be present based on visual observations or process knowledge.

1.7.2.2 Noncompliance closure activities

In 1995, the PGDP D&D program issued a report (LMES 1995) that summarized the actions performed to correct the "internally assigned" environmental noncompliance issues associated with the C-410 Feed Plant complex. Numerous actions were performed including:

- Removed 255 compressed gas cylinders,
- Collected and staged approximately 1100 containers,
- Collected and removed small containers of chemicals/materials,
- Characterized contents of five sumps and one pit,
- Characterized and placed 12 breached fluorine cells in a RCRA storage area,
- Drained and characterized 220 gal of oil from 166 items of shutdown equipment oil reservoirs,
- Cleaned 137 wet oil sites,
- Drained 165 gal of oil from two ammonia refrigeration systems,
- Removed Freon from 23 coolant systems,
- Corrected minor housekeeping deficiencies,
- Plugged all accessible floor drains,
- Collected and removed light bulbs, starters, waste mercury items, loose circuit boards, and other potentially RCRA-regulated items,
- Drained and characterized 3245 gal of liquids from eight non-uranium process tanks, and
- Removed paint chips on the floor from passive degradation, and determined the status of the process systems located in the facility.

1.7.2.3 Asbestos investigations

A partial asbestos survey was conducted in 1990 (Lee Wan and Associates 1990) to identify suspect homogenous areas of asbestos-containing materials (ACMs) present in a number of facilities including Buildings C-410, C-410C, C-411, and C-420. The study also assessed the condition of the ACM and determined a recommended course of action. Since this study was conducted, further deterioration of the ACM has occurred.

Ten of the 12 suspect areas identified at C-410 were determined to contain asbestos. Insulation on UF_6, HF, ammonia, fluorine, steam, potable cold water, and water pumping station lines and fittings contained between 15% and 90% asbestos. Other ACM included glycol tank insulation (up to 30% chrysotile asbestos) and carbon dioxide condensing equipment insulation (5% chrysotile asbestos). Cement wall panels used in the construction of C-410 are Transite™, the brand name for asbestos-reinforced concrete panels made by Johns-Manville Company and known to contain a minimum of 40% chrysotile asbestos. In C-410-C, the only suspect material was Transite™ cement wall panels. One of two suspect areas in C-411 was found to contain asbestos. The insulation on the 25-kilopascal (kPa) (35-lb) steam line in C-411 contained 40% asbestos.

Ten areas were identified in C-420, of which nine were determined to contain asbestos. ACM in C-420 included green salt reactor insulation (up to 95% chrysotile asbestos) and HF tank insulation (5% chrysotile asbestos). Other ACM included hydrogen, potable water, steam, and ammonia piping insulation that contained between 5% and 90% chrysotile asbestos. Cement wall panels (Transite™) and 23 × 23 cm (9 × 9 inch) floor tiles were also found to contain asbestos.

Table 1.4 summarizes the locations and approximate quantity of ACM present in the building.

Table 1.4. Summary of asbestos-containing material identified in the C-410 Complex

Type of material	Quantity
C-410	
Steam-condensate piping and fittings	550 lin m (1,800 lin ft)
UF_6 lines and fittings	142 lin m (465 lin ft)
Potable cold water elbow and fittings	76 lin m (250 lin ft)
Fluorine system pipe insulation and fittings	116 lin m (380 lin ft)
Glycol tank insultation	375 lin m (1,230 lin ft)
HF lines and fittings	9 lin m (31 lin ft)
Water pumping station lines and fittings	15 lin m (50 lin ft)
Ammonia pipes and fittings	64 lin m (210 lin ft.)
Cement wall panels	2440 m^2 (26,250 ft^2)
Carbon monoxide condensor	137 m^2 (1,474 ft^2)
C-410-C	
Cement wall panel	260 m^2 (2800 ft^2)
C-411	
35-lb steam line	Not provided
C-420	
Green salt reactor tank insulation	61 m^2 (650 ft^2)
Hydrogen pipe line runs and fittings	17 lin m (55 lin ft)
HF tanks insulation	150 m^2 (1,600 ft^2)
Steam-condensate lines and fittings	450 lin m (1,475 lin ft)
Potable cold water elbow and fittings	105 ea.
Ammonia pipe or HF pipe and fittings	67 lin m (220 lin ft)
Floor tile (9 inches by 9 inches)	100 m^2 (1,100 ft^2)
Potable cold water pipe insulation	240 lin m (800 lin ft)
Cement wall panel	1910 m^2 (20,600 ft^2)

lin m = linear meter.
ea. = each.
HF = hydrogen fluoride.
Source: Lee Wan and Associates 1990.

It was determined asbestos-containing debris is present on the floor and on equipment throughout the second, third, and fourth floors in C-420. This material is present without any of its former protective covering and, therefore, is highly susceptible to further destruction and release of fibers (Lee Wan and Associates 1990).

Lee Wan and Associates conducted personal breathing-zone air monitoring in all buildings during the asbestos survey. All air samples were found to be at, or below, instrument detection limits (.003 fibers/cm^3) and, therefore, significantly below the reported permissible exposure limit of 0.2 fibers/cm^3.

1.7.3 Inspections and Engineering Evaluations

In 1998, a Phase II facility assessment summary report for the C-410 Complex reported the following observations (BJC 1998):

- The entire complex is a radiological zone and requires special monitoring and clothing.
- The building has various plant chemical lines, ash receivers, etc. throughout the facility.
- Asbestos, some of it friable, is present in large quantities.
- There are PCB concerns identified within the facility (duct work, ballasts, etc.).
- Past Occupational Safety and Health Administration (OSHA) inspections of the facility have indicated that extensive OSHA nonconformances exist in the facility (although the most serious had been remedied prior to the assessment).

In 1999, Tetra Tech, Inc., completed an evaluation of the C-410 process lines that included the identification of process and utility piping entering and exiting the C-410/C-420 Complex. The report indicates that the majority of all incoming lines to the complex have been abandoned or isolated (valved off). However, due to the age of the facility and condition of the valves, it is uncertain if these valves are preventing water from entering the facility.

1.7.4 Site Evaluation Summary

A SER was prepared as part of the initial phase of the C-410 D&D work. This document delineates and describes the feed plant facilities to be addressed by the infrastructure removal action and provides the regulatory setting under which the action is to be accomplished. In addition, the SER provides a brief history of the complex including both process operations and post-shutdown activities, describes in general terms the nature of materials likely to be encountered and wastes likely to be generated, and presents a summary of environmental investigations conducted at the complex to date. The report also provides an overview of risks associated with the complex in its present condition, while considering the impacts of D&D activities on various environmental media. In essence, the SER provides a summary of available information on the C-410 Complex in preparation for subsequent activities associated with the site evaluation and infrastructure removal phases.

The collection of additional characterization data for the C-410 Complex will occur as a part of the implementation of the response action. This data will be used during performance of the removal action, for example, to establish health and safety controls for workers, and to make waste characterization and disposition decisions. In addition, this additional characterization information will be used in remedial decision making for the C-410 Complex. Characterization data will be incorporated, as appropriate, in the Removal Action Report and the Remedial Investigation/Feasibility Study for the Facility Structure and Environmental Media Phases.

1.8 NATURE AND EXTENT OF CONTAMINATION

The available data are a compilation of data collected at various times and locations. However, data and process knowledge indicate the following.

- Interior and exterior surfaces of the process equipment are radiologically contaminated.

- Hazardous chemicals within the $UO_3 \rightarrow UF_6$ process equipment were removed, although external surfaces may have lead paint and asbestos on them.

- The facility includes the potential for internal and external exposure to alpha, beta, and gamma-emitting radionuclides. Uranium, transuranics, and technetium are suspected to be the primary radionuclides present.

- The percentage of transuranics, such as neptunium and plutonium, and fission products such as technetium, in the reactor tails material was very small, estimated at approximately 0.2 ppm neptunium, 4 ppb plutonium, and 7 ppm technetium (DOE 2000).

- Auxiliary process equipment such as the refrigeration systems, fluorine generators, storage tanks, etc. may contain residual hazardous chemicals such as potassium bifluoride. Interviews with former operators indicate most of the systems were drained during shutdown; however, no records documenting the shutdown have been located (Energy Systems 1994b). Low levels of radioactive contamination are likely present on the exterior surfaces and potentially inside some of the equipment.

- Radioactive contamination on the interior building surfaces ranges from non-detect to high levels of contamination.

- Fluids such as lubricating fluids, hydraulic fluids, and dielectric fluids may be present inside equipment such as motors and condensers. Some of these fluids may contain PCBs.

- Electrical equipment such as transformers, rectifiers, and capacitors present within the building probably contain PCB-based oil.

- Pressure readings have been observed on some gauges. Until proven otherwise, process and instrument lines should be considered pressurized.

- Gaskets within the equipment and ventilation system may contain PCBs.

- Large quantities of ACMs are present in the facilities.

- Asbestos insulation has fallen off the piping and equipment and lies on the floor.

- Although mercury items were removed, there may be some mercury switches and possibly manometers present in the building.

- Exfoliating paint on surfaces likely contains lead.

- Process water was treated with chrome (VI) to prevent corrosion. Chromate may be deposited on the interior of the cooling system.

- Previous investigations at other facilities have discovered selenium in rectifiers. Therefore, selenium is a possible contaminant.

- Uranium above 1% enrichment has been identified in some areas. These areas are being further investigated.

The stored materials brought to the complex from other areas of the plant have not been fully characterized and may contain enriched uranium or other hazardous and/or radioactive materials. Table 1.5 summarizes the investigations to identify potential contaminants.

Table 1.5. Summary of results of investigations to identify the presence of potential contaminants

Contaminant[1]	Form
Uranium	UO_2, UO_3, UF_4, UF_6, U_3O_8, UO_2F_2 -- some above 1% enrichment
Am-241	Small quantities
Np-237	Small quantities
Cs-137	Small quantities
Co-60	Not detected
HF materials	Electrolyte, HF, LiF, KHF_2, H_2, F_2, HF
Asbestos	Blankets, insulation, floor tiles, etc.
Lead	Paint, may be in some anchors
Mercury	May be some remaining switches, manometers, DC arc tubes
PCBs	May be some remaining light ballasts, gaskets, electrical insulation
Refrigerants	Equipment reported as drained, but may contain residual quantities

[1] Radionuclides include their radioactive decay products.
HF = hydrogen fluoride.
PCBs = polychlorinated biphenyls.

1.9 SUMMARY OF BASELINE RISK EVALUATION FOR THE C-410 COMPLEX

In 1994, DOE prepared a Level 3 Baseline Risk Evaluation (BRE) for the C-410 Complex to assess the potential risks to human health and the environment posed by current and future potential releases from the complex (DOE 1994c). This Level 3 BRE followed the draft baseline risk assessment guidance prepared by DOE for the D&D Program. This guidance, which appeared in final form in *Baseline Risk Assessment Guidance for D&D Facilities* (DOE 1995), describes a Level 3 BRE as an evaluation that uses available characterization data and process history to perform a screening risk evaluation. A summary of the BRE may be found in Appendix B.

The results of the BRE for the C-410 Complex indicate that long-term exposures to contaminated media pose a potential health risk. The BRE evaluated both workers and potential residents as receptors. The risk is primarily from contaminant migration from the complex, and risks under catastrophic releases are of special concern. This analysis indicates that current conditions exceed the acceptable risk range for site-related exposures under both current and potential future uses.

1.10 COMMUNITY PARTICIPATION

DOE has involved the public in the scoping for this project. This process has included regular briefings for the PGDP Site-Specific Advisory Board , a citizen's panel advising the DOE.

DOE, EPA, and the Kentucky Department for Environmental Protection encourage the public to review this document and other relevant documents in the Administrative Record to gain an understanding of PGDP's environmental compliance plans and the proposed cleanup actions. A copy of this EE/CA, as well as the entire Administrative Record, is located at the DOE Environmental Information Center. During the comment period, the EE/CA will also be available at the McCracken County Public Library.

Administrative Record Availability for Public Review

DOE Environmental Information Center 115 Memorial Drive, Barkley Centre Paducah, KY 42001 (270) 554-6979	McCracken County Public Library 555 Washington Street Paducah, KY 42003 (270) 442-2510
Normal hours of operation (except for the week of the second Saturday of each month) are 10:00 a.m. to 6:00 p.m. Monday, Wednesday, Thursday, Friday 12:00 p.m. to 8:00 p.m. Tuesday **Hours of operation for the week of the second Saturday of each month are** 10:00 a.m. to 6:00 p.m. Monday, Thursday, Friday 12:00 p.m. to 8:00 p.m. Tuesday 2:00 p.m. to 6:00 p.m. Wednesday 8:00 a.m. to 12:00 p.m. Saturday	**Normal hours of operation for the library are** 9:00 a.m. to 9:00 p.m. Monday through Thursday 9:00 a.m. to 6:00 p.m. Friday and Saturday 1:00 p.m. to 6:00 p.m. Sunday

DOE will schedule a public meeting to discuss the removal action alternatives and to address questions and concerns the public may have about all the alternatives. DOE will establish a 45-day public comment period to allow the public time to review the documents and submit comments on the alternatives. Extensions to the comment period may be granted if requested in writing. DOE will document, evaluate, and respond to significant comments as part of the subsequent Action Memorandum. Comments may be addressed to

Public Affairs Manager
Environmental Management and Enrichment Facilities
Bechtel Jacobs Company LLC
761 Veterans Avenue
Kevil, KY 42053
(270) 441-5023

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2. REMOVAL ACTION JUSTIFICATION AND OBJECTIVES

This chapter discusses DOE's response authority under CERCLA for D&D actions, general removal action objectives (RmAOs), the justification for D&D of the C-410 Complex infrastructure, and proposed ARARs.

2.1 RESPONSE AUTHORITY AND STATUTORY LIMITS

Section 104 of CERCLA addresses the response to releases or threats of release of hazardous substances through removal actions. Executive Order 12580, "Superfund Implementation," delegates to DOE the response authorities for DOE facilities. As lead agency, DOE is authorized to conduct response measures (e.g., removal actions) under CERCLA. A response under CERCLA is appropriate when (1) hazardous substances or contaminants are released or (2) there is a substantial threat of a release into the environment and response is necessary to protect human health and the environment. DOE and EPA have issued a joint policy statement (DOE and EPA 1995) stating that building D&D activities should be conducted as non-time-critical removal actions unless circumstances at the facility make it inappropriate.

NEPA requires all federal agencies to consider the possible effects (both adverse and beneficial) of their proposed activities before taking action. DOE has issued a Secretarial Policy Statement on NEPA (DOE 1994b) stating that DOE will hereafter rely on the CERCLA process for review of actions to be taken under CERCLA and will address and incorporate NEPA values in CERCLA documents to the extent practicable. Such values may include socioeconomic, historical, cultural, ecological, aesthetic, and health effects, both short-term and cumulative, as well as environmental justice and land use issues and the impacts of off-site transportation of wastes. Guidance states that NEPA values will be incorporated to the extent practicable, with more attention given to those aspects of the proposed action having the greater anticipated effects. In keeping with this policy, NEPA values have been incorporated into this EE/CA.

2.2 REMOVAL ACTION OBJECTIVES

Specific RmAOs for the C-410 Complex have been developed and form the basis for identifying and evaluating appropriate response actions. The RmAOs for this removal action are the following:

- remove the materials causing the highest potential risks (e.g., transferable radioactive materials, asbestos, and other hazardous materials such as PCBs); thereby, significantly reducing the risk to current employees and potential off-site receptors in the event of building failure or further degradation to levels within the CERCLA risk range and in compliance with ARARs.

- reduce the potential for public, worker, and environmental exposure to radioactive and hazardous substances caused by uncontrolled release from the buildings, and

- remove the infrastructure from the C-410 Complex buildings in preparation for future final cleanup decision making.

2.3 JUSTIFICATION FOR A REMOVAL ACTION

The C-410 Complex and its contents present unacceptable risks to unprotected workers. Additionally, releases of process materials to the environment due to infrastructure collapse through deterioration or a catastrophic event would lead to unacceptable risks to on-site and off-site personnel, the public, and the environment. Finally, releases to the environment upon infrastructure collapse may result in contaminant releases that exceed ARARs.

The fact that unacceptable risks to unprotected workers are present is demonstrated by the results of the radiological investigations and the current status of the building. As concluded in Section 1.7.2, the transferable radioactive contamination on surfaces exceeds DOE guidelines for radiation protection throughout the C-410 Building, except in the control room. As noted in Section 1.6, activities in the building have been restricted due to worker health and safety concerns associated with the presence of airborne and other contaminants and the deteriorated condition of the building.

The fact that infrastructure collapse would lead to unacceptable risks to on-site personnel, the public, and the environment is demonstrated by the results of the BRE. As discussed in Section 1.9 and shown in Appendix B, the primary risks associated with the complex under current conditions are from contaminant migration, especially under a catastrophic release scenario. These risks exceed EPA's generally acceptable hazard index for both worker and resident populations assumed to be present in off-site and on-site locations. Additionally, it should be noted that characterization data from the most highly contaminated portions of the C-410 Complex (i.e., radiation regulated areas) were not available for assessment in the BRE. As noted in the BRE, if this information was assessed, higher risks would be calculated. The fact that calculated risks would be higher is demonstrated by the extensive list of process materials and contaminants expected to be present in the complex (Section 1.8). These materials include, but are not limited to, electrical transformers currently containing or having contained PCB-based oils, gaskets containing PCB-based oils, insulation containing asbestos, cooling system containing or having contained chromate-treated water, and process equipment containing potassium fluoride, HF, uranium fluoride, and uranium oxide.

Therefore, specific CERCLA justifications for performing D&D activities at the complex are as follows:

1. There is increasing potential for the compromise of the safety of site workers through loss of entry control or by complete or partial building and/or infrastructure collapse.

2. There is increasing potential for environmental releases through building and infrastructure deterioration and/or catastrophic events that would lead to unacceptable risks to on-site and off-site human populations and the environment. These risks would exceed EPA's acceptable risk range.

In addition to the CERCLA justifications, D&D of these buildings at this time is appropriate because there is no present or foreseeable future need for these facilities. Since the shutdown of the fluorine cells and uranium feedstock production, the buildings have had no identified function or mission. Additionally, based on their past operational history and current physical condition and the presence of high levels of contamination, no beneficial reuse has been identified.

2.4 COMPLIANCE WITH ARARS

In accordance with Section 300.415(j) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), on-site removal actions conducted under CERCLA are required to attain ARARs to the extent practicable. ARARs include only federal and state environmental or facility siting laws/regulations; they do not include occupational safety or worker radiation protection requirements. Additionally, per 40 *CFR* 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to be considered (TBC) category].

ARARs are typically divided into three categories: (1) location-specific, (2) chemical-specific, and (3) action-specific. Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., floodplains or historic districts). Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, or air) for specific hazardous substances, pollutants, or contaminants. Action-specific ARARs include operation, performance, and design requirements or limitations based on waste types, media, and removal/remedial activities.

In addition to ARARs, TBC information may also be used in developing and evaluating removal action alternatives. TBC information consisting of advisories, criteria, or guidance, such as DOE Orders, may be useful in determining cleanup levels that are protective of human health and the environment in the absence of ARARs. A list of potential ARARs and TBCs has been identified to address the alternatives proposed in this EE/CA and is included as Appendix C.

Except for the No Action Alternative, the removal action alternatives proposed in this document will comply with the appropriate identified ARARs and TBCs.

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3. REMOVAL ACTION TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES

3.1 TECHNOLOGY IDENTIFICATION AND SCREENING

This section identifies the technologies and disposal options based on site-specific conditions, contaminants, and the affected media. The technologies and disposal options identified below are appropriate for the decommissioning of buildings and equipment associated with the feed plant. The appropriate technologies have been identified based on the following resources:

- *The Decommissioning Handbook*, DOE/EM-0142P, DOE Office of Environmental Restoration, March 1994 (DOE 1994d);

- documentation written in support of D&D activities at other DOE facilities, including the Weldon Spring Chemical Plant in Missouri, the former Oak Ridge gaseous diffusion plant in Tennessee, and the Fernald Environmental Project in Ohio;

- collective knowledge and experience provided by DOE and its contractors that have completed other D&D projects; and

- documentation written in support of D&D activities for facilities licensed by the Nuclear Regulatory Commission (NRC) [e.g., *The Technology, Safety, and Costs of Decommissioning a Reference Uranium Hexafluoride Conversion Plant,* NUREG/CR-1757 (NRC 1981)].

Technologies were identified based on their ability to meet RmAOs and provide safety to workers, the feasibility of the technology under site-specific conditions, and the ability to provide radiological control of the D&D activity. The pool of successful technologies from past D&D projects was screened to create a list applicable to the waste streams and potential contaminants in the C-410 Complex.

These technologies have been divided into three groups: decontamination, treatment, and dismantlement/ size reduction. Disposal options and associated container options relevant to the waste streams that would be generated from D&D activities are also discussed.

3.1.1 Decontamination

Table 3.1 identifies the decontamination technologies considered for the C-410 Complex and addresses their applicability and limitations. The technologies considered most appropriate for decontamination of the buildings and equipment are sponge blasting, abrasive blasting, dusting, scrubbing, vacuuming, and wiping. The techniques selected will be based on the properties of the material being decontaminated. All will be carried forward as representative process options.

3.1.2 Treatment

Physical and chemical treatment technologies considered for the C-410 Complex are limited due to the nature of the radioactive materials. The resulting waste form(s) is critical relative to national release standards and to meeting waste acceptance criteria (WAC) for both on-site and off-site disposal. Table 3.2 identifies the treatment technologies considered and addresses their applicability and limitations.

Table 3.1. Description and evaluation of decontamination technologies for the D&D of the C-410 Complex and equipment

Technology	Description	Applicability	Limitations	Comments
Sponge blasting	Uses a sponge grit suspended in an air spray to loosen and remove surface contamination	Effective on flat, shatterproof surfaces (concrete, aluminum, steel, and painted or coated surfaces) and on hard to reach areas such as ceilings	Effective for near surface contamination; creates additional waste	Sponge grit can be recycled
Abrasive blasting	Uses an abrasive media (sand, glass beads, grit, or CO_2 pellets) suspended in an air spray to loosen and remove surface contamination	Effective on flat, shatterproof surfaces (concrete, aluminum, steel, and painted or coated surfaces) and on hard to reach areas such as ceilings	Effective for surface contaminants up to 0.64 centimeters (0.25 inches) deep, depending on abrasive technique; creates additional waste; slow, labor-intensive technique, which causes high potential for worker exposure	Can produce substantial amount of contaminated dust; appropriate for items that can be effectively decontaminated for reuse or "clean" disposal; CO_2 minimizes additional waste streams
Dusting/scrubbing/ vacuuming/wiping	Physical removal of dust, dirt, and loose surface contamination by common cleaning techniques	Removal of loose contamination from a variety of surfaces	Labor intensive, which causes high potential for worker exposure; wiping should not be used on porous or absorbent surfaces	Appropriate for most items where loose contamination could spread; vacuuming performed using HEPA filters
Rinsing/ dipping/ flushing	Rinsing, dipping, or flushing surfaces with water, acids, or caustic solutions	Surface contaminants are dissolved or desorbed from non-porous materials	Some applications can generate large quantities of wastewater or rinse solutions requiring treatment prior to disposal; strong acids or bases involve material compatibility issues	Application is limited due to potential generation of large quantities of secondary waste; applications should limit use of liquids to minimize the potential for exposure to workers, releases to the environment, and the need for treatment & disposal waste solutions

CO_2 = carbon dioxide.

Table 3.2. Description and evaluation of treatment technologies for the D&D of the C-410 Complex and equipment

Technology	Description	Applicability	Limitations	Comments
Recycling/metal reclamation	Reclamation and reuse of valuable metals	Process materials containing substantial amounts of valuable metals	Percentage of valuable metals must be high to make the process cost-effective	Concerns about residual contamination in recycled products may impose significant impediment to implementation
Encapsulation	Fixes wastes by encasement in low solubility solid matrix	Used for wastes that are unstable.	Increases volume and mass of waste	Reduces potential for leaching to groundwater
Chemical treatment	Water rinse, precipitation of uranium from solution by lime flocculation	Decontamination of process equipment with reduction in solubility of the residuals	Generation of liquid waste; waste solution can be treated by lime precipitation prior to discharge	Soluble uranyl fluoride may be rinsed from equipment leaving low solubility forms of uranium as residual in the pipe; uranium recovered from rinsate by lime precipitation
Applying fixative stabilizer coatings	Application of paints, films, and resins used as coatings to fix and stabilize contaminants in place	Stabilizes PCBs, and radioactive contamination	No removal of contaminant is achieved; experiments to ensure effectiveness of stabilizer are generally required due to site-specific requirements	Also useful for containment of contaminants on transite siding or other building materials

PCBs = polychlorinated biphenyls.

Recycling of uranium-contaminated process equipment is difficult due to the possibility of residual contamination in the recycled material products and potential exposure to workers in the recycling facilities. The Secretary of Energy has suspended the release of potentially contaminated scrap metals for recycling from DOE nuclear facilities as part of a policy aimed at ensuring contaminated materials are not recycled into consumer products. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily.

The application of fixative/stabilizer coatings (such as latex paints, gums, or resins) is considered a viable technology to fix any contamination found on the walls or slabs or to minimize further degradation of the buildings. An encapsulant such as concrete or polymer could be applied to equipment, pipes, and other materials having radioactive or other hazardous contamination. Alternatively, radioactively contaminated materials could be reduced in size by compaction or shredding and loaded into containers such as B-25 boxes. The void space within the boxes would then be filled with encapsulant such as concrete or polymer.

3.1.3 Dismantlement and Size-Reduction Technologies

Table 3.3 identifies the dismantlement and size-reduction technologies considered and addresses their applicability and limitations.

Table 3.3. Description and evaluation of dismantlement and size-reduction technologies for the D&D of the C-410 Complex and equipment

Technology	Description	Applicability	Limitations	Comments
Conventional disassembly	Hand-held tools and saws; hand removal of nuts and bolts	May be applied to any area	Labor intensive and slow; recommended for limited application	No additional worker training required; rotary saws, grinders, and other high-speed mechanical tools would produce airborne particulates and fines that may need to be collected
Mobile hydraulic shear	Two-bladed cutter attached to excavator; typically uses hydraulic power from excavator	Can cut 0.6-cm-(1/4-inch)-thick steel (large-diameter pipe, structural steel, tanks); up to 2.5-cm-(1-inch)-thick pipe can be cut with reduced blade life	Pipe ends are pinched, requiring further processing before decontamination, treatment, or disposal; eliminates airborne contamination associated with thermal cutting processes	Good for conduit and small piping.
Circular cutters	Self-propelled; cut as they move around a track on outside circumference	Metal pipes from 3.175 cm (1.25 inch) to 6 m (20-ft) diameter; wall thickness up to 15 cm (6 inches), depending on type of circular cutter used	10-cm (4-inch) to 5.3-cm (21-inch) clearance required, depending on type of circular cutter used; requires multiple passes for thickness greater than 1.9 cm (0.75 inches)	Safety concerns
Oxyacetylene torch	Oxygen and a fuel gas mixed and ignited at the tip of a torch; metal heated to 816°C (1500°F) is burned away	Very effective in cutting carbon steel; depth of cut up to 10 to 15 cm (4 to 6 inches); cutting speed up to 76 cm/min (30 inches/min); common technique for structural carbon steel member disassembly	Alloys uranium with the metal; however, generally does not affect cutting operation	Not recommended for aluminum or stainless steel due to formation of refractory oxides

Table 3.3. Description and evaluation of dismantlement and size-reduction technologies for the D&D of the C-410 Complex and equipment (continued)

Technology	Description	Applicability	Limitations	Comments
Burning bar (PGE 2001)	Pipe filled with wire, tubes, or metal shapes of varying alloys. Ignited in presence of high pressure oxygen. Temperatures up to 4430°C (8000°F) have been recorded at the burning tip. Cuts by melting material	Very effective for concrete or metal	Same as oxyacetylene torch	Can achieve higher cutting speeds than conventional cutting methods. Difficult to control
High-pressure abrasive water jet	Water with an abrasive (sand, garnet, etc.) jet stream erodes material producing a clean cut; pressures up to 3700 atm (55,000 psi) used	Can cut virtually all materials; may require multiple passes to cut thick materials	Creates slurry of contaminated water as secondary waste	Not recommended due to high volume of secondary waste generated
Plasma arc torch	Cutting technique in which an electrical arc is established between the tool and the work piece	Capable of cutting all metals	Hand-held plasma torches cannot be used for materials with a wall thickness greater than 3.8 cm (1.5 inches) thick	High-volume ventilation systems are required to draw the contaminated fumes through HEPA filters
Compaction (crushing) and super compaction	Compresses wastes using hydraulic mechanical technology to achieve volume reduction	Scrap metal, concrete, glass, rubble, plastic material, rubber, paper, and cloth	Limited to compressible wastes; supercompactors operating at 29,000 to 150,000 kPa (4000 to 22,000 psi) required to compact most items	Greatly reduces the volume of reactors, tanks, etc. Volume reduction factors of 4 to 5 can be achieved for scrap metal resulting in densities as high as 150 lb/ft^3
Shredding	Shreds waste to provide waste volume reduction	Waste materials with large void spaces and thin metals	Waste size restrictions for most shredders [>3.175 cm (>1.25-inch) rebar, 3.75 cm (1.25-inch) steel cable, and 10 cm (4.0-inch) Schedule 40 pipe]; primarily for metal wastes	Not recommended due to limitations on size of material that can be shredded

HEPA = high efficiency particulated air (filter).

Dismantlement using hand tools, circular cutters, hydraulic shears, oxyacetylene torches, burning bars, and plasma arc torches has been identified as viable. High-pressure abrasive water jet techniques have been eliminated due to safety concerns, cost considerations, or liquid waste generation.

Size-reduction techniques have also been identified for use in the D&D efforts. Compaction has been used as the representative process option since this technique can be easily applied to a variety of materials and results in substantial volume reduction.

3.1.4 Container Options

It will be necessary to containerize a portion of the waste generated during D&D activities for transportation and/or disposal. The waste streams and volume of waste requiring containers will depend heavily on the D&D technologies that are used and the disposal options that are selected. A large variety of containers are available that would be appropriate for the different waste streams that would be generated. Appropriate containers include Sea-land containers, intermodal containers, ST-boxes (B-25), steel drums, and polyethylene drums. Due to the variety of waste that will be generated from the D&D activities, it is anticipated that all of the container options will be used during implementation of the removal action.

3.1.5 Disposal Options

The equipment and infrastructure represent a volume of approximately 10,000 yd^3. In addition, it is assumed that the stored materials add an additional 2300 yd^3. An estimate for the process equipment inventory is shown in Appendix A. A complete inventory will be conducted as part of the site evaluation process. Depending on the alternative selected, much of this may require disposal as low-level radioactive waste, RCRA or TSCA hazardous waste, mixed waste, or non-hazardous solid waste. A listing of anticipated potential waste streams is presented in Table 3.4. The volumes are highly uncertain, especially for the stored materials and the supporting infrastructure. Because cost is very dependent on the volume, the estimated costs could change significantly once the inventory is firmly established.

Disposal options that can be considered for the disposal of certain waste generated during D&D activities at the C-410 Complex are limited by the presence of radioisotopes on most of the infrastructure at levels that exceed most industrial/sanitary landfills radioisotope limits. Three facilities are being evaluated as disposal options for the majority of the waste generated from the D&D activities—Nevada Test Site (NTS), a commercial facility, and potentially on-site disposal at PGDP. The disposal site located at DOE's Hanford facility was not considered because the cost for disposal/transportation at the Hanford Facility is significantly higher than the cost for disposal/transportation at Envirocare of Utah or NTS. The disposal site located at DOE's Savannah River facility was not considered because the Savannah River Site cannot accept other DOE waste. (Permitted, commercial disposal facilities may also be used, however, for disposal of limited volumes of waste.)

Although a variety of waste streams will be generated, the primary waste streams will be radiologically contaminated materials identified as low-level waste (LLW) and construction/demolition debris. Wastes such as PCB-containing liquids and electrical components, non-radioactive RCRA and/or mixed waste sludges or liquids, and petroleum products will also be generated. Mixed waste and RCRA waste will be treated, if necessary, to meet RCRA land disposal restrictions (LDRs) prior to disposal. All waste materials will be separated into waste streams that conform to the proposed disposal facility WAC. A discussion of the primary waste disposal facilities being considered for waste from the D&D activities and a summary of their respective WAC is presented in the following sections. In addition, there are other commercial disposal facilities available for wastes that cannot meet the WAC for the facilities discussed here (for currently unidentified mixed waste, RCRA waste, or PCB waste). The Bechtel Jacobs Company LLC (BJC)–approved commercial facilities are presented in *Commercial Hazardous Waste TSDRFs List*, December 21, 2000.

Table 3.4. Description of anticipated potential waste streams

Waste streams	Description
Radioactively Contaminated Recyclable Metals	These materials consist of equipment, pipe, tubings, valves, etc. of sufficient size to be economically decontaminated for recycle. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily.
Non-radioactive Recyclable Metals	These materials consist of equipment and larger diameter pipe, valves and fittings from non-process areas and systems that meet appropriate radiological release criteria. As such, this scrap metal may be suitable for release without decontamination.
LLW, Debris	LLW debris are defined as radioactively contaminated, non-consolidated, solid material with a size > 6.4 cm (2.5 inch) and are managed separately from non-debris LLW because of differing characterization requirements. The waste streams within this category consist of scrap metal of insufficient size for economic recycle, scrap metal constructed from alloys dissimilar to those destined for recycle (i.e., brass, monel, and/or bronze) and miscellaneous debris waste types from process areas or systems.
LLW, Non-debris	The waste streams classified in this category are solids, liquids or sludges that derive from project activities in Radiological Contamination Areas where the radioactivity may be dispersed within the waste matrix. The primary waste streams in this category are typically PPE, vacuum dusts, concrete dusts, floor sweep, spent shot, spent grit [from decontamination blasting], spent decontamination solutions, and various wastewater streams. These streams are separately categorized from LLW debris because of differences in characterization requirements or ultimate disposition.
Non-radioactive, Non-hazardous [Non-PCB] Solid Wastes	The waste streams in this category consist of both debris and non-debris wastes that can be certified as meeting radiological release criteria and are non-hazardous and non-PCB.
Radioactive ACM	This waste category includes ACM derived from process areas or systems such as process pipe insulation, feed-station seals and insulation, or concrete dusts from scabbling or blasting ACM material.
Non-radioactive ACM	This waste category consists of ACM that can be demonstrated to meet the appropriate radiological release criteria.
PCB Wastes	This waste category encompasses PCB electrical equipment, PCB oils, process ventilation system components and other wastes that are contaminated from regulated sources. PCB wastes may be categorized as radioactive PCB wastes or non-radioactive PCBs if radiological release criteria are met. These include PCB bulk product and PCB remediation wastes. Most of the waste is expected to meet the definition of PCB remediation waste and not require incineration.
Mixed Wastes	This waste category includes waste streams that are considered likely to have both a RCRA hazardous component and a radioactive component based on their origin within a radioactive materials management area, surface contamination exceeding release limits, or available characterization data. Among the wastes included in this category are inherently hazardous non-recyclable metal items, trap materials, concrete dusts from decontamination of [process] floors where lube oil leakage occurred, and radioactively contaminated lamps.
Hazardous Wastes	This waste category encompasses RCRA hazardous waste streams that meet radiological release criteria.

Table 3.4. (continued)

Waste streams	Description
PCB/RCRA/Rad	PCB/RCRA/Rad wastes are those mixed wastes that also contain PCBs. This category also includes ACM that is co-mingled with mixed waste and PCBs. These wastes may include residual hydraulic fluids, concrete dust and wastewater, ventilation duct gaskets, and deposits within the ventilation ducts.
Classified materials	This category includes materials that must receive special handling because of security concerns. This would include enriched uranium or items whose composition or function could divulge classified information on uranium enrichment technology. Enriched uranium is not expected to be found in the process equipment, though some may be among the stored materials brought from other areas of the plant.
TRU	Transuranic elements were detected in process materials and the possibility exists that small quantities of transuranic waste could be encountered. TRU is most likely to accumulate in the ash receivers, most of which have already been removed.

ACM = asbestos-containing material.
DOE = U.S. Department of Energy.
LLW = low-level waste.
PCB = polychlorinated biphenyl.
PPE = personal protective equipment.
RCRA = Resource Conservation and Recovery Act.
TRU = transuranic.

Enriched uranium is regulated as special nuclear material (SNM) and is subject to more restrictive transportation and disposal constraints than natural assay uranium. Items containing enriched uranium were brought into the building from other areas of the plant for storage after C-410 discontinued production.

3.1.5.1 Nevada Test Site

The DOE owns and operates the NTS land disposal facility. Waste accepted at the NTS must be radioactive and meet their waste acceptance criteria. Accepted wastes include the following:

- LLW,
- LLW gases (non-compressed),
- sealed sources,
- LLW containing asbestos, and
- radioactive animal carcasses.

Mixed waste currently cannot be accepted if generated outside the state of Nevada; however, NTS is in the process of modifying its Part B RCRA Permit to allow it to accept out of state mixed waste. NTS expects to be able to accept mixed waste in 2002. Nonradioactive, hazardous waste, waste containing free liquids, fine particulate waste (unless immobilized), compressed gases, PCB waste, explosive waste, pyrophoric waste, waste containing etiologic agents, and waste containing greater than 1% chelating agents cannot be accepted for disposal. NTS is working on approval for accepting PBC bulk product and PCB remediation wastes.

Fissionable (fissile) waste must meet nuclear criticality safety criteria, which requires a Criticality Safety Evaluation. The safety evaluation is required to be performed in accordance with DOE Order 420.1, "Facility Safety," and applicable American National Standards Institute/American Nuclear Society standards.

PGDP is now certified by NTS to send waste to NTS for disposal.

3.1.5.2 Commercial facilities

Envirocare of Utah is a privately owned and operated land disposal facility. Waste accepted at the facility must be radioactive and meet their waste acceptance criteria. Accepted wastes include the following:

- LLW,
- mixed waste,
- PCB/TSCA waste, including PBC remediation wastes,
- LLW gases (non-compressed), and
- LLW containing asbestos.

Specific items that cannot be disposed of at Envirocare of Utah are sealed sources, shock-sensitive waste and materials, batteries, and water or air reactive waste and materials (e.g., unstabilized trap material). In addition, biological waste such as animal carcasses need to be addressed on a case-by-case basis.

Mixed waste must meet applicable requirements of 40 *CFR* 264 for treatment and disposal. Nonradioactive hazardous waste, waste containing free liquids, compressed gases, explosive waste, pyrophoric waste, and waste containing greater than 0.1% chelating agents cannot be accepted for disposal.

Other permitted commercial facilities may be considered for disposal if they can accept waste at a lower cost than the identified disposal facilities or if the identified facilities are unavailable during implementation of the removal action (e.g., the TSCA incinerator may be deactivated, and NTS may not receive approval for its Part B Permit).

3.1.5.3 C-746-U Landfill

The C-746-U Landfill is an on-site disposal facility that is designed for solid waste and can accept industrial waste generated at PGDP. Accepted waste categories include (but are not limited to) brick, concrete, rock, lumber, vitrified clay materials, polyvinyl chloride pipe, polyethylene sheeting, roofing materials, and certain metals. The C-746-U Landfill cannot accept LLW, RCRA waste, mixed waste, PCB waste, or free liquids. The landfill cannot accept waste containing greater than the authorized limits of radioactive material (see Table 3.5). Long-term protectiveness and permanence of the landfill will be demonstrated using existing or new risk and performance evaluation of the landfill prior to disposal of any CERCLA remediation wastes. Only D&D waste allowed under the C-746-U Landfill permit will be disposed of in the landfill to allow disposal of D&D remediation wastes.

Asbestos-containing building material (friable) and empty containers (aerosol cans, paint cans, pesticide containers, etc.) are also waste streams accepted at C-746-U Landfill.

3.1.5.4 DOE TSCA Incinerator

DOE owns and operates a rotary kiln incinerator designed to treat hazardous organic wastes, PCBs, RCRA/LLW, TSCA/LLW, and LLW. This incinerator is currently in operation in Oak Ridge, Tennessee. It accepts waste from PGDP, as well as from the Oak Ridge Reservation, Portsmouth, and Fernald.

Wastes accepted at the TSCA incinerator include the following:

- liquid PCB wastes,

- hazardous waste under RCRA (specific waste codes as listed in the incinerator permit),

Table 3.5. C-746-U landfill waste acceptance limitations

Size limitations	Weight limitations	Waste limitations
Case-by-Case	Case-by-Case	The authorized limit for radionuclides is currently under evaluation < 50 ppm PCBs (including waste origination concentration) No RCRA waste No free liquids No batteries No bulky metal objects (desks, filing cabinets, etc.) No circuit boards No classified waste No light bulbs (except "green-end" fluorescent)

PCB = polychlorinated biphenyl. RCRA = Resource Conservation and Recovery Act

- waste containing uranium with ^{235}U enrichment of less than 1% cannot exceed 0.008 Ci total uranium per shipment (bulk shipment), and
- waste that exceeds 1% enrichment provided the total uranium concentration does not exceed 5 parts per million (ppm).

Tentative plans to close the incinerator in calendar year 2003 have been discussed due to cost considerations. Should the incinerator continue to operate within the timeframe of the proposed removal action at the C-410 and C-420 Buildings, this incinerator would be considered a viable option for a portion of the LLW/TSCA and/or RCRA/LLW waste. It will be carried forward as the representative process option for disposal of liquid and TSCA wastes.

A summary of the waste disposal options for the various waste streams is presented in Table 3.6.

3.1.5.5 CERCLA landfill

Because PGDP is on the National Priorities List and is expected to generate large quantities of waste from cleanup actions driven by CERCLA, DOE is examing construction of a waste disposal facility on the Paducah DOE Reservation as a potential alternative for the disposal of wastes generated by CERCLA remedial and removal actions at the site. A similar disposal facility has been approved by Tennessee and EPA regulatory authorities for the DOE Oak Ridge Reservation. The Oak Ridge facility is can accept all waste types listed in Table 3.6 except non-radiological construction waste and liquid waste. The Oak Ridge facility would not be able to accept Paducah wastes. If a decision is made to build a similar facility at PGDP, it is expected that the WAC for the PGDP's facility would be similar to Oak Ridge's WAC. If constructed, the PGDP CERCLA Landfill would be expected to be available in 2004.

Due to the uncertainty surrounding the availability of a PGDP CERCLA landfill, other facilities will be evaluated for disposal of LLW and mixed waste. It is assumed that non-radiological construction and asbestos wastes may be placed in the C-746 U Landfill.

3.2 DEVELOPMENT OF ALTERNATIVES

In accordance with the NCP and EPA guidance, DOE has identified six alternatives to address the potential risks to human health and the environment associated with the C-410 Complex and its contents. While the scope of the C-410 D&D project will cover the entire C-410 Complex, this EE/CA only covers

Table 3.6. Summary of disposal options for waste from C-410 Complex D&D

Facility	Low-level radiological waste	Mixed waste	Non-radiological hazardous (RCRA) waste	Non-radiological construction waste	TSCA waste	Asbestos waste	Liquid waste	Classified material	TRU
NTS	X	X				X		X	
Envirocare of Utah	X	X			X	X			
C-746-U Landfill				X		X			
TSCA incinerator	X	X	X		X		X		
Permitted, off-site commercial facilities	X	X	X	X	X	X	X		
Potential Paducah CERCLA Waste Disposal Facility	X	X	X	X	X	X		X	
WIPP									X

Notes: All waste accepted at NTS and Envirocare of Utah must be radiological waste.
Potential Paducah Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cell assumed to have WAC identical to Oak Ridge CERCLA cell.

NTS = Nevada Test Site.
RCRA = Resource Conservation and Recovery Act.
TSCA = Toxic Substances and Control Act.
TRU = transuranic.
WIPP = Waste Isolation Pilot Project.

the removal, disposal, or reuse/recycle of process and ancillary equipment inside the C-410 Complex buildings. The removal action does not address the primary building utilities, the building structure, or the underlying soil. These will be addressed in a later phase of the remedial actions for the C-410 Complex. Alternatives for the complex could include: (1) no action, (2) long-term surveillance and maintenance (S&M), (3) demolition of the C-410 Complex and the remediation of the underlying soil that is above industrial scenario action thresholds, or (4) free-release of the building. The infrastructure removal will remove the materials causing the highest potential risks (e.g., transferable radioactive materials, asbestos, and other hazardous materials such as PCBs); thereby, significantly reducing the risk to current employees and potential off-site receptors in the event of building failure or further degradation. The risk of a release from the facility will be greatly reduced by the removal of the equipment and infrastructure. The building utilities, building shell, and lagoons would be left to later remedial actions. This section identifies and describes the alternatives.

3.2.1 Alternative 1 — No Action

Inclusion of a no action alternative is provided as a baseline for comparison to the other alternatives. In the no action alternative, S&M would be discontinued, the buildings would be allowed to deteriorate, and D&D would not be performed on the buildings.

The following are key components of this alternative:

- Deactivation activities would likely be performed as part of other programs to isolate the buildings from major utility feeds (e.g., water and electric).

- Site-wide institutional controls, already in place, would continue to control access to PGDP. Existing physical barriers around PGDP, such as fences and check-in gates, would be maintained as part of separate activities. While locked doors and signs would deny personnel access to the buildings; new physical barriers around each building or other access controls would not be installed.

- Current S&M activities would be discontinued.

- Final disposition of waste streams generated by building degradation or collapse would be deferred until a further decision document.

3.2.2 Alternative 2 — Continued Surveillance and Maintenance for an Extended Period

In this alternative, the building infrastructure and the stored materials would remain inside the buildings of the C-410 Complex for an indefinite period. For evaluation, the EE/CA assumes a 30-year period of continued S&M. After this period, continued S&M or one of the other alternatives could be selected. The building would remain controlled and locked. Surveillance activities would continue and would include security patrols and periodic building walk-through inspections. Maintenance of the building structures would continue to assure structural integrity, but the building would not be upgraded or renovated in any manner except a new roof may be required to exclude water from the building..

3.2.3 Alternative 3 — Remove Stored Materials, Infrastructure, and Equipment, and Dispose

In this alternative, the building infrastructure and all stored items would be removed and disposed in appropriate disposal facilities. General waste segregation would be performed, but extensive processing or sampling would not be performed. The removal of the infrastructure would be sequenced to facilitate dismantling of the infrastructure systems. For example, the existing crane could remain energized and could be used to assist in the removal of equipment and infrastructure components on the upper floors. The specific order in which systems are taken out of service and dismantled would be determined during the design phase.

The following are key components of this alternative:

- Asbestos, PCB, and RCRA wastes would be treated as required by appropriate regulations and disposed at appropriate waste disposal facilities.

- Thorough vacuuming of all surfaces would be performed to reduce hazards to remedial workers due to asbestos dust and transferable contamination.

- Any residual fluids would be drained, drummed, sampled, and disposed in an appropriately authorized treatment or disposal facility.

- Stored materials would be surveyed and sent to appropriate disposal facilities.

- The remaining equipment and piping would be removed. Radioactively contaminated process equipment and piping would be sent to an LLW disposal facility. Auxiliary equipment and non-process equipment would be surveyed for radiological contamination and, if shown to be uncontaminated, sent to a landfill approved for industrial waste or construction debris.

- Further decontamination of building components and equipment would be performed as needed to protect workers, meet regulatory requirements, facilitate infrastructure removal, and meet the WAC for the intended disposal facility. Non-radiological materials containing non-friable asbestos would be sent to an industrial landfill for disposal.

3.2.4 Alternative 4 — Remove Stored Materials, Infrastructure, and Equipment, Decontaminate, Recycle, Treat, and Dispose

This alternative is similar to Alternative 3 except that radioactive equipment and materials would be decontaminated and recycled or released when feasible. Vacuuming, scrubbing, and wiping will be used to attempt to decontaminate accessible surfaces of equipment and other materials. It is expected that much of the uranium in the process equipment and piping is a soluble form of uranium. If physical cleaning is ineffective, or if components have inaccessible surfaces, the radioactively contaminated components would be rinsed to remove soluble uranium, then the waste liquid would be treated to precipitate the uranium. Currently, aqueous solutions of uranium are treated at C-400 using lime to precipitate uranium out of solution. The rinsate could be sent to C-400 for treatment or a similar system could be constructed to treat the wastewater to levels sufficiently low to allow discharge. The uranium remaining in the piping and equipment following the rinse would likely be in less soluble forms. Consequently, the treated equipment and piping would be safer to place in the ultimate disposal facility.

The following are key components of this alternative:

- Stored materials not associated with C-410 processes that are not in radiological areas would be surveyed and may be released for reuse or recycle consistent with DOE policy if found to be below surface contamination criteria.

- Stored materials located inside radiological areas could be reused within the DOE complex. Items outside of radiological areas that exceed surface criteria could also be reused within the DOE complex. These items would be decontaminated to a level consistent with the intended reuse.

- Stored materials for which no recycle/reuse application is identified, or which cannot readily be adequately decontaminated, would be sent to disposal.

- Thorough vacuuming of all surfaces would be performed to reduce hazards to remedial workers due to asbestos dust and transferable contamination. Vacuum wastes will be characterized and disposed.

- Equipment having accessible surfaces would be decontaminated using vacuuming and wiping. Inaccessible surfaces would not be decontaminated by vacuuming and wiping.

- Infrastructure and equipment that are radioactively contaminated may be decontaminated if their physical properties allow it. (However, no attempt would be made to decontaminate materials such as radioactive asbestos insulation or non-aqueous liquids.)

- Radioactive equipment and piping that cannot be decontaminated, either due to inaccessible surfaces or contaminant penetration beyond the surface, would be treated by rinsing (or immersion) to remove soluble uranium that was not removed by previous processing steps.

- Rinsate would be treated using lime precipitation as the representative process option. Additional treatment may be required to remove technetium (adsorption to iron or ion exchange resin). Treated water would be discharged in accordance with provisions of the permits.

- Some equipment or materials could be reused within the DOE complex. Some equipment, such as the fluorine generators, could be released outside of the DOE complex. Intact equipment would be reused or recycled to the extent possible. If there is no interest in the intact equipment, valuable metals such as the copper buses in the fluorine generators or the monel and inconel alloys used in some of the process equipment could be released to metal recyclers. Suspect materials that could not be released may be used within the DOE complex to make shielding or storage boxes, or the nickel-containing alloys could be utilized by the planned high-level waste repository. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily.

- Asbestos, PCB, and RCRA wastes would be treated as required by appropriate regulations and disposed at appropriate waste disposal facilities.

- Equipment that could potentially retain waste material (e.g., valves) would be disassembled to the point that any unknown waste material would be exposed.

- Equipment not from radiological areas, achieving release criteria as outlined in DOE Order 5400.5 following decontamination and/or treatment, would be sold or otherwise released to metal recyclers.

- Materials that still cannot be released following decontamination and treatment would be disposed as LLW or mixed waste, as appropriate, following size reduction through compaction or shredding. Appropriate treatment may be performed to meet LDRs.

3.2.5 Alternative 5 — Remove Stored Materials, Infrastructure, and Equipment, Reduce Size, Stabilize and Contain, and Dispose

In this alternative, radioactive contamination would be stabilized and contained in the equipment and other materials prior to removal and disposal. Following containment, the equipment would be disposed as LLW or mixed waste at an appropriate facility.

The following are key components of this alternative:

- Thorough vacuuming of all surfaces would be performed to reduce hazards to remedial workers due to asbestos dust and transferable contamination. Vacuum wastes will be characterized and disposed.

- Radioactively contaminated materials would be reduced in size by compaction or shredding and loaded into containers such as B-25 boxes. The void space within the boxes would then be filled with encapsulant such as concrete or polymer. Preparing large items for size reduction would require additional handling to cut the items into pieces small enough to fit into the compactor or shredder.

- The stabilized and contained radioactive materials would then be removed and disposed at a LLW or mixed waste facility, as appropriate.

- Asbestos, RCRA, and PCB wastes would be treated as required by the appropriate regulations and disposed at appropriate waste disposal facilities.

3.2.6 Alternative 6 — Remove Stored Materials, Infrastructure, and Equipment; Segregate Materials; Selectively Decontaminate; Reuse or Recycle Selected Materials; Reduce Size; and Dispose

Alternative 6 recognizes that each of the other action alternatives contains elements that could be effectively used for one or more categories of the waste, but none of these other alternatives would be best for all of the waste. Therefore, Alternative 6 attempts to group waste categories and then matches the features of each of the other alternatives to the waste groupings for which these features may be advantageous. The four groupings are as follows:

- reusable equipment,
- high-value metals,
- large components and components that can be easily decontamined, and
- the remainder of the infrastructure and equipment.

The first grouping is material for which the cost of reuse is break-even or better compared with the cost of disposal. The break-even cost is where the combined value of the equipment plus the cost avoided by eliminating disposal equals the added cost of decontamination and preparation of the equipment. This first grouping includes some of the remaining fluorine generators, the specialty electrical equipment and a limited number of the valves and other components (including materials brought to C-410 from other areas of the plant). This equipment would be decontaminated and released for reuse as described in Alternative 4. If this material can not be reused or if there are no bidders, the material would be disposed with material from the other groupings.

Grouping 2 includes the components constructed of high-value metals such as inconel, monel, copper, and stainless steel that have the potential to be recycled. Depending upon DOE policy in effect at the time of implementation, metals that could be recycled at or better than the break-even cost may be decontaminated and recycled. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily. Any recycle would honor the DOE policies and any changes to those policies. If material cannot be recycled if would be disposed with material from the other groupings.

Grouping 3 includes the large components that would be awkward and more costly if bulk disposal were used, and other components that can be easily decontaminated. The size-reduction technologies of Alternative 5 will be applied to the large components and waste materials. Grout addition to the packages will not be performed unless required by the disposal facility WAC. Easily decontaminated materials would be decontaminated to meet the WAC of the on-site disposal facilities if such facilities are available at the time of the action. Otherwise, the material will be sent to off-site facilities. This would reduce the risks and costs due to long-distance transportation of the waste materials.

Grouping 4 consists of all other remaining infrastructure and equipment. These materials will be removed and disposed as described in Alternative 3. No additional treatment beyond that needed to prepare the wastes for transport and disposal would be performed.

The following are key components of this alternative:

- Asbestos materials would be removed, bagged, and disposed of appropriately.

- Thorough vacuuming of all surfaces would be performed to reduce hazards to remedial workers due to asbestos dust and transferable contamination. Dust gathered by vacuum would be fully characterized prior to disposal.

- Any residual fluids would be drained, drummed, sampled, and disposed in an appropriate treatment or disposal facility.

- Equipment that could potentially retain waste material (e.g., valves) would be disassembled to the point that any unknown waste material would be exposed.

- Items with a high resale potential would be identified, and an estimate of the cost of preparation (including decontamination) for transfer would be prepared. These items would then be offered to the highest bidder with a minimum bid requirement equal to the estimated cost of preparation.

- Materials composed of high-value metals would be segregated and kept to allow time to evaluate the progress in metal recycle programs. If DOE policy allows the metals to be recycled at a cost at or better than the break-even cost and there is a willing bidder, the metals would be recycled. If recycle options are not available at the time of the action or if the material cannot be sold for break-even or better cost, the material will be disposed.

- Equipment and materials that can be easily decontaminated, such as non-process equipment having transferable or lightly fixed contamination, would be decontaminated to meet the WAC of the on-site facilities. The equipment would then be sent to the on-site facilities rather than transported long distances to other waste disposal facilities.

- Size reduction technologies would be applied to large waste components.

- Asbestos, RCRA wastes, and PCB wastes would be treated as required by appropriate regulations and disposed at appropriate waste disposal facilities.

- The remainder of the infrastructure, stored materials, and equipment would be removed and disposed at the appropriate disposal facilities.

4. ANALYSIS OF ALTERNATIVES

In accordance with the NCP and EPA guidance (EPA 1993), the alternatives presented in Section 3.2 have been evaluated using the criteria of effectiveness, implementability, and cost. The three criteria were used to draw sufficient distinctions among the alternatives to allow a recommended alternative to be proposed. These criteria are briefly described below. NEPA values have been incorporated directly, where appropriate, in the evaluation of each alternative.

- The effectiveness of each alternative is based primarily on the alternative's ability to meet the RmAOs presented in Section 2. Other specific effectiveness considerations include the following:

  - ability to provide protection of human health and the environment via reduction of potential hazards;

  - ability to comply with ARARs (a complete listing of ARARs and TBCs is presented in Appendix C);

  - long-term effectiveness and permanence; and

  - short-term effectiveness.

- The implementability of each alternative is based on the technical and administrative feasibility and the availability of services and materials required to implement the alternative. Specific implementability factors include the following:

  - ability to construct and operate the technology;
  - reliability of the technology;
  - ease of implementing additional responses (if necessary);
  - ability to monitor effectiveness;
  - ability to obtain approval from other agencies;
  - availability of treatment, storage, and disposal services and capacity;
  - availability of equipment, prospective technologies, and specialists; and
  - likelihood of treatability studies being required to define operational characteristics.

- The cost of each alternative is presented for comparison purposes. Each cost estimate includes capital costs and operation and maintenance costs. Costs are escalated using an annual escalation factor of 2.5%. Costs are through the end of the implementation period or for a 30-year period.

4.1 ALTERNATIVE 1 — NO ACTION

4.1.1 Effectiveness

The no action alternative would fail to achieve any of the RmAOs outlined in Section 2. In the near term, the health and safety hazards to personnel would be reduced because no one would enter the buildings to perform maintenance, and there would be no transportation risk associated with this alternative. In the long term, the potential for an uncontrolled release of contaminants would increase as the buildings and contained equipment continued to deteriorate. Animal intruders, such as mice and birds, could track contamination out of the buildings. As the equipment deteriorated, contaminants would continue to mix, increasing the complexity of the problem.

The no action alternative would not comply with ARARs and TBCs. Without controls, there would be no assurance that doses would be restricted to less than those specified in DOE Orders and relevant NRC regulations.

Based upon the results in the Level 3 BRE (see Appendix B), the contaminants in the C-410 Complex could pose an unacceptable risk to workers and potential residents. This risk is due primarily to exposure from contaminants migrating from the buildings under a catastrophic release scenario. Potentially exposed individuals include on-site workers and off-site residents. Pathways of exposure for the workers include direct exposure to contamination through incidental ingestion (including inhalation and subsequent ingestion of large particulates), inhalation of dust, dermal exposure, and external exposure to ionizing radiation. Pathways of exposure for off-site residents include ingestion of contaminated groundwater and inhalation of contaminated dust. Note that unlike in the BRE, the trespasser is not included as one of the potentially exposed individuals under the no action alternative. This receptor is not included because the no action alternative discussed in this EE/CA includes the current site-wide institutional controls found at PGDP. These controls would prevent any trespassing for the foreseeable future.

No action would inhibit future land use. Because this material is inside of the C-410 buildings, there would be limited impacts to air, soil, and other affected environments unless a catastrophic release occurred. Wetlands and floodplains would not be affected. No federal- or state-listed Threatened and Endangered (T&E) plant or animal species have been identified. The federally endangered Indiana bat (*Myotis sodalis*) potentially occurs in the vicinity, but C-410 does not provide suitable habitat. No action would not have any direct or indirect adverse impacts on local socioeconomic resources.

Executive Order 12898, "Federal Actions to address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects their activities may have on minority and low-income populations. No census tracts near the site include a higher proportion of minorities than the national average. Some nearby tracts meet the definition of low-income populations, but there would be no disproportionate or adverse environmental justice impacts to any minority or low-income populations.

4.1.2 Implementability

The no action alternative is readily implementable from a technical perspective, as discontinuing S&M would not require any specialized services or equipment. Obtaining agreement from regulators and the public may be difficult, as the environmental regulatory community would prefer to see progress demonstrated at PGDP.

No off-site treatment, storage or disposal services would be required for the no action alternative. Therefore, there would be no irretrievable commitment of landfill resources; however, use of the land currently occupied by the buildings would be greatly restricted.

4.1.3 Cost

The cost for Alternative 1 as described, with no further S&M, is $0, as no activities would be performed. However, maintenance costs of about $400,000 per year would likely be required to address regulatory requirements and limit impacts on other facilities. Ultimate costs for cleanup of C-410 contaminants at a later time may be greatly increased if a release occurs as a result of building degreadation.

4.2 ALTERNATIVE 2 — CONTINUE SURVEILLANCE AND MAINTENANCE FOR AN EXTENDED PERIOD

4.2.1 Effectiveness

Continued S&M would provide protection of human health and the environment and comply with ARARs for the short term; however, it would not achieve any of the RmAOs. A complete listing of the ARARs is presented in Appendix A. Current levels of exposure to maintenance personnel would continue.

This alternative would not achieve long-term effectiveness. Animal intruders, such as mice and birds, could track contamination out of the buildings. Continued S&M would not remove materials from the buildings and would, therefore, delay any future use of the buildings or remedial actions (e.g., underlying soil removals) until the infrastructure and stored materials were removed. The baseline risk evaluation concluded that the material in the C-410 Complex could pose unacceptable hazards if a catastrophic release occurs. Building S&M will do nothing to mitigate the risk of a catastrophic release resulting from flood, tornado, or earthquake.

The primary unavoidable adverse impact expected under Alternative 2 is continued exposure for the maintenance workers. In addition, continued S&M at C-410 would inhibit future land use. Because the contaminated materials are inside the buildings, there would be limited impacts to air, soil, and other affected environments. Wetlands and floodplains would not be affected. No federal- or state-listed T&E plant or animal species have been identified. The federally endangered Indiana bat (Myotis sodalis) potentially occurs in the vicinity, but C-410 does not provide suitable habitat. Therefore, this alternative is not expected to have any adverse impacts on T&E species. Continuing S&M would not have any direct or indirect adverse impacts on local socioeconomic resources.

Executive Order 12898, "Federal Actions to address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects their activities may have on minority and low-income populations. No census tracts near the site include a higher proportion of minorities than the national average. Some nearby tracts meet the definition of low-income populations, but there would be no disproportionate or adverse environmental justice impacts to these populations.

The magnitude of the residual risk would be unchanged from baseline conditions.

This alternative does not include treatment to reduce toxicity, mobility, or volume.

4.2.2 Implementability

Continued S&M is readily implementable, but the degree of difficulty is expected to continue to increase as the rate of building degradation is expected to increase. There would be no irretrievable commitment of resources, but the land currently occupied by the buildings would be restricted until some future action was taken.

Implementation of Alternative 2 would have no adverse impact on any known cultural or archeological resources.

Only small volumes of waste resulting from maintenance activities would be generated by this alternative. Adequate disposal capacity is available to accept these wastes.

Equipment required to implement this alternative is readily available.

No treatability studies would be required to implement this alternative.

4.2.3 Cost

Currently S&M costs are about $200,000 per year plus markup, indirect costs and other support costs. It is estimated that this cost could increase due to the need for major repairs (e.g., a new roof) and continued degradation per year. At 5%/year increase, the total cost over the 30-year period would be $28 million. The 30-year cost for Alternative 2, Continue S&M, is less than the cost for Alternatives 3 through 6. However, because Alternative 2 is not complete at the end of the 30-year period, additional costs would be incurred for continuing S&M. The undiscounted cost would continue to increase and would become larger than Alternatives 3 through 6 before another 30-year period of S&M was complete. Additionally, the future inevitable D&D of the structures would add future cost to this alternative similar to one of the other alternatives.

4.3 ALTERNATIVE 3 — REMOVE STORED MATERIALS, INFRASTRUCTURE, AND EQUIPMENT, AND DISPOSE

4.3.1 Effectiveness

Removal of the infrastructure and equipment would achieve all of the RmAOs by removing hazardous substances from the buildings and disposing of the substances in a manner that greatly reduces the potential for a release.

Alternative 3 would comply with the ARARs. A complete listing of the ARARs is presented in Appendix A. Members of the public would not receive a radiation dose greater than that allowed by DOE Order 5400.5 and relevant NRC regulations as a result of implementing this alternative. Wastes generated during implementation of this alternative would be appropriately characterized as RCRA, asbestos, PCB, LLW, mixed, or nonhazardous and disposed accordingly. Packaging, labeling, manifesting, and placarding requirements for hazardous materials transportation would be met. In addition, SNM packaging requirements would need to be met for any enriched uranium waste encountered among the stored materials.

Alternative 3 would be effective at protecting human health and the environment in the long term, although short-term exposures to personnel engaged in the removal would occur. Exposures would be kept as low as reasonably achievable (ALARA) through safe work practices, ongoing controls, staging operations to remove the most hazardous material first (e.g., asbestos abatement, ash receiver material), and the use of personal protective equipment (PPE). In the long term, the potential for worker exposure to contaminants in the C-410 Complex would be reduced because there would be no further need for maintenance and reduced need for inspections following infrastructure removal. Remaining contamination would be fixed surface contamination, which is less hazardous than transferable radioactive material or loose friable asbestos. The general public would not receive significant exposure during implementation because there is very little opportunity for release as a result of implementation.

The only unavoidable adverse impact under Alternative 3 is expected to be increased exposure to radiation for the workers. Other unavoidable adverse impacts are not expected because the removal action would be taking place within a heavily industrialized area that has already been impacted.

The risk of radioactive material releases resulting from transportation accidents could be reduced by selecting a disposal facility closer to Paducah. Such releases would be of minor consequence, however, as they would be quickly contained and recovered. The risk of a fatality from sending the waste to a disposal facility such as Envirocare has been calculated on the basis of a truck accident fatality rate of 3.58E-7/km (5.76E-7/mile) (ANL 1994). Because the distance from PGDP to Clive, Utah, is approximately 2600 km

(1600 miles) according to MapQuest (MapQuest 2001), each truckload of waste would pose a 9.1E-4 risk of a fatality. The risk of a fatality could be reduced by shipping the waste by rail rather than by truck. The risk of a fatality by rail is 2.66E-8/railcar-km (4.28E-8/railcar-mile) (ANL 1994).

No significant adverse environmental impacts are expected if this alternative were to be implemented. The vegetation around the buildings is mowed grass. No important ecological resources would be affected by the building D&D activities.

This alternative would remove materials from the buildings in preparation for future removal actions that would make the land available for other uses. Because the actions are conducted inside of the building, there would be minimal impacts on air, soil, water, and local ecosystems. Wetlands and floodplains would not be affected. No T&E plant or animal species would be impacted.

Increased noise levels from the use of construction equipment in the immediate vicinity would also be short-term, sporadic, and localized. Noise levels are already slightly elevated in the vicinity because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near C-410, thus no noise impacts would occur.

This alternative would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (i.e., utilities, hospitals, and police and fire protection). The workforce that would be required for construction would likely be drawn from the local labor market. There would be no disproportionate or adverse environmental justice impacts to any minority or low-income population.

The magnitude of the residual risk would be within acceptable limits. This alternative would remove some of the contaminant source materials identified in the BRE, treat these materials to ensure they meet WAC, and appropriately dispose of this material. Specific sources addressed are asbestos and process materials. Because surface contamination on building surfaces would be removed to the extent required to protect workers only, fixed contamination would remain on building surfaces. For the potentially exposed individuals identified under the no action alternative, on-site workers and off-site residents, this alternative eliminates all pathways of exposure except external (gamma) radiation. This pathway is applicable only to the worker because off-site residents cannot gain access to the contaminated facility as long as institutional controls remain in place. Additionally, according to the results in the BRE, the risks posed to workers through the external exposure route would be within the EPA generally acceptable risk range and may be at PGDP *de minimis* levels.

While some treatment may be required to meet WAC, this alternative does not include treatment to reduce toxicity, mobility, or volume.

4.3.2 Implementability

Alternative 3 would be readily implementable. Only conventional construction technologies would be required to remove the equipment and infrastructure from the buildings.

Implementation of Alternative 3 would have no adverse impact on any known cultural or archeological resources.

Regulations relating to transportation of radioactive materials would have to be met for implementation; however, DOE frequently transports radioactive materials and can readily administer the requirements for shipping. Special packaging requirements are imposed on SNM wastes.

Adequate disposal capacity exists to accept wastes generated by implementation of this alternative, however, space occupied at the disposal facility by the waste generated would represent an irretrievable commitment of resources in terms of reduced disposal capacity.

Equipment required to implement this alternative is readily available as are contractors with experience in construction technology. Asbestos removal is a somewhat specialized field and workers must have special training for working with hazardous and radioactive materials; however, qualified bidders are readily available.

No treatability studies would be required to implement this alternative.

4.3.3 Cost

The estimated cost of Alternative 3 is $61 million (year 2001 dollars). This is the highest cost of any of the alternatives due to high transportation and disposal costs, although Alternative 2 would be higher if the cost of a permanent action at the end of the 30 years were included.

4.4 ALTERNATIVE 4 — REMOVE STORED MATERIALS, INFRASTRUCTURE, AND EQUIPMENT, DECONTAMINATE, RECYCLE, TREAT, AND DISPOSE

4.4.1 Effectiveness

Alternative 4 would achieve all the RmAOs by removing hazardous substances and disposing of them in a safe manner.

Alternative 4 would comply with all ARARs. A complete listing of ARARs is presented in Appendix C. Members of the public would not receive a radiation dose greater than that allowed by DOE Order 5400.5 and relevant NRC regulations as a result of implementing this alternative. Wastes generated during implementation of this alternative would be appropriately characterized as RCRA, asbestos, PCB, LLW, mixed, or nonhazardous and disposed accordingly. Packaging, labeling, manifesting, and placarding requirements for hazardous materials transportation would be met. In addition, SNM packaging requirements would need to be met for any enriched uranium waste encountered among the stored materials.

Alternative 4 would be effective at protecting human health and the environment in the long term, although this alternative would result in the greatest short-term exposure of workers due to the increased time and proximity to contaminated surfaces during decontamination. Exposures would be kept ALARA through safe work practices, ongoing controls, staging operations to remove the most hazardous material first (e.g., asbestos abatement, ash receiver material), and the use of PPE. In the long term, the potential for worker exposure to contaminants in the C-410 Complex would be reduced because following infrastructure removal, there would be no further need for maintenance and reduced need for inspections. Remaining contamination would be fixed surface contamination, which is less hazardous than transferable radioactive material or loose friable asbestos. The general public would not receive significant exposure during implementation because very little opportunity for release as a result of implementation exists. The potential for a release due to transportation risks is greatly reduced in this alternative by decontamination and recycle. This is because the volume of contaminated material is greatly reduced and contamination remaining on the equipment and infrastructure components would be firmly fixed as evidenced by the failure of decontamination and treatment to remove it.

The only unavoidable adverse impact under Alternative 4 is expected to be increased exposure to radiation for the worker. Other unavoidable adverse impacts are not expected because the removal action would be taking place within a heavily industrialized area that has already been impacted.

The risk of radioactive material releases resulting from transportation accidents could be reduced by selecting a disposal facility closer to Paducah. Such releases would be of minor consequence, however, as they would be quickly contained and recovered. The risk of a fatality from sending the waste to a disposal facility such as Envirocare has been calculated on the basis of a truck accident fatality rate on rural roads of 3.58E-7/km (5.76E-7/mile) (ANL 1994). Because the distance from PGDP to Clive, Utah, is approximately 2600 km (1600 miles) according to MapQuest (MapQuest 2001), each truckload of waste would pose a 9.1E-4 risk of a fatality. The risk of a fatality could be reduced by shipping the waste by rail rather than by truck. The risk of a fatality by rail is 2.66E-8/railcar-km (4.28E-8/railcar-mile) (ANL 1994), resulting in a risk of 6.8E-5 /railcar. Alternative 4 minimizes the risk of both release and traffic related fatality because decontamination and recycling reduces the amount of material that would need to be shipped.

No significant adverse environmental impacts are expected if this alternative were to be implemented. The vegetation around the buildings is mowed grass. No important ecological resources would be affected by the building D&D activities.

Risks to potentially exposed individuals under this alternative would be somewhat greater than those discussed under Alternative 3 due to the increased exposure time and closer proximity to contaminated surfaces required for decontamination. However, the BRE shows that risks to the only potentially exposed individuals, the workers, will probably still be within the EPA generally acceptable risk range as a result of ALARA practices and may be at PGDP *de minimis* levels. The off-site residents cannot reasonably be expected to be exposed under this scenario.

This alternative would remove materials from the buildings in preparation for future remediation that would make the land available for other uses. Because the actions are conducted inside of the building, there would be minimal impacts on air, soil, water, and local ecosystems. Wetlands and floodplains would not be affected. No T&E plant or animal species would be impacted.

Increased noise levels from the use of construction equipment in the immediate vicinity would also be short-term, sporadic, and localized. Noise levels are already slightly elevated in the vicinity because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near C-410, thus no noise impacts would occur.

This alternative would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (i.e., utilities, hospitals, and police and fire protection). The workforce that would be required for construction would likely be drawn from the local labor market. There would be no disproportionate or adverse environmental justice impacts to any minority or low-income population.

Mobility and volume of contaminated materials would be reduced during implementation of this alternative. Rinsing or dipping the items that cannot be decontaminated by simple vacuuming and wiping will reduce mobility by preventing soluble forms of uranium from being disposed. The volume would be reduced by transferring the uranium to the rinsate and subsequently concentrating it into a smaller volume through lime precipitation.

4.4.2 Implementability

To implement this alternative, an area within one of the buildings would be refurbished as a D&D shop for disassembly and decontamination of the equipment. Decontamination of the radiologically contaminated surfaces is a well-established technology that would be readily implementable. Likewise, PGDP personnel have had long experience with treatment of uranium containing liquids and the treatment aspects of this alternative would be easily implemented.

Implementation of recycle could prove administratively difficult in that current DOE policy disallows recycle of materials suspected of having radioactive contamination. Demonstrating materials to be clean may prove difficult.

Following completion of this alternative, an additional response action would be required at some future time to address the building structure, foundation, and underlying environmental media. Removal of the stored materials, infrastructure and equipment would facilitate future actions for the C-410 Complex.

Implementation of this alternative would demonstrate progress toward remediating the contamination at PGDP. The public may have a negative reaction to recycling unless the material is kept within the DOE complex. There is a potential for public concern that contaminated metals could find their way into consumer products. Kentucky regulators have expressed opposition to treatment that uses large volumes of liquid.

Implementation of Alternative 4 would have no adverse impact on any known cultural or archeological resources.

Regulations relating to transportation of radioactive materials would have to be met for implementation; however, DOE frequently transports radioactive materials and can readily administer the requirements for shipping. Special packaging requirements are imposed on SNM wastes.

Adequate disposal capacity exists to accept wastes generated by implementation of this alternative;, however, space occupied at the disposal facility by the waste generated would represent an irretrievable commitment of resources in terms of reduced disposal capacity. This adverse effect would be mitigated by decontamination and treatment and recycle because the volume of waste, and therefore the volume of disposal capacity required, would be minimized.

Equipment required to implement this alternative is readily available as are contractors capable of performing the work. Asbestos removal is a somewhat specialized field and workers must have special training for working with hazardous and radioactive materials; however, qualified bidders are readily available.

Treatability studies may be used to determine which process units are unlikely to be amenable to decontamination and to find optimal rinsing solutions.

4.4.3 Cost

The estimated cost of Alternative 4 is $51 million (year 2001 dollars). This is intermediate in cost compared with the other alternatives.

4.5 ALTERNATIVE 5 — REMOVE STORED MATERIALS, INFRASTRUCTURE, AND EQUIPMENT, REDUCE SIZE, STABILIZE AND CONTAIN, AND DISPOSE

4.5.1 Effectiveness

Size reduction, stabilization, and removal of the infrastructure and equipment would achieve all of the RmAOs by removing hazardous substances from the buildings and disposing of the substances in a manner that reduces the potential for a release.

Alternative 5 would comply with ARARs. A complete listing of ARARs is presented in Appendix C. Members of the public would not receive a radiation dose greater than that allowed by DOE Order 5400.5 and relevant NRC regulations as a result of implementing this alternative. Wastes generated during implementation of this alternative would be appropriately characterized as RCRA, asbestos, PCB, LLW, mixed, or nonhazardous and disposed accordingly. Packaging, labeling, manifesting, and placarding requirements for hazardous materials transportation would need to be met.

Alternative 5 would be effective at protecting human health and the environment in the long term, especially as a result of providing an additional barrier to migration although this alternative would result in increased short-term exposure of workers due to their proximity to contaminated material. Objects too large to fit in the compactor or shredder would need to be cut into pieces prior to size reduction. This additional handling would increase worker exposure and cost. Exposures would be kept ALARA through safe work practices, ongoing controls, staging operations to remove the most hazardous material first (asbestos abatement and ash receiver material), and the use of PPE. In the long term, the potential for worker exposure to contaminants in the C-410 Complex would be reduced because following infrastructure removal, there would be no further need for maintenance and reduced need for inspections. Remaining contamination would be fixed surface contamination, which is less hazardous than transferable radioactive material or loose friable asbestos. The general public would not receive significant exposure during implementation because very little opportunity for release as a result of implementation exists. The potential for a release due to transportation risks is minimized by this alternative because the volume of contaminated material is stabilized in encapsulant and therefore would not spread readily into other media following an accident.

The only unavoidable adverse impact under Alternative 5 is expected to be increased exposure for the worker. Other unavoidable adverse impacts are not expected.

The risk of radioactive material releases resulting from transportation accidents could be reduced by selecting a disposal facility closer to Paducah. Such releases would be of minor consequence, however, as they would be quickly contained and recovered. The risk of a fatality from sending the waste to a disposal facility such as Envirocare has been calculated on the basis of a truck accident fatality rate of 3.58E-7 km (5.76E-7/mile) (ANL 1994). Because the distance from PGDP to Clive, Utah, is approximately 2600 km (1600 miles) according to MapQuest (MapQuest 2001), each truckload of waste would pose a 9.1E-4 risk of a fatality. The risk of a fatality could be reduced by shipping the waste by rail rather than by truck. The risk of a fatality by rail is 2.66E-8/km (ANL 1994), resulting in a risk of 6.8E-5/railcar. Alternative 5 reduces the risk of both release and traffic related fatality by crushing or shredding and placement in a box which reduces the volume that would need to be sent to Envirocare. In addition, the box and encapsulant would isolate the contaminants from the environment in the event of an accident.

No significant adverse environmental impacts are expected if this alternative is implemented. The vegetation around the buildings is mowed grass. No important ecological resources would be affected by the building D&D activities.

This alternative would remove materials from the buildings in preparation for future remediation that would make the land available for other areas. Because the actions are conducted inside of the building, there would be minimal impacts on air, soil, water, and local ecosystems. Wetlands and floodplains would not be affected. No T&E plant or animal species would be impacted.

Increased noise levels from the use of construction equipment in the immediate vicinity would also be short-term, sporadic, and localized. Noise levels are already slightly elevated in the vicinity because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near C-410, thus no noise impacts would occur.

This alternative would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (i.e., utilities, hospitals, and police and fire protection). The workforce that would be required for construction would likely be drawn from the local labor market. There would be no disproportionate or adverse environmental justice impacts to any vicinity or low-income population.

Risks to potentially exposed individuals under this alternative would be less than those discussed under Alternative 4. Risks to the only potentially exposed individuals, the workers, will probably be within the EPA generally acceptable risk range and may be at PGDP *de minimis* levels. The off-site residents cannot reasonably be expected to be exposed under this scenario.

There would be reduction in mobility through treatment as a result of implementing Alternative 5. Stabilization with grout-like material is the treatment element of this alternative.

4.5.2 Implementability

Alternative 5 would be readily implementable. Only conventional construction technologies would be required to remove the equipment and infrastructure from the buildings. Size reduction equipment is commonly used in several applications and is readily available. Taking up the void space in the boxes with polymer or grout is not difficult; however, the recommended maximum payload for a B-25 box is 2440 kg (5340 lbs) [2700 kg (6000 lbs) gross weight] based on forklift capacity. The inside volume of the container is approximately 90 cubic feet. A B-25 box filled with concrete would weigh about 5400 kg (12,000 lbs). Care and planning would need to be exercised to ensure the weight restrictions are not exceeded. Lightweight grout or polymer could be used to reduce weight. Following completion of this alternative, an additional response action would be required at some future time to address the building structure and foundation. Removal of the stored materials, infrastructure, and equipment would facilitate future actions for the complex.

Implementation of this alternative would demonstrate progress toward remediating the contamination at PGDP. In addition, the public may feel safer if waste is encapsulated prior to shipment.

Implementation of Alternative 5 would have no adverse impact on any known cultural or archeological resources.

Regulations relating to transportation of radioactive materials would have to be met for implementation; however, DOE frequently transports radioactive materials and can readily administer the requirements for shipping. Special packaging requirements are required for SNM, if such material is found among the stored materials

Adequate disposal capacity exists to accept wastes generated by implementation of this alternative; however, space occupied at the disposal facility by the waste generated would represent an irretrievable loss of resources in terms of reduced disposal capacity. The demand on disposal capacity would be mitigated by size reduction of the equipment.

Equipment required to implement this alternative is readily available as are contractors with experience in construction technology. Asbestos removal is a somewhat specialized field and workers must have special training for working with hazardous and radioactive materials, however, qualified bidders are readily available as this type of project has been successfully undertaken in the past at PGDP and at many other sites.

No treatability studies would be required to implement this alternative.

4.5.3 Cost

The estimated cost of Alternative 5 is $59 million (year 2001 dollars). The cost driver for Alternative 5 is the intensive labor required to decontaminate and scan the equipment.

4.6 ALTERNATIVE 6 — REMOVE STORED MATERIALS, INFRASTRUCTURE, AND EQUIPMENT; SEGREGATE MATERIALS; SELECTIVELY DECONTAMINATE; REUSE OR RECYCLE SELECTED MATERIALS; REDUCE SIZE; AND DISPOSE

4.6.1 Effectiveness

Alternative 6 would achieve all the RmAOs by removing hazardous substances and disposing of them in a safe manner. Alternative 6 would be the most effective overall because it treats different waste categories in the most effective manner.

Alternative 6 would comply with all ARARs. A complete listing of ARARs is presented in Appendix C. Members of the public would not receive a radiation dose greater than that allowed by DOE Order 5400.5 and relevant NRC regulations as a result of implementing this alternative. Wastes generated during implementation of this alternative would be appropriately characterized as RCRA, asbestos, PCB, LLW, mixed, or nonhazardous and disposed accordingly. Packaging, labeling, manifesting, and placarding requirements for hazardous materials transportation would be met. In addition, SNM packaging requirements would be met for any enriched uranium waste encountered among the stored materials.

Alternative 6 would be effective at protecting human health and the environment in the long term, although short-term exposures to personnel engaged in the removal would occur. Exposures would be kept ALARA through safe work practices, ongoing controls, staging operations to remove the most hazardous material first (e.g., asbestos abatement, ash receiver material), and the use of PPE. In the long term, the potential for worker exposure to contaminants in the C-410 Complex would be reduced because there would be no further need for maintenance and reduced need for inspections. Remaining contamination would be fixed surface contamination, which is less hazardous than transferable radioactive material or loose friable asbestos. The general public would not receive significant exposure during implementation because there is very little opportunity for release as a result of implementation.

The only unavoidable adverse impact under Alternative 6 is expected to be increased exposure to radiation for the workers. Other unavoidable adverse impacts are not expected because the removal action would be taking place within a heavily industrialized area that has already been impacted.

Risk of radioactive material releases resulting from transportation accidents would be reduced over the other alternatives because much of the equipment would be decontaminated and disposed on-site, reducing the transportation distance. Releases that did occur would be of minor consequence, however, as they would be quickly contained and recovered. The risk of a fatality from sending the waste to a disposal facility such as Envirocare of Utah could be calculated on the basis of a truck accident fatality rate of 3.58E-07/km (5.76E-07/mile) (ANL 1994). The distance from PGDP to Clive, Utah, is approximately 2600 km (1600 miles) according to MapQuest (MapQuest 2001). This implies that each truckload of waste would pose a 9.1E-04 risk of a fatality. The risk of a fatality could be reduced by shipping the waste by rail rather than by truck. The risk of a fatality by rail is 2.66E-08/railcar-km (4.28 E-08/railcar-mile) (ANL 1994).

No significant adverse environmental impacts are expected if this alternative were to be implemented. No important ecological resources would be affected by the building D&D activities.

Risks and potentially exposed individuals under this alternative would be somewhat greater than those discussed for Alternative 3 due to the increased exposure time resulting from decontamination for disposal as nonradioactive waste as well as decontamination for recycle and size reduction of large components. However, risks to the only potentially exposed individuals, the workers, will probably still be within the EPA generally acceptable risk range as a result of ALARA practices and may be at PGDP *de minimis* levels. Off-site residents cannot reasonably be expected to be exposed under this alternative.

The volume and mobility of contaminated materials would be reduced by treatment during implementation of this alternative. Decontamination of some of the equipment would reduce the volume of radioactive waste.

4.6.2 Implementability

Implementation would require that the inventory be carefully examined to determine which items should be included in the four groupings, and judgment would be required to determine which items are good candidates for decontamination. However, implementation would not be difficult from a technical perspective, as all the technologies used in this alternative are well-established, conventional technologies. The four groupings are as follows:

- reusable equipment,
- high-value metals,
- large, bulky components, and
- the remainder of the infrastructure and equipment.

Implementation of recycle could prove administratively difficult in that current DOE policy disallows recycle of materials suspected of having radioactive contamination. Demonstrating materials to be clean may prove difficult. The public may have a negative reaction to recycling unless the material is kept within the DOE complex. There is a potential for public concern that contaminated metals could find their way into consumer products. This impediment to implementation could be mitigated if the materials were utilized within the DOE complex. Materials that cannot be recycled due to these or cost considerations will be disposed. Kentucky regulators have expressed opposition to treatment systems that use large volumes of water.

Following completion of this alternative, an additional response action would be required at some future time to address the building structure, foundation, and underlying environmental media. Removal of the infrastructure and equipment would facilitate future actions for the C-410 Complex.

Implementation of this alternative would represent progress toward remediating the contamination at PGDP.

This alternative would remove materials from the buildings in preparation for future response actions that would make the land available for other uses. Because the actions are conducted inside of the building, there would be minimal impacts on air, soil, water, and local ecosystems. Wetlands and floodplains would not be affected. No T&E plant or animal species would be impacted.

Increased noise levels from the use of construction equipment in the immediate vicinity would also be short-term, sporadic, and localized. Noise levels are already slightly elevated in the vicinity because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near C-410, thus no noise impacts would occur.

This alternative would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (i.e., utilities, hospitals, and police and fire protection). The workforce that would be required for construction would likely be drawn from the local labor market. There would be no disproportionate or adverse environmental justice impacts to any minority or low-income population.

Regulations relating to transportation of radioactive materials present some administrative requirements to implementation; however, DOE frequently transports radioactive materials and can readily administer the requirements for shipping. Special packaging requirements are imposed on special nuclear materials.

Adequate disposal capacity exists to accept wastes generated by implementation of this alternative; however, space occupied at the disposal facility by the waste generated would represent an irretrievable loss of resources in terms of reduced disposal capacity. This adverse effect would be mitigated by decontamination and treatment and recycle because the volume of waste, and therefore the volume of disposal capacity required, would be reduced. Decontamination for disposal as nonradioactive waste would reduce the volume of LLW disposal capacity and provide a reduction in mobility due to treatment. Volume reduction of the large items would also reduce the disposal capacity requirements of this alternative.

Equipment required to implement this alternative is readily available, as are contractors capable of performing the work. Asbestos removal is a somewhat specialized field and workers must have special training for working with hazardous and radioactive materials; however, qualified bidders are readily available.

Treatability studies may be used to determine which process units are likely to be amenable to decontamination and to optimize decontamination technologies.

4.6.3 Cost

The estimated cost of Alternative 6 is $49 million (year 2001 dollars). This is the lowest cost of the action alternatives because of the avoidance of high transportation and disposal fees for recycled materials.

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5. COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the alternatives are compared against each other for each of the criteria used in the analysis. Table 5.1 presents the comparative analysis.

5.1 EFFECTIVENESS

Alternative 1, no action, is the least effective because discontinuing S&M would increase the chance of an environmental release from the buildings. Even if there were no release, Alternative 1 would not meet any of the RmAOs. Alternative 2, Continue S&M, provides protection of human health and the environment for the short term, but does not provide a permanent solution for the stored materials and infrastructure. All of the other alternatives would achieve the RmAOs and satisfy the ARARs. All except No Action would be protective of human health and the environment in both the short and long term. Alternatives 4, 5, and 6 satisfy the statutory preference for treatment because soluble uranium is removed or grouting is used to contain contamination. Alternatives 4, 5, and 6 have lower transportation risk than Alternative 3 because the volume of waste would be reduced and fewer shipments would be required. Alternative 6 would have the highest exposure to remedial workers because of the close proximity to contaminated surfaces required for decontamination and increased handling of radioactive waste during size reduction operations. Alternative 6 would offer the greatest reduction in volume of contaminated waste. Alternatives 4, 5, and 6 would reduce mobility through treatment. Overall, Alternative 6 is the most effective because it combines the best features of the other alternatives and selectively applies them to the waste groupings for which they are most effective.

5.2 IMPLEMENTABILITY

Alternative 1 would be easiest to implement technically because no additional activities would be required. Alternative 2 is easy to implement, but the continued aging and degradation of materials and equipment would increase the difficulty of any permanent solution selected in the future. Alternative 3 would be the next easiest because it involves the least handling of the waste. Alternative 5 would be more difficult than Alternative 3 because of the additional operations of size reduction, packaging, and pouring grout into the packages. Alternative 4 would be difficult to implement because of the labor-intensive decontamination procedures and treatment of wastewater. Alternative 6 would be difficult to implement because it includes the implementability impediments of Alternatives 3, 4, and 5, and it requires additional segregation of the materials into the four waste groupings. Administratively, Alternatives 3, 4, and 5 are similar. Alternative 6 would be more difficult administratively, again because of the additional segregation of the materials.

5.3 COST

Cost estimates are shown in Table 5.1.

The 30-year cost for Alternative 2, Continue S&M, is less than the cost for Alternatives 3 through 6. However, because Alternative 2 is not complete at the end of the 30-year period, additional costs would be incurred for continuing S&M. The undiscounted cost would continue to increase and would become larger than Alternatives 3 through 6 before another 30-year period of S&M was complete. Additionally, the future inevitable D&D of the structures would add future cost to this alternative similar to one of the other alternatives. Alternative 3 is the next highest-cost alternative because of the high cost for transportation and disposal. Alternative 5 has the next highest cost because of the labor required to decontaminate and scan the equipment. Alternative 4 has the next highest cost. Of the action alternatives, Alternative 6 has slightly lower costs because of the avoidance of high transportation and disposal fees for materials that are recycled, size reduced, or disposed following decontamination. Alternative 1 has no cost, although discontinuing S&M is probably not realistic.

Table 5.1. Comparative analysis of alternatives

Alternative	Effectiveness	Implementability	Cost ($ in millions year 2001)
1. No Action	• Will not achieve removal action objectives (RmAOs) • Least protective of human health and the environment • Would not comply with applicable or relevant and appropriate requirements (ARARs) • Highest potential for an environmental release • Not permanent solution	• Readily implementable technically but administratively difficult • Generates no waste media	0
2. Continue Surveillance & Maintenance	• Will not achieve RAOs • Requires long-term worker exposure • Complies with ARARs • Not permanent solution	• Readily implementable • Generates small volume of waste	28[1]
3. Remove Stored Materials, Infrastructure and Equipment, and Dispose	• Achieves RmAOs • Protective of human health and the environment • Complies with ARARs • Exposures to remediation worker • Low residual risk • Reduction in radiation exposure in long term	• Readily implementable • Highest volume of waste	61
4. Remove Stored Materials, Infrastructure and Equipment, Decontaminate, Recycle, Treat, and Dispose	• Achieves RmAOs • Protective of human health and the environment • Complies with ARARs • Higher worker exposure during remediation • Low residual risk • Satisfies statutory preference for treatment • Reduction in radiation exposure in long term • Reduces risk from transportation accident	• Treatability studies may need to be conducted • Volume of waste to be disposed reduced • Most effective at minimizing rad waste volume • Generates additional wastes	51

[1] Does not include cost of taking a permanent action in the future.

Table 5.1. Comparative analysis of alternatives (continued)

Alternative	Effectiveness	Implementability	Cost ($ in millions year 2001)
5. Remove Stored Materials Infrastructure and Equipment, Reduce Size, Stabilize and Contain, and Dispose	• Achieves RmAOs • Protective of human health and the environment • Complies with ARARs • Less remedial worker exposure than Alternatives 4 and 6 • Low residual risk • Satisfies statutory preference for treatment. • Reduction in radiation exposure in long term • Reduces risk from transportation accident	• Intermediate in difficulty to implement • Reduces waste volume by size reduction • Generates additional waste	59
6. Remove Stored Materials, Infrastructure and Equipment; Segregate Materials; Selectively Decontaminate; Reuse or Recycle Selected Materials; Reduce Size; and Dispose	• Achieves RMAOs • Highest overall effectiveness • Protective of human health and the environment • Complies with ARARs • Low residual risk • Satisfies statutory preference for treatment • Reduction in radiation exposure in long term	• Treatability studies may be required • Reduced volume of radioactive waste to be disposed, decontamination, and size reduction. • Optimizes waste minimization and cost effectiveness	49

6. RECOMMENDED REMOVAL ACTION ALTERNATIVE

A recommended removal action was developed to effectively remove the infrastructure from the C-410 Complex in a manner that can be implemented in the near future for reasonable cost. The recommended removal action is Alternative 6, which is summarized in Fig. 6.1. This alternative divides the material into four groupings:

- reusable equipment,
- high-value metals for recycle,
- large, bulky components that can be easily decontaminated, and
- the remainder of the infrastructure and equipment.

The first grouping is equipment that has a high potential for effective reuse. While this grouping represents only a small fraction of the total infrastructure material, reuse of this equipment preserves disposal space and may reduce the overall cost of the removal action. This grouping is defined as the equipment for which the cost of reuse is break-even or better compared to the cost of disposal. The break-even cost is where the combined value of the equipment plus the cost avoided by eliminating disposal equals the added cost of decontamination and preparation of the equipment. The equipment would be offered for sale to government or commercial buyers, with a minimum bid set at the level estimated to achieve break-even. The equipment would be decontaminated and released for reuse as appropriate consistent with DOE policy. Any equipment for which the bids received were less than the minimum needed for break-even would be placed in one of the other groupings described below. High value metals may be removed for potential recycling. This first grouping includes some of the remaining fluorine generators, the specialty electrical equipment, and a limited number of the valves and other components (including some of the components brought to C-410 from other areas of the plant).

Grouping 2 includes the components constructed of high-value metals such as inconel, monel, copper, and stainless steel that have the potential to be recycled. This group includes the components that contain large amounts of these metals and which would require little or no decontamination in preparation for recycle. These components would be separated and held, allowing time to evaluate the progress in metal recycle programs such as those conducted at the DOE National Center of Excellence for Metal Recycle. These metals have potential uses in restricted applications such as the manufacture of disposal containers. Other metal recycle products are also possible and will be evaluated separate from this EE/CA. On January 19, 2001, Secretary Richardson announced his determination that the DOE should prepare an environmental impact statement to allow an open and healthy discussion of the broadest range of concerns associated with the unrestricted release of materials from DOE sites. Changes 4 and 5 to DOE Order 5400.5 relating to release of materials from radiological areas have been issued for review but are not approved. If it appears these programs will allow the metals to be recycled at a cost near or better than the break-even cost, the metals would then be stored (e.g., at the Paducah nickel ingot storage yard). Storage containers or facilities would be determined based on the type of and size of materials and remaining contamination levels, and would be selected to provide protection to human health and the environment. When approved, these metals would be decontaminated and recycled. Otherwise, if recycle options are not available at the time of the infrastructure removal action completion, the metals would be disposed of as described below for the other groupings. While DOE has significant and extensive limitations on releasing materials for free release, this option is included rather than dismissing recycling summarily.

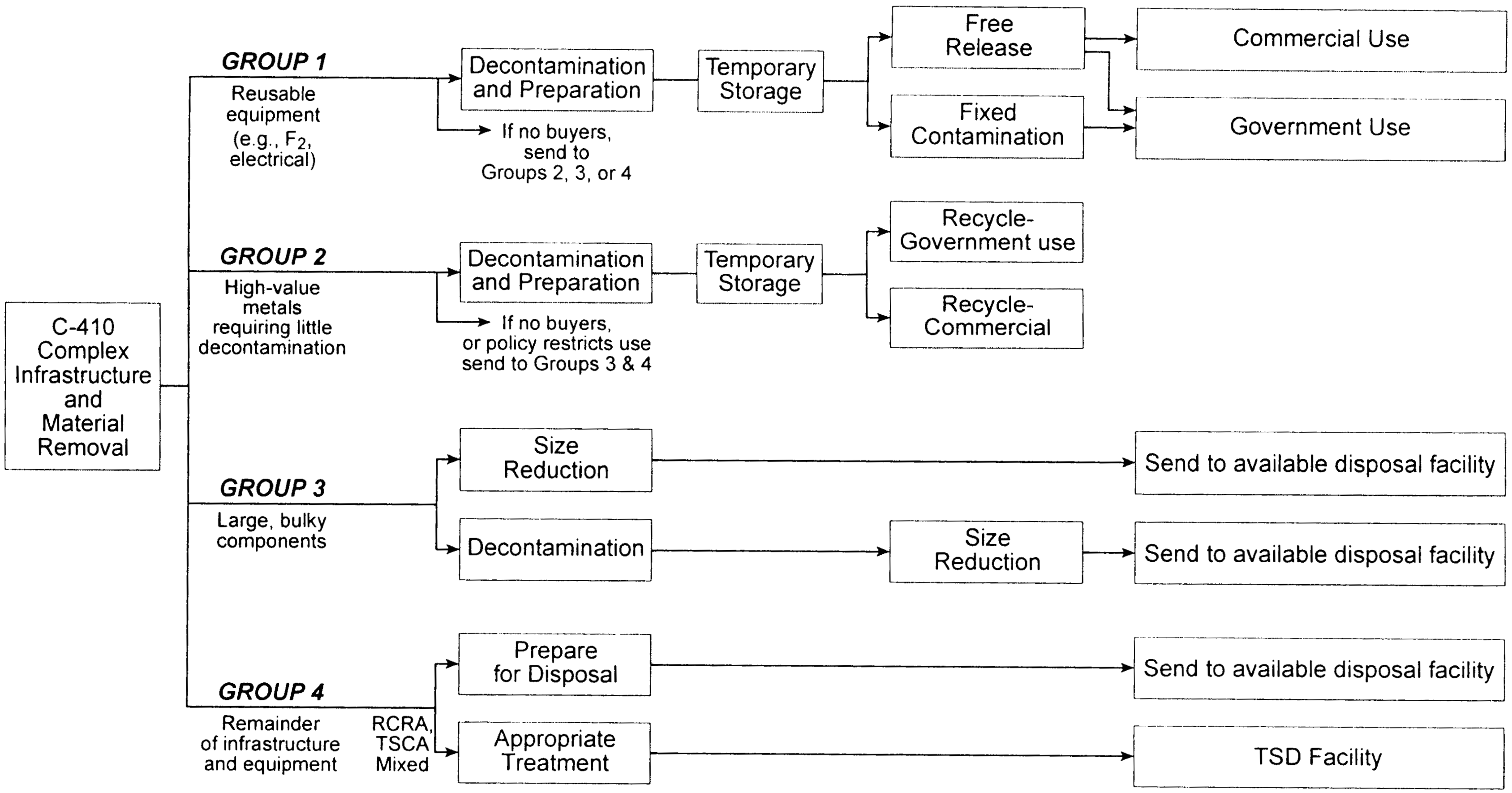
Grouping 3 includes the large, bulky components that would be awkward and more costly if bulk disposal were used, and components that can be easily decontaminated. For the large components and waste materials, the size reduction technologies will be used. The grout addition of Alternative 5 will not be used, because the small incremental benefit of grouting the waste package does not outweigh the increased cost of additional processing. The easily decontaminated components would be decontaminated to meet the WAC of the on-site waste disposal facilities. This would reduce the risks and costs due to long-distance transportation. Items not meeting the WAC of on-site facilities will be sent to off-site disposal facilities.

Grouping 4 consists of all other remaining infrastructure and equipment. The majority of the materials and wastes fall into this group. These materials will be removed and disposed at appropriate facilities. No additional treatment beyond that needed to prepare the wastes for transport and disposal would be performed. Disposal could be in an on-site facility for equipment and infrastructure that meets WAC for on-site facilities. Otherwise, the materials will be disposed in off-site facilities.

The evaluation for this EE/CA was based on the cost of using primarily a commercial off-site facility and on-site disposal. Facilities, such as a potential on-site CERCLA waste disposal facility, are being evaluated under separate actions. These other facilities may become available by the time this removal action is implemented. Long-term protectiveness and permanence of the landfill will be demonstrated using existing or new risk and performance evaluation of the landfill prior to disposal of any CERCLA remediation wastes. Only D&D waste allowed under the C-746-U Landfill permit will be disposed of in the landfill to allow disposal of D&D remediation wastes. All appropriate disposal facilities are included as viable options for this removal action. The choice of the specific facilities will be made as part of the design and operations activities for this removal action. If materials must be sent to an off-site disposal facility, costs would increase.

The exact cost of the recommended action will depend on the demand and bid prices for some reuse equipment and recycle metals, developments that could affect the cost of metal recycle, and the availability of new lower-cost disposal facilities. These potential future developments could reduce the cost of the infrastructure removal action. For the cost estimate, it was assumed that only a small fraction of the material could be reused or recycled (e.g., the fluorine generators, the copper bus, and some metal). Consequently, reused and recycle only make a relatively small change to the total estimated cost. The estimated cost for Alternative 6, the recommended removal action, is $49 million (year 2001 dollars). Additional cost reductions would be possible if lower-cost transportation and disposal facilities should become available in the future.

Infrastructure D&D is a multi-year project. The final length of time for the project is funding dependent. A projected schedule, which is non-enforceable and was developed for information, planning, and cost estimating purposes, is shown in Figure 6-2. Enforceable milestones for the project will be established in accordance with the requirements of this PGDP FFA.



62-112701-020 a

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
Bechtel Jacobs Company LLC

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

SAIC

Science Applications International Corporation
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Oak Ridge, Tennessee 37831

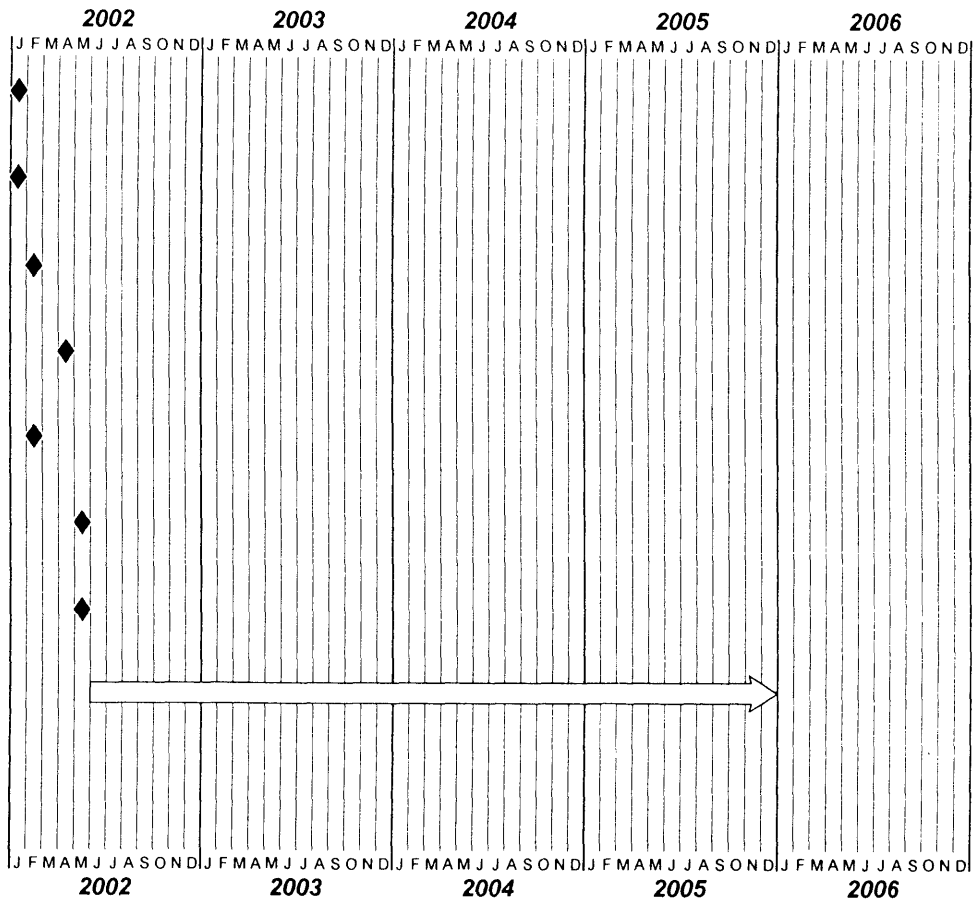
Fig. 6.1. Summary of Recommended Alternative 6.

Figure No. 6.1
DATE 11/27/01

Fig. 6.1. Summary of Recommended Alternative 6.

DOCUMENT No. DOE/OR/07-1952&D2 R1

Activity	Date
Public Comment Period on the EE/CA Begins	January 2002
Public Meeting	January 2002
D1 Action Memorandum to Regulatory Agencies	February 2002
Action Memorandum Signature	April 2002
D1 Removal Action Work Plan	February 2002
Removal Action Work Plan Signature	May 2002
Field Start	May 2002
Infrastructure Removal	Summer 2002
Completion	*To Be Defined



* This projected schedule is non-enforceable and was developed for information, planning, and cost-estimating purposes. Enforceable milestones for the project will be established in accordance with the requirements of the PGDP FFA. The schedule for implementation of this action will be presented in the Removal Action Work Plan, and will be contingent on receipt of funding. The schedule for completing the action will be impacted by variations in DOE funding levels for the C-410 Complex in future years.

62-112601-019

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
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Fig. 6.2. Schedule for C-410 Complex Infrastructure Removal Action.

Figure No. 6 2
DATE 11/26/01

Fig. 6.2. Schedule for C-410 Complex Infrastructure Removal Action.

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APPENDIX A

INFRASTRUCTURE INVENTORY FOR THE C-410 COMPLEX

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Appendix A lists the primary equipment for the C-410 Complex. The left-hand columns list the parts of the facilities. The infrastructure is first divided into the plant, then the system, then the subsystem, and finally the component. The location is then described in three columns that give the building, floor, and location. Information is then given to describe the size, volume, and area for the components. Finally, additional information and notes are provided in the last column.

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Table A.1. C-410 Complex infrastructure & equipment inventory

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
UF6	UF4 Handling	Feed/Transport	Storage Hopper (A)	410	22		ea	V	8	12			64	603	1	603	Two chambers with flapper system to alow processing of two different assays (D.K.)
UF6	UF4 Handling	Feed/Transport	Storage Hopper (B)	420	22		ea	V	6	8			36	226	2	452	"B" hopper handled refeed material (Morris)
UF6	UF4 Handling	Feed/Transport	Screener	410	22		ea	V		2	6	6	36	72	3	216	Inclined vibrating screen served to "reject" larger objects from entering fluorination process (D.K.)
UF6	UF4 Handling	Feed/Transport	Cleanup Reactor Feed Hopper	410	22		ea	V		5	3	3	9	45	2	90	
UF6	UF4 Handling	Feed/Transport	Cleanup Reactor Return Hopper	410	22		ea	V		5	3	3	9	45	2	90	
UF6	UF4 Handling	Feed/Transport	UF6 Absorber Feed Hopper	410	22		ea	V		5	3	3	9	45	1	45	
UF6	UF6 Handling	Secondary UF6 Gas Cleanup	F2 Cleanup Reactor	410	22	Mezz	ea	H	2	8			16	25	2	50	Similar in design to C-420 screw reactor (Morris)
UF6	UF6 Handling	Off-Gas Handling	Vent Gas Booster	410	22		ea	V		4	4	6	24	96	1	96	Centrifugal pump with associated platform, not used, opted for using jet at stack (Morris)
UF6	UF6 Handling	Off-Gas Handling	Fluidized Bed (UF6) Absorber	410	22		ea	V	2.5	8			6.25	39	1	39	Fed UF4 to absorb remaining noncondensables (e.g., F2) (D.K.)
UF6	UF6 Handling	Off-Gas Handling	Seal Leg	410	22		ea	V	1.333	6			1.7769	8	1	8	Handled UF4 overflow from UF6 absorber, provided system seal analogous to seal hopper (D.K.)
UF6	UF6 Handling	Off-Gas Handling	Cyclone Separator	410	22		ea	V	3	4			9	28	1	28	
UF6	UF6 Handling	Off-Gas Handling	Filter	410	22		ea	V	1.5	7			2.25	12	1	12	
UF6	UF4 Handling	Feed/Transport	Feed/Return Conveyors	410	22		sys	V		0.667	0.667	1000	667	445	1	445	
UF6	UF4 Handling	Feed/Transport	Reactor Feed Hopper	410	22		ea	V		5	3	3	9	45	9	405	
UF6	UF6 Production	Fluorination	F2 Preheater	410	22, 26		ea	V		3	3	6	18	54	8	432	Metal jacket, Monel tubes
UF6	UF6 Production	Fluorination	Disperser	410	22, 26		ea	V	0.667	1			0.4449	0	8	3	
UF6	UF6 Production	Fluorination	F2 Tower	410	22, 26		ea	V	0.667	20			0.4449	7	8	56	Three originally, five added during expansion (D.K.)
Auxiliary	UF4 Handling	Feed	5-ton Hopper Rotator	410	25	1st	ea	V		8	12	6	72	576	1	576	
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Primary Cyclone Separator	410	22, 26	Bsmt	ea	V	3	4			9	28	9	254	Tapers to 8 inches at tower
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Secondary Cyclone Separator	410	22, 26	Bsmt	ea	V	3	4			9	28	9	254	
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Sintered Metal Filter	410	22, 26	Bsmt	ea	V	1.5	6			2.25	11	9	95	
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Technetium Filter	410	23	Mezz	ea	V	3.25	6			10.563	50	2	100	One operated on stream, one served as spare (Morris)
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Ash Receiver (Primary)	410	22, 26	Bsmt	ea	V	4.5	3.67			20.25	58	8	467	
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Ash Receiver (Secondary)	410	22, 26	Bsmt	ea	V	3	3			9	21	16	339	Essentially same dimensions as primary, thinner wall
UF6	UF6 Handling	Primary UF6 Gas Cleanup	Ash Receiver Housings	410	22, 26	Bsmt	ea	V		6	5	5	25	150	24	3,600	Clamshell design, hinged
Auxiliary	Control Room		Instrument Panels	410	36		sys	V		8	40	2.5	100	800	2	1,600	F2 Plant and F2 Towers

Table A.1. C-410 Complex infrastructure & equipment inventory (continued)

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
UF6	UF6 Production	Fluorine Generation	Day Tanks	410	41	1st	ea	V	4	6			16	75	3	226	F2 Plant Day Tank (800 gal), Feed Plant Day Tank (1,500 gal), HF Receiver (300 gal), removed from system (CDM)
UF6	UF6 Production	Fluorine Generation	Vaporizer	410	41	1st	ea	V	4	6			16	75	3	226	Unit 356D removed from system (CDM)
UF6	UF6 Production	Fluorine Generation	MgF2 Traps	410	41	1st	ea	V	2.5	8			6.25	39	2	79	
UF6	UF6 Production	Fluorine Generation	Sintered Metal Filter	410	41		ea	V	2	8			4	25	4	101	
Other	Cascade	Fluorine Generation	PPI Pump	410	41		ea	V		3	3	4	12	36	2	72	Used to increase pressure in F2 storage tanks (D.K.)
Auxiliary	Facility Vacuum	Green Salt	Vacuum Blowers	410	49		ea	V		4	4	6	24	96	4	384	
Auxiliary	Facility Vacuum	Day Filter	Compressor	410	49		ea	V		4	4	6	24	96	1	96	Day filter system pulled on fluorination tower components (D.K.)
UF6	UF6 Production	Fluorine Generation	Makeup Tank	410	51	Mezz	ea	V	5	6			25	118	2	236	500-gal capacity tank (CDM); drained upon shutdown, visible lube oil, potential PCB (CDM), includes agitator/motor assembly
UF6	UF6 Production	Fluorine Generation	Feed Hopper	410	51		ea	V		2	1	1	1	2	2	4	
UF6	UF6 Production	Fluorine Generation	F2 Surge Tank	410	51	Mezz	ea	H	4	16			64	201	1	201	500-ft3 capacity tank (CDM); most vent piping removed, potential for electrolyte sludge (CDM), including mounting base, overall height is roughly 7 feet
UF6	UF6 Production	Fluorine Generation	H2 Surge Tank	410	52	Mezz	ea	H	4	16			64	201	1	201	
UF6	UF6 Production	Fluorine Generation	H2 Filter	410	51		ea	V	1.5	6			2.25	11	6	64	
Auxiliary	Cooling	Fluorine Generation	Tempered Water Tank	410	52		ea		4	8			32	101	1	101	Estimated 1000-gal tanks, cooled F2 cells, one original installation, one added during expansion (Morris)
UF6	UF6 Production	Fluorine Generation	F2 Booster Pump (Blower)	410	58	1st	ea	V		3	3	4	12	36	2	72	Reflects entire pump assembly including base
UF6	UF6 Production	Fluorine Generation	Superheater	410	38	1st	ea	V		3	3	6	18	54	2	108	
UF6	UF6 Handling	Product Withdrawal	Alco Cold Trap	410	38	Mezz	ea	H	2.5	12			30	69	6	353	Chilled with liq CO2, heated with 70% methanol-in-H2O solution, also condensed unreacted HF gas from F2 cleanup reactor (Morris)
Auxiliary	Refrigeration	CO2	Converter (Melter)	410	38		ea	H	2	8			16	25	1	25	
Auxiliary	Refrigeration	CO2	Receiver	410	38		ea	H	1.5	6			9	11	1	11	
Auxiliary	Refrigeration	CO2	Compressor	410	38		ea	V		6	6	6	36	216	4	864	Two large, two small (D.K./Morris), smaller compressors estimated at 5x5x5
Auxiliary	Electrical		F2 Rectifiers	410	54		ea	V		6	20	2.5	50	300	5	1,500	#1 thru #4 - vacuum-sealed tubes (water-cooled), #5 - Mercury (D.K.)
Auxiliary	Electrical		F2 Bus Work	410	42, 43, 59, 60, 62		sys	V		200	2.5	2.5	6.25	1,250	1	1,250	
Auxiliary	Electrical		Conditioning Rectifiers	410	56		ea	V		6	8	2.5	20	120	2	240	Large, air-cooled units, an outside firm had expressed interest in obtaining these, but DOE would not approve due to contamination concerns (D.K.)
UF6	UF6 Production	Fluorine Generation	Electrolytic Cell	410	42, 43, 59, 60, 62		ea	V		8	4	3	12	96	70	6,720	Equipped with steel water jacket, some shipped to Oak Ridge, some sold to ARC, Tulsa, OK, estimated ~70 remaining (~17) (D.K.)

Table A.1. C-410 Complex infrastructure & equipment inventory (continued)

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
Auxiliary	HF Supply	HF Tank Farm	HF Storage Tanks	410	Outside		ea	H	9	28			252	1,781	12	21,375	12-15 ASTs, 12,500-gal capacity each, some covered, some not; some dedicated to hydrous HF, some to anhydrous; tanks have been emptied and purged, sampling recommended to determine whether residual liquids are present (CDM)
Auxiliary	HF Supply	HF Tank Farm	Scrubber	410	Outside		ea	H	0.667	5			3.335	2	1	2	Used when venting tanksprior to opening them Morris)
Auxiliary	Refrigeration	Ethylene Glycol	Storage Tank	410	23, 24	1st	ea	H	4	10			40	126	3	377	Cold, intermediate, and hot tanks; EG drained 1/25/94 (CDM), hot tank not insulated (D.K.); including mounting base, overall height is roughly 6 feet; approximate 500-gal tank (Morris)
Auxiliary	Refrigeration	Ethylene Glycol	Chiller/Cooler	410	23, 24	1st	ea	H	3	10			30	71	1	71	EG cooled via NH3 refrig system
Auxiliary	Refrigeration	Ethylene Glycol	Transfer Pump	410	23, 24	1st	ea	V		3	3	4	12	36	3	108	
Auxiliary	Refrigeration	Ammonia	Primary Compressor	410	23, 24	1st	ea	V		6	6	6	36	216	3	648	Oil visible in sight glass (CDM)
Auxiliary	Refrigeration	Ammonia	Primary NH3 Condenser	410	23, 24	1st	ea	H	3	8			24	57	2	113	
Auxiliary	Refrigeration	Ammonia	Primary Ammonia Receiver	410	23, 24	1st	ea	H	3	8			24	57	1	57	Visible oily liquid in sight glass (CDM)
Auxiliary	Refrigeration	Ammonia	Primary Oil Separator	410	23, 24	1st	ea	V	3	3			9	21	3	64	
Auxiliary	Refrigeration	Ammonia	Primary Glycol Chiller/Cooler	410	23, 24	1st	ea	H	4	8			32	101	1	101	Visible oily liquid in sight glass (CDM)
UF6	UF6 Handling	Product Withdrawal	Scale	410	25, 44		ea	V		2	6	12	72	144	2	288	Located in West expansion and Alco areas
UF6	UF6 Handling	Product Withdrawal	Cylinder Cart	410	25, 44		ea	V		2	6	12	72	144	2	288	
Auxiliary	Electrical		Double-Ended Substation	410	53		ea	V		6	30	2.5	75	450	2	900	
Auxiliary	Refrigeration	Methanol	Storage Tank/Vaporizer	410	33	1st	ea	H	4	10			40	126	1	126	No pump; vapor/condensate loop
Auxiliary	Refrigeration	Ammonia	Secondary Compressor	410	33	1st	ea	V		6	6	6	36	216	4	864	Visible oily liquid in sight glass of 3 of 4 units (CDM)
Auxiliary	Refrigeration	Ammonia	Secondary NH3 Condenser	410	33	1st	ea	H	3	8			24	57	2	113	Kalo insulation (D.K./Morris)
Auxiliary	Refrigeration	Ammonia	Secondary Ammonia Receiver	410	33	1st	ea	H	3	8			24	57	1	57	Kalo insulation (D.K./Morris)
Auxiliary	Refrigeration	Ammonia	Secondary Oil Separator	410	33	1st	ea	V	3	3			9	21	2	42	Kalo insulation (D.K./Morris)
Auxiliary	Refrigeration	Ammonia	Secondary Glycol Chiller/Cooler	410	33	1st	ea	H	4	8			32	101	1	101	Kalo insulation (D.K./Morris)
Auxiliary	Refrigeration	Ammonia	NH3-CO2 Condenser	410	33	1st	ea	H	3	8			24	57	6	339	Kalo insulation (D.K./Morris)
Auxiliary	Refrigeration	R-12	Liquid Receiver	410	33	1st	ea	H	1.5	6			9	11	1	11	Lubricating oil may still be present in compressors, piping disconnected, system drained at shutdown and visually inspected (CDM)
Auxiliary	Refrigeration	R-12	Compressors	410	33	1st	ea	V		5	3	3	9	45	3	136	
UF6	UF6 Handling	Product Withdrawal	Drain Station	410	23	Bsmt	ea	V		6	8	1	8	48	1	48	Sheet metal housing, Monel manifold (Morris) five drain positions - 4 associated with Modines, 1 with Alco cold traps
UF6	UF6 Handling	Product Withdrawal	Primary Modine Cold Trap	410	23, 24, 27	Mezz	ea	H	4.5	14			63	223	7	1,559	EG on tube side, UF6 on shell side; ~8 inches of insulation
UF6	UF6 Handling	Product Withdrawal	Secondary Modine Cold Trap	410	23, 24, 27	Mezz	ea	H	4.5	14			63	223	2	445	EG on tube side, UF6 on shell side, ~8 inches of insulation
UF6	UF6 Production	Fluorine Generation	H2 Holder	410	Outside		ea								1		Intended use involved capture/reuse of hydrogen from F2 cells within process; difficulties associated with pumping of H2 resulted in its abandonment; Nash (under water) pumping system torn out; status of H2 holder tank uncertain (Morris)
Auxiliary	Electrical		Transformer	410	Outside		ea	V		8	6	6	36	288	4	1,152	

Table A.1. C-410 Complex infrastructure & equipment inventory (continued)

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
Auxiliary	Compressed Gas	Propane	Tank	420	Outside		ea	H	3	6			18	42	1	42	Residential -type pig outside building
Auxiliary	Treatment	Neutralization	Neutralization Tank	410	Outside		ea	V	4	6			16	75	1	75	1,000-gal tank; oil visible on top exterior of tank; white solid, most likely dried Ca(OH)2, visible in upper portions of tank; white sludge, assumed to be lime slurry, visible in lower portions of tank (CDM)
Other	Cascade	Fluorine Generation	Storage Tank	410	Outside		ea	H	5	18			90	353	3	1,060	Two handled cascade needs, one floated (Morris)
Other	RCW	pH Control	Sulfuric Acid Storage Tank	410	Outside		ea	H	8	24			192	1,206	1	1,206	Periodically filled 500-lb pigs from this location for RCW pH control - not associated with C-410 operations (Morris)
UF4	UO3 Handling	Feed	Charge Station	420	2	5th	ea	V	1.5	2			2.25	4	4	14	
UF4	UO3 Handling	Feed	Rotary Feeder	420	2	5th	ea	V		1.5	1	1	1	2	4	6	
UF4	UO3 Handling	Feed	Seal Hopper	420	5	4th-5th	ea	V		5	3	3	9	45	4	180	
UF4	UO3 Handling	Feed	Screw	420	5	4th	ea	H	0.4167	4			1.6667	1	4	2	3-inch barrel, ~1/2-inch thick casing
UF4	UO2 Production	Reduction Reactors	Jacket Heater	420	5	4th	ea	V	5	6			25	118	8	942	Clamshell, hinged, fire brick, covers both reactors (which are closely spaced)
UF4	UO2 Production	Reduction Reactors	H2 Reduction Reactor	420	5	4th	ea	V	1.17	5			1.3689	5	8	43	
UF4	UO2 Production	Ammonia Dissociation	Metering Station	420	5	4th	ea	V		4	3	3	9	36	1	36	
UF4	UO2 Handling	Feed/Transport	Reoxidizer	420	5	4th	ea	V	0.667	4.5			0.4449	2	2	3	Section of 4-inch pipe, only on C and D lines (Cascade Division Training Manual)
UF4	UO2 Handling	Feed/Transport	Hopper	420	5	4th	ea	V		4	3	3	9	36	4	144	
UF4	UO2 Handling	Feed/Transport	Screw	420	5	4th	ea	H	0.4167	4			1.6667	1	4	2	
UF4	UO2 Handling	Feed/Transport	Seal Hopper	420	5	4th	ea	V		5	2	2	4	20	4	80	
UF4	UO2 Handling	Feed/Transport	Screw	420	5	4th	ea	H	0.4167	4			1.6667	1	4	2	
UF4	UF4 Production	Off-Gas Handling	Cyclone Separator	420	5	4th	ea	V		3	2	2	4	12	4	48	
UF4	UF4 Production	Hydrofluorination	Stirrer Motor	420	5, 8	4th	ea	V		2.5	3	3	9	23	2	45	
UF4	UF4 Production	Hydrofluorination	Fluidized Bed Reactor (E Line)	420	8, 11	4th	ea	V	5	6			25	118	2	236	Two stages, one on 3rd/4th floor, one on 2nd/3rd floor; could be used as alternative to "D" line screw reactor set, offered greater throughput, Inconel stirrer (Morris)

Table A.1. C-410 Complex infrastructure & equipment inventory (continued)

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
UF4	UF4 Production	Hydrofluorination	Clamshell Heaters	420	8, 11	2nd	ea	V	4.3	18			18.49	261	12	3,137	Electric
UF4	UF4 Production	Hydrofluorination	Drive Train	420	8, 11	2nd-3rd	ea	V		2.5	3	3	9	23	12	270	
UF4	UF4 Production	Hydrofluorination	HF Screw Reactor	420	8, 11	2nd-3rd	ea	H	1.33	22			29.26	31	12	367	Monel shell, Inconel screws, 18-inch barrel (Morris), Hastelloy C helical ribbon screw (Cascade Division Training Manual)
UF4	UF4 Production	Hydrofluorination	Bellowed Downcomer	420	8, 11	2nd	ea	V	1	1.5			1	1	12	14	
Auxiliary	Electrical		Large-Screw Rectifiers (Se)	420	8	3rd	ea	V		2.5	4	2	8	20	12	240	
UF4	UO2 Production	Off-Gas Handling	H2 Burner/Settling Chamber	420	2	5th	ea	V		2	2	2	4	8	4	32	Integral 6-inch exhaust duct; potential for powder (Morris)
UF4	UF4 Production	Off-Gas Handling	Refeed Screw	420	11	2nd	ea	H	0.4167	6			2.5	1	4	3	
UF4	UF4 Production	Hydrofluorination	Transfer Screw	420	16	1st	ea	H	0.4167	10			4.1667	1	1	1	
UF4	UF4 Production	Hydrofluorination	Fluid Lift	420	16	1st	ea	V	0.5	4			0.25	1	1	1	
Auxiliary	Facility Vacuum	Oxide	Vacuum Blowers	420	16		ea	V		4	4	6	24	96	2	192	
UF4	UF4 Handling	Feed/Transport	Seal Hopper	420	14	1st	ea	V		5	3	3	9	45	4	180	
UF4	UF4 Handling	Feed/Transport	Feed Screw	420	14	1st	ea	H	0.4167	5			2.0833	1	4	3	
UF4	UF4 Handling	Feed/Transport	Cooling Screw	420	14	1st	ea	H	0.5	10			5	2	4	8	Nitrogen purge, 4-inch screw (Morris)
UF4	UF4 Handling	Off-Gas Handling	Carbon Tube Filter	420	14	1st	ea	V	3	4			9	28	4	113	Insulation adds 6 inches to diameter
Auxiliary	Facility Vacuum	Oxide	Vacuum Room	420	16		area	V		18	12	6	72	1,296	1	1,296	Entails 3 baghouse enclosures
UF4	UF4 Handling	Feed/Transport	Weigh Hopper	420	16	1st	ea	V		6	6	6	36	216	4	864	Tapers down to 8 inches about half way down
UF4	UF4 Handling	Feed/Transport	Main Conveyors	420	16	1st	ea	V		0.667	0.667	100	66.7	44	2	89	Cast iron chains (Morris)
UF4	UF4 Handling	Sample/Product Removal	Drum-Off Station (Bellowed Piping)	420	16	1st	ea	V	0.4167	6			0.1736	1	1	1	
UF6	UF4 Handling	Feed/Transport	Screener	420	16		ea	V		2	6	6	36	72	3	216	Inclined vibrating screen served to "reject" larger objects from entering fluorination process (D.K.)
UF6	UF4 Handling	Feed/Transport	Storage Hopper (C)	420	16		ea	V	6	8			36	226	2	452	"C" hopper provided extra storage capacity (allowed C-420 to continue operations for a period of time with C-410 shutdown) (Morris)

Table A.1. C-410 Complex infrastructure & equipment inventory (continued)

Plant	System	Subsystem	Component	Bldg	Zone	Floor	Unit	Orientation	Diameter	Height/Length	Width	Depth	Area	Est. Volume	Quantity	Total Volume	Additional Information
UF4	UO2 Production	Off-Gas Handling	Monel Tube Filter	420	2	4th/5th	ea	V	3	4			9	28	4	113	Figure indicates Monel, yet most oxide components are SS, tubes thought to have been removed upon shutdown (Morris)
Auxiliary	Control Room		Instrument Panels	420	13	2nd	sys	V		8	40	2.5	100	800	1	800	
UF4	UF4 Production	Off-Gas Handling	Carbon Tube Filter	420	2	5th	ea	V	3	5			9	35	4	141	One on each line plus 2 common units, serving as backups (Morris); insulation adds roughly 6 inches to diameter
UF4	UF4 Handling	Off-Gas Handling	Bag Dust Collector (Green Salt)	420	2	5th	ea	V		12	12	12	144	1,750	1	1,750	Also includes roughly 50 feet of 8-inch ductwork
UF4	UO2 Production	Off-Gas Handling	Bag Dust Collector (Oxide)	420	2	5th	ea	V		12	12	12	144	1,728	1	1,728	Also includes roughly 50 feet of 8-inch ductwork
UF4	UF4 Production	Off-Gas Handling	Carbon Tube Filter (Backup)	420	2	5th	ea	V	5	6			25	118	2	236	Tapers to 18 inches, very similar to 5-ton containers
UF4	UF4 Production	Hydrofluorination	HF Vaporizer	420	10	2nd	ea	V	3	6			9	42	3	127	300-gal capacity tank (CDM); designated "Potential U Contamination" due to past feeding of C-340 reclaimed HF (contained U), practice halted due reclaimed HF plugging system (D.K.); ~3-inch insulation all around
UF4	UF4 Production	Hydrofluorination	HF Superheater (Steam)	420	7	3rd	ea	H	1.5	9.5			14.25	17	2	34	Potential for residual HF in low section of piping (CDM); but thought to have been disconnected and/or removed from system (Morris); insulation increases diameter to around 2 feet (Morris)
UF4	UF4 Production	Hydrofluorination	HF Superheater (Electric)	420	7	3rd	ea	V		3	3	6	18	54	2	108	3-inch piping coil
UF4	UF4 Production	Off-Gas Handling	Scrubber (Experimental)	420	4	4th	ea	H	0.667	13			8.671	12	1	12	Two component/vessel system, pipe and tank (tank is roughly the size of 55-gal drum)
UF4	UF4 Production	Off-Gas Handling	Karbate Condenser (Scrubber)	420	See Note	5th	ea	V	0.83	18			0.6889	10	2	19	Water jacket with Karbate tubes, located on exterior of building near roof, vertically oriented, normally operated one with second serving as backup unit, aqueous HF to drain tank/gases to vent (Morris)
Auxiliary	Cooling	Fluorine Generation	Tempered Water Tank	420	65		ea		4	8			32	101	1	101	Estimated 1000-gal tanks, cooled F2 cells; one original installation, one added during expansion (Morris)
Auxiliary	Refrigeration	R-12	Compressor	420	15	1st	ea	V		5	3	3	9	45	2	90	One rotary, one H2O-cooled (CDM); system may have been taken out of service/removed when C-420 was operational (Morris)
Auxiliary	Refrigeration	R-12	Condenser	420	15	1st	ea	H	1.5	6			9	11	1	11	
Auxiliary	Refrigeration	R-12	Intercooler	420	15	1st	ea	H	2	5			10	16	1	16	
Auxiliary	Refrigeration	R-12	Liquid Receiver	420	15	1st	ea	H	1.5	6			9	11	1	11	Removed from system, system drained at shutdown (CDM)
Auxiliary	Refrigeration	R-12	Oil Separator	420	15	1st	ea	V	1.5	3			2.25	5	1	5	
UF4	UO3 Handling	Feed	5-ton Container	TBD	TBD	TBD	ea	V	5	6			25	118	50	5,890	Tapers to 18 inches about half way down (Morris); two test hoppers are located in C-410, contain no rad material (D.K.); quantity TBD

APPENDIX B

SUMMARY OF BASELINE RISK EVALUATION FOR THE C-410 COMPLEX

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B.1 SUMMARY OF BASELINE RISK EVALUATION FOR THE C-410 COMPLEX

In 1994, the U.S. Department of Energy (DOE) prepared a Level 3 Baseline Risk Evaluation (BRE) for the C-410 Complex to assess the potential risks to human health and the environment posed by current and future potential releases from the complex (DOE 1994). This Level 3 BRE followed the draft baseline risk assessment guidance prepared by DOE for the D&D Program. This Baseline Risk Assessment Guidance, which appeared in final form in *Baseline Risk Assessment Guidance for D&D Facilities* (DOE 1995), describes a Level 3 BRE as an evaluation that uses available characterization data and process history to perform a screening risk evaluation.

This section presents a summary of the BRE for the C-410 Complex, including descriptions of the following:

- the purpose and scope of the BRE,
- the data set used in the BRE,
- the exposure assessment assumptions applied in the BRE,
- the toxicity assessment information used in the BRE,
- the risk characterization methods and results, and
- the uncertainties affecting the interpretation of the results of the BRE.

Generally, the results of this BRE estimate the baseline risk for the C-410 Complex under a No Action alternative.

B.1.1 Purpose and Scope of the BRE

The purpose of the BRE was to provide a preliminary estimate of potential risk to human health and the environment under "worst case" assumptions. In meeting this purpose, the scope of the BRE was limited to the evaluation (1) of risks to workers and hypothetical future residents exposed to radiological contaminants associated with the surfaces of equipment and the building structure, (2) exposure to contaminated groundwater resulting from infiltration of rainwater contaminated with potassium bifluoride (HF-KF), and (3) exposures to wind-borne uranium tetrafluoride dust.

B.1.2 Data Evaluation

Data used in the BRE originated from three sources. These were health and safety monitoring reports, volumetric or mass estimates of materials, and operation reports. The health and safety reports consisted of results from a limited number of surveys prepared between 1991 and 1994. The volumetric or mass estimates of materials were estimates of the amount of UF_4 and HF-KF electrolyte present in storage hoppers and electrolyte cells. The operation reports include descriptions of the raw materials, intermediate and final products, and waste products present as a result of the process of converting UO_2 feedstock to UF_6; descriptions of the manufacturing process; and descriptions of the manufacturing facilities.

Generally, the data evaluation determined that the C-410 Complex is contaminated with varying levels of process materials. These include uranium, asbestos, HF-KF, Resource Conservation and Recovery Act of 1976 (RCRA) wastes, polychlorinated biphenyls (PCBs), lead (in paint), and other heavy metals. The evaluation also determined that the uranium contamination can be found at varying levels throughout the C-410 Complex, being primarily associated with piping, vessels, and building structures associated with the process system. The asbestos was also described as being found throughout the facility as insulation on pipes and ductwork. Finally, the evaluation noted that RCRA wastes are found in storage areas.[2]

To address contaminant migration from the complex, the GENII model was used to model concentrations of UF_4 in air and the Multimedia Environmental Pollutant Assessment System model was used to model concentrations of HF-KF in groundwater. Additionally, three scenarios were developed for HF-KF releases. These were a release rate of 1% of total inventory per year for 100 years, 10% of total inventory per year for 10 years, and 100% of total inventory in 1 year. These release rates were selected to allow for the consideration of both the gradual degradation of the C-410 Complex and the sudden loss of all containment.

B.1.3 Exposure Assessment

The exposure assessment in the BRE provides estimates of the level of exposure to chemicals and radionuclides that could result from actual and hypothetical activities in the C-410 Complex. Much of the information used to derive these estimates [especially the physical description and process history of the C-410 Complex and a description of the Paducah Gaseous Diffusion Plant (PGDP) environs] is presented elsewhere in this engineering evaluation/cost analysis (EE/CA) and will not be repeated here.

The exposure assessment concluded that the human populations that may be exposed to contamination at or released from the C-410 Complex include the following:

- employees of DOE and its subcontractors,
- employees of state and federal regulatory agencies,
- residents living in areas surrounding PGDP,
- recreational users that visit the Western Kentucky Wildlife Management Area that surrounds PGDP, and
- trespassers who are seeking shelter (under hypothetical future exposure scenarios).

The ecological receptors identified in the BRE included terrestrial and aquatic organisms that spend all or part of their lives on or near PGDP.

As shown in Fig. 1.1 of the EE/CA, the C-410 Complex is located near the center of PGDP. In keeping with this conclusion, the BRE describes the most likely current and future uses of the area encompassing the C-410 Complex as industrial use. While it is likely that DOE will continue to maintain both the facilities found in the C-410 Complex and those found in surrounding buildings for the near future, the BRE examines a worst-case scenario in which DOE is assumed to abandon the C-410 Complex and lose institutional control after a 100-year period. The future worst-case scenario is described in Table B.1.

For both the current and hypothetical future scenarios, the BRE identified and evaluated several pathways of exposure. In this evaluation, each part of each exposure pathway was examined to determine if the exposure pathway was complete. These pathways included the following:

- a source and mechanism for release of a contaminant,
- a retention or transport mechanism,

[2] The RCRA wastes have since been moved.

Table B.1. Future exposure scenario and potential receptors for the C-410 Complex

Scenario	Action	Final property disposition	Potential receptors
Abandonment	Complete immediate abandonment of the building. Loss of institutional controls on the building. Retain institutional controls of the DOE property surrounding the building for 100 years.	None – DOE walks away without converting the land to any predetermined use.	Trespasser – an adult that uses the abandoned building as shelter. Residential – exposure to contaminants migrating from the building to an off-site location.

- a point of potential human or environmental contact with a contaminated medium, and
- an exposure route at the exposure point.

Conceptual site models showing the complete and incomplete pathways of exposure and the receptors considered in the BRE are shown in Fig. B.1 and B.2. In Fig. B.1, the conceptual site model considering process releases is shown (called Site Model A in the BRE). In Fig. B.2, the conceptual site model considering release due to natural disasters is shown (called Site Model B in the BRE).

As shown in the figures, the primary source of contamination at the C-410 Complex under either scenario is process equipment. The primary mechanisms of release are past spills and leaks from the process equipment. These releases subsequently contaminated the walls, floors, equipment surfaces, and insulation found in the C-410 Complex, which act as secondary sources of contamination. Releases from these secondary sources resulted in contamination of the media to which the receptors are assumed to be exposed. (Note that in some cases the secondary source also serves as an exposure medium.)

The potentially complete current and future exposure pathways, including receptors and exposure routes are shown in Table B.2. As shown there, the exposure media considered in the BRE were air, building structures, surface water, groundwater, and soil. The receptors under current conditions were maintenance workers, and the receptors under future conditions were employees, trespassers, and off-site residents. The exposure routes considered were inhalation, ingestion, dermal absorption (absorption through the skin), and external (gamma) exposure. As noted in the BRE, although the evaluation considered several routes of exposure under current conditions, actual exposure through these routes is minimized under current conditions through the use of protective clothing and respirators.

Subsequent to the development of the conceptual site model, the BRE estimated reasonable maximum exposure estimates of dose for selected receptors. These estimates were derived by integrating, in standard exposure equations, the contaminant concentrations derived in the data evaluation with exposure parameters selected under the following guidelines and assumptions.

- The BRE is to provide a worst-case estimate of exposure.

- The isotopic ratios of uranium on a weight basis in the UF_4 are 99.27% ^{238}U, 0.72% ^{235}U, and 0.01% ^{234}U.

- Releases of UF_4 to air can be modeled using two particle size distributions.

- Releases of HF-KF to groundwater can be estimated using release rates of 1% per year for 100 years, 10% per year for 10 years, and 100% in one year.

Fig. B.1. Conceptual Site Model A.

Fig. B.2. Conceptual Site Model B.

Table B.2. Selection of potentially complete current exposure pathways

D&D complex use scenario	Exposure medium	Receptor	Exposure route: Inhalation	Ingestion	Dermal absorption	External exposure[a]
Current	Air	Worker[b]	●	N/A	N/A	❍
	Building Structure	Worker	N/A	●	●	●
	Surface Water	Worker	❍	❍	❍	❍
	Groundwater	Worker	❍	❍	❍	❍
	Soil	Worker	❍	❍	❍	❍
Future (Abandonment)	Air	Employee[c]	●	N/A	N/A	❍
	Air	Adult Trespasser[d]	●	N/A	N/A	❍
	Air	Off-site Resident[e]	●	N/A	N/A	❍
	Air	Teen Trespasser[f]	●	N/A	N/A	❍
	Building Structure	Employee	N/A	●	●	●
	Building Structure	Adult Trespasser	N/A	●	●	●
	Building Structure	Off-site Resident	N/A	❍	❍	❍
	Building Structure	Teen Trespasser	N/A	●	●	●
	Surface Water	Employee	❍	❍	❍	N/A
	Surface Water	Adult Trespasser	❍	❍	❍	N/A
	Surface Water	Off-site Resident	❍	❍	❍	N/A
	Surface Water	Teen Trespasser	❍	❍	❍	N/A
	Groundwater	Employee	❍	●	●	N/A
	Groundwater	Adult Trespasser	❍	●	●	N/A
	Groundwater	Off-site Resident	❍	●	●	N/A
	Soil	Employee	●	●	●	●
	Soil	Adult Trespasser	●	●	●	●
	Soil	Off-site Resident	●	●	●	●
	Soil	Teen Trespasser	●	●	●	●

Notes:

● Potentially complete pathway

❍ No complete pathway

N/A Not applicable

[a] External exposure (sometimes called direct exposure) is exposure to ionizing radiation from radionuclides external to the body.

[b] Workers are PGDP employees who routinely access the C-410 Complex to perform maintenance.

[c] Employees are workers that do not access the C-410 but are exposed during the 100 year institutional control period.

[d] The adult trespasser is assumed to regularly use the C-410 Complex for shelter after the loss of institutional control.

[e] The off-site resident is assumed to have a home at the edge of the industrial portion of PGDP.

[f] The teen trespasser is assumed to enter the C-410 Complex for short periods after the loss of institutional control.

- The isotopic distribution of transferable contamination on an activity basis is ^{238}U and ^{234}U in approximately equal proportions.

- The contamination measured during scans is predominantly uranium; hence, conversion from scanned results in disintegrations per minute (dpm) to pCi/cm^2 is possible. (See Appendix A of DOE 1994.)

B.1.4 Toxicity Assessment

The toxicity assessment in the BRE used readily available information. Toxicity values were not developed for any chemical in the BRE. The toxicity values used in the BRE are presented in Table B.3.

Table B.3. Toxicity values used in the C-410 Complex BRE

Analyte	CASRN	Chronic oral RfD [mg/(kg × day)]	Subchronic oral RfD [mg/(kg × day)]	Confidence level	MF	UF	RfD source	RfD basis (vehicle)	Critical effect
Noncancer Toxicity Values									
Fluoride	7782-41-4	6.0E-02	6.0E-02	High	1	1	IRIS	Water	Dental fluorosis
Uranium	7440-61-1	3.0E-03	3.0E-03	Medium	1	1000	IRIS	Oral (diet)	Body weight loss Nephrotoxicity
Aroclor 1016	12674-11-2	7.0E-05	—	—	—	—	IRIS	—	—

Analyte	CASRN	Oral slope factor [$(pCi)^{-1}$ or $(mg/kg\text{-}day)^{-1}$]	Inhalation slope factor [Risk/pCi]	External exposure slope factor [risk/year per pCi/g]	EPA class	Slope factor source	Slope factor basis (vehicle)	Type of cancer
Cancer Toxicity Values								
U-234	13966-29-5	1.60E-11	9.18E-08	3.0E-11	A	HEAST	—	Various
U-235	15117-96-1	1.60E-11	2.5E-08	2.4E-07	A	HEAST	—	Various
U-238	7440-61-1	1.60E-11	2.4E-08	2.1E-11	A	HEAST	—	Various
PCBs	1336-36-3	7.70E+00	—	—	B2	IRIS	—	—

Notes:

All information taken from DOE 1994.

RfD is the reference does, a noncancer toxicity value which represents the amount of intake that is not expected to result in a toxic effect.

CASRN is the Chemistry Abstract Service Number.

MF is the modifying factor applied to the RfD. UF is the uncertainty factor applied to the RfD.

IRIS is the EPA Integrated Risk Information System.

HEAST is EPA Health Effects Assessment Summary Tables.

B.1.5 Risk Characterization

The risk characterization in the BRE integrated the reasonable maximum exposure estimates of dose with the toxicity values compiled during the toxicity assessment. Because characterization data was lacking for some contaminants, the quantitative risk characterization focused on risks from exposure to uranium and fluorides. A qualitative risk characterization considered other contaminants.

The results of the BRE for the C-410 Complex were as follows:

- Given the assumptions in the worker and off-site resident scenarios, excess cancer risk estimates from exposure to transferable uranium at the C-410 Complex (see Table B.4) are below the U.S. Environmental Protection Agency's (EPA's) generally acceptable risk range of 1E-04 to 1E-06 for all receptors via the ingestion, external exposure, and inhalation routes of exposure. [In fact, all excess cancer risks under these scenarios from this source are below the current PGDP *de minimis* risk level of 1E-06 established in PGDP risk assessment methods document (DOE 2000).]

- Given the assumptions in the worker and off-site resident scenarios, noncarcinogenic effects are above the range of potential concern (i.e., exceed threshold levels) for exposure to fluoride in groundwater at some points of exposure.

- Given the assumption in building worker and residential scenarios, excess cancer risk from exposure to wind-blown UF4 via inhalation is below or equal to EPAs generally acceptable risk range for all maximally exposed individuals. Excess cancer risks are also below EPA's generally acceptable risk range for on-site and off-site maximally exposed individuals under the process release model (i.e., under Site Model A) and under the natural disaster model (i.e., under Site Model B).

- When evaluated qualitatively, the amounts of asbestos, PCBs, and lead in paint present can be expected to increase both carcinogenic risk and hazard via ingestion, dermal contact, and inhalation routes of exposure.

Table B.4. Excess cancer risk estimates for receptors exposed to transferable uranium in the C-410 Complex (DOE 1994)

	Route of exposure			
Receptor	Ingestion of dust	Inhalation of dust	External exposure to ionizing radiation	Total cancer risk
Resident[a]	1.4E-08	5.3E-10	9.6E-10	1.5E-08
Resident[b]	1.5E-07	5.6E-09	1.0E-08	1.7E-07
Maintenance Worker[a]	4.3E-09	4.3E-10	5.7E-10	5.3E-09
Maintenance Worker[b]	4.6E-08	4.6E-09	6.1E-09	5.7E-08

[a] Risk calculated using exposure estimates calculated assuming the mass of contamination is equally distributed throughout the C-410 Complex.

[b] Risk calculated using exposure estimates calculated assuming the mass of contamination is confined to the radionuclide regulated areas found in the C-410 Complex.

Table B.5. Concentrations in groundwater (mg/l) and hazard estimates for residents and workers exposed to fluoride migrating in groundwater from the C-410 Complex under varying release scenarios (DOE 1994)

Distance from Site Boundary (miles)	100%/year released			10%/year released			1%/year released		
		Hazard Quotient			Hazard Quotient			Hazard Quotient	
	C (mg/L)	Resident	Worker	C (mg/L)	Resident	Worker	C (mg/L)	Resident	Worker
0	1930	880	310	678	310	110	6.8	3.1	1.1
0.25	55.3	25	9	19.6	8.9	3.2	2.0	0.9	0.3
0.5	13.7	6.3	2.2	4.9	2.2	0.8	0.5	0.2	0.08
0.75	6.0	2.7	1.0	2.2	1.0	0.4	0.2	0.1	0.04
1	4.1	1.9	0.7	1.6	0.7	0.3	0.2	0.07	0.03
2	1.8	0.8	0.3	0.8	0.4	0.1	0.08	0.04	0.01

C = concentration in groundwater
Concentration and hazards were made consistent with Appendix B of the BRE for the 100% release 0.40-km (0.25-mile) case. Actual values in the BRE table were 100 times those shown here, but are believed to be in error.

Table B.6. Excess cancer risks to individuals exposed to wind-blown UF_4 under two release scenarios (DOE 1994)

		Off-site maximally exposed individuals	On-site maximally exposed individuals
Process (A)	Resident	3.0E-08	2.0E-07
Process (A)	Worker	1.8E-08	1.2E-07
Disaster (B)	Resident	5.1E-07	1.2E-06
Disaster (B)	Worker	3.0E-07	6.7E-07

Note:
Exposure concentration calculated using the GENII model. Total off-site and on-site populations assumed to be 500,502 [80-km (50-mile) radius] and 1952, respectively.

B.1.6 Uncertainties Affecting the BRE

Several uncertainties affect the results of the BRE. The major uncertainties and assumptions listed in the BRE are as follows:

- No data were available from the most highly contaminated parts of the building (i.e., radiation regulated areas).
- Contaminant concentrations were not reduced over time.
- Exposure rates remained constant over time.
- The C-410 Complex was assumed to deteriorate in place or be turned over to private enterprise without any decontamination.
- The intake rates and population characteristics are assumed to be representative of the population.
- All dose from contamination is assumed to be from site-related media, and no other sources of contamination are assumed to be present.

B.1.7 Overall Conclusion of the C-410 Complex BRE

The results of the BRE for the C-410 Complex, which is a worst-case estimate, indicate that long-term exposures to contaminated media inside the building pose a potential health risk. The risk is primarily from contaminant migration from the complex, and risks under catastrophic releases are of special concern. If this analysis is assumed to represent the risks present under a no-further-action-scenario, then risks under this scenario exceed EPA's generally acceptable hazard index for site-related exposures under both current and potential future uses.

B.2 REFERENCES

DOE 1994. *Level III Baseline Risk Evaluation for the C-410 Complex at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. ES/ER/TM-133. September 1994.

DOE 1995. *Final Report Plant 7 Dismantling—Removal Action No. 19*, Fernald Environmental Management Project, Fernald, OH.

DOE 1995. *Baseline Risk Assessment Guidance for D&D Facilities*. K/ER-153/R1. September 1995.

DOE 2000. *Volume I Methods for Conducting Human Health Risk Assessments at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1506 & D1, V1/RO, December.

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APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO BE CONSIDERED (TBC) GUIDANCE FOR THE C-410 COMPLEX INFRASTRUCTURE D&D

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ACRONYMS FOR APPENDIX C

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CAA	Clean Air Act of 1970, as amended
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended
CFR	*Code of Federal Regulations*
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
KAR	*Kentucky Administrative Regulations*
LLW	low-level (radioactive) waste
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act of 1976, as amended
TBC	to be considered
T&E	threatened and endangered
TSCA	Toxic Substances Control Act of 1976, as amended

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C.1 INTRODUCTION

In accordance with Sect. 40 *Code of Federal Regulations* (*CFR*) 300.415(j) of the National Oil and Hazardous Substances Pollution Contingency Plan and U.S. Department of Energy (DOE) Headquarters guidance, DOE on-site removal actions conducted under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, are required to attain applicable or relevant and appropriate requirements (ARARs) to the extent practicable, considering the exigencies of the situation. ARARs include only federal and state environmental or facility siting laws/regulations; they do not include occupational safety or worker radiation protection requirements. Additionally, per 40 *CFR* 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to-be-considered (TBC) category]. The decontamination and decommissioning (D&D) removal action alternatives for the C-410 Complex Infrastructure include removal of scrap metal, equipment, infrastructure, and any waste materials; decontamination of equipment or metal surfaces, if necessary; and removal of the structure/debris so that only the buildings remain. The removal action alternatives (i.e., other than no action) would comply with all identified ARARs/TBCs and would not require an ARAR waiver. ARARs are typically divided into three groups: (1) chemical-specific, (2) location-specific, and (3) action-specific. Tables C.1, C.2, and C.3 list the Chemical-, Location-, and Action-Specific ARARs/TBCs, respectively, for the D&D removal action. A brief description of key ARAR/TBC issues follows.

C.2 CHEMICAL-SPECIFIC ARARs/TBCs

Chemical-specific ARARs provide health or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, and air) for specific hazardous substances, pollutants, or contaminants; these are listed on Table C.1 and discussed below.

The radiation dose to members of the public must not exceed 100-millirem (mrem)/year total effective dose equivalent from all sources excluding dose contributions from background radiation, medical exposures, or voluntary participation in medical/research programs [10 *CFR* 20.1301(a)(1); 902 *KAR* 100:019 Section 10(1)] and must be reduced below this limit as low as reasonably achievable (ALARA) per 10 *CFR* 20.1101(b); 902 *KAR* 100:015 Section 2. This dose limit addresses exposure to radiation from all sources and activities (including both operations and removal/remedial actions) at a facility. In addition, DOE is required to use procedures to maintain the dose ALARA. Thus, the actual dose that the public might receive from any individual activity such as this removal action is expected to be a very small fraction of the 100-mrem/year dose limit. Unrestricted use of a facility following D&D would require limiting residual radioactivity distinguished from background to an average member of the critical group to 25 mrem and ALARA (10 *CFR* 20; 902 *KAR* 100:042, Section 2). This would generally apply after removal or lease of the building and soil, which will be addressed as part of subsequent actions.

C.3 LOCATION-SPECIFIC ARARS/TBCS

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., wetlands, floodplains, critical habitats, historic districts, and streams). Table C.2 lists federal and state location-specific ARARs for protection of cultural or sensitive resources.

C.3.1 Floodplains and Wetlands

None of the activities associated with the removal action alternatives would be conducted within any floodplain. In addition, no wetlands are present on or near the vicinity of the buildings. Thus, no impacts to either floodplains or wetlands would result from any of the alternatives considered for this proposed removal action.

C.3.2 Threatened and Endangered Species

None of the removal action alternatives would adversely impact any federally or state-listed threatened or endangered (T&E) species located or seen at Paducah Gaseous Diffusion Plant (PGDP) since the removal action activities will mostly occur inside the buildings. Consequently, none of the requirements for protection of T&E species or critical habitat are included as ARARs.

C.3.3 Cultural Resources

No archeological surveys have been conducted at PGDP, however this removal action will not involve any outdoor excavation. Also, an inventory of historic structures has not been conducted. The earliest structures at PGDP are approaching 50 years of age and therefore will need to be evaluated for eligibility or inclusion on the National Register of Historic Places in the near future.

C.4 ACTION-SPECIFIC ARARs/TBCs

Action-specific ARARs include operation, performance, and design requirements or limitations based on the waste types, media, and removal/remedial activities. ARARs for the D&D alternatives include requirements related to waste characterization, scrap metal removal, decontamination, waste storage, treatment and disposal and transportation of hazardous materials.

C.4.1 Building Remediation

The D&D alternatives include removal of scrap metal, equipment, infrastructure, any waste materials and debris, and where necessary, decontamination of equipment, metal surfaces, etc. Loose radioactive contamination, asbestos wastes, and/or fixtures (including any electrical equipment) would be removed as well. Any regulated Class I/II refrigerants found must be evacuated from any air handling equipment. Requirements under the Clean Air Act (CAA) of 1970, as amended for control of asbestos, Class I/II refrigerants, and/or radionuclide emissions included in Table C.3 would have to be met.

Reusable scrap metal may be segregated from the waste materials/debris. Any scrap metal otherwise considered hazardous waste under Resource Conservation and Recovery Act (RCRA) of 1976, as amended, regulations is not subject to RCRA Subtitle C requirements if it is intended for recycle or reuse. The Secretary of Energy has recently suspended the release of potentially contaminated scrap metals for recycling from DOE nuclear facilities. Clean structural steel would be released to scrap dealers or, if available, to a DOE-operated recycler provided this is in compliance with guidance in effect during implementation of the removal action. Materials for unrestricted release must meet DOE Order 5400.5 TBC requirements listed on Table C.3 for residual surface radioactive contamination. Polychlorinated biphenyl (PCB)-contaminated equipment or metal surfaces should be decontaminated if intended for recycle or reuse in accordance with the requirements specified on Table C.3.

C.4.2 Waste Management

Building remediation activities may result in generation of, RCRA solid or hazardous waste (e.g., mercury switches, hazardous-debris-containing lead paint), low level radioactive waste (LLW), mixed waste, asbestos-containing waste materials, Toxic Substances Control Act (TSCA) of 1976, as amended, PCBs in fluorescent light ballasts, capacitors or drained equipment, PCB bulk-product waste, and/or PCB remediation wastes. Although some characterization has been performed, additional waste streams may be identified during implementation of the removal action.

PCB bulk-product waste, as defined by 40 *CFR* 761.3, is derived from manufactured products containing PCBs in a non-liquid state where the concentration at the time of designation for disposal was greater than or equal to 50 parts per million (ppm). It includes non-liquid bulk wastes and debris from demolition (of buildings and other man-made structures) that was manufactured, coated, or serviced with PCBs. Examples of bulk PCB product waste are insulation, dried paints, varnishes, sealants, caulking, and gaskets.

PCB remediation waste, as defined in 40 *CFR* 761.3, contains PCBs as a result of a spill, release, or other unauthorized disposal. It includes rags and other debris generated as a result of any PCB-spill cleanup in buildings and other man-made structures containing concrete, wood floors, or walls contaminated from leaking PCBs or PCB-contaminated transformers. PCB remediation waste also includes PCB-contaminated nonporous surfaces such as smooth glass, unpainted marble, granite, or porous surfaces such as fiberglass, painted stone, and corroded metal.

All primary wastes (e.g., D&D debris, removed waste materials) and secondary wastes (e.g., contaminated personal protective equipment, decontamination wastes) generated during building remediation activities must be appropriately characterized as either RCRA (solid or hazardous waste), asbestos, PCB, radioactive waste(s), and/or mixed wastes and managed in accordance with appropriate RCRA, CAA, TSCA, or DOE Order requirements. Table C.3 lists the requirements associated with the characterization, storage, treatment, and disposal of the aforementioned waste types.

C.4.3 Land Use Controls

In accordance with DOE Order 5400.5(IV)(6)(c), interim controls, including physical barriers (i.e., fences, signs) to prevent access, and appropriate radiological safety measures will be used, if necessary to prevent disturbance of any residual radioactive material left in the buildings or in the event the building structures are radioactively contaminated. Since the removal action does not involve demolition of the buildings and a follow-up CERCLA action for the building/site is expected, controls related to use of the building site (i.e., land/media below the building) are unnecessary at this time.

C.4.4 Transportation

Any wastes transferred off-site or transported in commerce along public right-of-ways must meet the requirements summarized on Table C.3, depending on the type of waste (e.g., RCRA, PCB, LLW, or mixed). These include packaging, labeling, marking, manifesting, and placarding requirements for hazardous materials at 49 *CFR* 170–180 *et seq*. However, transport of C-410 Complex wastes along roads within the PGDP site that are not accessible to the public would not be considered "in commerce."

In addition, CERCLA Section 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that complies with applicable federal and state laws and has been approved by the U.S. Environmental Protection Agency (EPA) for acceptance of CERCLA waste (see also the "Off-Site Rule" at 40 *CFR* 300.440 *et seq.*). Accordingly, DOE will verify with the appropriate EPA regional contact that any needed off-site facility is acceptable for receipt of CERCLA wastes before transfer.

Table C.1. Chemical-specific ARARs and TBC guidance for D&D of the C-410 Complex

Action/medium	Requirements	Citations
Release of radionuclides into the environment	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs—**relevant and appropriate**	10 *CFR* 20.1301(a)(1); 902 *KAR* 100:019 Section 10 (1)
	Shall use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve doses to members of the public that are ALARA— **relevant and appropriate**	10 *CFR* 20.1101(b); 902 *KAR* 100:015 Section 2
Unrestricted use	A site shall be considered acceptable for unrestricted us if the residual radioactivity that is distinguishable from background radiation results in a total EDE to an average member of the critical group that does not exceed 25 mrem/year and the residual radioactivity has been reduced to ALARA levels – **relevant and appropriate after removal or release of the building and soil.**	10 *CFR* 20.1402; 902 *KAR* 100:042 Section 2

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
D&D = decontamination and decommissioning
EDE = effective dose equivalent
KAR = *Kentucky Administrative Regulations*
mrem = millirem
TBC = to be considered.

Table C.2. Location-specific ARARs and TBC guidance for D&D of the C-410 Complex

Location characteristics	Requirements	Prerequisite	Citations
	Cultural resources		
Presence of historic properties (including artifacts, records, or remains located within such properties)	Must consider the adverse effects on historic properties per Sect. 106 of the NHPA	Undertaking [as defined in 36 *CFR* 800.16(y)] that has the potential to affect historic property on or eligible for inclusion on the National Register of Historic Places—**applicable**	36 *CFR* 800.1(a) 36 *CFR* 800.3
	Determine adverse effects per 36 *CFR* 800.5(a)(1), and if found, evaluate alternatives or modifications to the undertaking to avoid, minimize, or mitigate the adverse effects on the property		36 *CFR* 800.5(a) and (d) 36 *CFR* 800.6

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
D&D = decontamination and decommissioning
NHPA = National Historic Preservation Act of 1966
TBC = to be considered

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex

Action	Requirements	Prerequisite	Citations
	General construction standards		
Activities causing airborne radionuclide emissions	Shall not exceed those amounts that would cause any member of the public to receive an EDE of 10 mrem per year	Radionuclide emissions from point sources, as well as diffuse or fugitive emissions, at a DOE facility—**applicable**	40 *CFR* 61.92;
	Decontamination and waste removal standards		
Decontamination of radioactively contaminated equipment and building structure	Must meet surface contamination guidelines for residual activity provided in Fig. IV-1 of the DOE Order for specified radionuclides	Residual radioactive material on equipment and building structures for unrestricted use—**TBC**	DOE Order 5400.5(IV)(4)(d) and Fig. IV-1
Removal of refrigeration equipment	Disposal is prohibited of any such appliances that may vent or otherwise release to the environment any Class I or II substances as a refrigerant	Appliances that contain Class I or II substances used as a refrigerant—**applicable**	40 *CFR* 82.154(a)
	No person may dispose of such appliances, with certain exceptions, without: • observing the required practices set forth in 40 *CFR* 82.156 and • using equipment that is certified for that type of appliance pursuant to 40 *CFR* 82.158		40 *CFR* 82.154(b)
Removal of RACM from a facility	Procedures for asbestos emission control per 40 *CFR* 61.145(c)(1-10) shall be followed, as appropriate	Demolition of a facility containing RACM exceeding the volume requirements of 40 *CFR* 61.145(a)(1)—**applicable**	40 *CFR* 61.145(c); Chap. 1200-3-11-.02(2)(d)(3)
Decontamination of PCB nonporous surface ***(e.g., scrap metal)***	For unrestricted use, meet standard of: • 10 µg/100 cm^2 as measured by a standard wipe test (40 *CFR* 761.123) at locations selected in accordance with 40 *CFR* 761.300 *et seq.* and	Nonporous surfaces previously in contact with liquid PCBs, where no free-flowing liquids are present—**applicable**	40 *CFR* 761.79(b)(3)(i)(A)
	• clean to Visual Standard No. 2 of NACE. Verify compliance by visually inspecting all cleaned areas	Nonporous surfaces in contact with non-liquid PCBs—**applicable**	40 *CFR* 761.79(b)(3)(i)(B)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	For disposal in a smelter operating in accordance with 40 *CFR* 761.72(b), meet standard of: • $<100\ \mu g/100\ cm^2$ as measured by a standard wipe test (40 *CFR* 761.123) at locations selected in accordance with 40 *CFR* 761.300 *et seq*. and	Nonporous surfaces previously in contact with liquid PCBs at any concentration, where no free-flowing liquids are present—**applicable**	40 *CFR* 761.79(b)(3)(ii)(A)
	• clean to Visual Standard No. 3 of NACE. Verify compliance by visually inspecting all cleaned areas	Nonporous surfaces in contact with non-liquid PCBs (including nonporous surfaces covered with a porous surface, e.g., paint or coating on metal)—**applicable**	40 *CFR* 761.79(b)(3)(ii)(B)
Decontamination of movable equipment contaminated by PCBs	May decontaminate by: • swabbing surfaces that have contacted PCBs with a solvent; • a double wash/rinse as defined in 40 *CFR* 761.360-378; or • another applicable decontamination procedure under 40 *CFR* 761.79	Movable equipment contaminated by PCBs and used in storage areas, tools, and sampling equipment—**applicable**	40 *CFR* 761.79(c)(2)
Decontamination of metal surfaces in contact with PCBs	For surfaces in contact with liquid or non-liquid PCBs <500 ppm, may be decontaminated in an industrial furnace for purposes of disposal in accordance with 40 *CFR* 761.72	Use of thermal processes to decontaminate metal surfaces as required by 40 *CFR* 761.61 (a)(6)—**applicable**	40 *CFR* 761.79 (c)(6)(i)
	For surfaces in contact with liquid or non-liquid PCBs ≥500 ppm, may be smelted in an industrial furnace operating in accordance with Sect. 761.72(b), but must first be decontaminated in accordance with 40 *CFR* 761.72(a) or to a surface concentration of $<100\ \mu g/100\ cm^2$		40 *CFR* 761.79 (c)(6)(ii)
Decontamination of PCB-contaminated concrete	If commenced within 72 h of initial spill, $\leq 10\ \mu g/100\ cm^2$ as measured by the standard wipe test (40 *CFR* 761.123)	Spill of liquid PCBs—**applicable**	40 *CFR* 761.79 (b)(4)
Decontamination of PCB-contaminated water	For discharge to a treatment works as defined in 40 *CFR* 503.9 (aa), or discharge to navigable waters, meet standard of <3 ppb PCBs; or	Water containing PCBs regulated for disposal—**applicable**	40 *CFR* 761.79 (b)(1)(ii)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	For unrestricted use, meet standard of 0.5 ppb PCBs		40 *CFR* 761.79(b)(1)(iii)
Decontamination of PCB-contaminated liquids	Meet standard of <2 ppm PCBs	Organic liquids and non-aqueous inorganic liquids containing PCBs—**applicable**	40 *CFR* 761.79(b)(2)
Decontamination of PCB-containers	Must flush the internal surfaces of the container three times with a solvent containing <50 ppm PCBs. Each rinse shall use a volume of the flushing solvent equal to approximately 10% of the PCB container capacity	PCB container as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.79(c)(1)
	Waste generation, characterization, segregation, and storage— removed wastes, debris, and secondary wastes		
Characterization of solid waste ***(all primary and secondary wastes)***	Must determine if solid waste is hazardous waste or if waste is excluded under 40 *CFR* 261.4(b) [401 *KAR* 32:010 Section 4]; and	Generation of solid waste (as defined in 40 *CFR* 261.2) that is not excluded under 40 *CFR* 261.4(a)—**applicable**	40 *CFR* 262.11(a); 401 *KAR* 32:010 Section 2(1)
	Must determine if waste is listed under 40 *CFR* Part 261[401 *KAR* 31:040]; or		40 *CFR* 262.11(b); 401 *KAR* 32:010 Section 2(2)
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.		40 *CFR* 262.11(c); 401 *KAR* 32:010 Section 3
	Must refer to Parts 261,262,264,265,266,268,and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste	Generation of solid waste which is determined to be hazardous—**applicable**	40 CFR 262.11(d); 401 *KAR* 32:010 Section 4
Characterization of hazardous waste ***(all primary and secondary wastes)***	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 *CFR* 264 and 268	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 264.13(a)(1); 401 *KAR* 34:020 Section 4(1)(a)
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the D001, D002, D012-D043 waste	Generation of RCRA characteristic hazardous waste (other than D001 High TOC Subcategory or treated by CMBST or RORGS) for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) 401 *KAR* 37:010 Section 9(1)
	Must determine if the waste is restricted from land disposal under 40 *CFR* 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste		40 *CFR* 268.7; 401 *KAR* 37:010 Section 7

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 *et. seq.*		40 CFR 268.9(a) 401 *KAR* 37:010 Section 9(1)
Temporary storage of hazardous waste in containers ***(e.g., lead contaminated debris)***	A generator may accumulate hazardous waste at the facility provided that	Accumulation of RCRA hazardous waste on-site (as defined in 40 *CFR* 260.10)—**applicable**	40 *CFR* 262.34(a); 401 *KAR* 32:030 Section 5
	• waste is placed in containers that comply with 40 *CFR* 265.171–173, and		40 *CFR* 262.34(a)(1)(i); 401 *KAR* 32:030 Section 5(1)(a)
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container		40 *CFR* 262.34(a)(2); 401 *KAR* 32:030 Section 5(1)(b)
	• container is marked with the words "hazardous waste," or		40 *CFR* 262.34(a)(3); 401 *KAR* 32:030 Section 5(1)(c)
	• container may be marked with other words that identify the contents	Accumulation of 55 gal. or less of RCRA hazardous waste at or near any point of generation—**applicable**	40 *CFR* 262.34(c)(1); 401 *KAR* 32:030 Section 5(3)(a)
Use and management of hazardous waste in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition	Storage of RCRA hazardous waste in containers—**applicable**	40 *CFR* 265.171; 401 *KAR* 34:180 Section 2
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired		40 *CFR* 265.172; 401 *KAR* 34:180 Section 3
	Keep container closed during storage, except to add/remove waste		40 *CFR* 265.173(a); 401 *KAR* 34:180 Section 4(1)
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak		40 *CFR* 265.173(b); 401 *KAR* 34:180 Section 4(2)
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 *CFR* 264.175(b) [401 *KAR* 34:180 Section 6(2)]	Storage of RCRA-hazardous waste in containers with free liquids—**applicable**	40 *CFR* 264.175(a); 401 *KAR* 34:180 Section 6(1)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or	Storage of RCRA-hazardous waste in containers that do not contain free liquids—**applicable**	40 *CFR* 264.175(c); 401 *KAR* 34:180 Section 6(3)
	Containers must be elevated or otherwise protected from contact with accumulated liquid		
Storage of RCRA lamps ***(e.g., fluorescent, mercury vapor)***	Must contain any lamp in containers or packages that are structurally sound, adequate to prevent breakage, and compatible with the contents of the lamps.	Management of "universal waste lamp" as defined in 40 CFR 273.9 that are RCRA characteristic hazardous waste—**applicable**	40 CFR 273.13(d)(1); 401 *KAR* 43:020 Section 4(4)(a)
	Containers must be closed, structurally sound, compatible with the contents of the lamps and must lack evidence of leakage, spillage, or damage that could cause leakage or releases of mercury or other hazardous constituents to the environment under reasonably foreseeable conditions.		40 CFR 273.13(d)(2); 401 *KAR* 43:020 Section 4(4)(a)
	Each lamp or a container or package in which such lamps are contained must be labeled or marked clearly with one of the following phrases: "Universal Waste-Lamp(s),", or "Waste Lamps", or "Used Lamps".		40 CFR 273.14(e); 401 *KAR* 43:020 Section 5(5)
	Mark or label the individual item with the date the lamp(s) became a waste, or mark or label the container or package with date wastes received.		40 CFR 273.15(c)(1)-(6); 401 *KAR* 43:020 Section 6(3)
Characterization of LLW ***(e.g., radioactively contaminated equipment, debris)***	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility	Generation of LLW for storage or disposal at a DOE facility—**TBC**	DOE M 435.1-1(IV)(I)
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)(a)
	• physical and chemical characteristics;		DOE M 435.1-1(IV)(I)(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(IV)(I)(2)(b)
	• weight of the container and contents;		DOE M 435.1-1(IV)(I)(2)(c)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	• identities, activities, and concentration of major radionuclides;		DOE M 435.1-1(IV)(I)(2)(d)
	• characterization date;		DOE M 435.1-1(IV)(I)(2)(e)
	• generating source; and		DOE M 435.1-1(IV)(I)(2)(f)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives		DOE M 435.1-1(IV)(I)(2)(g)
Temporary storage of LLW ***(e.g., radioactively contaminated equipment, debris)***	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water	Management of LLW at a DOE facility—**TBC**	DOE M 435.1-1(IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage		DOE M 435.1-1(IV)(N)(3)
	Shall be managed to identify and segregate LLW from mixed waste		DOE M 435.1-1(IV)(N)(6)
Packaging of solid LLW for storage ***(e.g., radioactively contaminated equipment, debris)***	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container	Storage of LLW in containers at a DOE facility —**TBC**	DOE M 435.1-1(IV)(L)(1)(a)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container		DOE M 435.1-1(IV)(L)(1)(b)
	Containers shall be marked such that their contents can be identified		DOE M 435.1-1(IV)(L)(1)(c)
Segregation of scrap metal for recycle	Material is not subject to RCRA requirements for generators, transporters, and storage facilities under 40 *CFR* Parts 262 through 266, 268, 270, or 124	Scrap metal [as defined in 40 *CFR* 261.1(c)(6)] intended for recycle—**applicable**	40 *CFR* 261.6(a)(3)(ii);
	Scrap metal may be subject to additional RCRA requirements if it is not recycled in a timely manner		KAR 31:010, Section 6

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Release of scrap metal ***(e.g., metal piping, steel structures)***	Before being released, items shall be surveyed to determine whether both removable and total surface contamination (including contamination present on or under any coating) is greater than the levels given in Fig. IV-1 of the DOE Order and that the contamination has been subjected to the ALARA process	Radionuclide-contaminated scrap materials and equipment intended for recycle or reuse—**TBC**	DOE Order 5400.5(II)(5)(c)(1)
Management of asbestos-containing waste prior to disposal ***(e.g., transite siding, pipe lagging, insulation, and ceiling tiles)***	Discharge no visible emissions to the outside air, or use one of the emission control and waste treatment methods specified in paragraphs (a)(1) through (a)(4) of 40 *CFR* 61.150	Collection, processing, packaging, or transporting of any asbestos-containing waste material generated by demolition activities —**applicable**	40 *CFR* 61.150(a);
Management of PCB waste ***(e.g., PCB liquids, PCB-contaminated articles, PCB bulk-product wastes)***	Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* 761, Subpart D	Generation of waste containing PCBs at concentrations ≥50 ppm—**applicable**	40 *CFR* 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found	Generation of PCB remediation waste (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.61
Management of PCB/ radioactive waste ***(e.g., PCB liquids, PCB-contaminated articles, PCB bulk-product wastes)***	Any person storing such waste must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* 761.65(a)(1), (b)(1)(ii), and (c)(6)(i)	Generation for disposal of PCB/radioactive waste with ≥50 ppm PCBs—**applicable**	40 *CFR* 761.50(b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties		40 *CFR* 761.50(b)(7)(ii)
	If, after taking into account only the PCB properties in the waste, the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill [e.g., PCB bulk-product waste under 40 *CFR* 761.62(b)(1)], the person may dispose of such waste without regard to the PCBs, based on its radioactive properties alone in accordance with applicable requirements		

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Temporary storage of PCB waste ***(e.g., PCB liquids, PCB-contaminated articles, PCB bulk-product wastes)***	Container(s) shall be marked as illustrated in 40 *CFR* 761.45(a)	Storage of PCBs and PCB items at concentrations ≥50 ppm for disposal—**applicable**	40 *CFR* 761.65(a)(1)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10)		40 *CFR* 761.65(c)(3)
	Any leaking PCB items and their contents shall be transferred immediately to a properly marked non-leaking container(s)		40 *CFR* 761.65(c)(5)
	The date shall be recorded when PCB items are removed from service, and the storage shall be managed such that PCB items can be located by this date. (Note: Date should be marked on the container.)	PCB items (includes PCB wastes) removed from service for disposal—**applicable**	40 *CFR* 761.65(c)(8)
	Container(s) shall be in accordance with requirements set forth in DOT HMR at 49 *CFR* 171–180		40 *CFR* 761.65(c)(6)
Storage of PCB/radioactive waste in containers ***(e.g., PCB liquids, PCB-contaminated articles, PCB bulk-product wastes)***	For liquid wastes, containers must be non-leaking	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performances standards—**applicable**	40 *CFR* 761.65(c)(6)(i)(A)
	For non-liquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 *CFR* 761.65(b)(1)(ii)		40 *CFR* 761.65(c)(6)(i)(B)
	For both liquid and non-liquid wastes, containers must meet all regulations and requirements pertaining to nuclear criticality safety		40 *CFR* 761.65(c)(6)(i)(C)
Storage of PCB waste and/or PCB/radioactive waste in a non-RCRA regulated unit	Storage facility must have or be	Storage of PCBs and PCB items at concentrations ≥50 ppm for disposal—**applicable**	40 *CFR* 761.65(b)(1)
	• adequate roof and walls to prevent rainwater from reaching stored PCBs and PCB items:		40 *CFR* 761.65(b)(1)(i)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	• adequate floor that has continuous curbing with a minimum 6-in.-high curb. Floor and curb must provide a containment volume equal to at least two times the internal volume of the largest PCB article or container or 25% of the internal volume of all articles or containers stored there, whichever is greater. (*Note:* 6 in. minimum curbing not required for area storing PCB/radioactive waste);	Storage of PCB/radioactive waste (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.65(b)(1)(ii)
	• no drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from curbed area;		40 *CFR* 761.65(b)(1)(iii)
	• floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, nonporous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* 761.65(b)(1)(iv)
	• not located at a site that is below 100-year flood water elevation		40 *CFR* 761.65(b)(1)(v)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10)		40 *CFR* 761.65(c)(3)
Storage of PCB waste and/or PCB/radioactive waste in a RCRA-regulated container storage area	Does not have to meet storage unit requirements in 40 *CFR* 761.65(b)(1) provided unit:	Storage of PCBs and PCB items designated for disposal—**applicable**	40 *CFR* 761.65(b)(2)
	• is permitted by EPA under RCRA Sect. 3004, or		40 *CFR* 761.65(b)(2)(i)
	• qualifies for interim status under RCRA Sect. 3005, or		40 *CFR* 761.65(b)(2)(ii)
	• is permitted by an authorized state under RCRA Sect. 3006, and		40 *CFR* 761.65(b)(2)(iii)
	• PCB spills cleaned up in accordance with Subpart G of 40 *CFR* 761		40 *CFR* 761.65(c)(1)(iv)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Temporary storage of PCB remediation waste or bulk PCB bulk-product waste in a waste pile	Waste must be placed in a pile that: • is designed and operated to control dispersal by wind, where necessary, by means other than wetting;	Storage of PCB remediation waste or PCB bulk-product waste at cleanup site or site of generation for up to 180 days—**applicable**	40 *CFR* 761.65(c)(9)(i)
	• does not generate leachate through decomposition or other reactions; and		40 *CFR* 761.65(c)(9)(ii)
	• is at a storage site with a liner designed, constructed, and installed to prevent any migration of wastes off or through liner into adjacent subsurface soil, groundwater, or surface water		40 *CFR* 761.65(c)(9)(iii)(A)
	Liner must be: • constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure because of pressure gradients, physical contact with waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;		40 *CFR* 761.65(c)(9)(iii)(A)(1)
	• placed on foundation or base capable of providing support to liner and resistance to pressure gradients above and below the liner to prevent failure because of settlement compression or uplift; and		40 *CFR* 761.65(c)(9)(iii)(A)(2)
	• installed to cover all surrounding earth likely to be in contact with waste		40 *CFR* 761.65(c)(9)(iii)(A)(3)
	Has a cover that meets the above requirements and installed to cover all of the stored waste likely to be contacted by precipitation, and is secured so as not to be functionally disabled by winds expected under normal weather conditions		40 *CFR* 761.65(c)(9)(iii)(B)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	Has a run-on control system designed, constructed, operated, and maintained such that it prevents flow on the stored waste during peak discharge from at least a 25-year storm, and collects and controls at least the water volume resulting from a 24-hour, 25-year storm		40 *CFR* 761.65(c)(q)(iii)(e)(1) and (2)
	Requirements of 40 *CFR* 761.65(c)(9) of this part may be modified under the risk-based disposal option of 40 *CFR* 761.61(c)		40 *CFR* 761.65(c)(9)(iv)
Treatment/disposal of waste— removed wastes, debris, and secondary wastes			
Disposal of RCRA-hazardous waste in a land-based unit ***(e.g., debris with lead paint, mercury switches, etc.)***	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal	Land disposal (as defined in 40 *CFR* 268.2) of restricted RCRA waste—**applicable**	40 *CFR* 268.40(a); 401 *KAR* 37:040 Section 1
Disposal of RCRA wastewaters	Are not prohibited unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40, or are D003 reactive cyanide	Restricted RCRA characteristic hazardous waste waters managed in a treatment system that is NPDES permitted—**applicable**	40 *CFR* 268.1(c)(4)(iv); 401 *KAR* 37:010 Section 2 (5)(e)
Disposal of hazardous debris	May be land disposed if it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 *CFR* 268.45 before land disposal or the debris is treated to the waste-specific treatment standard provided in 40 *CFR* 268.40 for the waste contaminating the debris	Land disposal (as defined in 40 *CFR* 268.2) of restricted RCRA-hazardous debris—**applicable**	40 *CFR* 268.45(a); 401 *KAR* 37:040 Section 6(1)
Disposal of treated hazardous debris	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 *CFR* 268.45 and which no longer exhibits a characteristic is not a hazardous waste and need not be managed in RCRA Subtitle C facility	Treated debris contaminated with RCRA-listed or characteristic waste—**applicable**	40 *CFR* 268.45(c); 401 *KAR* 37:040 Section 6(3)
	Hazardous debris contaminated with listed waste that is treated by immobilization technology must be managed in a RCRA Subtitle C facility		
Disposal of hazardous debris treatment residues	Except as provided in 268.45(d)(2) and (d)(4), residues from treatment of hazardous debris must be separated from debris, and such residues are subject to the waste-specific treatment standards for the waste contaminating the debris	Treated debris contaminated with RCRA-listed or characteristic waste—**applicable**	40 *CFR* 268.45(d)(1); 401 *KAR* 37:040 Section 6(4)(a)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Packaging of LLW for disposal ***(e.g., radioactively contaminated equipment, debris)***	Must not be packaged for disposal in cardboard or fiberboard boxes	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(b)
	Must be solidified or packaged in sufficient absorbent material to absorb twice the volume of liquid	Generation of liquid LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(c)
	Shall contain as little free standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume	Generation of solid LLW containing liquid for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(d)
	Must not be capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures or of explosive reaction with water	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(e)
	Must not contain, or be capable of generating, quantities of toxic gases, vapor, or fumes	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(f)
	Must not be pyrophoric	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(g)
	Gaseous waste must be packages at a pressure not to exceed 1.5 atmospheres at 20 degrees C	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(h)
	Wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the nonradiological materials	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(1)(I)
	Must have structural stability either by processing the waste or placing the waste in a container or structure that provides stability after disposal	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(2)(a)(2)
	Must be converted into a form that contains as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form	Generation of liquid LLW or LLW containing liquids for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(2)(b)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	Void spaces within the waste and between the waste and its package must be reduced to the extent practicable	Generation of LLW for disposal at a LLW disposal facility —**relevant and appropriate**	902 *KAR* 100:021 Section 7(2)(c)
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility	Generation of LLW for disposal at a LLW disposal facility—**TBC**	DOE M 435.1-1(IV)(O)
Treatment of uranium and thorium bearing LLW	Such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause exceedance of Rn-222 emission limits of DOE Order 5400.5(IV)(6)(d)(1)(b) and will not result in premature structure failure of the facility	Placement of potentially biodegradable contaminated wastes in a long-term management facility —**TBC**	DOE Order 5400.5(IV)(6)(d)(1)(c)
Disposal of solid LLW ***(e.g., radioactively contaminated equipment, debris)***	LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility	Generation of LLW for disposal at a DOE facility—**TBC**	DOE M 435.1-01(IV)(J)(2)
Disposal of asbestos-containing waste material ***(e.g., transite siding, pipe lagging, insulation, and ceiling tiles)***	Shall be deposited as soon as practicable at:	Asbestos-containing waste material or RACM (except Category I non-friable asbestos-containing material) from demolition activities—**applicable**	40 *CFR* 61.150(b);
	• an approved waste disposal site operated in accordance with 40 *CFR* 61.154 or		40 *CFR* 61.150(b)(1);
	• an EPA-approved site that converts RACM and asbestos-containing waste material into non-asbestos (asbestos-free) material according to the provisions of 40 *CFR* 61.155		40 *CFR* 61.150(b)(2);
Disposal of fluorescent light ballasts	Must be disposed of in a TSCA-approved disposal facility, as bulk-product waste under 40 *CFR* 761.62, or in accordance with the decontamination provisions of 40 *CFR* 761.79	Generation for disposal of fluorescent light ballasts containing PCBs in the potting material—**applicable**	40 *CFR* 761.60(b)(6)(iii)
Disposal of PCB capacitor(s)	Shall comply with all requirements of Sect. 761.60 unless it is known from label or nameplate information, manufacturer's literature, or chemical analysis that the capacitor does not contain PCBs	Generation of PCB Capacitors with ≥50 PCBs for disposal—**applicable**	40 *CFR* 761.60(b)(2)(i)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
	May dispose of in a municipal solid waste landfill unless subject to 40 *CFR* 761.60(b)(2)(iv)	Generation for disposal of intact, non-leaking PCB small capacitors (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.60(b)(2)(ii)
	Shall dispose of in accordance with either of the following: • disposal in an incinerator that complies with 40 *CFR* 761.70 or • disposal in a chemical waste landfill that complies with 40 *CFR* 761.75	PCB large capacitor which contains $\geq$500 ppm PCBs—**applicable**	40 *CFR* 761.60(b)(2)(iii)
	Shall dispose of in one of the following disposal facilities approved under this part: • incinerator under 40 *CFR* 761.70, • chemical waste landfill under 40 *CFR* 761.75, • high-efficiency boiler under 40 *CFR* 761.70, or • scrap metal recovery oven and smelter under 40 *CFR* 761.71	Disposal of large capacitors that contain $\geq$50 ppm but <500 ppm PCBs—**applicable**	40 *CFR* 761.60(b)(4)(ii)
Disposal of PCB-contaminated electrical equipment (except capacitors)	Must remove all free-flowing liquid from the electrical equipment and dispose of the removed liquid in accordance with 40 *CFR* 760.61(a) and	Generation of PCB-contaminated electrical equipment (as defined in 40 *CFR* 761.3) for disposal—**applicable**	40 *CFR* 761.60(b)(4)
	Dispose of by one of the following methods:	Drained PCB-contaminated electrical equipment including any residual liquids— **applicable**	
	• in a facility permitted, licensed, or registered by a state to manage municipal solid waste or nonmunicipal nonhazardous waste;		40 *CFR* 761.60(b)(4)(i)(A)
	• in an industrial furnace operating in compliance with 40 *CFR* 761.72; or		40 *CFR* 761.60(b)(4)(i)(B)
	• in a disposal facility approved under this part		40 *CFR* 761.60(b)(4)(i)(C)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Disposal of decontamination waste and residues	Such waste shall be disposed of at their existing PCB concentration unless otherwise specified in 40 *CFR* 761.79(g)(1-6)	PCB decontamination waste and residues—**applicable**	40 *CFR* 761.79(g)
Disposal of PCB-contaminated precipitation, condensation, leachate, or load separation	May be disposed in a chemical waste landfill which complies with 40 *CFR* 761.75 if:	PCB liquids at concentrations ≥50 ppm from incidental sources and associated with PCB articles or non-liquid PCB wastes—**applicable**	40 *CFR* 761.60(a)(3)
	• disposal does not violate 40 *CFR* 268.32(a) or 268.42(a)(1) and		40 *CFR* 761.60(a)(3)(i)
	• liquids do not exceed 500 ppm PCB and are not an ignitable waste as described in 40 *CFR* 761.75(b)(8)(iii)		40 *CFR* 761.60(a)(3)(ii)
Disposal of PCB-contaminated porous surfaces	Shall be disposed on-site or off-site as bulk PCB-remediation waste according to 40 *CFR* 761.61(a)(5)(i) or decontaminated for use according to 40 *CFR* 761.79(b)(4)	PCB remediation waste porous surfaces (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.61(a)(5)(iii)
Disposal of PCB-contaminated nonporous surfaces on-site	Shall be cleaned on-site or off-site to levels in 40 *CFR* 761.61(a)(4)(ii) using: • decontamination procedures under 40 *CFR* 761.79, • technologies approved under 40 *CFR* 761.60(e), or • risk-based procedures/technologies under Sect. 761.61(c)	PCB remediation waste nonporous surfaces (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.61(a)(56)(ii)(A)
Disposal of PCB-contaminated nonporous surfaces off-site	Shall be disposed of in accordance with 40 *CFR* 761.61(a)(5)(i)(B)(3)(ii) [sic] 40 *CFR* 761.61(a)(5)(i)(B)(2)(ii) Metal surfaces may be thermally decontaminated in accordance with 40 *CFR* 761.79(c)(6)(i)	PCB remediation waste nonporous surfaces (as defined in 40 *CFR* 761.3) having surface concentrations <100 µg/100 cm^2—**applicable**	40 *CFR* 761.61(a)(5)(ii)(B)(1)
	Shall be disposed of in accordance with 40 *CFR* 761.61(a)(5)(i)(B)(3)(iii) [sic 40 *CFR* 761.61(a)(5)(i)(B)(2)(iii)] Metal surfaces may be thermally decontaminated in accordance with 40 *CFR* 761.79(c)(6)(ii)	PCB remediation waste nonporous surfaces having surface concentrations ≥100 µg/100 cm^2 —**applicable**	40 *CFR* 761.61 (a)(5)(ii)(B)(2)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Disposal of PCB-contaminated articles ***(e.g., hydraulic machines, electrical equipment)***	Must remove all free-flowing liquid from the article, disposing of the liquid in compliance with the requirements of 40 *CFR* 761.60(a)(2) or (a)(3) and	Generation for disposal of PCB-contaminated articles (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.60(b)(6)(ii)
	Dispose by one of the following methods:	Disposal of PCB-contaminated articles with no free-flowing liquid—**applicable**	40 *CFR* 761.60(b)(6)(ii)
	• in accordance with the decontamination provisions at 40 *CFR* 761.79;		40 *CFR* 761.60(b)(6)(ii)(A)
	• in a facility permitted, licensed, or registered by a state to manage municipal solid waste or nonmunicipal nonhazardous waste;		40 *CFR* 761.60(b)(6)(ii)(B)
	• in an industrial furnace operating in compliance with 40 *CFR* 761.72; or		40 *CFR* 761.60(b)(6)(ii)(C)
	• in a disposal facility approved under this part		40 *CFR* 761.60(b)(6)(ii)(D)
Disposal of PCB articles	Must be disposed of:	Generation of PCB articles (with ≥500 ppm PCBs) for disposal—**applicable**	40 *CFR* 761.60(b)(6)(i)
	• in an incinerator that complies with 40 *CFR* 761.70 or		40 *CFR* 761.60(b)(6)(i)(A)
	• in a chemical waste landfill that complies with 40 *CFR* 761.75 [provided all liquids are removed (i.e., drained) and disposed in an incinerator that complies with 40 *CFR* 761.70]		40 *CFR* 761.60(b)(6)(i)(B)
Disposal of PCB liquids ***(e.g., from drained electrical equipment)***	Must be disposed of in an incinerator that complies with 40 *CFR* 761.70, except	PCB liquids at concentrations ≥50 ppm—**applicable**	40 *CFR* 761.60(a)
	• for mineral oil dielectric fluid may be disposed of in a high-efficiency boiler according to 40 *CFR* 761.71(a) and	PCB liquids at concentrations ≥50 ppm and <500 ppm—**applicable**	40 *CFR* 761.60(a)(1)
	• for liquids other than mineral oil dielectric fluid, may be disposed of in a high-efficiency boiler according to 40 *CFR* 761.71(b)		40 *CFR* 761.60(a)(2)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Performance-based disposal of PCB remediation waste ***(e.g., contaminated building structure or materials)***	May dispose of by one of the following methods:	Disposal of non-liquid PCB remediation waste (including porous and non-porous surfaces contaminated from a leaking PCB transformer)—**applicable**	40 *CFR* 761.61(b)(2)
	• in a high-temperature incinerator approved under 40 *CFR* 761.70(b), • by an alternate disposal method approved under 40 *CFR* 761.60(e), • in a chemical waste landfill approved under 40 *CFR* 761.75, • in a facility with a coordinated approval issued under 40 *CFR* 761.77, or • through decontamination in accordance with 40 *CFR* 761.79		40 *CFR* 761.61(b)(2)(i)
Disposal of PCB cleanup wastes ***(e.g., contaminated PPE, non-liquid cleaning materials)***	Shall be disposed of either: • in a facility permitted, licensed, or registered by a state to manage municipal solid waste under 40 *CFR* 258 or nonmunicipal, nonhazardous waste subject to 40 *CFR* 257.5 through 257.30; • in a RCRA Subtitle C landfill permitted by a state to accept PCB waste; • in an approved PCB disposal facility; or • through decontamination under 40 *CFR* 761.79(b) or (c)	Generation of non-liquid PCBs at any concentration during and from the cleanup of PCB remediation waste—**applicable**	40 *CFR* 761.61(a)(5)(v)(A)
Disposal of PCB cleaning solvents, abrasives, and equipment	May be reused after decontamination in accordance with 40 *CFR* 761.79	Generation of PCB wastes from the cleanup of PCB remediation waste—**applicable**	40 *CFR* 761.61(a)(5)(v)(B)
Performance-based disposal of PCB bulk-product waste	May dispose of by one of the following:	Disposal of PCB bulk-product waste (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.62(a)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
(e.g., equipment, debris with PCB painted surfaces)	• in an incinerator approved under 40 *CFR* 761.70,		40 *CFR* 761.62(a)(1)
	• in a chemical waste landfill approved under 40 *CFR* 761.75,		40 *CFR* 761.62(a)(2)
	• in a hazardous waste landfill permitted by EPA under Sect. 3004 of RCRA or by authorized state under Sect. 3006 of RCRA,		40 *CFR* 761.62(a)(3)
	• under alternate disposal approved under 40 *CFR* 761.60(e)		40 *CFR* 761.62(a)(4)
	• in accordance with decontamination provisions of 40 *CFR* 761.79, or		40 *CFR* 761.62(a)(5)
	• in accordance with thermal decontamination provisions of 40 *CFR* 761.79(e)(6) for metal surfaces in contact with PCBs		40 *CFR* 761.62(a)(6)
Disposal of PCB bulk-product waste in solid waste landfill	May dispose of in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill	Non-liquid PCB bulk-product waste (known or presumed to leach <10 μg/L PCBs) that is not RCRA hazardous—**applicable**	40 *CFR* 761.62(b)(1)(i) and (ii)
	May dispose of in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill if	Other PCB bulk-product waste not meeting conditions of 40 *CFR* 761.62(b)(1) (e.g., paper/ felt gaskets contaminated by liquid PCBs)—**applicable**	40 *CFR* 761.62(b)(2)
	• PCB bulk-product waste is segregated from organic liquids disposed of in the landfill and		
	• leachate is collected from the landfill and monitored for PCBs		
	Materials removed from the C-410 Complex containing PCB residue in excess of 50 ppm cannot currently be placed within the U-Landfill		

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Risk-based disposal of PCB bulk-product waste	May dispose of in a manner other than prescribed in 40 *CFR* 761.62(a) or (b) if receive approval in writing from EPA and the method (based on technical, environmental, or waste-specific characteristics) will not pose an unreasonable risk of injury to human health or the environment	Disposal of PCB bulk-product waste—**applicable**	40 *CFR* 761.62(c)
	Land use controls—contaminated structures and facilities left in place		
Radioactive material left in place	A property may be maintained under interim management provided administrative controls are established to protect members of the public	Residual radioactive material above guidelines in inaccessible locations which would be unreasonably costly to remove—**TBC**	DOE Order 5400.5(IV)(6)(c)(1)
	Controls include, but are not limited to, periodic monitoring as appropriate, appropriate shielding, physical barriers (i.e., fences, warning signs) to prevent access, appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate		DOE Order 5400.5(IV)(6)(c)(2)
	Transportation		
Transportation of hazardous materials (including Class 7 radioactive materials)	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 *CFR* 171–180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material —**applicable**	49 *CFR* 171.1(c)
Transportation of radioactive waste	Shall be packaged and transported in accordance with DOE Order 460.1A and DOE Order 460.2	Shipment of LLW and/or TRU waste off-site—**TBC**	DOE M 435.1-(I)(1)(E)(11)
Transportation of LLW	To the extent practical, the volume of the waste and the number of the shipments shall be minimized	Shipment of LLW off-site—**TBC**	DOE M 435.1-1(IV)(L)(2)
Transportation of PCB wastes	Must comply with the manifesting provisions at 40 *CFR* 761.207 through 40 *CFR* 761.218	Relinquishment of control over PCB wastes by transporting, or offering for transport —**applicable**	40 *CFR* 761.207(a)

Table C.3. Action-specific ARARs and TBC guidance for D&D of the C-410 Complex (continued)

Action	Requirements	Prerequisite	Citations
Transport of RCRA wastewaters to wastewater treatment facility	All tank systems, conveyance systems, and ancillary equipment used to store or transport waste to an on-site NPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards	On-site wastewater treatment units that are subject to regulation under Section 402 or Section 307(b) of the CWA (NPDES-permitted)— **applicable**	40 CFR 270.1(c)(2)(v) 401 *KAR* 38:010 Section 1(2)(b)(5)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number	Off-site transportation of RCRA-hazardous waste—**applicable**	40 *CFR* 262.10(h); 401 *KAR* 32:030
	Must comply with the requirements of 40 *CFR* 263.11–263.31	Transportation of hazardous waste within the United States requiring a manifest—**applicable**	40 *CFR* 263.10(a); 401 *KAR* 33:010
	A transporter who meets all applicable requirements of 49 *CFR* 171–179 and the requirements of 40 *CFR* 263.11 and 263.31 will be deemed in compliance with 40 *CFR* 263		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 *CFR* 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**	40 *CFR* 262.20(f); 401 *KAR* 32:020 Section 1(1)

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
D&D = decontamination and decommissioning
DEACT = deactivation
DOE = U.S. Department of Energy
DOE M = *Radioactive Waste Management Manual*
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
KAR = *Kentucky Administrative Regulations*
mrem = millirem
TRU = transuranic

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APPENDIX D

COST ESTIMATE FOR THE C-410 INFRASTRUCTURE REMOVAL ACTION ALTERNATIVES

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TABLE OF CONTENTS

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D. KEY PARAMETERS AND ASSUMPTIONS FOR THE COSTING OF ALTERNATIVES

Information provided in this appendix includes the cost analysis for Alternatives 2 through 6 for the C-410 Complex Infrastructure Engineering Evaluation/ Cost Assessment. The cost estimates are intended to form a basis for comparing alternatives and not to provide a construction estimate for the remedial actions. The costs used in this analysis are based on existing contracts and labor agreements, estimating reference manuals, vendor quotes, and engineering estimates. The cost estimates are expected to provide an accuracy of -30 percent to +50 percent and are prepared using data available for the EE/CA.

The format for the cost estimate is based on guidance from the USEPA, Guide to Developing and Documenting Cost Estimates During a Feasibility Study, July 2000. The work breakdown structure and major assumptions are described below. The volumes of stored materials and process equipment infrastructure are summarized in Table D-1. A description of the indirect project cost has been provided in Table D-2. A summary report for each alternative is attached and includes capital cost, the operation and maintenance (O&M) cost, and indirect cost.

D.1 Work Breakdown Structure and Major Assumptions

The C-410 Complex work breakdown structure was setup for each building as follows:

1. Building C-420
2. Building C-410
3. Building C-410 C, F, G, H, J, and C-411 (These are smaller buildings and are estimated as a percentage of the C-410 building and applied as a markup at the end of the estimate.)
4. Stored Materials

The building infrastructure was originally estimated using historical information (site walk down was not performed). Therefore, the scope of removal and associated volumes were unknown and/or not completely defined. The scope of the process piping, auxiliary lines, and other small components were limited or unknown and were included by applying a cost markup to these items.

In August 2001, a walk down of the C-410 Complex was performed to better define the inventory of the major process equipment, process support equipment (i.e. process piping, auxiliary lines, and other small components), and stored materials. The new inventory resulted in a small increase of the major process equipment volume and a large increase compared to the initial estimates in process support equipment volume. The volume of stored materials was inventoried and found to be less than originally estimated. To provide an expedited revision to the cost estimates to account for the additional volume of major process equipment and process support equipment, a markup was applied to the existing major process equipment volumes. The additional volumes will be accounted for by applying a 225% cost markup to the cost of removing the major process equipment. The cost markup will be equal to 2.25 times the cost of removing, packaging, and disposing that piece of equipment.

The C-410 Complex infrastructure removal includes stored materials and process equipment contained within the buildings. The process equipment was further divided into the following categories (1) Major Process Equipment, (2) Process Support, (3) Auxiliary Buildings, and (4) Asbestos. The estimated volumes of stored materials and process equipment are shown in the Table D.1.

Table D.1. Stored Materials and Process Equipment Infrastructure Volumes

Item	Volume (cy)	Notes
Stored Materials	2,300	Based on Building Inventory. August 2001.
Major Process Equipment	2,850	Based on tabulation of existing building inventory of in-place equipment. February 2001.
Process Support Equipment	6,400	Assumed to be 225% of Major Process Equipment. Included as a markup of cost based on the August 2001 inventory.
Auxiliary Building	550	Assumed to be 8% of the C-410 building based on floor area. C-410 volume is 2,050 cy + (2,050 cy x 2.25) = 550 cy. Included as a markup of cost.
Asbestos	320	Based on Lee Wan Report
Total	12,420	

The C-410 Complex infrastructure is assumed to be removed for each of the alternatives except Alternative 1 (No Action) and 2 (Continue Surveillance and Maintenance). Alternatives 3-6 include the use of various technologies including decontamination, reuse, recycling, treatment, size reduction, and disposal. While several different disposal facilities may be available for use, the costing of alternatives assumed the use of Envirocare, U-landfill, and TSCA facilities.

The cost estimate for the C-410 Complex infrastructure alternatives included several contractor and owner markups. The contractor and owner markups included the following; (1) field overhead, (2) office overhead, (3) sales tax, (4) design contingency, (5) construction contingency, (6) design, (7) project management, (8) and program management. The markups used in the alternative cost are described in Table D.2.

Table D.2. Contractor and Owner Markups

Markup Item	Markup (%)	Notes
Field Overhead	20	Includes all general conditions (i.e. mobilization/demobilization cost) including field supervision of labor. This overhead item also includes all employee submittals, training, and ODC items required for the project.
Office Overhead	5	Includes engineering and technical support during construction and after construction. Does not include project or construction management.
Sales Tax	6	A sales tax of 6% was applied to all materials.
Design & Construction Contingency	25	Design contingency includes uncertainties due to the early stages of design. Construction contingency includes uncertainties during field activities. This would also include cost overruns, modifications, and change orders.
Design	7	
Project/Construction Management	8	
Program Management and Profit	10	

D.1 Other Key Parameters and Assumptions

- Productivity is adjusted for about 3 hours per 8-hour day due to anticipated working conditions.
- A typical crew includes ½ escort, 1 safety & health, ½ fire watch, and 4-5 laborers and operators. Field and home office supervision, management, and support are in addition.
- The total estimated labor hours required to complete all infrastructure removal activities for Alternative 6 is 290,000 hours. This is approximately equal to 24 trade workers for a six-year duration. Doubling the workforce would reduce the duration to three years. Alternatives 3-5 would have approximately the same total labor hours.
- The stored materials are assumed to be 25% sanitary materials, 70% LLW, and 5% mixed waste.
- Respirators are changed twice a day at $68 per change. This applies to a crew of about 25 for about 6 years.
- Monitoring and Sampling is included at over $800K for most alternatives (3-6) to cover radiation monitoring, contamination sampling, and waste acceptance sampling.
- Site work for most alternatives (3-6) includes provisions for lifting equipment, elevators, purge systems, shutdown confirmation, cover floor cutouts, and a rail spur upgrade. The allowance includes about $1.8 million for these activities.
- Asbestos abatement includes several steps that in combination cost about $340-430/c.y.
- Dismantlement of major process equipment includes about 220 items with a volume of about 2850 c.y. Individual operations vary, but this is typically estimated to cost over $400/c.y.
- Staging and packaging for major process equipment varies by item, but this is typically estimated to cost about $280/c.y.
- Staging, size reduction, and packaging are estimated to cost almost $500/c.y.
- Transportation for equipment is estimated at $104/c.y. Transportation for asbestos is estimated at $130/c.y.
- Disposal costs are $395/c.y. for debris, $50/c.y for sanitary materials, and $1000/c.y. for mixed solid waste.
- Only a limited quantity of material, about 300 c.y., is expected to be reused. No credit is provided for reuse, i.e., the bids are assumed to be about the breakeven cost for refurbishment for sale.
- Only about 100,000 lb of metal is assumed for recycle. A credit of $1/lb is assumed.

Note: All unit cost items listed above are bare cost and exclude indirect and owner cost.

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ALTERNATIVE 2 - Non-Discounted Cost

Project No. S/C 23900-BA-RM086F

Designed By:

SAIC

Estimated By:

Mike Fitzgerald and Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/02/2001

Effective Date of Pricing: 10/02/2001

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S/C 23900-BA-RM086F ALTERNATIVE 2 - Non-Discounted Cost

	Quantity		Unit Cost	Total Cost	
342 Building C-410 Complex (Non-Discounted Cost)					
02 Monitoring, Sampling, Testing, and Analysis					
01 Surveillance	30	YR	443,333.33	13,300,000	
SUBTOTAL Monitoring, Sampling, Testing, and Analysis	30	YR	443,333.33	13,300,000	95%
03 Sitework					
02 Maintenance	30	YR	23,462.21	703,866	
SUBTOTAL Sitework	30	YR	23,462.21	703,866	5%
SUBTOTAL Building C-410 Complex (Non-Discounted Cost)	30	YR	466,795.54	14,003,866	100%
SUBTOTAL	*12,420*	*CY*	*1,127.53*	*14,003,866*	
Field Overhead - Prime Contractor	20.0%		225.51	2,800,773	
Home Ofc. Overhead - Prime Contractor	5.0%		67.65	840,232	
SUBTOTAL	*12,420*	*CY*	*1,420.68*	*17,644,871*	
Design and Construction Contingencies	25.0%		355.17	4,411,218	
Remedial Design	7.0%		124.31	1,543,926	
Project and Construction Management	8.0%		152.01	1,888,001	
Program Management and Profit	10.0%		205.22	2,548,802	
ALTERNATIVE 2 - Non-Discounted Cost	**12,420**	**CY**	**2,257.39**	**28,036,818**	

ALTERNATIVE 3

Project No. S/C 23900-BA-RM086F

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SAIC

Estimated By:

Mike Fitzgerald and Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/02/2001

Effective Date of Pricing: 10/02/2001

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S/C 23900-BA-RM086F ALTERNATIVE 3

	Quantity	Unit Cost	Total Cost	
331 Building C-420 D&D				
02 Monitoring,Samplng,Test,Analysis				
01 PPE for Entire Project			5,940,000	
02 Radiation Monitoring			214,848	
07 Sampling Asbestos			5,000	
08 Sampling Radioactve Contam Media			70,000	
09 Waste Acceptance Criteria Sampling			200,000	
14 Off-Site Laboratory Facilities			75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis			6,504,848	48%
03 Site Work				
90 Elevators	2 EA	88,290.31	176,581	
91 Lifting Equipment (Personnel and Equipment)			750,000	
92 Rail Spur			50,000	
94 Nitrogen Purge System			5,000	
95 Confirm Equip Shutdown			11,684	
96 Patch/Cover Floor Cutouts			10,000	
SUBTOTAL Site Work			1,003,265	7%
10 Asbestos Abatement				
02 Asbestos Abatement Training			58,420	
04 Asbestos Abatement				
01 Preparatory Abatement Work	140 CY	137.80	19,293	
02 C-420 Abatement	140 CY	205.57	28,780	
03 Post-Abatement Work	140 CY	61.62	8,627	
99 Waste packaging, handling, & disposal	140 CY	3.17	444	
SUBTOTAL Asbestos Abatement	140 CY	408.17	57,144	
SUBTOTAL Asbestos Abatement	140 CY	825.46	115,564	1%
17 Decontamination & Decommission				
04 Dismantling Activities				
05 Zone 2 - Fifth Floor Removal			70,251	
10 Zone 5 - Fourth Floor Removal			109,361	
15 Zone 8 - Third Floor Removal			108,088	
20 Zone 11and 13 - Second Floor Zone			15,866	
25 Zone 14, 16, 17, 18, and 20 - First Floor (Inc. Mezzanine)			99,574	
27 Zone 15 - First Floor Auxillary			11,276	
30 Zones 4, 7, and 10 - HF Recovery Components			36,825	
SUBTOTAL Dismantling Activities			451,241	

	Quantity		Unit Cost	Total Cost	
SUBTOTAL Decontamination & Decommission				451,241	11%
18 Disposal					
18 Transport to Staging Area	790	CY	156.18	123,383	
19 Packaging	790	EA	223.96	176,929	
21 Transport to Storage/Disp Facil					
01 Equipment and Debris	1,200	CY	130.00	156,000	
02 Asbestos Contain. Materials	140	CY	130.00	18,200	
SUBTOTAL Transport to Storage/Disp Facil	1,340	CY	130.00	174,200	
22 Disposal Fees and Taxes	1,340	CY	633.67	849,120	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Disposal	1,340	EA	1,323.61	1,773,632	34%
SUBTOTAL Building C-420 D&D				9,848,550	45%
331 Building C-410 D&D					
02 Monitoring,Samplng,Test,Analysis					
02 Radiation Monitoring				214,848	
07 Sampling Asbestos				5,000	
08 Sampling Radioactve Contam Media				70,000	
09 Waste Acceptance Criteria Sampling				200,000	
14 Off-Site Laboratory Facilities				75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis				564,848	4%
03 Site Work					
91 Lifting Equipment (Personnel and Equipment)				750,000	
93 Staging Area				15,000	
95 Confirm Equip Shutdown				11,684	
SUBTOTAL Site Work				776,684	6%
10 Asbestos Abatement					
04 Asbestos Abatement					
01 Preparatory Abatement Work	180	CY	159.27	28,668	
02 Abatement	180	CY	85.67	15,420	
03 Post-Abatement Work	80,000	SF	0.21	16,987	
99 Waste packaging, handling, & disposal	180	CY	3.18	573	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	0%
17 Decontamination & Decommission					

	Quantity		Unit Cost	Total Cost	
04 Dismantling Activities					
05 Zones 22 and 26				188,785	
10 Zones 23, 24, and 27				63,884	
15 Zones 33				24,880	
20 Zones 36 and 37				29,196	
25 Zone 38				28,860	
30 Zone 41				28,137	
35 Zone 49				24,023	
40 Zone 50				7,478	
45 Zone 51				14,590	
60 Zone 54				23,268	
65 Zone 56				12,021	
70 Zone 58				4,301	
85 Outside Facilities and Equipment				78,549	
90 Removal and Staging of Fluorine Cells				63,110	
95 Removal of Copper Bus Work				185,726	
100 Waste Staging Area				4,695	
SUBTOTAL Dismantling Activities				781,503	
SUBTOTAL Decontamination & Decommission	299	EA	2,613.72	781,503	18%
18 Disposal					
18 Transport to Staging Area	2,050	CY	60.19	123,383	
19 Packaging	2,050	EA	195.09	399,925	
21 Transport to Storage/Disp Facil					
01 Equipment and Debris	3,070	CY	130.00	399,100	
02 Asbestos Contain. Materials	140	CY	130.00	18,200	
SUBTOTAL Transport to Storage/Disp Facil	3,210	CY	130.00	417,300	
22 Disposal Fees and Taxes	3,210	CY	647.75	2,079,291	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Disposal	3,210	EA	1,080.97	3,469,899	72%
SUBTOTAL Building C-410 D&D				5,654,581	50%
331 Building C-410 C, F, G, H, J & Building 411				1	0%
331 Stored Materials	2,272	CY	788.66	1,791,836	6%
SUBTOTAL	*12,420*	*CY*	*1,392.51*	*17,294,968*	
Field Overhead - Prime Contractor	20.0%		278.50	3,458,994	
Home Ofc. Overhead - Prime Contractor	5.0%		83.55	1,037,698	
SUBTOTAL	*12,420*	*CY*	*1,754.56*	*21,791,660*	

	Quantity		Unit Cost	Total Cost
No Inventory Available	225.0%		1,239.25	15,391,451
Bldg 410 C,F,G,H,J and 411	8.0%		113.97	1,415,448
Design and Construction Contingencies	25.0%		776.94	9,649,640
Remedial Design	7.0%		271.93	3,377,374
Project and Construction Management	8.0%		332.53	4,130,046
Program Management and Profit	10.0%		448.92	5,575,562
ALTERNATIVE 3	**12,420**	**CY**	**4,938.10**	**61,331,180**

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ALTERNATIVE 4

Project No. S/C 23900-BA-RM086F

Designed By:

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Estimated By:

Mike Fitzgerald and Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/02/2001

Effective Date of Pricing: 10/02/2001

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	Quantity	Unit Cost	Total Cost	
S/C 23900-BA-RM086F ALTERNATIVE 4				
331 Building C-420 D&D				
02 Monitoring,Samplng,Test,Analysis				
01 PPE for Entire Project			5,940,000	
02 Radiation Monitoring			214,848	
07 Sampling Asbestos			5,000	
08 Sampling Radioactve Contam Media			70,000	
09 Waste Acceptance Criteria Sampling			200,000	
14 Off-Site Laboratory Facilities			75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis			6,504,848	49%
03 Site Work				
90 Elevators	2 EA	88,290.31	176,581	
91 Lifting Equipment (Personnel and Equipment)			750,000	
92 Rail Spur			50,000	
94 Nitrogen Purge System			5,000	
95 Confirm Equip Shutdown			11,684	
96 Patch/Cover Floor Cutouts			10,000	
SUBTOTAL Site Work			1,003,265	8%
10 Asbestos Abatement				
02 Asbestos Abatement Training			58,420	
04 Asbestos Abatement				
01 Preparatory Abatement Work	140 CY	137.80	19,293	
02 C-420 Abatement	140 CY	205.57	28,780	
03 Post-Abatement Work	140 CY	61.62	8,627	
99 Waste packaging, handling, & disposal	140 CY	3.17	444	
SUBTOTAL Asbestos Abatement	140 CY	408.17	57,144	
SUBTOTAL Asbestos Abatement	140 CY	825.46	115,564	1%
17 Decontamination & Decommission				
01 Pre-Decommissioning Operations				
03 Decontamination and Rad Surveys	75 EA	1,721.05	129,079	
05 Decon Rinsate Treatment System			25,000	
SUBTOTAL Pre-Decommissioning Operations			154,079	

	Quantity		Unit Cost	Total Cost	
04 Dismantling Activities					
05 Zone 2 - Fifth Floor Removal				59,297	
10 Zone 5 - Fourth Floor Removal				80,648	
15 Zone 8 - Third Floor Removal				93,074	
20 Zone 11and 13 - Second Floor Zone				13,675	
25 Zone 14, 16, 17, 18, and 20 - First Floor (Inc. Mezzanine)				85,904	
27 Zone 15 - First Floor Auxillary				9,699	
30 Zones 4, 7, and 10 - HF Recovery Components				32,239	
SUBTOTAL Dismantling Activities				374,536	
SUBTOTAL Decontamination & Decommission				528,615	13%
18 Disposal					
18 Transport to Staging Area	810	CY	152.32	123,383	
19 Packaging and Loading	810	EA	188.33	152,547	
21 Transport to Storage/Disp Facil					
01 Equipment and Debris	1,170	CY	108.76	127,250	
02 Asbestos Contain. Materials	140	CY	130.00	18,200	
SUBTOTAL Transport to Storage/Disp Facil	1,340	CY	108.54	145,450	
22 Disposal Fees and Taxes	1,340	CY	460.57	617,159	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Disposal	1,310	EA	1,136.29	1,488,539	29%
SUBTOTAL Building C-420 D&D				9,640,830	52%
331 Building C-410 D&D					
02 Monitoring,Samplng,Test,Analysis					
02 Radiation Monitoring				214,848	
07 Sampling Asbestos				5,000	
08 Sampling Radioactve Contam Media				70,000	
09 Waste Acceptance Criteria Sampling				200,000	
14 Off-Site Laboratory Facilities				75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis				564,848	6%
03 Site Work					
91 Lifting Equipment (Personnel and Equipment)				750,000	
93 Staging Area				15,000	
95 Confirm Equip Shutdown				11,684	
SUBTOTAL Site Work				776,684	8%
10 Asbestos Abatement					

	Quantity		Unit Cost	Total Cost	
04 Asbestos Abatement					
01 Preparatory Abatement Work	180	CY	159.27	28,668	
02 Abatement	180	CY	85.67	15,420	
03 Post-Abatement Work	80,000	SF	0.21	16,987	
99 Waste packaging, handling, & disposal	180	CY	3.18	573	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	1%
17 Decontamination & Decommission					
01 Pre-Decommissioning Operations					
03 Decontamination and Rad Surveys				438,382	
05 Decon Rinsate Treatment System				25,000	
SUBTOTAL Pre-Decommissioning Operations				463,382	
04 Dismantling Activities					
05 Zones 22 and 26				175,202	
10 Zones 23, 24, and 27				59,035	
15 Zones 33				23,011	
20 Zones 36 and 37				26,362	
25 Zone 38				26,669	
30 Zone 41				26,093	
35 Zone 49				22,154	
40 Zone 50				6,689	
45 Zone 51				13,480	
60 Zone 54				21,399	
65 Zone 56				11,232	
70 Zone 58				3,979	
85 Outside Facilities and Equipment				72,386	
90 Removal and Staging of Fluorine Cells				58,436	
95 Removal of Copper Bus Work				177,927	
100 Waste Staging Area				4,374	
SUBTOTAL Dismantling Activities				728,429	
SUBTOTAL Decontamination & Decommission	299	EA	3,985.99	1,191,810	40%
18 Disposal					
18 Transport to Staging Area	1,800	CY	68.55	123,383	
20 Packaging and Loading	1,800	EA	157.39	283,301	
21 Transport to Disposal/Recycle Facility					
01 Equipment and Debris	2,600	CY	52.60	136,750	
02 Asbestos Contain. Materials	180	CY	130.00	23,400	
SUBTOTAL Transport to Disposal/Recycle Facility	2,780	CY	57.61	160,150	
22 Disposal Fees and Taxes	2,780	CY	217.39	604,357	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Disposal	2,780	CY	583.16	1,621,191	45%

	Quantity		Unit Cost	Total Cost	
SUBTOTAL Building C-410 D&D				4,216,180	41%
331 Building C-410 C, F, G, H, J & Building 411				1	0%
331 Stored Materials	2,272	CY	788.66	1,791,836	7%
SUBTOTAL	*12,420*	*CY*	*1,259.97*	*15,648,848*	
Field Overhead - Prime Contractor	20.0%		251.99	3,129,770	
Home Ofc. Overhead - Prime Contractor	5.0%		75.60	938,931	
SUBTOTAL	*12,420*	*CY*	*1,587.56*	*19,717,548*	
No Inventory Available	225.0%		904.35	11,232,086	
Bldg 410 C,F,G,H,J and 411	8.0%		77.83	966,675	
Design and Construction Contingencies	25.0%		642.44	7,979,077	
Remedial Design	7.0%		224.85	2,792,677	
Construction Management	8.0%		274.96	3,415,045	
Program Management & Profit	10.0%		371.20	4,610,311	
ALTERNATIVE 4	**12,420**	**CY**	**4,083.21**	**50,713,420**	

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ALTERNATIVE 5

Project No. S/C 23900-BA-RM086F

Designed By:

SAIC

Estimated By:

Mike Fitzgerald and Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/02/2001

Effective Date of Pricing: 10/02/2001

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by Building Systems Design, Inc.

	Quantity	Unit Cost	Total Cost	
S/C 23900-BA-RM086F ALTERNATIVE 5				
331 Building C-420 D&D				
02 Monitoring,Samplng,Test,Analysis				
01 PPE for Entire Project			5,940,000	
02 Radiation Monitoring			214,848	
07 Sampling Asbestos			5,000	
08 Sampling Radioactve Contam Media			70,000	
09 Waste Acceptance Criteria Sampling			200,000	
14 Off-Site Laboratory Facilities			75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis			6,504,848	47%
03 Site Work				
90 Elevators	2 EA	88,290.31	176,581	
91 Lifting Equipment (Personnel and Equipment)			750,000	
92 Rail Spur			50,000	
94 Nitrogen Purge System			5,000	
95 Confirm Equip Shutdown			11,684	
96 Patch/Cover Floor Cutouts			10,000	
SUBTOTAL Site Work			1,003,265	7%
10 Asbestos Abatement				
02 Asbestos Abatement Training			58,420	
04 Asbestos Abatement				
01 Preparatory Abatement Work	140 CY	137.80	19,293	
02 C-420 Abatement	140 CY	205.57	28,780	
03 Post-Abatement Work	140 CY	61.62	8,627	
99 Waste packaging, handling, & disposal	140 CY	3.17	444	
SUBTOTAL Asbestos Abatement	140 CY	408.17	57,144	
SUBTOTAL Asbestos Abatement	140 CY	825.46	115,564	1%
17 Decontamination & Decommission				
04 Dismantling Activities				
05 Zone 2 - Fifth Floor Removal			70,251	
10 Zone 5 - Fourth Floor Removal			109,361	
15 Zone 8 - Third Floor Removal			108,088	
20 Zone 11and 13 - Second Floor Zone			15,866	
25 Zone 14, 16, 17, 18, and 20 - First Floor (Inc. Mezzanine)			99,574	
27 Zone 15 - First Floor Auxillary			11,276	
30 Zones 4, 7, and 10 - HF Recovery Components			36,825	
SUBTOTAL Dismantling Activities			451,241	

	Quantity		Unit Cost	Total Cost	
SUBTOTAL Decontamination & Decommission				451,241	11%
18 Size Reduction, Transportation & Disposal					
18 Transport to Staging Area	810	CY	152.32	123,383	
19 Size Reduction & Packaging	810	CY	797.82	646,232	
21 Transport to Storage/Disp Facil					
01 Equipment and Debris	490	CY	130.00	63,700	
02 Asbestos Contain. Materials	140	CY	130.00	18,200	
SUBTOTAL Transport to Storage/Disp Facil	630	CY	130.00	81,900	
22 Disposal Fees and Taxes	630	CY	810.33	510,506	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Size Reduction, Transportation & Disposal	630	CY	2,876.22	1,812,022	34%
SUBTOTAL Building C-420 D&D				9,886,940	47%
331 Building C-410 D&D					
02 Monitoring,Samplng,Test,Analysis					
02 Radiation Monitoring				214,848	
07 Sampling Asbestos				5,000	
08 Sampling Radioactve Contam Media				70,000	
09 Waste Acceptance Criteria Sampling				200,000	
14 Off-Site Laboratory Facilities				75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis				564,848	4%
03 Site Work					
91 Lifting Equipment (Personnel and Equipment)				750,000	
93 Staging Area				15,000	
95 Confirm Equip Shutdown				11,684	
SUBTOTAL Site Work				776,684	6%
10 Asbestos Abatement					
04 Asbestos Abatement					
01 Preparatory Abatement Work	180	CY	159.27	28,668	
02 Abatement	180	CY	85.67	15,420	
03 Post-Abatement Work	80,000	SF	0.21	16,987	
99 Waste packaging, handling, & disposal	180	CY	3.18	573	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	
SUBTOTAL Asbestos Abatement	180	CY	342.48	61,647	0%
17 Decontamination & Decommission					

	Quantity		Unit Cost	Total Cost	
04 Dismantling Activities					
05 Zones 22 and 26				188,785	
10 Zones 23, 24, and 27				63,884	
15 Zones 33				24,880	
20 Zones 36 and 37				29,196	
25 Zone 38				28,860	
30 Zone 41				28,137	
35 Zone 49				24,023	
40 Zone 50				7,478	
45 Zone 51				14,590	
60 Zone 54				23,268	
65 Zone 56				12,021	
70 Zone 58				4,301	
85 Outside Facilities and Equipment				78,549	
90 Removal and Staging of Fluorine Cells				63,110	
95 Removal of Copper Bus Work				185,726	
100 Waste Staging Area				4,695	
SUBTOTAL Dismantling Activities				781,503	
SUBTOTAL Decontamination & Decommission	299	EA	2,613.72	781,503	20%
18 Size Reduction, Transportation & Disposal					
18 Transport to Staging Area	2,050	CY	60.19	123,383	
20 Size Reduction & Packaging	2,050	EA	539.23	1,105,428	
21 Transport to Disposal/Recycle Facility					
01 Equipment and Debris	1,220	CY	130.00	158,600	
02 Asbestos Contain. Materials	180	CY	130.00	23,400	
SUBTOTAL Transport to Disposal/Recycle Facility	1,400	CY	130.00	182,000	
22 Disposal Fees and Taxes	1,400	CY	857.21	1,200,089	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Size Reduction, Transportation & Disposal	1,400	CY	2,186.36	3,060,900	69%
SUBTOTAL Building C-410 D&D				5,245,582	47%
331 Building C-410 C, F, G, H, J & Building 411				1	0%
331 Stored Materials	2,272	CY	788.66	1,791,836	6%
SUBTOTAL	*12,420*	*CY*	*1,362.67*	*16,924,359*	
Field Overhead - Prime Contractor	20.0%		272.53	3,384,872	
Home Ofc. Overhead - Prime Contractor	5.0%		81.76	1,015,462	
SUBTOTAL	*12,420*	*CY*	*1,716.96*	*21,324,693*	

	Quantity		Unit Cost	Total Cost
No Inventory Available	225.0%		1,149.85	14,281,161
Bldg 410 C,F,G,H,J and 411	8.0%		102.79	1,276,691
Design and Construction Contingencies	25.0%		742.40	9,220,636
Remedial Design	7.0%		259.84	3,227,223
Construction Management	8.0%		317.75	3,946,432
Program Management and Profit	10.0%		428.96	5,327,684
ALTERNATIVE 5	**12,420**	**CY**	**4,718.56**	**58,604,519**

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ALTERNATIVE 6

Project No. S/C 23900-BA-RM086F

Designed By:

SAIC

Estimated By:

Mike Fitzgerald and Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/02/2001

Effective Date of Pricing: 10/02/2001

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by Building Systems Design, Inc.

	Quantity		Unit Cost	Total Cost	
S/C 23900-BA-RM086F ALTERNATIVE 6					
331 Building C-420 Major Process Equipment D&D					
02 Monitoring,Samplng,Test,Analysis					
01 PPE for Entire Project				5,940,000	
02 Radiation Monitoring				214,848	
07 Sampling Asbestos				5,000	
08 Sampling Radioactve Contam Media				70,000	
09 Waste Acceptance Criteria Sampling				200,000	
14 Off-Site Laboratory Facilities				75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis				6,504,848	51%
03 Site Work					
90 Elevators	2	EA	110,362.89	220,726	
91 Lifting Equipment (Personnel and Equipment)				750,000	
92 Rail Spur				50,000	
94 Nitrogen Purge System				5,000	
95 Confirm Equip Shutdown				11,684	
96 Patch/Cover Floor Cutouts				10,000	
SUBTOTAL Site Work				1,047,410	8%
10 Asbestos Abatement					
02 Asbestos Abatement Training				58,420	
04 Asbestos Abatement					
01 Preparatory Abatement Work	140	CY	145.30	20,342	
02 C-420 Abatement	140	CY	208.18	29,145	
03 Post-Abatement Work	140	CY	69.55	9,737	
99 Waste packaging, handling, & disposal	140	CY	3.17	444	
SUBTOTAL Asbestos Abatement	140	CY	426.20	59,668	
SUBTOTAL Asbestos Abatement	140	CY	843.48	118,088	1%
17 Decontamination & Decommission					
01 Pre-Decommissioning Operations					
03 Decontamination and Rad Surveys	75	EA	811.82	60,886	
05 Decon Rinsate Treatment System				25,000	
SUBTOTAL Pre-Decommissioning Operations				85,886	

	Quantity		Unit Cost	Total Cost	
04 Dismantling Activities					
05 Zone 2 - Fifth Floor Removal				70,251	
10 Zone 5 - Fourth Floor Removal				109,361	
15 Zone 8 - Third Floor Removal				108,088	
20 Zone 11and 13 - Second Floor Zone				15,866	
25 Zone 14, 16, 17, 18, and 20 - First Floor (Inc. Mezzanine)				99,574	
27 Zone 15 - First Floor Auxillary				11,276	
30 Zones 4, 7, and 10 - HF Recovery Components				36,825	
SUBTOTAL Dismantling Activities				451,241	
SUBTOTAL Decontamination & Decommission				537,128	14%
18 Disposal					
18 Transport to Staging Area	810	CY	152.32	123,383	
19 Size Reduction & Packaging	810	EA	591.64	479,232	
21 Transport to Storage/Disp Facil					
01 Equipment and Debris	525	CY	103.71	54,450	
02 Asbestos Contain. Materials	140	CY	130.00	18,200	
SUBTOTAL Transport to Storage/Disp Facil	665	CY	109.25	72,650	
22 Disposal Fees and Taxes	665	CY	262.85	174,798	
99 Mixed and Hazardous Waste	101	CY	4,455.45	450,000	
SUBTOTAL Disposal	665	EA	1,954.98	1,300,063	26%
SUBTOTAL Building C-420 Major Process Equipment D&D				9,507,537	52%
331 Building C-410 Major Process Equipment D&D					
02 Monitoring,Samplng,Test,Analysis					
02 Radiation Monitoring				214,848	
07 Sampling Asbestos				5,000	
08 Sampling Radioactve Contam Media				70,000	
09 Waste Acceptance Criteria Sampling				200,000	
14 Off-Site Laboratory Facilities				75,000	
SUBTOTAL Monitoring,Samplng,Test,Analysis				564,848	6%
03 Site Work					
91 Lifting Equipment (Personnel and Equipment)				750,000	
93 Staging Area				15,000	
95 Confirm Equip Shutdown				11,684	
SUBTOTAL Site Work				776,684	8%
10 Asbestos Abatement					

	Quantity		Unit Cost	Total Cost	
04 Asbestos Abatement					
01 Preparatory Abatement Work	180	CY	167.35	30,123	
02 Abatement	180	CY	85.96	15,473	
03 Post-Abatement Work	80,000	SF	0.23	18,377	
99 Waste packaging, handling, & disposal	180	CY	3.18	573	
SUBTOTAL Asbestos Abatement	180	CY	358.59	64,546	
SUBTOTAL Asbestos Abatement	180	CY	358.59	64,546	1%
17 Decontamination & Decommission					
01 Pre-Decommissioning Operations					
03 Decontamination and Rad Surveys				178,600	
05 Decon Rinsate Treatment System				25,000	
SUBTOTAL Pre-Decommissioning Operations				203,600	
04 Dismantling Activities					
05 Zones 22 and 26				188,785	
10 Zones 23, 24, and 27				63,884	
15 Zones 33				24,880	
20 Zones 36 and 37				29,196	
25 Zone 38				28,860	
30 Zone 41				28,137	
35 Zone 49				24,023	
40 Zone 50				7,478	
45 Zone 51				14,590	
60 Zone 54				23,268	
65 Zone 56				12,021	
70 Zone 58				4,301	
85 Outside Facilities and Equipment				78,549	
90 Removal and Staging of Fluorine Cells				63,110	
95 Removal of Copper Bus Work				185,726	
100 Waste Staging Area				4,695	
SUBTOTAL Dismantling Activities				781,503	
SUBTOTAL Decontamination & Decommission	299	EA	3,294.66	985,103	35%
18 Disposal					
18 Transport to Staging Area	1,800	CY	68.55	123,383	
20 Size Reduction & Packaging	1,800	EA	388.05	698,498	
21 Transport to Disposal/Recycle Facility					
01 Equipment and Debris	1,460	CY	79.08	115,450	
02 Asbestos Contain. Materials	180	CY	130.00	23,400	
SUBTOTAL Transport to Disposal/Recycle Facility	1,640	CY	84.66	138,850	
22 Disposal Fees and Taxes	1,640	CY	144.88	237,603	
99 Mixed and Hazardous Waste				450,000	
SUBTOTAL Disposal	1,640	CY	1,005.08	1,648,334	50%

	Quantity		Unit Cost	Total Cost	
SUBTOTAL Building C-410 Major Process Equipment D&D				4,039,515	40%
331 Stored Materials	2,272	CY	788.66	1,791,836	7%
SUBTOTAL	*12,420*	*CY*	*1,235.02*	*15,338,887*	
Field Overhead - Prime Contractor	20.0%		247.00	3,067,777	
Home Ofc. Overhead - Prime Contractor	5.0%		74.10	920,333	
SUBTOTAL	*12,420*	*CY*	*1,556.12*	*19,326,998*	
No Inventory Available (Process & Auxillary lines)	225.0%		851.19	10,571,794	
Bldg 410 C,F,G,H,J and 411	8.0%		74.42	924,295	
Design and Construction Contingency	25.0%		620.43	7,705,772	
Remedial Design	7.0%		217.15	2,697,020	
Project/Construction Mgt.	8.0%		265.55	3,298,070	
Program Management and Profit	10.0%		358.49	4,452,395	
ALTERNATIVE 6	**12,420**	**CY**	**3,943.34**	**48,976,345**	

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