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OAK RIDGE Y-12 PLANT

MARTIN MARIETTA

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ENVIRONMENTAL ASSESSMENT

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PROPOSED
REPLACEMENT AND OPERATION
OF THE
ANHYDROUS HYDROGEN FLUORIDE
SUPPLY
AND FLUIDIZED-BED REACTOR SYSTEM
AT BUILDING 9212

March 1995

Prepared by the
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
managed by
Martin Marietta Energy Systems, Inc.
for the U.S. Department of Energy
under Contract DE-AC05-84OR21400

MASTER

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY
UCN-13672 (2 10-90)

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**NOTICE OF AVAILABILITY
and OPPORTUNITY TO COMMENT
on the
Environmental Assessment
for the
Replacement and Operation of the Anhydrous Hydrogen Fluoride Supply System
at the Oak Ridge Y-12 Plant**

In accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, the U.S. Department of Energy (DOE) has prepared an Environmental Assessment (EA) for the Replacement and Operation of the Anhydrous Hydrogen Fluoride (AHF) Supply System at the Oak Ridge Y-12 Plant. The EA evaluates the potential environmental impacts associated with the replacement and operation of an existing supply and distribution system for AHF in Building 9212 of the Oak Ridge Y-12 Plant.

Anhydrous Hydrogen Fluoride is a key component in the chemical operation processes associated with the recycling and manufacturing of highly enriched uranium at the Oak Ridge Y-12 Plant. The current AHF Supply System was designed and constructed more than 40 years ago, and its long-term reliability cannot be assured. This system has not operated since January 1992. The proposed action would provide for an upgraded system that when operated would reduce the risk of exposing the Y-12 Plant work force, public, and environment in the event of an accidental release and would ensure the continuing ability of the Y-12 Plant to manufacture highly enriched uranium metal and process uranium from retired weapons for storage.

In accordance with the DOE NEPA Implementing Procedures (Title 10, Code of Federal Regulations, Part 1021), DOE is hereby making the EA available for review to other federal agencies, states, local governments, American Indian tribes, interested groups, and the general public for a 30-day comment period. At the close of this 30-day comment period, DOE will consider any written comments received as part of its decision-making process before approving or modifying the EA, as appropriate.

Based on the comments and analyses in the EA, DOE will determine if the proposed action is a major federal action significantly affecting the quality of the human environment and will make a decision to either prepare an Environmental Impact Statement or issue a Finding of No Significant Impact.

The EA can be reviewed in the DOE Public Reading Room located in the Federal Office Building, 200 Administration Road, Oak Ridge, Tennessee, during normal working hours. Written comments should be submitted to:

S. D. Morris, NEPA Program Manager
U.S. Department of Energy
Oak Ridge Operations Office
DOE Y-12 Site Office
Post Office Box 2001
Oak Ridge, Tennessee 37830

Comments must be received at the above address on or before _____ to be eligible for DOE consideration.

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FINDING OF NO SIGNIFICANT IMPACT
FOR THE PROPOSED REPLACEMENT AND OPERATION
OF THE ANHYDROUS HYDROGEN FLUORIDE SUPPLY
AND FLUIDIZED-BED REACTOR SYSTEMS FOR BUILDING 9212
AT THE Y-12 PLANT
OAK RIDGE, TENNESSEE

AGENCY: Department of Energy

ACTION: Finding of No Significant Impact

SUMMARY: The U.S. Department of Energy (DOE) has prepared an environmental assessment (EA) to evaluate the impacts from the proposed replacement and operation of the anhydrous hydrogen fluoride (AHF) supply and fluidized-bed reactor systems at Building 9212, Y-12 Plant in Oak Ridge, Tennessee. The Y-12 Plant is operated by Martin Marietta Energy Systems, Inc. (Energy Systems) for DOE. Based on the analysis in the EA, DOE has determined that the proposed action is not a major federal action significantly affecting the quality of the human environment, within the meaning of the National Environmental Policy Act of 1969. Therefore, the preparation of an environmental impact statement is not required, and the Department is issuing this Finding of No Significant Impact.

COPIES OF THE EA ARE AVAILABLE FROM:

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NEPA Program Manager
U.S. Department of Energy
Oak Ridge Operations
DOE Y-12 Site Office
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93-056P/033195

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**FOR FURTHER INFORMATION REGARDING THE DOE NEPA PROCESS
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BACKGROUND: Manufacture and chemical recovery and recycling of highly enriched uranium are unique capabilities of the Oak Ridge Y-12 Plant, which is managed for DOE by Energy Systems and is located within DOE's Oak Ridge Reservation in Oak Ridge, Tennessee. These capabilities are necessary to fulfill DOE missions.

AHF and fluidized-bed reactors are required for the manufacture and chemical recovery and recycling of purified highly enriched uranium metal. The systems, which were designed and constructed more than 40 years ago, were adequate for the era in which they were first used. However, due to their continuously deteriorating condition, the corrosive nature of the materials processed, and the antiquated design philosophy upon which they are based, their long-term reliability cannot be assured. Current general design criteria and safety analysis processes involve a much more detailed and systematic approach to defining, identifying, and mitigating potential design and safety hazards. The present AHF supply system and fluidized-bed reactor do not capture accidental releases of AHF; fugitive gases are vented directly to the atmosphere. The current AHF supply and fluidized-bed reactor systems also require a high degree of manual operation, which increases the potential for operator error and worker exposure.

PROPOSED ACTION: DOE proposes to replace the current AHF supply and fluidized-bed reactor systems to reduce the probability of future accidental releases that would expose the Y-12 Plant work force, the public, and the environment to AHF and to ensure that the ability of the Y-12 Plant to manufacture highly enriched uranium metal is maintained.

The proposed construction and operation of the replacement systems would provide an AHF supply and distribution system that would meet operational and safety requirements into the next century. The proposed AHF supply equipment would have an automated valve configuration system and an AHF cylinder containment structure designed to contain and neutralize AHF emissions resulting from a system malfunction. A new fluidized-bed reactor system, with its associated maintenance enclosures and off-gas treatment systems, would enhance worker protection from exposure to radiation and fugitive emissions.

The proposed project would be scheduled for completion by the end of the first quarter of Fiscal Year 1999 at a cost of approximately \$28,820,000. The proposed system replacement would have a design life of 20 years after which time the systems would be decommissioned. Asbestos and other identified health/environmental hazards would be excluded from the systems by design. At the end of the useful life of the equipment and facilities, a determination would be made as to whether they would be dismantled or modified and reconditioned for other uses.

ENVIRONMENTAL IMPACTS: The environmental impacts associated with the proposed action were all found to be beneficial. Air quality would be improved because 99.9 percent of fugitive emissions from the proposed AHF supply system would be removed by scrubbers. Water resources would be protected because no new effluents would be produced. Soil disturbance related to construction would be minimal and only subsurface soil would be disturbed. No natural habitat would be disturbed and no threatened or endangered species would be affected. No wetlands or floodplains would be altered or impacted by the proposed action. Although modifications would be made to Building 9212, which may be designated as historically significant, the modifications would not change the use of the building. No minority or low-income populations would be adversely affected by the proposed action.

The replacement systems would lessen the risk of an AHF exposure to the worker population and the general public. The control systems would prevent uncontrolled AHF emissions, eliminating any potential threat to the general public and worker population in the vicinity. In the event of an accident, the new equipment would capture the entire inventory of AHF in the secondary containment enclosure. In summary, the proposed action would better protect workers and the public from accidental releases of AHF and would pose no adverse effects to the biotic and abiotic environment.

POTENTIAL CUMULATIVE IMPACTS: No other actions at the Y-12 Plant or on the Oak Ridge Reservations are considered additive to the impacts of the proposed action.

ALTERNATIVES CONSIDERED: The no-action alternative, which is to continue operating the existing AHF supply and fluidized-bed reactor systems for Building 9212, was considered. Even with the interim safety improvements to the existing AHF supply system, further modifications would be required to sufficiently reduce the risk of an unacceptable AHF exposure to the Y-12 Plant population, the public, and the environment.

Extensive modification of AHF supply and fluidized-bed reactor systems was also considered. The existing AHF supply and fluidized-bed reactor systems have been modified to the extent practicable to provide interim operational safety until DOE can determine the appropriate final course of action. Additional and extensive modifications of the systems are still required to address all operational safety concerns. Further systems modifications would not be technically superior, safer, nor as cost effective compared to system replacement. Therefore, this is not a reasonable alternative for providing additional worker safety and protection of the environment.

Termination and shutdown of AHF supply and fluidized-bed reactor systems was also considered. Under this alternative, DOE would terminate and shut down the AHF supply system and fluidized-bed reactor operations. As one of the largest handlers of enriched uranium in the world, the Y-12 Plant provides a broad spectrum of enriched uranium handling, processing, and storage capabilities that are not available at any other single DOE site. The AHF supply and fluidized-bed reactor systems are key processes for the chemical

recovery and recycling of highly enriched uranium, which are necessary to fulfill DOE mission requirements.

Therefore, termination and shutdown of the AHF supply and fluidized-bed reactor systems would not meet the Department's mission requirements.

DETERMINATION: The proposed replacement and operation of the AHF supply and fluidized-bed reactor systems at Building 9212, Y-12 Plant in Oak Ridge, Tennessee, does not constitute a major federal action significantly affecting the quality of the human environment as defined within the meaning and purpose of the National Environmental Policy Act of 1969. This finding is based on analyses in the EA. Therefore, an environmental impact statement for the proposed action is not required and DOE is issuing this Finding of No Significant Impact.

Issued at Department of Energy Oak Ridge Operations, Oak Ridge, Tennessee, this ____ day of ____, 1995.

Joe La Grone

Manager, Oak Ridge Operations Office

CONTENTS

	Page
FIGURES	v
TABLES	v
ACRONYMS AND ABBREVIATIONS	vii
GLOSSARY	ix
EXECUTIVE SUMMARY	xiii
1. INTRODUCTION	1-1
1.1 PURPOSE AND NEED FOR ACTION	1-1
1.2 BACKGROUND	1-4
1.3 SCOPE OF THE ENVIRONMENTAL ASSESSMENT	1-6
2. PROPOSED ACTION AND ALTERNATIVES	2-1
2.1 PROPOSED ACTION—REPLACEMENT OF THE AHF SUPPLY AND FLUIDIZED-BED REACTOR SYSTEMS	2-1
2.1.1 Construction	2-1
2.1.2 Operation	2-8
2.1.3 Emissions, Effluents, Wastes	2-14
2.2 NO-ACTION ALTERNATIVE	2-15
2.3 ALTERNATIVE SITES	2-15
2.3.1 AHF Facility	2-16
2.3.2 Fluidized-Bed Reactor Site Selection	2-17
2.4 EXTENSIVE MODIFICATION OF AHF SUPPLY AND FLUIDIZED-BED REACTOR SYSTEMS	2-18
2.5 TERMINATION AND SHUTDOWN OF AHF SUPPLY AND FLUIDIZED-BE REACTOR SYSTEMS	2-18
3. AFFECTED ENVIRONMENT	3-1
3.1 AIR QUALITY	3-1
3.2 WATER RESOURCES	3-2
3.3 SOIL	3-2
3.4 ARCHAEOLOGICAL AND CULTURAL RESOURCES	3-2
3.5 BACKGROUND RADIATION	3-3
4. ENVIRONMENTAL IMPACTS	4-1
4.1 DEMOLITION AND CONSTRUCTION	4-1
4.1.1 Air Quality	4-1
4.1.2 Soils/Topography	4-1
4.1.3 Water Quality	4-1
4.1.4 Natural and Historic Resources	4-2
4.1.5 Health and Safety	4-2
4.1.6 Waste Management	4-4
4.2 IMPACTS OF INCIDENT-FREE OPERATION	4-4
4.2.1 Air Quality	4-4
4.2.2 Health and Safety	4-4
4.2.3 Waste Management	4-5

4.3	ACCIDENT AND CONSEQUENCE ANALYSIS	4-5
4.3.1	Hazardous Materials	4-5
4.3.2	Accident Identification	4-6
4.3.3	Consequence Methodology	4-6
4.3.4	Accident Analysis	4-7
4.4	ENVIRONMENTAL JUSTICE	4-11
4.5	NO-ACTION ALTERNATIVE	4-14
5.	CUMULATIVE IMPACTS	5-1
6.	PERMITS AND REGULATORY REQUIREMENTS	6-1
6.1	CLEAN AIR ACT	6-1
6.2	FEDERAL WATER POLLUTION CONTROL ACT	6-1
6.3	ENDANGERED SPECIES ACT	6-2
6.4	NATIONAL HISTORIC PRESERVATION ACT	6-2
6.5	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION	6-2
6.6	EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT AND EXECUTIVE ORDER 12856	6-3
6.7	TOXIC SUBSTANCES CONTROL ACT	6-3
7.	RELATIONSHIP WITH APPLICABLE LAND USE PLANS	7-1
8.	DOE DECISION PROCESS ON RELATED ACTIONS	8-1
8.1	PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR RECONFIGURATION OF THE NUCLEAR WEAPONS COMPLEX	8-1
8.2	PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR LONG-TERM STORAGE AND DISPOSITION OF WEAPONS-USABLE FISSILE MATERIALS	8-1
9.	REFERENCES	9-1
10.	LIST OF AGENCIES CONTACTED	10-1
11.	LIST OF PREPARERS	11-1
APPENDIX A	PROPOSED FACILITY DESIGN, EQUIPMENT, AND EMISSION CONTROL TECHNOLOGY SELECTION INFORMATION	A-1
APPENDIX B	TRANSPORTATION RISK ANALYSIS	B-1

FIGURES

	Page
1.1. Map showing the location of Oak Ridge and the Oak Ridge Reservation in relation to the geographic region	1-2
1.2. Map showing DOE's Oak Ridge Reservation and the location of the three major installations	1-2
1.3. Y-12 Plant location site plan highlighting the site of the proposed action	1-3
2.1. Dock 8/8A site utility plan	2-2
2.2. Proposed AHF supply and distribution system equipment layout	2-5
2.3. Glovebox systems for transfer of uranium trioxide	2-9
2.4. AHF supply and fluidized-bed reactor systems process block flow diagram	2-10
4.1 City of Oak Ridge, census tracts 1990	4-12

TABLES

2.1 Proposed construction schedule for the AHF supply system and fluidized-bed reactor systems	2-1
4.1 Protective equipment requirements for demolition work	4-3
4.2 1990 population distribution by race in census tracts near the Y-12 Plant	4-11
4.3 1989 Household income by census tract	4-13

ACRONYMS AND ABBREVIATIONS

AHF	anhydrous hydrogen fluoride
C	centigrade
cm	centimeter
cm ²	square centimeters
DOE	U.S. Department of Energy
Energy Systems	Martin Marietta Energy Systems, Inc.
ERPGs	Emergency Response Planning Guides
F	fahrenheit
ft	feet
HF	hydrogen fluoride
in.	inches
in. ²	square inches
kg	kilograms
lb	pounds
m	meter
min	minute
PCB	polychlorinated biphenyl
PEIS	Programmatic Environmental Impact Statement

GLOSSARY

Anhydrous hydrogen fluoride (AHF): A chemical form of hydrogen fluoride in which water is essentially absent. AHF has a purity of 99 to 99.9 percent. Hydrogen fluoride containing water molecules (designated as HF in this document) is generally produced commercially as a 70 percent solution. Both forms of the compound (AHF and HF) occur at various stages of the process described in this document.

Batch cycle: Chemicals or materials are added to an industrial process all at once instead of being metered in over time or as required.

Categorical exclusion: A category of actions that do not individually or cumulatively have a significant effect on the human environment and that have been found to have no such effect in procedures adopted by a federal agency in implementation of regulations specified in 40 CFR Part 1500-1508, for implementing the Procedural Provisions of the National Environmental Policy Act.

Characterize: As used in this document, characterize means to identify any contaminants present and their levels within a specific location or material.

Design basis accident: An accident scenario that provides the basis for the design of preventative or mitigative features. For this proposed action, it is assumed to be the loss of the contents of a full [590-kg (1,300-lb)] AHF cylinder.

Dip tube: A tube at or near the bottom of an AHF cylinder that evacuates AHF as nitrogen gas is added to the AHF cylinder. The increased pressure in the cylinder that results from adding nitrogen gas forces the AHF into the dip tube and, subsequently, into the AHF delivery system for use at the hydrofluorination fluidized-bed reactor.

Fluidized-bed reactor: As referred to in this document, a fluidized-bed reactor is a cylindrical structure, approximately 15 cm (6 in.) in diameter, that would initially contain either uranium trioxide powder or uranium dioxide powder. The cylinder would be heated and nitrogen gas introduced to suspend the uranium powder within the cylinder. The suspended powder would resemble a boiling liquid. After the appropriate reaction temperature was reached the nitrogen gas would be replaced by either hydrogen gas (in the case of uranium trioxide) or AHF gas (in the case of uranium dioxide). The reaction would be allowed to proceed to the completion products of uranium dioxide or uranium tetrafluoride, respectively.

Fugitive emissions: Uncontrolled air emissions that escape from the operating system and are not treated prior to discharge.

Gamma radiation: Penetrating electromagnetic waves or rays emitted from nuclei during radioactive decay, similar to x-rays. Dense materials such as concrete and lead are used to provide shielding against gamma radiation.

High-level switch: A detection system that shuts down the AHF transfer process when the AHF liquid level reaches a predetermined point.

Highly enriched uranium metal: Metal consisting of purified uranium with an enrichment of the uranium-235 isotope in excess of 20 percent by weight.

Hydrostatically tested: Equipment is filled with liquid under pressure to ensure that no leaks are present at the prescribed operating pressure. Equipment is usually tested at pressures above normal operating pressures.

Material access area: A controlled security area that segregates highly enriched uranium storage areas from normal industrial operations.

Mixed waste: Waste that contains both radioactive and hazardous components.

Monel metal: Used for an alloy of approximately 67 percent nickel, 28 percent copper, and 5 percent other elements that is made by direct reduction from ore in which the constituent metals occur in these proportions.

Nuclear criticality: The attainment of physical conditions such that a fissile material will sustain a chain reaction.

Nuclear-safe geometry: A geometric configuration that prevents a fissile material from becoming critical by keeping the surface-to-volume ratio such that excessive neutron leakage makes it impossible to attain a multiplication factor as great as one.

100-year floodplain: A flat or nearly flat land surface that has a 1 percent chance of being flooded in any given year.

Order of magnitude: A range of magnitude extending from some value to ten times that value. Two quantities are of the same order of magnitude if one is no larger than ten times the other; but if one is one hundred times the other, it is larger by two orders of magnitude.

Pigtail: Flexible tubing that allows ease of connection to a rigid piping system. Pigtail refers to its corkscrew or pigtail appearance.

Pneumatically operated or transferred: Filled with or operated by compressed gas.

Radionuclide: A radioactive species of an atom that gives off, or is capable of giving off, radiant energy in the form of particles (alpha or beta radiation) or rays (gamma radiation) by the spontaneous disintegration of the nuclei of atoms. Radioisotopes of elements lose particles and energy through the process of radioactive decay. Elements may decay into a different atom(s) or a different state of the same atom.

Scrubber: An air pollution control device that uses either a spray of water or reactant or a dry process to physically trap and/or chemically alter potential air pollutants found in the exhaust air stream prior to their atmospheric release.

Special Nuclear Material: Material such as plutonium, uranium-233, uranium enriched in the isotopes 233 or 235, and any other material that the Nuclear Regulatory Commission determines to be Special Nuclear Material.

Transuranics: Nuclides with atomic numbers greater than 92 (uranium).

Venturi scrubber: As referred to in this document, a Venturi scrubber is a high-efficiency scrubber that uses a pressure differential to drive a chemical reaction between AHF and either water or potassium hydroxide to neutralize the AHF.

Waste stream: The waste products that result from an industrial process or other waste-producing activity. A waste stream can refer to the generation of one particular waste or many.

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) proposes to replace the existing anhydrous hydrogen fluoride (AHF) supply and fluidized-bed reactor systems for the Weapons Grade Highly Enriched Uranium Chemical Recovery and Recycle Facility, Building 9212, which is located within the Y-12 Plant on DOE's Oak Ridge Reservation in Oak Ridge, Tennessee.

The current AHF supply and fluidized-bed reactor systems were designed and constructed more than 40 years ago. Because of their deteriorating condition, the corrosive nature of the materials processed, and the antiquated design philosophy upon which they are based, their long-term reliability cannot be assured. The current AHF supply system cannot mitigate an accidental release of AHF and vents fugitive AHF directly to the atmosphere during operations. The proposed action would reduce the risk of exposing the Y-12 Plant work force, the public, and the environment to an accidental release of AHF and would ensure the continuing ability of the Y-12 Plant to manufacture highly enriched uranium metal and process uranium from retired weapons for storage.

The replacement AHF supply and distribution system equipment would be located on the existing Dock 8/8A at Building 9212. Utilities would be extended to the dock to service the process equipment. The following process equipment modules would be prefabricated for installation at the modified dock: a refrigerated AHF cylinder enclosure; an AHF supply manifold and vaporizer skid; an AHF sump tank and transfer skid; and an AHF supply off-gas scrubber assembly skid.

The fluidized-bed reactor system would be constructed in an area adjacent to the existing system in Building 9212. The replacement equipment would consist of a new reduction fluidized-bed reactor, a hydrofluorination fluidized-bed reactor, and associated air emission control equipment. The no-action alternative, which is the continued operation of the existing AHF supply and fluidized-bed reactor systems, was also evaluated. Two other alternatives were considered and dismissed from further consideration: (1) extensive modification of the existing systems, which was dismissed because it was not practical or cost effective and (2) shutdown of the systems and termination of the activities they support, which was not considered further because it would prevent DOE from fulfilling its mission. The environmental impacts associated with the proposed action were all found to be beneficial. Air quality would be improved because 99.9 percent of fugitive emissions from the proposed AHF supply system would be removed by scrubbers. Water resources would be protected because no new effluents would be produced. Soil disturbance related to construction would be minimal and only subsurface soil would be disturbed. No natural habitat would be disturbed and no threatened or endangered species would be affected. No wetlands or floodplains would be altered or impacted by the proposed action. Although modifications would be made to Building 9212, which may be designated as historically significant, the modifications would not change the use of the building. No minority or low-income populations would be adversely affected by the proposed action.

The replacement systems would lessen the risk of an AHF exposure to the worker population and the general public. The control systems would prevent uncontrolled AHF emissions, eliminating any potential threat to the general public and worker population in the vicinity. In the event of an accident, the new equipment would capture the entire inventory of AHF in the secondary containment enclosure. In summary, the proposed action would better protect workers and the public from accidental releases of AHF and would pose no adverse effects to the biotic and abiotic environment.

1. INTRODUCTION

1.1 PURPOSE AND NEED FOR ACTION

Manufacture and chemical recovery and recycling of highly enriched uranium are unique capabilities of the Oak Ridge Y-12 Plant, which is managed for the U.S. Department of Energy (DOE) by Martin Marietta Energy Systems, Inc. (Energy Systems) and is located within DOE's Oak Ridge Reservation in Oak Ridge, Tennessee (Fig. 1.1). The capabilities for manufacture and chemical recovery and recycling of highly enriched uranium are necessary to fulfill several DOE missions: (1) converting uranium salvage from retired weapons to alternate forms (such as metal or oxide), which are more readily accountable and safer to store; (2) providing safe and accountable storage of highly enriched uranium at a national repository where prestorage processing is available to support continued weapons dismantlement; and (3) maintaining nuclear competence and providing requested specification-grade uranium for weapons component fabrication and other special needs (DOE 1994b).

Anhydrous hydrogen fluoride* (AHF) and fluidized-bed reactors* are required for the manufacture and chemical recovery and recycling of purified highly enriched uranium metal.* Presently, AHF storage vessels and equipment are located on the northeastern side of the Weapons Grade Highly Enriched Uranium Chemical Recovery and Recycle Facility, Building 9212, and the fluidized-bed reactors are located in the B-1 Wing of Building 9212 (Figs. 1.2 and 1.3). The systems, which were designed and constructed more than 40 years ago, were adequate for the era in which they were first used. However, due to their continuously deteriorating condition, the corrosive nature of the materials processed, and the antiquated design philosophy upon which they are based, their long-term reliability cannot be assured. Current general design criteria and safety analysis processes involve a much more detailed and systematic approach to defining, identifying, and mitigating potential design and safety hazards. The present AHF supply system and fluidized-bed reactor do not capture accidental releases of AHF; fugitive gases are vented directly to the atmosphere. Under incident-free operation, the fugitive emissions do not exceed permissible limits established by the State of Tennessee (Energy Systems 1994). The current AHF supply and fluidized-bed reactor systems also require a high degree of manual operation, which increases the potential for operator error and worker exposure.

The Occupational Safety and Health Administration regulations governing process safety management of highly hazardous chemicals (29 CFR 1910.119) specify requirements to prevent or lessen the potential of catastrophic releases from processes that use chemicals listed in 29 CFR 1910.119, Appendix A. Hydrogen fluoride (HF) is governed under these requirements when used in quantities of 454 kg (1,000 lb) or more. Full compliance with these regulations will not be required until May 26, 1997. The existing AHF supply system does not violate these regulations because when it was designed and constructed it was in accordance with the codes, standards, and practices in effect at that time. However, the existing AHF supply system does not meet the spirit and intent of the major objective of the regulations, which is to minimize the potential of an uncontrolled release of hazardous chemicals that could expose Y-12 Plant employees and others to a serious health hazard.

*Words that are marked with an asterisk are defined in the glossary at the beginning of the document.

Fig. 1.1. Map showing location of Oak Ridge and the Oak Ridge Reservation in relation to the geographic region.

Fig. 1.2. Map showing DOE's Oak Ridge Reservation and the location of the three major installations.

Fig. 1.3. Y-12 Plant location site plan, highlighting the site of the proposed action.

In January 1992, several factors—including an improperly set valve, which resulted in the activation of a relief valve—resulted in an accidental release of AHF. The AHF release was localized and was not detected outside the Y-12 Plant. A report on the investigation of the accidental release (Energy Systems 1992c) concluded that modifications to the design and construction of the AHF supply system are needed to reduce the potential for a large leak and to provide for isolation in the event of a leak.

To reduce the probability of future accidental releases that would expose the Y-12 Plant work force, the public, and the environment to AHF and to ensure that the ability of the Y-12 Plant to manufacture highly enriched uranium metal is maintained (Energy Systems 1993a), DOE has proposed replacement of the current AHF supply and fluidized-bed reactor systems.

The proposed construction and operation of the replacement systems would provide an AHF supply and distribution system that would meet operational and safety requirements into the next century. The 1992 accidental release could not have occurred if the proposed AHF replacement system was in operation. The proposed AHF supply equipment would have an automated valve configuration system and an AHF cylinder containment structure designed to contain and neutralize AHF emissions resulting from a system malfunction. A new fluidized-bed reactor system, with its associated maintenance enclosures and off-gas treatment systems, would enhance worker protection from exposure to radiation and fugitive emissions.

The proposed project would be scheduled for completion by the end of the first quarter of Fiscal Year 1999 at a cost of approximately \$28,820,000 (Energy Systems 1993b). The proposed system replacement would have a design life of 20 years after which time the systems would be decommissioned. Asbestos and other identified health/environmental hazards would be excluded from the systems by design. At the end of the useful life of the equipment and facilities, a determination would be made as to whether they would be dismantled or modified and reconditioned for other uses. The potential impacts of decommissioning or future use of the equipment and facilities would be addressed in a separate National Environmental Policy Act document, which would be prepared at the appropriate time.

1.2 BACKGROUND

The Y-12 Plant uses AHF as a vital raw material in its uranium salvage and recycle operations. AHF is necessary for the conversion of uranium dioxide to uranium tetrafluoride (Energy Systems 1993c). AHF is the only proven production-scale chemical that can be used to convert uranium dioxide to the uranium metal product (Niemann 1992).

Highly enriched uranium metal is produced by a manufacturing process that begins with the thermal decomposition of uranyl nitrate solutions into uranium trioxide. The uranium trioxide is subsequently reduced with hydrogen to form uranium dioxide, which can then be converted to uranium tetrafluoride by reaction with AHF. A series of fluidized-bed reactors is used to accomplish these chemical conversions. The uranium tetrafluoride is reduced with calcium to generate highly enriched uranium metal. The reactant gases (hydrogen and AHF) used in the synthesis of oxides and fluorides of uranium are extremely hazardous materials that require exact design features and rigorous operating protocols for their safe use (Energy Systems 1993c).

AHF exists either as a clear liquid or as a colorless gas that reacts with moisture in the air to produce a white fume. Either form is highly toxic to aquatic and terrestrial life. AHF is one of the most acidic substances known (Stecher 1968) and does not biodegrade when released in water, in air, or on land. It must be reacted, buffered, or diluted to reduce its acidity (EPA 1992). In most cases, because it is extremely reactive, AHF will be quickly neutralized by reaction with other substances upon release. An air concentration of 30 parts per million can be immediately dangerous to life and health (NIOSH 1990) and, even in lower air concentrations, can severely irritate the eyes, skin, and respiratory system (EPA 1992). The Occupational Safety and Health Administration limits occupational HF exposure to an 8-hour time-weighted average of 3 parts per million, which cannot be exceeded in an 8-hour work day. Burns resulting from exposure to less than 30 percent HF may not be painful or visible for several hours after exposure (Stecher 1968, EPA 1992). AHF has a low normal boiling point [19.5°C (67°F)] and a vapor density greater than air. Because of the high vapor pressure of AHF, even a small spill may present a severe health threat. For these reasons, extreme caution must be exercised in the transportation, storage, and processing of AHF (Energy Systems 1993c).

AHF is received at the Y-12 Plant in vendor-provided 612-kg (1,350-lb) capacity cylinders. The AHF cylinders are delivered to the loading and vaporization dock (Dock 8/8A) at Building 9212, where the AHF delivery system is operated. The cylinders are unloaded by a forklift equipped with a cylinder gripper, placed in a cradle that moves the cylinder into a refrigerated enclosure, and within the enclosure the cylinder valves are connected to the AHF delivery system. Nitrogen gas is then used to push the AHF liquid from the cylinders into a hot-water-jacketed vaporizer where the AHF is converted from a liquid to a gas. Once vaporized, the gaseous AHF is delivered to the fluidized-bed reactors, which require approximately 13.6 kg/hour (30 lb/hour) of AHF, delivered at $11.3\text{ kg}/6.5\text{ cm}^2$ ($25\text{ lb}/\text{in.}^2$) gauge pressure and 93°C (200°F). The fluidized-bed reactors convert uranium dioxide to uranium tetrafluoride. The valving process is complicated and, therefore, can lead to operator error and potential injury to the operator or others (DOE 1991). The current AHF delivery system does not have emissions control technology nor does it have a containment system for AHF spills. The refrigerated enclosure is not a sealed system.

Operational hazards associated with the continued operation of Building 9212 include routine untreated process and fugitive AHF releases vented directly to the atmosphere. Operation of the present AHF supply system requires personnel to manually configure the valves and change AHF supply cylinders (DOE 1991), thus potentially subjecting workers to an accidental release of AHF.

As an interim measure, the existing AHF supply system was modified in 1992 and 1994 to improve the safety of AHF operations. These improvements have been reviewed in compliance with the National Environmental Policy Act and documented in general Categorical Exclusion* documents (Wilkinson 1993). The modifications are designed to minimize and mitigate the impacts of a small-quantity release of AHF (Energy Systems 1993a). Design basis accidents* of very low probability, but high consequence, cannot be mitigated through the modified system because there is not enough space in the existing AHF location to allow for the full complement of equipment necessary to meet the DOE safety and design criteria. The modified AHF supply system meets all state and federal emission(s) permits and standards (DOE 1991).

1.3 SCOPE OF THE ENVIRONMENTAL ASSESSMENT

The proposed action would be carried out at a previously disturbed industrial site, and all construction would be performed according to best management practices for soil erosion control. For this reason, construction would not adversely affect ecological resources. Air quality (as a baseline) is discussed to serve as a measure of improvements expected to result from operation of the new system. Socioeconomics is not an issue because the existing labor pool would be used. Geologic features would not be altered because no large-scale excavation or topographic alteration would be needed.

2. PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION—REPLACEMENT OF THE AHF SUPPLY AND FLUIDIZED-BED REACTOR SYSTEMS

The reader is referred to Appendix A for further information concerning selection of the proposed facility design, required equipment, and emission control technology.

2.1.1 Construction

Site work for the proposed AHF supply system (Fig. 2.1) would include the relocation of a 46-cm (18-in.) storm sewer line; demolition of an existing concrete curb and gutter, grading, and asphalt paving; relocation of the Brake Press Pavilion (a facility where sheet metal is bent to 90° angles); and establishment of erosion and sediment control. The new fluidized-bed reactor system would be constructed in the eastern portion of Building 9212, B-1 Wing. This would involve demolishing the existing area, including a mezzanine, partitions, stairways, and miscellaneous structures. The proposed schedule for these activities is given in Table 2.1; however, none of these activities would begin until the National Environmental Policy Act process for the proposed action is completed. Nonradioactive and nonhazardous construction waste would be disposed of at the Y-12 Plant landfill. Low-level radioactive waste would be loaded in B-25 boxes and stored in vaults at the K-25 Site. Based on knowledge of processes performed in the construction areas, no mixed waste* is expected.

Table 2.1. Proposed construction schedule for the AHF supply system and fluidized-bed reactor systems

<i>Dock 8/8A - AHF supply system</i>	
• Dock 8/8A stripping/demolition	April 1995 - July 1995
• Dock 8/8A site modifications	April 1995 - October 1995
• Dock 8/8A modules installation/ interconnection	January 1997 - October 1997
<i>B-1 Wing Building 9212 - fluidized-bed reactor system</i>	
• B-1 Wing stripping/demolition	July 1995 - December 1995
• B-1 Wing building modification	December 1995 - December 1996
• B-1 Wing modules installation/ interconnection	January 1997 - July 1998
Test and Checkout	July 1998 - December 1998

2.1.1.1 AHF supply system

Removing the existing Brake Press Pavilion, currently located south of Building 9820 (Fig. 2.1), would require sawcutting and removing the reinforced concrete slab. The new Brake

Fig. 2.1. Dock 8/8A site utility plan.

Press Pavilion would be located north of existing Building 9820. This relocation would require the design and construction of a reinforced concrete slab foundation approximately 6.10×6.10 m (20×20 ft). Further removal activities would include sawcutting and removing existing asphalt and concrete curbs on the eastern side of Dock 8/8A. These activities would be required to provide a driveway for trucks on the eastern side of Dock 8/8A. This access corridor would be required for maneuvering and safely loading and off-loading AHF cylinders.

Removing an existing storm drain manhole and rerouting a 46-cm (18-in.) storm drain located on the eastern side of Dock 8/8A also would be required. Relocation of the existing storm drain would require approximately 30.5 linear meters (100 linear feet) of new storm drain piping and four new precast concrete manholes. The existing storm drain piping, which would no longer be used after the relocation, would not be excavated and removed but would be sealed after it was disconnected (see Fig. 2.1). Excavation for the storm drains would take place in existing paved areas. Any excavated soil not needed for backfill of storm drain trenches would be used in the subsurface of newly paved areas near Dock 8/8A. The new stormwater management system would consist of storm drains, catch basins, manholes, and roof drains to collect area runoff. Any other utilities that pass through the work area would be maintained and protected. All benchmarks, existing structures, sidewalks, and paving would be protected from excavation equipment and vehicular traffic. All areas adjacent to the construction that were disturbed would be restored to original or better condition. Erosion and sediment control would be installed to minimize erosion and the subsequent transport of sediment into storm sewers or beyond the limits of the construction area.

The replacement AHF supply and distribution system equipment would be located on Dock 8/8A (see Fig. 2.2). The dock would be modified to permit installation of the new supply system and related components. Utilities would be extended to the dock to service process equipment. The following process equipment modules would be prefabricated for installation at the modified dock: a refrigerated AHF cylinder enclosure including the AHF supply manifold; an AHF vaporizer skid; an AHF sump tank and transfer skid; and an AHF supply off-gas scrubber* assembly skid (Fig. 2.2).

The approximate dimensions of the refrigerated AHF cylinder enclosure would be 1.2 m (4 ft) $\times$ 3.0 m (10 ft) $\times$ 1.5 m (5 ft) high. The AHF cylinder is approximately 75 cm (30 in.) $\times$ 205 cm (82 in.) Each cylinder head is dished, forming a rim that is crimped inward to provide a substantial grip for the hydraulically operated fork lift gripper that is used to handle the cylinder. Each cylinder head has two valves provided with outlet caps and is protected further by a removable hemispherical steel bonnet.

The framework for the AHF supply manifold and vaporizer skid would be approximately 1.2 m (4 ft) $\times$ 2.1 m (7 ft) $\times$ 3.6 m (12 ft) high. The manifold includes pressure relief devices, valves, pressure regulators, a pressure indicator, and cross-connections between the nitrogen and AHF systems. The vaporizer would be heated by band heating elements so that it would operate at 60°C (140°F) and $13.6\text{ kg}/6.5\text{ cm}^2$ ($30\text{ lb}/\text{in}^2$) gauge pressure. The saturated AHF vapor would be heated in a superheater, which is also heated by a band heating element, to deliver AHF at approximately 107°C (225°F) and $11.3\text{ kg}/6.5\text{ cm}^2$ ($25\text{ lb}/\text{in}^2$) gauge pressure to the fluidized-bed reactor. Both the vaporizer and superheater are located within the AHF supply manifold and vaporizer skid.

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DOCK 8 & 8A PROCESS EQUIPMENT PLAN
SCALE: 3/8" = 1'-0"

Fig. 2.2. Proposed AHF supply

BUILDING 9212 DOCK 8/8A AREA PLAN
NOT TO SCALE

1 distribution system equipment layout.

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Two saddle-type carbon steel supports would be designed to support the 946-liter (250-gallon) capacity AHF sump tank. The AHF sump tank would have a maximum allowable working pressure of approximately 6.8 kg/6.5 cm² (15 lb/in.²) at a design temperature of 93° C (200° F). The tank would be equipped with a metering pump to transfer collected fluids for neutralization and disposal. Nozzles would be provided for AHF collection, transfer, and venting to the Venturi scrubber.* Process drain lines would be provided from the refrigerated AHF cylinder and vaporizer skids to the AHF sump tank. The discharge system would include a pump for transferring liquids to a transportable container.

The AHF supply off-gas scrubber system would consist of a Venturi scrubber followed by a packed column scrubber. Both scrubbers would sit atop the 14,384-liter (3,800-gallon) reservoir scrubber sump tank. Water would be used as the scrubbing medium. Any release would be captured by the scrubbers, and the resulting scrub solution would be neutralized with potassium hydroxide in a separate neutralization tank. The equipment would require an area of approximately 12.1 × 6.7 m (40 × 22 ft). The system would be designed to mitigate the effects of a design basis accident (see Sect. 4.3).

2.1.1.2 Fluidized-bed reactor system

The proposed fluidized-bed reactor system would include the installation of new uranium oxide to uranium tetrafluoride hydrofluorination equipment consisting of a reduction (by hydrogen) fluidized-bed reactor (uranium trioxide to uranium dioxide), a hydrofluorination (by AHF) fluidized-bed reactor (uranium dioxide to uranium tetrafluoride), and supporting equipment. The new equipment would be located in an existing maintenance area of the B-1 Wing in Building 9212 (see Fig. 1.3) adjacent to the existing fluidized-beds. The existing maintenance area would be isolated from the material access area during demolition of the mezzanine, partitions, and stairways and during construction activities. The current fluidized-bed reactor system would remain operational throughout the construction project and would not be dismantled.

The proposed location would be cleared of unnecessary equipment and structures, and the existing supply and exhaust systems would be modified to make the area suitable for demolition and construction activities. In addition, the ventilation systems would be permanently upgraded through evaluation and replacement of the supply air and exhaust ductwork, as needed to maintain the operations areas under a slight negative pressure to the surrounding atmosphere and adjacent noncontaminated areas.

The new fluidized-bed reactor system would consist of two cylindrical reactor vessels (reduction and hydrofluorination) within a heater. Uranium trioxide powder would be pneumatically* transported into the reduction fluidized-bed reactor. The reagent gas (hydrogen) would be preheated and fed into the bed with nitrogen to convert uranium trioxide into uranium dioxide. The off-gas from this reaction (excess hydrogen, water vapor, and nitrogen) would exhaust through a primary set of metallic filters and a secondary group of filters before exiting through a dedicated stack that would be monitored for uranium. The reactor bed, preheater, and filters would be contained within a single enclosed module. The enclosure would serve as a walk-in maintenance enclosure and would be ventilated through intake and outlet high-efficiency particulate air filters. A hydrogen detection system would be provided within the enclosure and in the general process area.

The hydrofluorination reaction would be accomplished by pneumatically conveying uranium dioxide from the reduction bed into the hydrofluorination reactor bed where AHF would be heated and fed with nitrogen into the reactor to convert uranium dioxide to uranium tetrafluoride. The hydrofluorination reactor-bed equipment would be similar in configuration to the reduction reactor and its supporting equipment with the addition of an off-gas HF scrubber system. The hydrofluorination reactor off-gas would contain HF, water vapor, and nitrogen. The HF would be scrubbed from the off-gas. Potassium hydroxide would be used as a scrubbing solution and would be supplied from the existing "Dry Chemistry" potassium hydroxide storage facility.

Two glovebox systems (Fig. 2.3) would be used to transfer the uranium powder product to and from the reduction beds. Each glovebox would house a canning, weighing, and sampling station. The canned uranium powder product would be inserted into and removed from the glovebox through a down-draft entrance hood.

A central control and monitoring system for both the AHF supply and fluidized-bed reactor facilities would be located in an adjacent existing control room. Automatic systems would be used to perform routine operations from the control center. Closed circuit television and intercoms would be provided at the new fluidized-bed reactor location and the AHF supply dock facility. These systems would be monitored from the central control room.

The following general utilities would be provided to the B-1 Wing in Building 9212:

- new motor control centers;
- service and utility piping (e.g., steam, chilled water, condensate);
- emergency shower and eye wash stations;
- fresh air breathing stations;
- air sampling station;
- fire sprinkler system; and
- plant emergency notification, public address, fire alarm, and security systems.

Two new exhaust systems (i.e., fans, filters, stacks, and exhaust monitors) would be provided for the HF off-gas and enclosure exhaust.

Most of the process equipment would be designed and procured as completely preassembled and tested process modules to minimize field installation.

2.1.2 Operation

The proposed operation of the AHF supply system, the reduction fluidized-bed reactor module, and the hydrofluorination fluidized-bed reactor module are described in Sects. 2.1.2.1 through 2.1.2.3. Figure 2.4 is a flow diagram of the AHF supply and fluidized-bed reactor systems process. The new systems would be expected to be operational by December 1998, which is in the first quarter of Fiscal Year 1999. Personnel requirements for new systems would not differ from the existing systems.

18-012085-258

Fig. 2.3. Glovebox systems for transfer of uranium trioxide.

Fig. 2.4. AHF supply and fluidized-bed reactor systems process block flow diagram.

2.1.2.1 AHF supply system

The AHF cylinders would be similar to standard 1-ton chlorine cylinders, except they would not have safety pressure relief devices (fusible plugs). The vendor-provided cylinders would meet U.S. Department of Transportation specifications and would be inspected and hydrostatically tested* to 227 kg per 67.5 cm² (500 lb/in.²) at least once every 5 years. Upon arrival at the Y-12 Plant, and before being accepted into the facility, the AHF cylinders would be weighed. Multiple readings would be made to ensure accuracy. Overfilled cylinders would be rejected and returned immediately to the supplier on the same vehicle that delivered them.

The AHF cylinders would then be delivered directly to Dock 8/8A at Building 9212 on the vehicle that transported the cylinders to the Y-12 Plant from the chemical manufacturer. A lift truck would be used to transfer the cylinders from the carrier vehicle into the refrigerated AHF cylinder enclosure. The door of the cylinder enclosure would operate like a garage door. The cylinder would be lowered onto the rack in a horizontal position and then rotated in the rack to place the valves in a vertical line, one above the other. Thus configured, the lower valve would be used to discharge liquid AHF and the upper valve would be connected to the nitrogen supply. The rack would then retract into the cylinder enclosure. When the cylinder was inside the enclosure, the operator would remove the valve caps and connect the pigtails.* The pigtails would be connected to fixed piping transfer and nitrogen lines in the cylinder enclosure. The door to the cylinder enclosure would then be closed and locked. Manual valve controls, which would pass through the cylinder containment door, would be inserted into the cylinder valves. The pigtails would then be checked for leaks.

The pigtails would be checked for leaks using the purge and evacuation system. With the manual cylinder valves closed, the nitrogen valve, cylinder vent valve, and liquid HF transfer valve would be closed and the nitrogen leak-check valve opened. The leak-check valve would then be closed and the pressure in the lines would be monitored. If the pressure remained constant for 10 minutes, the pigtail connections would be considered tight. The nitrogen would then be vented to the primary off-gas treatment system through the vent valve as the transfer operation began.

The AHF cylinder would be protected from overpressure by a rupture disk that would be monitored by a current loop. An alarm would sound if the rupture disk released, breaking the circuit. Downstream of the rupture disk would be a pressure relief valve set to open at approximately 45.3 kg per 6.5 cm² gauge (100 lb/in.² gauge). A high-pressure switch with an alarm would be located between the rupture disk and the pressure relief valve to provide redundant pressure relief detection. A bypass valve would be provided around the pressure relief valve so that pressure buildup between it and the rupture disk due to leakage could be bled off.

The refrigerated cylinder enclosure and the vaporizer enclosure would be maintained at lower-than-atmospheric pressure by the Venturi scrubber. No provision for makeup air would be necessary because neither enclosure is completely leak tight and the Venturi scrubber could be operated at no-gas-flow conditions, unlike an induced draft fan. This operation would minimize corrosion that could result from fugitive emissions* of AHF reacting with moisture-laden air.

To conduct a batch transfer from the AHF cylinder into the AHF manifold and vaporizer, transfer valves would have to be set in their proper positions. Transfer into the vaporizer tank

would require that the tank first be vented to the primary off-gas system and that the inlet liquid AHF line isolation valve be opened.

After the vaporizer tank valves had been properly set, the operator would correctly configure the cylinder transfer valves. The vapor space above the liquid in the cylinder would be pressurized with nitrogen, pushing the liquid AHF through a dip tube* assembly that would extend within 1.3 cm (1/2 in.) of the bottom of the vessel.

Transfer would begin when the liquid AHF transfer valve was opened. A high-level switch* would be triggered when a batch level of AHF in the vaporizer is reached. This switch automatically would close the transfer valve to prevent overfilling of the vaporizer. A control panel would alert the operator that the transfer was complete. A second, independent high-high-level switch would be triggered if the batch feed tank continued to fill with AHF. This switch would be interlocked with a second valve independent of the first high-level switch valve. These features would provide redundant overfill protection for the vaporizer. Once a batch of AHF had been transferred and the AHF cylinder vented, the vaporizer and superheater would be heated to supply gaseous AHF to the hydrofluorination fluidized-bed reactor.

When the AHF cylinder was empty, the operator would purge the AHF lines with nitrogen through the off-gas treatment system so that the cylinder could be removed from the refrigerated cylinder enclosure. After the purge cycle, the refrigerated AHF cylinder enclosure would be opened, and the operator would close the vent valve, disconnect the pigtail, and remove the empty cylinder from the enclosure.

A lift truck would be used to move the empty cylinder from its rack to a pallet for pickup by the vendor. During this and all routine operations involving the cylinder, the operators would wear rubber chemical aprons, rubber gloves, face shields, and goggles to protect them from accidental exposure to AHF.

The AHF supply off-gas scrubber system would be operated continuously during cylinder change-out and transfer activities. To begin operation, one of the two installed centrifugal recirculation pumps would be selected as the primary; the other would be used as a standby. The primary pump would be started using push-button switches. Flow indicators would be used to adjust the manual throttling valves to obtain the desired flow distribution in the recirculation line.

Scrubbed gases from the Venturi scrubber, which would remove up to 95 percent of the HF present in the gas stack, would flow upward through the packed column scrubber. The packed column scrubber further reduces the HF level, and the 0.1 percent remaining would be discharged to the atmosphere. Differential pressure indicators would be used to monitor for flooding of the packed column and to evaluate the efficiency of the high-energy Venturi scrubber. The top of the stack would be approximately 15 m (50 ft) above the ground. Actual release rates are not known; however, the existing system allows releases to be vented directly to the atmosphere and these do not exceed applicable standards (see Sect. 3.1). Approximately 99 percent of the HF entering the packed column would be removed, resulting in an overall system removal efficiency of 99.9 percent. Scrub solution would be collected in the scrubber sump tank, which is the common circulant holding tank for both the Venturi and the packed column scrubbers. HF absorbed by the Venturi and packed column scrubbers would be neutralized in a separate tank

with potassium hydroxide. Liquid wastes are generated by the scrubbing process; these are transported to the Y-12 Plant Central Pollution Control Facility.

The spill retention basin in which the AHF supply off-gas scrubber system would be located would drain to a sump. An air-operated diaphragm pump would be used to empty the dike into a tanker in the event of a spill. The sump could also be emptied into the scrubber sump tank. The roof over Dock 8/8A would be extended to minimize rainwater collection in the sump. Should rainwater be captured in the sump, it would be sampled for pH and uranium and discarded to the storm sewer, if within National Pollutant Discharge Elimination System (NPDES) permit limits.

2.1.2.2 Reduction fluidized-bed reactor module

Uranium trioxide would be transferred in cans through an airlock into the uranium trioxide transfer glovebox. The uranium trioxide would be loaded into a receiver and the cans would be cleaned and weighed for inventory purposes. The uranium trioxide would be transferred pneumatically into the reduction fluidized-bed reactor by a positive pressure system using nitrogen gas. Nitrogen would be forced through the distributor plate in the bottom of the reduction fluidized-bed reactor during all transfer steps to minimize the potential for powder to settle and lodge in the distributor.

After the powder was transferred into the reduction fluidized-bed reactor, a heater would bring the reactor and the powder up to near reaction temperature [566° C (1,050° F)]. When the bed was near the reaction temperature, the nitrogen flow would be reduced as the hydrogen flow was simultaneously initiated, keeping the overall gas flow constant as the type of gas changed. The fluidization controller would control the total flow during this operation. When the reaction had ended, the moisture analyzer in the reactor off-gas line would indicate that no more water was being generated by the product. The hydrogen flow would be maintained for a set period of time after the reaction was complete and then the fluidizing gas would once again be switched to nitrogen only. The product, uranium dioxide, would be transferred to the hydrofluorination bed through a pneumatic transfer line. The bottom of the reduction fluidized-bed reactor would be cylindrical and up to 15 cm (6 in.) in diameter to facilitate fluidization of the powder.

The reduction fluidized-bed reactor and associated equipment would be housed in a maintenance enclosure to minimize the potential for the spread of radiological contamination. The equipment primarily requiring maintenance would be anticipated to be the filters that prevent uranium-containing powder from being drawn into the process vent. Nitrogen would be periodically pulsed back through the primary filters to rid them of clinging powder and to increase the time between filter change-outs. Personnel would only enter the facility to perform maintenance activities when the fluid beds were not in operation and after the systems had been purged and the supply valves locked out.

2.1.2.3 Hydrofluorination fluidized-bed reactor module

Uranium dioxide would be pneumatically transferred from the reduction fluidized-bed reactor into the hydrofluorination fluidized-bed reactor. Nitrogen would be forced through the distributor

plate in the bottom of the hydrofluorination fluidized-bed reactor during all transfer steps to minimize the potential for powder to settle and lodge in the distributor.

After the powder had been transferred into the reactor, a heater would bring the reactor and the powder up to near reaction temperature [232° C (450° F)]. When the bed neared the reaction temperature, the temperature in the reactor would be controlled by the flow rate of AHF. Because the reaction of AHF and uranium dioxide produces extreme heat, the flow rate of the AHF would govern the reactor temperature. The fluidization controller would control the total gas flow during this operation. When the reaction had ended, the moisture analyzer in the reactor off-gas line would indicate that no more water was being generated by the product. The AHF flow would be maintained for a set period of time after the reaction was complete, and then the fluidizing gas would once again be switched to nitrogen only.

After the product (uranium tetrafluoride) had cooled, it would be transferred pneumatically into the uranium tetrafluoride receiver. The uranium tetrafluoride receiver would be located above the uranium tetrafluoride canning glovebox. Transfer from the receiver to cans would be accomplished by gravity. During the canning step, a sample would be taken to be tested for purity. A scale (for weighing the uranium tetrafluoride) and a housekeeping vacuum (for cleaning up loose uranium tetrafluoride) would be incorporated into the glovebox. Canned uranium tetrafluoride would be transferred out of the glovebox through an airlock and would be stored in existing facilities to await lab analysis and further processing (reduction to uranium metal). The bottom of the hydrofluorination fluidized-bed reactor would be cylindrical and up to 15 cm (6 in.) in diameter to facilitate fluidization of the powder.

The hydrofluorination fluidized-bed reactor and associated equipment would be housed in a maintenance enclosure to minimize the potential for the spread of radiological contamination. Personnel would only enter the facility once a month to perform maintenance activities. The equipment primarily requiring maintenance would be the filters that prevent uranium-containing powder from being drawn into the process vent. Nitrogen would be periodically pulsed through the primary filters to rid them of clinging powder and to increase the time between change-outs.

An off-gas treatment system would be provided for the hydrofluorination fluidized-bed reactors. This scrubber would be designed to remove 99 percent of the HF and would accommodate a flow of approximately 27 kg (60 lb) of HF per hour.

2.1.3 Emissions, Effluents, Wastes

The ways in which the proposed new AHF supply and fluidized-bed reactor systems would differ from the existing systems are described in Sects. 2.1.3.1 through 2.1.3.3.

2.1.3.1 Emissions

The new AHF supply system would allow less than 0.1 percent of fugitive emissions from the system to escape into the air as compared to the present system, which releases 100% of gaseous emissions. No quantification of fugitive AHF with the existing system is available, other than perimeter monitors that indicate releases are well below standards established by the State of Tennessee (Energy Systems 1994).

Emissions from the existing and new fluidized-bed reactor systems are expected to be comparable; however, the change in design involves complete secondary containment of the reactors to better protect workers.

2.1.3.2 Effluents

The new AHF supply system would prevent release of effluents from the supply dock because any liquid discharge would be routed to the sump. The existing system allows any water released from the deluge system to flow into storm drains.

No effluents are associated with either the proposed new or existing fluidized-bed reactor systems.

2.1.3.3 Wastes

Liquid waste resulting from operation of the proposed new AHF and fluidized-bed reactor systems and the existing systems would be comparable. Spent scrubber waste would consist of residual KOH, potassium fluoride, and water. During normal operations, the scrubber for the proposed fluidized-bed reactor system would remove residual HF from the process off-gas stream, just as the current system does.

The proposed new scrubber in the Dock 8/8A area would use water as the scrubbing medium. Under normal operations no waste would be generated by this scrubber; waste from this scrubber would be generated only by operation during an accidental release. In that case, the spent water scrubbing solution (which would be a weak hydrofluoric acid solution) would be treated with KOH. The treated waste would then consist of residual KOH, potassium fluoride, and water.

The waste stream from the scrubbing process would be processed through the Y-12 Plant's Central Pollution Control Facility, just as the current waste stream is processed.

2.2 NO-ACTION ALTERNATIVE

The no-action alternative is to continue operating the existing AHF supply and fluidized-bed reactor systems for Building 9212. Even with the interim safety improvements to the existing AHF supply system, further modifications would be required to sufficiently reduce the risk of an unacceptable AHF exposure to the Y-12 Plant population, the public, and the environment.

2.3 ALTERNATIVE SITES

Several sites were considered and rejected from further consideration for installation of either the AHF supply system or the fluidized-bed reactor systems. These sites are discussed below and are compared to the proposed location of both the AHF supply system and the fluidized-bed reactor systems.

2.3.1 AHF Facility

The sites reviewed and eliminated from consideration for the AHF supply system are located: (1) west of Building 9212 on the site of Building 9812 and (2) inside Building 9212 in B-1 Wing, adjacent to the fluidized-bed reactors.

Initial site selection criteria were based on an analysis of safety and operational factors (Energy Systems 1992b). Some of the factors considered in this analysis were:

- the importance of minimizing the line distance between the AHF supply system and the fluidized-bed reactor systems because a long AHF pipeline would increase the potential for line damage and subsequent personnel exposure to AHF;
- the difficulty of maintaining a constant operational temperature over a long AHF pipeline;
- the importance of good vehicular access to the site; and
- the importance of not being in close proximity to offices staffed with personnel not involved in site operations.

Building 9812. The Building 9812 site had the advantage of allowing operating personnel easy and routine access and had limited nonproduction personnel stationed near it. However, this facility was used to store uranyl nitrate solution, received from DOE's Savannah River Operations in South Carolina, for reprocessing at the Y-12 Plant. Sections and equipment in this facility's interior are radionuclide-contaminated as a result of spills and leaks throughout its years of operation. The cost of the decontamination and demolition activities that would be required to prepare this site for construction has been estimated to be close to \$10,000,000. Because of the high cost of decontamination and demolition, the long AHF supply lines, the comparatively longer demolition and construction time periods, and the lack of advantages over the proposed location, this alternative was rejected from further consideration.

Building 9212. Installation of the supply system inside Building 9212 would minimize the AHF pipeline distance. However, several serious potential problems are associated with this location. Vendor-leased cylinders would have to be transported through radiological control areas. The cylinders could become contaminated, leading to contractual problems with the vendor that could make it necessary to procure AHF in government-owned cylinders. This could increase liability significantly in the transportation of AHF to and from the plant site. Additionally, nuclear criticality* safety considerations would preclude installation of the system inside a material access area;* therefore, operator access would not be significantly improved. Installation of the containment scrubber system would require major structural modifications to the eastern side of Building 9212. This would require expensive demolition and excavation in uranium-contaminated areas. For these reasons, installation of the AHF supply system within Building 9212 was not considered further.

2.3.2 Fluidized-Bed Reactor Site Selection

Fifteen alternatives to the proposed site location were considered; these 15 were narrowed to the 3 that were reviewed: (1) rebuild in place, (2) use Building 9423, or (3) use the Enriched Uranium Conversion Facility in D Wing of Building 9212. Rebuilding in place was rejected because of high cost and the necessity of operation shutdown during the construction period. Building 9423 would require extensive modifications to convert it for uranium processing and has already been committed to other activities as part of long-term reconfiguration efforts at the Y-12 Plant. The use of D Wing in Building 9212, while ideal from a materials-flow perspective, has several unresolved safety issues. Major portions of D Wing would have to be modified to facilitate construction. Subsequently, the standby status of the Enriched Uranium Conversion Facility site could not be maintained if the fluidized-bed reactors were installed. Because none of the alternative site locations offered any compelling advantages when compared with the proposed location, these alternative sites were eliminated from further consideration.

2.4 EXTENSIVE MODIFICATION OF AHF SUPPLY AND FLUIDIZED-BED REACTOR SYSTEMS

The existing AHF supply and fluidized-bed reactor systems have been modified to the extent practicable to provide interim operational safety until DOE can determine the appropriate final course of action. Additional and extensive modifications of the systems are still required to address all operational safety concerns. Further systems modifications would not be technically superior, safer, nor as cost effective compared to system replacement. Therefore, this is not a reasonable alternative for providing additional worker safety and protection of the environment.

2.5 TERMINATION AND SHUTDOWN OF AHF SUPPLY AND FLUIDIZED-BED REACTOR SYSTEMS

Under this alternative, DOE would terminate and shut down the AHF supply system and fluidized-bed reactor operations. As one of the largest handlers of enriched uranium in the world (U.S. Congress 1993), the Y-12 Plant provides a broad spectrum of enriched uranium handling, processing, and storage capabilities that are not available at any other single DOE site. The AHF supply and fluidized-bed reactor systems are key processes for the chemical recovery and recycling of highly enriched uranium. The recovery and recycling of highly enriched uranium are a unique capabilities of the Oak Ridge Y-12 Plant and is necessary to fulfill several DOE mission requirements. These mission requirements include support for:

- interim and long-term storage of enriched uranium at a location where prestorage processing capability is available to support continued weapons dismantlement;
- nonproliferation goals by converting uranium salvage from retired weapons to alternate forms, which are more readily accountable and safer to store;
- maintenance of nuclear competence through weapons life extension and providing requested specification-grade uranium for weapons component fabrication and other special needs; and

- other purposes of national security (DOE 1994b and Energy Systems 1994).

The Department also needs to process enriched uranium to provide material control, accountability, and maximum utilization of existing interim storage space and to consolidate, process, and manage on an interim basis any enriched uranium that is not needed at other sites. Additionally, only the Y-12 Plant has the processing capabilities necessary for disassembly of secondaries (weapons components) received from the Pantex Plant in Amarillo, Texas. Prestorage processing capability could not be added at other sites in the near term (DOE 1994a). Therefore, termination and shutdown of the AHF supply and fluidized-bed reactor systems would not meet the Department's mission requirements.

3. AFFECTED ENVIRONMENT

Most of the information in this chapter was taken from the *Oak Ridge Reservation Annual Site Environmental Report for 1993* (Energy Systems 1994). The Oak Ridge Reservation's approximately 14,300 hectares (35,300 acres) lie wholly within the corporate boundaries of the city of Oak Ridge, Tennessee. The Y-12 Plant is situated in Bear Creek Valley at the eastern boundary of the Oak Ridge Reservation, about 4.8 km (3 miles) from the population center of the city of Oak Ridge. The plant site is bounded on the south by Chestnut Ridge and on the north by Pine Ridge and lies on the valley floor and northern slope of Chestnut Ridge. The Y-12 Plant industrial complex occupies approximately 1,376 hectares (3,400 acres) and has a surrounding buffer zone of about 1,233 hectares (2,800 acres).

The estimated residential population within an 80-km (50-mile) radius of the Oak Ridge Reservation is approximately 880,000. A major urban center, Knoxville (population approximately 165,000), is located about 32 km (20 miles) to the east. The city of Oak Ridge has a population of about 27,000. The approximate populations and locations of other towns near the Oak Ridge Reservation are as follows: Oliver Springs (population 3,400), 11 km (6.8 miles) northwest; Clinton (population 9,000), 16 km (10 miles) northeast; Lenoir City (population 6,100), 11 km (6.8 miles) southeast; Kingston (population 4,600), 11 km (6.8 miles) southwest; and Harriman (population 7,100), 13 km (8 miles) west.

The population within 80 km (50 miles) of the Oak Ridge Reservation consists of people who live in the area and people involved in other industrial activities, schools, recreational activities, and health care facilities, as well as those traveling through the area. In December 1992, the Y-12 Plant employed 6,575 people.

3.1 AIR QUALITY

Airborne discharges from DOE Oak Ridge facilities are subject to regulations issued by the Tennessee Department of Environment and Conservation Air Pollution Control Board and the U.S. Environmental Protection Agency and to DOE Orders. Hydrogen fluoride is the Y-12 Plant emission relevant to the proposed action and its alternative. Nonradioactive emissions are regulated under the rules of the Tennessee Department of Environment and Conservation Division of Air Pollution Control.

Periodic fluoride sampling was begun in the late 1950s or early 1960s and ceased in December 1994 (Shelton 1995). Eleven samplers encircling the Y-12 Plant filtered the ambient air continuously to collect fluorides. In 1986, the sampling time was increased to "continuous," with sample filters being exchanged every 7 days so that the data could be compared to the Tennessee Department of Environment and Conservation's standard of $1.6 \mu\text{g}/\text{m}^3$ for a 7-day average. Average 7-day fluoride concentrations at the Oak Ridge Reservation stations were only a small portion of the Tennessee Department of Environment and Conservation standards [typically less than 2 percent (Energy Systems 1994)].

In December 1994, ambient air sampling for fluorides around the Y-12 Plant was discontinued because it is not required by federal or state regulatory requirements or DOE

Orders. Dispersion modeling using Y-12 Plant meteorological data can be used to predict or estimate exposure in the event of a release and spot sampling can be conducted to confirm model results. When operations using AHF are resumed, it is anticipated that future fluoride emissions will be much lower than in previous years because of new and improved emission controls such as the addition of an AHF scrubber and the improved administrative and process controls brought about from the 1992 release and investigation conclusions (Energy Systems 1993e).

3.2 WATER RESOURCES

The Y-12 Plant is located in the Bear Creek and East Fork Poplar Creek drainage basins of the Clinch River.

The Bear Creek watershed has a drainage area of 19.4 km² (12 miles²). The headwaters of Bear Creek originate near the western end of the Y-12 Plant. The creek flows westward through Bear Creek Valley for about 7 km (4.5 miles) then turns northward to flow into East Fork Poplar Creek.

The East Fork Poplar Creek drainage basin has an area of 77.2 km² (30 miles²). The headwaters of East Fork Poplar Creek consist of springs that originate on the northwestern slope of Chestnut Ridge near the Y-12 Plant. The stream is contained in culverts through much of the western end of the Y-12 Plant before it enters a rip-rap channel. Just east of the plant boundary, East Fork Poplar Creek flows into Lake Reality. Lake Reality is a retention basin with gates that can be used to contain contaminated water and minimize off-site releases in the event of a spill. From the outfall of Lake Reality, the creek flows 23.7 km (15 miles) to its confluence with Poplar Creek, a tributary of the Clinch River. Many storm water drains at the Y-12 Plant discharge to East Fork Poplar Creek; thus, it is the likely receiving body of water for any construction-related sediment erosion. The construction location for the proposed action is approximately 1,070 m (1,170 yd) from the channel of East Fork Poplar Creek.

3.3 SOIL

Soil that would be disturbed during construction is in the area of Dock 8/8A. The area around the dock that would be disturbed is paved, so it is subsurface soil that would be excavated. Based on limited sampling and operational process knowledge, the only hazardous material likely to be present in the soil surrounding Dock 8/8A is enriched uranium oxide. The likelihood of finding other hazardous constituents is considered small. Personal protective equipment for excavation workers would be based on protection from enriched uranium oxide that may be present. No further characterization of the soil is planned.

3.4 ARCHAEOLOGICAL AND CULTURAL RESOURCES

An evaluation of the facilities within the Y-12 Plant for their potential listing on the National Register of Historic Places is planned for 1995. The Y-12 Plant, or some of its properties, may be eligible for inclusion in the National Register of Historic Places because of its role in and impact on local, national, and international events from the scientific, military, and historical

perspectives (DuVall 1992). A programmatic agreement concerning management of historical properties and cultural resources at the Oak Ridge Reservation was executed among the DOE Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation on May 6, 1994 (Advisory Council on Historic Preservation 1994). The DOE Oak Ridge Operations Office will develop a management plan for historical and cultural resources as part of this agreement. By carrying out the terms of this agreement, DOE will have fulfilled its responsibilities under Sections 106 and 110 of the National Historic Preservation Act and the regulations of the Advisory Council on Historic Preservation. DOE is preparing a Cultural Resources Management Plan for the Oak Ridge Reservation, which will include a survey to identify significant historical properties. Building 9212 will be included in the survey and in the management plan, a draft of which is scheduled for completion in May 1996.

3.5 BACKGROUND RADIATION

The exposure rate from external natural background radiation (i.e., radiation from cosmic and terrestrial sources) across the state of Tennessee averages about 42 mrem/year, which is similar to the average U.S. external exposure rate of 55 mrem/year. Natural background radiation is derived from both external and internal sources. External sources include cosmic rays and naturally occurring radioactive materials in the earth (NCRP 1987).

External radiation exposure rates are measured at a number of locations on and off the Oak Ridge Reservation. The average total dose (including background) at perimeter air monitoring stations around the Oak Ridge Reservation during 1993 was 49 mrem. With the exception of two locations, all measured exposure rates outside the Oak Ridge Reservation boundaries are near background levels. The two exceptions are a stretch of bank along the Clinch River and a section of Poplar Creek that flows through the K-25 Site on the Oak Ridge Reservation. The Clinch River bank is affected by air-scattered radiation derived from cesium used in experiments on a nearby field. The radiation field along Poplar Creek is due to storage areas within the K-25 Site.

4. ENVIRONMENTAL IMPACTS

4.1 DEMOLITION AND CONSTRUCTION

All demolition and construction activities associated with the proposed project would be conducted in accordance with Y-12 Plant, Energy Systems, and DOE environmental policies. A best management practices plan would be prepared during the design phase and implemented to minimize the potential release of pollutants by means of storm runoff to the waterways on the plant site. The requirements of the best management practice plan would be made an integral part of the construction plans and specifications.

4.1.1 Air Quality

Impacts to air quality would be short-term and localized. Dust would be generated during construction activities and exhaust emissions would be produced from operation of construction vehicles and other internal combustion driven equipment.

Best management construction practices would be employed to minimize dust generation during construction. Dust control measures would include respiratory protection or dust suppression techniques for interior demolition activities. For example, for removal of piping insulation, sheetrock joint compound, roofing or flooring materials that contain asbestos, negative-pressure enclosures would probably be needed. Stainless steel, galvanized ductwork, Monel metal*, and paint contain materials that are potential respiratory hazards if aerosolized as a respirable dust or fume during demolition. Release of these materials would necessitate that workers use respiratory protection.

4.1.2 Soils/Topography

Impacts to soil and topography would be minimal. Demolition and construction would entail minor excavation (primarily associated with removal and replacement of the Brake Press Pavilion and installation of a new section of storm drain) and grading of the site.

4.1.3 Water Quality

Erosion and sediment control would be provided to minimize the transport of sediment into storm sewers or beyond the limits of the construction. Construction would be based on the Y-12 Plant Spill Prevention Control and Countermeasure Plan (Energy Systems 1989). Erosion control measures to be employed during excavation and grading include temporary control measures for slope protection and controls to reduce erosion, sedimentation, and water pollution by using mulches, grasses, temporary silt fences and other controls such as filter cloth. As a first step in construction, workers would install inlet sediment filters, perimeter barriers, and other measures to deter erosion and transport of sediment associated with construction activities before upslope land disturbance takes place. Earthen structures, such as dams, berms, and diversion ditches, would be seeded and mulched. Silt fences would be installed to reduce the quantity of sediment and velocity of flow to downstream areas. Silt fences are constructed of 1.7-m (5.5-ft)-long wood or steel posts with 1-m (3-ft) -high wire fencing as backing for the geotextile filter

fabric, typically consisting of pervious sheets of synthetic material. Immediately after each rainfall, and daily during prolonged rainfall, the silt fences would be inspected and repaired, as needed; sediment deposits would be removed after each storm event.

The natural waterway most likely affected by sediment runoff would be East Fork Poplar Creek. Many of the storm drains at the Y-12 Plant discharge to this creek. Because very little soil would be disturbed during construction, the amount of sediment contributed, even with a breach in silt fencing, would be small.

4.1.4 Natural and Historic Resources

The demolition and construction activities of the proposed action would occur within a heavily industrialized setting in an area dominated by buildings, parking lots, and roadways. Two minor wetlands are located within the eastern section of the Y-12 Plant, neither of which are near the proposed action (Hardy, Pounds, and Cook 1992). Building 9212 is not within the 100-year floodplain* (Energy Systems 1993c). Because no natural habitat would be disturbed, no federally or state-protected plant or animal species would be affected during the demolition or construction phase.

Prehistoric or historic archaeological sites circa 1940 or earlier would not be affected by the proposed action (DuVall 1992). An evaluation of the facilities within the Y-12 Plant for their potential listing on the National Register of Historic Places is planned but has not yet been performed (Advisory Council on Historic Preservation 1994). The Y-12 Plant may be eligible for inclusion in the National Register of Historic Places (or may have properties that are eligible) because of its role and impact on local, national, and international events from the scientific, military, and historical perspectives (DuVall 1992). However, the proposed action would fall within the category of actions that are programmatic exclusions from submission of a no-effects report to the State Historic Preservation Office under Section IV the Programmatic Agreement among DOE, the Advisory Council on Historic Preservation, and the State Historic Preservation Office (Advisory Council on Historic Preservation 1994). Thus, no consultation letter to the State Historic Preservation Office is presented for the proposed action.

4.1.5 Health and Safety

The health and safety hazards facing workers during demolition and construction are: exposure to low-level radioactive contaminants during soil excavation in the area of Dock 8/8A and demolition inside B-1 Wing of Building 9212; inhalation of dust during demolition of the Brake Press Pavilion and inside Building 9212; inhalation of asbestos fibers during demolition inside Building 9212; and construction accidents.

All decontamination and demolition would be performed by workers familiar with radiation hazards, would be closely monitored by the Energy Systems Health and Safety Office, and would be performed in accordance with all DOE and Occupational Safety and Health Administration policies and regulations. Before decontamination and demolition, a thorough radiological, chemical, and asbestos characterization survey would be conducted.

Portions of the eastern end of the B-1 Wing in Building 9212 would have to be demolished to construct the new fluidized-bed reactor system. The facility's ventilation gaskets potentially

contain polychlorinated biphenyls (PCBs); however, these potentially contaminated gaskets could be removed easily without worker exposure.

Health physics surveys indicate radiological contamination of the Dock 8/8A and B-1 Wing maintenance shop areas. The contamination is primarily fixed. On the basis of the health physics surveys, Y-12 Radiological Engineering has outlined protective equipment requirements for the demolition work (Table 4.1) (England 1992). These requirements would be documented in a Safety Work Permit and, where necessary, a Radiation Work Permit prior to demolition work. Exposure to workers during construction/demolition would thus be within acceptable limits. As described in Sect. 3.3, the only hazardous material likely to be present in the soil surrounding Dock 8/8A is enriched uranium oxide. A conservative assumption has been made that the soil is contaminated with enriched uranium oxide and all personnel would be equipped with personal protective equipment for enriched uranium during excavation activities. During excavation, samples would be taken to verify and determine the extent of uranium contamination. So although actual exposures to unprotected workers have not been determined, the use of personal protective equipment would ensure that workers would receive no unacceptable exposure. The protective equipment requirements listed below may change as additional field surveys are completed and site conditions warrant.

Table 4.1. Protective equipment requirements for demolition work

Dock 8/8A work

- Half-face respirator
- Type H particulate cartridge
- Safety glasses
- Gloves
- Paper suits, double clothing for welding or burning
- Area roped off at a minimum of 10 ft and posted as a "Half-Face Respirator Area" during dust-producing activities
- The area shall be deemed a Radiological Area - Airborne Contamination Area
- All personnel and material shall be monitored by Health Physics prior to leaving the Radiological Area
- At completion of work, the area shall be cleaned, surveyed by Health Physics, and deemed free from contamination. The area shall then be made a Non-Radiological Area.

B-1 Maintenance Shop

- Full-face respirator
 - Type H particulate cartridge
 - Gloves
 - Paper suits, double clothing for welding or burning
 - Area roped off at a minimum of 10 ft from the work area and posted as a "Full-Face Respirator Area" during dust-producing activities
-

4.1.6 Waste Management

Most demolition debris would be expected to be classified as "low-level contaminated solid waste." It would be necessary to cut these materials into sizes that could be placed in special containers for waste storage. A standard container such as a B-25-type box has approximate dimensions of 1.2 m (4 ft) $\times$ 1.8 m (6 ft) $\times$ 1.2 m (4 ft) deep. B-12-type boxes are 1.2 m (4 ft) $\times$ 1.8 m (6 ft) $\times$ 0.6 m (2 ft) deep. Therefore, cutting dimensions must be less than 1.2 m (4 ft) $\times$ 1.8 m (6 ft).

Clothing would be collected daily and returned to a regulated laundry facility. Scaffolding, plastic sheets, and plywood would be boxed. High-efficiency particulate air filters and ductwork that were removed would be surveyed for radionuclide contamination and boxed for storage. Further processing of high-efficiency particulate air filters could be required if significant amounts of radionuclides were collected. All containerized waste would be stored in waste-storage vaults at the K-25 Site.

4.2 IMPACTS OF INCIDENT-FREE OPERATION

4.2.1 Air Quality

Routine process emissions of AHF would be routed through an off-gas treatment system scrubber prior to release to the atmosphere. Therefore, the potential for an uncontrolled or untreated AHF release to the atmosphere would be decreased compared to current operations.

4.2.2 Health and Safety

The proposed modifications are designed to reduce the risk of an unacceptable exposure to the worker population and the general public. Automated control features, leak detection systems, and fugitive emission and emergency release HF capture and treatment systems would be provided. The control systems would be designed to prevent uncontrolled releases of AHF emissions to the atmosphere, eliminating any potential threat to the general public and workers in the vicinity. In the event of an accident, the facility would be designed to capture the entire inventory of AHF in the secondary containment enclosure.

4.2.3 Waste Management

Once operational, the air emission control systems would routinely generate wastes that must be disposed. Off-gas treatment systems for the hydrofluorination fluidized-bed reactor systems would use potassium hydroxide scrubbers. Spent potassium hydroxide scrubber solution (containing potassium fluoride) would be transported to the Central Pollution Control Facility for treatment and disposal (see Section 2.1.3.3). Waste treatment operations are under review and may in the future regenerate the potassium hydroxide from the spent scrubber solutions.

4.3 ACCIDENT AND CONSEQUENCE ANALYSIS

4.3.1 Hazardous Materials

Radioactive, fissile, and toxic materials are associated with the proposed action. Their characteristics are described below.

4.3.1.1 Toxic materials

The principal toxic substances associated with the proposed action are AHF, potassium hydroxide scrubber solution, uranium oxides (uranium dioxide and uranium trioxide) and green salt (uranium tetrafluoride).

AHF is the greatest concern because it is present in large quantities, produces severe health effects at relatively low concentrations, and is readily vaporized. [The boiling point at atmospheric pressure is 19.5° C (67° F).] Although the other chemicals are about equally toxic in terms of permissible concentrations, they are present in smaller quantities and do not easily become airborne. (Uranium is present as coarsely-divided solids and potassium hydroxide is present in aqueous solution.) For this reason, health effects are dominated by exposure to AHF, and other materials are eliminated from further consideration.

Short-term (acute) exposure to AHF at relatively high concentrations can result from accidents; therefore, permissible doses (intakes) are suggested by several published limits. The Immediately Dangerous to Life and Health concentration is 30 parts per million (25 mg/m³) (NIOSH 1990). Immediately Dangerous to Life and Health is the concentration from which one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects. At a typical breathing rate of 1 m³/hour, a 30-minute exposure at the Immediately Dangerous to Life and Health concentration produces an inhaled dose of 12.5 mg.

Emergency Response Planning Guides (ERPGs) are concentration values that are developed specifically for accident evaluations and are published by the American Industrial Hygiene Association (AIHA 1989). Three ERPG levels are defined, each of which is based on a 1-hour exposure. ERPG-1 is expected to produce, at most, minor effects. Irreversible health effects are not predicted at ERPG-2 (20 parts per million or 17 g/m³ for AHF), and life-threatening health effects are not predicted at ERPG-3 (50 parts per million or 42 mg/m³ for AHF). At a typical breathing rate of 1 m³/hour, the corresponding AHF doses for 1-hour exposure are 17 mg (at ERPG-2) and 42 mg (at ERPG-3).

In *System Safety Analysis for Hydrogen Fluoride Distribution System for Building 9212* (Energy Systems 1993d), it is suggested that a short-term inhalation dose of 500 mg provides a practical definition for the onset of death. This is one-half of the estimated LI_{50} , the chemical dose that causes death in one-half of the exposed population, for AHF of 1,000 mg (Energy Systems 1993d).

4.3.1.2 Radioactive materials

Uranium, enriched up to 93 percent uranium-235, is processed in the fluidized-bed reactors and may be present in the off-gas streams. Internal radiation doses could occur from inhalation or ingestion of solids or solutions. Because uranium is primarily an alpha emitter, there is little risk from external radiation. Significant doses require that uranium enter the body, typically through inhalation, ingestion, or an open wound. Inhalation is the only significant exposure pathway for accidents related to the proposed action.

Only inhaled particles with diameters less than 5 to 10 microns will reach the lungs. The fraction of particles in an aerosol that are in this size range is commonly referred to as the "respirable fraction." The only sources of airborne uranium are the coarse granules that comprise the feed materials to the two reactors. Measurements of particle size distribution indicate that the respirable fraction in these materials is so low as to be considered zero (Energy Systems 1993d). For this reason, accidents related to the proposed action that result in airborne uranium are not expected to produce health consequences, and accidents that might lead to uranium inhalation are eliminated from further consideration.

4.3.1.3 Fissile materials

The uranium that is processed in the fluidized-bed reactors is enriched to 93 percent uranium-235 and is therefore capable of a self-sustaining fission reaction. The potential for a criticality accident is included in this assessment.

4.3.2 Accident Identification

Accidents described in this assessment are taken from a safety analysis of the AHF processes (Energy Systems 1993d). Although the Energy Systems analysis addresses interim upgrades to the AHF processes, much of the information remains applicable to the proposed action. Examples of relevant information include identification of basic failure modes and their frequencies, accident scenarios leading to releases of AHF, release rates (for liquids, vapors, and two-phase flow), airborne concentrations, and doses to both operators and the public.

4.3.3 Consequence Methodology

Dose Calculations. The dose from exposure to an airborne contaminant is the product of its concentration and the receptor's breathing rate. A standard breathing rate is 1 m³/hour. Concentrations in closed spaces (such as process rooms) are calculated assuming that AHF mixes instantaneously and uniformly as it is released and that diluted vapor is removed by the ventilation exhaust system.

Concentrations at the point of public exposure (location described below) depend on atmospheric dispersion, which is a function of meteorological conditions and the physical characteristics of AHF.

Dispersion calculations (Energy Systems 1993d) are based on the assumption of Class D stability and a wind speed of 4.5 m/sec. This is consistent with the approach taken by DOE for assigning hazard categories to nuclear facilities (DOE 1992).

Due to the tendency of AHF to polymerize and interact with moisture, it behaves as a dense (heavier-than-air) gas near the point of release and changes to neutral buoyancy as it disperses. Dispersion calculations for this condition are performed with the HEGADAS-S computer program, which is a subroutine of the HGSYSTEM family of models for predicting heavy gas behavior (Puttock et al. 1991). HGSYSTEM is one of the programs used in a congressional report on AHF that was prepared by the Environmental Protection Agency (EPA 1992).

The following relationship between ground-level AHF release rate (in units of kilograms per minute) and AHF concentration at 300 m (984 ft) from the source (in units of milligrams per cubic meter) results from HGSYSTEM calculations (Energy Systems 1993d):

$$\text{Concentration} = (\text{Release Rate} \times 1.18) - 0.16 \quad (\text{Equation 1})$$

AHF that is discharged from an exhaust stack is sufficiently diluted at the point of discharge to permit the use of standard Gaussian dispersion formulations. Values of the dispersion parameter (X/Q) at a distance of 300 m (984 ft) are $3.5 \times 10^{-5} \text{ sec/m}^3$ (0.000035 sec/m^3) for release from the D-Wing stack and $3.9 \times 10^{-5} \text{ sec/m}^3$ (0.000039 sec/m^3) for release from the Dock 8/8A stack. Downwind concentration is equal to the product of release rate and X/Q .

The assumed point of public exposure is the nearest gate on Bear Creek Road. This gate is located 300 m (984 ft) east of Dock 8/8A. The nearest point of public access is approximately 230 m (755 ft) north of Dock 8/8A; however, several buildings form a barrier to the transport of AHF in this direction.

4.3.4 Accident Analysis

4.3.4.1 Accidents during cylinder handling

An accident that occurs during transport between the delivery truck and the secondary confinement structure, such as dropping or crushing a cylinder during lifting, could release the entire contents of one cylinder to the atmosphere at ground level. During some (but not all) parts of the off-loading operation, the effects of such a spill would be mitigated by floor drains that would direct liquid AHF to a covered catchment basin and by the water deluge system that would absorb some airborne vapors. In the worst case, all of the AHF would be released to atmosphere.

The dose received by a person at the site boundary would depend on the rate of vapor production at the spill site. At temperatures below the boiling point, AHF will form a liquid pool and become airborne through the relatively slow process of evaporation. A calculated evaporation rate of 16 kg/minute (36 lb/minute) would result in a dose at the site boundary of 21 mg AHF (Energy Systems 1993d).

Because cylinders are not cooled during shipment to the site, AHF would be at or near ambient air temperature, which may be above the boiling point. At an assumed temperature of 38° C (100° F), AHF leaking from the cylinder would flash to vapor. The calculated dose at the site boundary for a 386-kg (850-lb) cylinder is 16 mg (Energy Systems 1993d). The linearly scaled dose for a 612-kg (1,350-lb) release from the larger cylinder is 25 mg.

The frequency of cylinder failures during handling is estimated as 2×10^{-5} /year (0.00002/year) (Energy Systems 1993d). This estimate includes dropping, crushing, and over-pressurization due to a fork lift fuel fire.

4.3.4.2 Accidents at Dock 8/8A

This accident category includes AHF release scenarios within the secondary confinement structure at Dock 8/8A (for example, failures in the cylinder, vaporizer, and piping connecting the cylinder and the vaporizer). The design basis for the scrubber in the secondary confinement exhaust line would be 99.9 percent AHF removal, assuming that one full cylinder was released as vapor at a rate of 18 kg/minute (40 lb/minute). The maximum release to atmosphere would be 6.1×10^5 (610,000 mg) (1.35 lb). The release would occur from the Dock 8/8A stack, and the dose at the site boundary would be on the order of 1×10^{-2} (0.01 mg).

Frequencies are estimated for several failures that remain applicable under the proposed action (Energy Systems 1993d). Occurrence rates for representative failures** are:

Cylinder or vaporizer shell corrosion	1×10^{-2} /year (once in 100 years)
Flexible connection failures from work hardening	4×10^{-4} /year (four in 10,000 years)
Pipe fitting failures	1×10^{-1} /year (once in 10 years)
Pipe weld failures	2×10^{-1} /year (twice in 10 years)

An earthquake exceeding the facility design basis could cause the design basis vapor release [18 kg/minute (40 lb/minute)] to occur at ground level without mitigation. The frequency of exceedance for the project design basis earthquake would be 5×10^{-4} /year (five in 10,000 years). The concentration at the site boundary for a ground-level release rate of 18 kg/minute (40 lb/minute) would be 47 mg/m³ (from Equation 1). The resulting dose would be 27 mg, assuming that the concentration remained constant over the duration of the release.

4.3.4.3 Transfer line accidents

Secondary confinement for the AHF transfer line would be provided along the entire run from the secondary confinement structure at Dock 8/8A to the maintenance enclosure surrounding the reduction reactor in Building 9212. The annulus between the primary line and the outer line would be vented back to each of these spaces. The potential consequence of a transfer pipe failure (with the outer pipe intact) would be a combination of the consequences of AHF releases within the secondary confinement at Dock 8/8A and releases inside Building 9212.

The frequency of transfer line failures is estimated at 0.3/year (Energy Systems 1993d). This includes relatively minor faults such as small cracks.

An earthquake exceeding the facility design basis could cause both the inner and outer pipes to be severed, allowing direct release of AHF to atmosphere. Dispersion would likely be enhanced because (for most of its length) the transfer line would be approximately the same height above ground as the Dock 8/8A stack. Rupture of both pipes could also be caused by

**Representative failure frequencies include all failure modes, many of which are minor.

crane impact during maintenance in the vicinity of the transfer pipe. The frequency of a crane mishap is estimated at 2×10^{-5} /hour (0.00002/hour) of crane operation in the vicinity of the transfer pipe (Energy Systems 1993d).

An assumed release of 386 kg (850 lbs) from the transfer line directly to atmosphere would result in a dose of 3 mg at the site boundary (Energy Systems 1993d). A release of this magnitude is not possible in the new system because the supply cylinder is isolated from the vaporizer during transfer operations. The linearly scaled dose for the maximum release of 73 kg (160 lb) is less than 3 mg. It is likely that releases caused by events other than a large earthquake would be terminated by closing the valves at the supply station on Dock 8/8A so that the total release would be less than the quantity of AHF remaining in the vaporizer at the time a leak develops.

4.3.4.4 Accidents inside Building 9212 (B-1 Wing)

Accidents inside B-1 Wing have the greatest potential for worker injury because AHF could be released into occupied spaces where rapid accumulation would require prompt evacuation. AHF vapors would ultimately be exhausted to atmosphere through one or more of the Building 9212 stacks.

Release modes that are postulated in *System Safety Analysis for Hydrogen Fluoride Distribution System for Building 9212* (Energy Systems 1993d) include leaking pipe joints, failures caused by hydrogen explosion, and failure of the scrubber in the off-gas line from the hydrofluorination reactor. Leakage from the AHF transfer pipe would no longer be of immediate concern because secondary confinement is included in the proposed action. However, one of the postulated hydrogen explosion accidents remains applicable and may be capable of rupturing both the primary AHF pipe and the secondary confinement pipe.

An explosion could occur if the hydrogen leakage inside the reduction reactor enclosure remained undetected and the exhaust fan failed, allowing the concentration to reach the lower explosive limit prior to ignition. It is assumed that the resulting explosion could result in failure of both the primary and secondary AHF confinement pipes. The stated frequency of 3.5×10^{-2} /year (0.035/year) (Energy Systems 1993d) appears to result from a very conservative estimate.

Both hydrogen and AHF detectors monitor for leakage in the vicinity of process equipment in B-1 Wing. AHF releases in B-1 Wing can be terminated either by local valves or remote valves at the supply station on Dock 8/8A.

The estimated operator dose following complete severance of the AHF supply pipe inside B-1 Wing followed by prompt evacuation (within 2 minutes) would be approximately 90 mg. Possibly fatal doses could be received by operators who were unable to evacuate within approximately 5 minutes (Energy Systems 1993d).

The off-site consequences that would result from releasing 612 kg (1,350 lb) of AHF (one full supply cylinder) to atmosphere through a Building 9212 stack are bounded by the dose of 3 mg that would result from complete rupture of the AHF transfer pipe outside the building (discussed above).

4.3.4.5 Nuclear criticality in the fluidized-bed processes

Nuclear criticality could occur if sufficient uranium accumulated in the exterior storage tank for spent potassium hydroxide (used to scrub HF vapor from the hydrofluorination reactor off-gas line). The potential for criticality would arise from the unfavorable geometry of the tank. Other process vessels would have nuclear-safe geometry.

Physical features that would prevent unsafe accumulation are the filters in the reactor off-gas lines, each of which would trap all particles greater than 11 microns, and a particle size distribution in the feed materials that would be sufficiently coarse to prevent suspension in the off-gas stream. Administrative controls require double sampling and double valve operations before transferring solution from the interior (nuclear-safe) tank to the exterior tank. The estimated frequency of nuclear criticality is well below 1×10^{-6} /year (0.000001/year) (Energy Systems 1993d).

4.3.4.6 On-site transportation

A limited transportation risk assessment was performed in 1990 (see Appendix B). Transportation risk was defined as the time the commercial transport vehicle with a full AHF cylinder turned off Scarboro Road into the Y-12 Plant, proceeded to Building 9212, and returned to Scarboro Road with a depleted cylinder. The scenario included cylinder handling and change-out operations (H&R Technical Associates, Inc. 1990).

Only on-site transportation operations were found to have the potential to result in fatalities; no fatalities or severe health effects were predicted to occur outside the Y-12 Plant boundary. The risk assessment analysis indicated that nearly 100 percent of the total estimated risk from on-site transport, handling, and change-out is associated with cylinder handling. Drop tests of nearly identical 612-kg (1,350-lb) cylinders, performed for the U.S. Army, showed that the cylinders can be expected to survive impacts on their sides or ends equivalent to a 12-m (40-ft) drop onto any unyielding surface. The mean risk for the AHF cylinder handling, change-out, and on-site transportation is 2.9×10^{-4} (0.00029) severe health effects per year for the on-site population, which is approximately one severe health effect every 3,500 years. One major contributor (approximately 83 percent) to these risks is a scenario in which a forklift tine punctures a full 612-kg (1,350-lb) cylinder while unloading it from the transport vehicle; however, this scenario is not credible because the forklift would be equipped with a gripper rather than standard forklift tines.

4.3.4.7 Natural phenomena

Releases of AHF caused by earthquakes that exceed the design basis are considered in the preceding accident discussions. High winds could cause damage similar to an earthquake; however, increased dispersion of airborne AHF would result in lower consequences.

4.3.4.8 Aircraft crash

The AHF supply area (Dock 8/8A) provides a very small target. Using methodology recommended by the Nuclear Regulatory Commission, the calculated frequency of an aircraft

crash anywhere in the Building 9212 complex is 4.6×10^{-7} /year (0.00000046/year) (Seigler and Luttrell 1992).

4.4 ENVIRONMENTAL JUSTICE

Executive Order 12898 requires federal agencies to achieve environmental justice "to the greatest extent practicable" by identifying and addressing "disproportionately high and adverse human health or environmental effects of its...activities on minority populations and low-income populations..."

Census data on areas near the Y-12 Plant have been examined to identify any low-income or minority populations that could be affected by the proposed action. The census tracts adjacent to the Y-12 Plant are shown in Fig. 4.1. The population distribution by race in these census tracts is shown in Table 4.2.

Table 4.2. 1990 population distribution by race in census tracts near the Y-12 Plant^a

Tract	Total population	White		Black		Other non-white		Hispanic ^b	
		Pop.	%	Pop.	%	Pop.	%	Pop.	%
201	2,767	1,520	58.5	1,019	36.8	128	4.6	24	0.9
202	6,260	5,814	92.9	230	3.7	21	3.5	68	1.1
203	4,533	4,232	93.4	232	5.1	69	1.5	26	0.6
204	4,544	4,228	93.0	249	5.5	67	1.5	44	1.0
205	3,932	3,625	92.2	255	6.5	52	1.3	28	0.7
206	2,707	2,463	91.0	158	5.8	86	3.2	33	1.2
301	2,563	2,423	94.3	37	1.4	143	5.6	13	1.4
Total	27,306	24,405	89.4	1,936	7.0	761	2.8	236	0.9

^a"An Analysis of Impediments to Fair Housing," prepared by the City of Oak Ridge for the U.S. Department of Housing and Urban Development, June 1994.

^bHispanic origin may be any race and are included in other totals.

In census tract 201, 36.8 percent of the population is black; in the other census tracts, the black population ranges from 1.4 to 6.5 percent of the total. The other non-white and Hispanic populations are less than 6 percent in each census tract, and no tract has a substantially larger percentage of these populations. With these data, tract 201 is identified as the community with the highest percentage of minority households. The 1989 household income by census tract is shown in Table 4.2. The 1994 Federal Poverty Guideline on income levels by size of family unit for all states (except Alaska, Hawaii, and the District of Columbia) is as follows (59 FR 6277):

Fig. 4.1. City of Oak Ridge, census tracts 1990.

Size of family unit	Poverty guidance
1	\$7,360
2	9,840
3	12,320
4	14,800
5	17,280
6	19,760
7	22,240
8	24,720

Though guidance defines a low-income *household*, there is no guidance available yet on what would comprise a low-income *community*, that is, what percentage of the total households in the community have incomes in the poverty range. Another concern in identifying a low-income community is the availability of data. For the census tracts near the Y-12 Plant, no data on household income by household size are available. As shown in Table 4.3, the available data, which are from a report prepared by the City of Oak Ridge, list households by income level and census tract but without information on household size. Therefore, this analysis uses two reference points for considering whether low-income communities are located near the Y-12 Plant.

Table 4.3. 1989 Household income by census tract^a

Income range	Census tract						
	201	202	203	204	205	206	301
Less than \$5,000	135	145	40	146	218	7	11
\$5,000 - 9,999	191	268	114	271	200	14	23
\$10,000 - 14,999	133	138	198	177	246	33	0
\$15,000 - 24,999	281	346	359	344	299	129	57
\$25,000 - 34,999	217	332	397	335	275	154	39
\$35,000 - 49,999	173	411	445	401	209	221	137
\$50,000 - 74,999	170	638	258	342	140	254	367
\$75,000 - 99,000	20	198	88	86	43	161	213
\$100,000 or more	29	161	35	32	23	81	117
Total	1,349	2,637	1,934	2,134	1,653	1,054	964

^a"An Analysis of Impediments to Fair Housing," prepared by the City of Oak Ridge for the U.S. Department of Housing and Urban Development, June 1994.

First, the analysis uses the Federal Poverty Guideline income level of \$14,800 for a family of four; this is very close to the \$14,999 break point used in the available data, as shown in Table 4.3. Second, the analysis uses the State of Tennessee median household income level of \$24,807, which is based on 1990 census data; this is very close to the \$24,999 break point used in the available data, as shown in Table 4.3.

In tract 201, 55 percent of the households have incomes less than \$24,999 and 34 percent have incomes less than \$14,999. In tract 205, 58 percent of the households have incomes less than \$24,999, and 40 percent have incomes less than \$14,999. In other tracts, more than 50 percent of the households have incomes greater than the Tennessee median income. Also, less than 30 percent of the households in the other tracts have incomes of less than \$14,999. Based on these data, tracts 201 and 205 are identified as having the highest percentage of low-income or minority households in areas near the Y-12 Plant.

This environmental assessment analyzes impacts to the public under accident conditions in Sect. 4.3. It is not possible to forecast exactly the weather conditions that would exist during an accident, and therefore it is not possible to predict the site where the maximally exposed individual would be during a particular accident. Therefore, it is assumed that the maximally exposed individual could be located in any of the census tracts near the Y-12 Plant.

As discussed in Sects. 4.2. and 4.3 of this environmental assessment, the Y-12 Plant implements extensive environmental, safety, and health measures that would minimize HF exposure to the public under normal operations and during accident conditions. These environmental, safety, and health measures, including secondary containment, emissions, stack scrubbers, and stringent administrative controls, mitigate the potential effects on low-income and minority households as well as the other members of the public. Therefore, this analysis does not identify disproportionate effects on low-income and minority populations.

4.5 NO-ACTION ALTERNATIVE

The existing AHF supply and fluidized-bed reactor systems could continue to operate in the conversion of uranium trioxide to uranium tetrafluoride; however, the danger of an accidental, unmitigated release of AHF would remain. The Y-12 Plant Safety Evaluation Team identified an AHF release as having serious potential consequences (Energy Systems 1992b). Those at greatest risk from such an accident would be workers in the vicinity of Dock 8/8A, the AHF supply dock. During the accidental release of AHF in January 1992, several workers were injured. Cold air temperature and occurrence after normal work hours moderated the severity of the impacts during that release. The consequences to workers would likely have been more severe under less favorable environmental conditions.

Release of HF from the existing processing area stack is not monitored but is calculated from material balance sheets which are classified (DOE 1994a). Fugitive emissions from the Dock 8/8A area coupled with emission stack releases of HF result in a very low level of fluoride in the ambient air (see Sect. 3.1). No waterways, ecological receptors, or other media are adversely affected by operation of the existing system.

The no-action alternative represents an approximate saving to the federal government of \$28,820,000. Additionally, the proposed facility is expected to have a slightly higher comparative operating cost associated with it. However, should a design basis accident occur, damage and remediation effects could result in severe fiscal impacts.

5. CUMULATIVE IMPACTS

Cumulative impacts are the impacts on the environment that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 *CFR* 1508.7).

No other actions at the Y-12 Plant or on the Oak Ridge Reservation are considered additive to the impacts of the proposed action or the no-action alternative.

6. PERMITS AND REGULATORY REQUIREMENTS

6.1 CLEAN AIR ACT

The proposed action would replace existing equipment in a permitted air emission source. The modifications would decrease air emissions and would not result in the emission of a new air pollutant. Therefore, this activity would not require the issuance of a construction permit by the Tennessee Department of Environment and Conservation. However, the Technical Secretary would have to be notified 30 days before any of the following changes:

- change in air pollution control equipment,
- change in stack height or diameter, or
- change in exit velocity (more than 25 percent) or exit temperature (more than 15 percent).

A letter describing the changes to be made, updated flow diagrams, and emission forms (if required), would be transmitted to the Tennessee Department of Environment and Conservation 30 days before the replacement of the AHF supply and fluidized-bed reactor systems (Seeber 1993). Additionally, the Division of Air Pollution Control would be notified of the demolition activities in Building 9212 at least 10 working days before the proposed action. Because of asbestos concerns, notification would be required prior to the demolition or refurbishment of buildings so that the state could comment or inspect the buildings before the action. Because radionuclide emissions would be controlled and would not exceed ambient levels, Environmental Protection Agency authorization for construction or demolition would not be required.

6.2 FEDERAL WATER POLLUTION CONTROL ACT^{***}

National Pollutant Discharge Elimination System permits are required by the Environmental Protection Agency and Tennessee Department of Environment and Conservation under the authority of the Clean Water Act for liquid point- or area-source discharges from new or modified facilities. The Tennessee Water Quality Control Act dictates that a facility must have a National Pollutant Discharge Elimination System permit to discharge into waters of the state. If the facility has no treatment system, but its waste stream is being directed to another permitted facility, that treatment facility permit must be amended to reflect the receipt of the new facility's waste stream. Therefore, prior to operation of the AHF supply and fluidized-bed reactor systems, the Y-12 Plant's National Pollutant Discharge Elimination System permit would be amended to reflect the addition of Building 9212's waste stream into the Central Pollution Control Facility.

Because construction of the AHF supply and fluidized-bed reactor systems would disturb less than 2.4 hectares (6 acres), a National Pollutant Discharge Elimination System permit for construction related to industrial activity would not be required. A best management practices

^{***}Commonly referred to as the Clean Water Act, the Federal Water Pollution Control Act was amended by the Clean Water Act amendments of 1977, hence the popular name.

plan is required by Energy Systems policy to minimize demolition/construction-related release of potential pollutants. Prior to demolition/construction, an approved best management practices plan would be in place.

Under 40 *CFR* 112.3(a), facilities that could discharge oil in harmful quantities into or upon the navigable waters of the United States must prepare a Spill Prevention Control and Countermeasure Plan. The Y-12 Plant has a sitewide Spill Prevention Control and Countermeasure Plan that addresses oil and other hazardous material. This plan is updated yearly for the Y-12 Plant and would include the upgrade to the AHF Supply fluidized-bed reactor systems in Building 9212 once construction is under way. Additionally, construction practices would be based on the Spill Prevention Control and Countermeasure Plan (Energy Systems 1993c).

6.3 ENDANGERED SPECIES ACT

Section 7 of the Endangered Species Act requires that federal agencies consult with the U.S. Fish and Wildlife Service for construction projects that have the potential to affect Threatened or Endangered species, candidate species, or their critical habitats. The upgrade of the AHF supply and fluidized-bed reactor systems would occur wholly within the highly industrialized setting of the Y-12 Plant and would not affect any of these species or habitats.

6.4 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act requires that, prior to their proposed undertaking, federal agencies take into account the potential impacts to properties eligible for or listed in the National Register of Historic Places. The proposed project would meet the requirements for programmatic exclusion from submission of a no-effect report to the State Historic Preservation Office in accordance with the Programmatic Agreement among DOE, the Advisory Council on Historic Preservation, and the State Historic Preservation Office (Advisory Council on Historic Preservation 1994). Thus no consultation letter to the State Historic Preservation office is presented for the proposed action.

6.5 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Prior to the demolition or construction activities, a project construction safety work permit would be prepared in accordance with Energy Systems Engineering Procedures and submitted for the required plant safety approvals. All demolition and construction practices would conform with Occupational Safety and Health Administration Safety and Health Standards (29 *CFR* 1910/1926) for the construction industry.

6.6 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT AND EXECUTIVE ORDER 12856

Under the Emergency Planning Community Right-to-Know Act, Section 313, facilities are required to report annual emissions of more than 300 chemicals, including HF, when threshold reporting limits are exceeded (EPA 1992). This requirement was voluntary for Federal facilities until the recently issued Executive Order entitled "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements" which requires that every applicable federal facility comply with Section 313 (Clinton 1993). DOE's Y-12 Plant has voluntarily reported its annual HF emissions in the past and would continue to do so in the future provided that the usage exceeds the threshold reporting requirements of 4,536 kg/year (10,000 lb/year).

6.7 TOXIC SUBSTANCES CONTROL ACT

Because of the potential presence of PCB-contaminated ventilation gaskets, all demolition waste disposal activities would be conducted in accordance with the Toxic Substances Control Act regulations governing PCB disposal. A project waste management plan would be prepared during the design phase to address characterization and disposal of PCBs.

7. RELATIONSHIP WITH APPLICABLE LAND USE PLANS

The Y-12 Plant is located within the city limits of Oak Ridge, Tennessee, in Anderson County. The city has zoned the majority of the Oak Ridge Reservation as a Forestry, Agriculture, Industry, and Research district, which permits a wide range of uses associated with past operations. The proposed action would remain compatible with the surrounding operations and would not create any change of land use or character.

8. DOE DECISION PROCESS ON RELATED ACTIONS

8.1 PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR RECONFIGURATION OF THE NUCLEAR WEAPONS COMPLEX

Because the Y-12 Plant will be one of the weapons production facilities under review in the Programmatic Environmental Impact Statement for the Reconfiguration of the Nuclear Weapons Complex, the proposed action has been reviewed in relation to the Programmatic Environmental Impact Statement. The Programmatic Environmental Impact Statement will consider the option of moving or modernizing/downsizing in place the weapons functions now carried out at the Y-12 Plant. In addition, the Programmatic Environmental Impact Statement is considering transferring additional missions to the Oak Ridge Reservation. These potential missions include a small number of non-nuclear component missions, plutonium operations, high explosives and final assembly operations, tritium production, and long-term storage for nuclear weapons material.

The initial Notice of Intent to prepare a Programmatic Environmental Impact Statement was published on February 11, 1991, and was followed by the Programmatic Environmental Impact Statement Implementation Plan on February 19, 1992. Since that time, an arms reduction agreement between the United States and Russia was announced in June 1992, and was signed by former President Bush and Russian President Yeltsin in January 1993 as the START II Treaty. This agreement caused the most significant reductions to date in the planned future weapons stockpiles of both nations and has provided DOE with an historic opportunity to consider a much smaller weapons complex than previously envisioned. Therefore, in the latter part of 1992, DOE decided to reevaluate the reconfiguration program to ensure that only alternatives that reflected requirements of a greatly downsized nuclear weapons stockpile would be assessed in the Programmatic Environmental Impact Statement.

On July 23, 1993, because of this decision to reevaluate the program, DOE issued a revised Notice of Intent (58 FR 39528) to prepare a Nuclear Weapons Complex Reconfiguration Programmatic Environmental Impact Statement (DOE 1993). The proposed AHF supply and fluidized-bed reactor systems replacement would span the time until the Programmatic Environmental Impact Statement Record of Decision is issued and implemented.

8.2 PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR LONG-TERM STORAGE AND DISPOSITION OF WEAPONS-USABLE FISSILE MATERIALS

As part of the decision-making process for the storage and disposition of fissile material, the Department is preparing the Programmatic Environmental Impact Statement for Long-Term Storage and Disposition of Weapons-Usable Fissile Materials (Disposition PEIS). Recent nuclear arms reduction agreements and pledges, along with Presidential decisions concerning what stocks of plutonium, highly enriched uranium, and other nuclear materials are to be reserved for national defense, will largely determine how much and when material will be declared "surplus" and become available for disposition. As stated in the June 21, 1994, Notice of Intent to prepare the Disposition PEIS (59 FR 31935), the Disposition PEIS will evaluate alternatives for long-term storage of all weapons-usable fissile materials and for disposition of weapons-usable fissile

materials declared surplus to national defense needs by the President. The Disposition PEIS would be followed by project-specific National Environmental Policy Act documents to the extent necessary to implement any decisions.

The Disposition PEIS Notice of Intent states that the Department "may reduce its surplus by blending down some of the highly enriched uranium. The resulting low-enriched uranium could then be made available for commercial sale." The Disposition PEIS will consider the alternative of blending down surplus highly enriched uranium with more abundant, naturally occurring uranium, depleted uranium or other low-enriched uranium, to make low-enriched uranium for reactor fuel, as well as other reasonable alternatives for highly enriched uranium disposition. As noted in the Notice of Intent, "highly enriched uranium can be made highly proliferation resistant by blending it down into a low-enriched uranium (less than 20 percent uranium-235)..."

The Y-12 Plant in Oak Ridge, Tennessee, has processing capabilities to blend down highly enriched uranium metal from weapons to low-enriched uranium metal. Three other DOE facilities have the capability for blending down highly enriched uranium. The Savannah River Site, like the Y-12 Plant, has had a role in uranium processing for DOE nuclear programs; however, many key Savannah River facilities are no longer operating. Los Alamos National Laboratory has a limited capability to blend down small batch quantities of highly enriched uranium. The Portsmouth Gaseous Diffusion Plant has the capability to blend down highly enriched uranium that is in the gaseous uranium fluoride form, but not any other forms of highly enriched uranium such as metal or oxide. Secretary O'Leary announced on June 27, 1994, that Portsmouth will not be used for blending down highly enriched uranium from U.S. military programs (DOE 1994c).

Although the decision-making process for the long-term storage and disposition of all weapons-usable fissile materials has been initiated, it is likely that final decisions and implementation will take several years. Until these decisions are made and implemented, both interim storage and processing for interim storage are needed for fissile nuclear materials, including highly enriched uranium that is shipped to the Y-12 Plant from the Pantex Plant.

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10. LIST OF AGENCIES CONTACTED

No agencies outside DOE were contacted in the preparation of this environmental assessment.

11. LIST OF PREPARERS

This Environmental Assessment was prepared by Science Applications International Corporation under contract to Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee. Energy Systems and the Department of Energy provided technical review. The following personnel contributed significantly to the preparation of this document:

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APPENDIX A

**PROPOSED FACILITY DESIGN,
EQUIPMENT, AND EMISSION CONTROL
TECHNOLOGY SELECTION INFORMATION**

**APPENDIX A
PROPOSED FACILITY DESIGN, EQUIPMENT,
AND EMISSION CONTROL TECHNOLOGY SELECTION INFORMATION**

A.1 AHF FACILITY DESIGN ALTERNATIVES**A.1.1 Method of AHF Delivery and Storage**

As currently proposed, the anhydrous hydrogen fluoride (AHF) would be procured in vendor-owned 612-kg (1,350-lb) cylinders. It is assumed that AHF vendors would continue to provide the 612-kg (1,350-lb) cylinders for the foreseeable future. The 612-kg (1,350-lb) cylinder is structurally stronger than the government-owned 386-kg (850-lb) cylinder that was previously used.

Martin Marietta Energy Systems, Inc. (Energy Systems) could purchase the 612-kg (1,350-lb) cylinders and construct an AHF storage and cylinder refill facility on the west side of the Y-12 Plant. The AHF would be supplied to the facility by rail car or tank truck, a practice that is common in the commercial environment where the demand is larger. This alternative could result in substantial savings in the cost of AHF. However, the high capital cost and safety considerations of maintaining a large quantity of AHF on site make the vendor-owned and -provided AHF cylinders the preferred alternative.

A.2 AHF STRUCTURES

Each of the three alternative AHF storage structures that were reviewed provided protection from direct sun and rain, and diking for AHF spill containment. Two of the alternatives (a basic structure with a roof only and a facility with walls and a simple heating system) were not selected for further consideration because neither structure would protect the AHF from temperature variation. Temperature variation could cause the AHF cylinder walls and related items such as flanges and seals to weaken. Therefore, a temperature-controlled building is the preferred alternative. A temperature-controlled building would protect the AHF cylinders from temperature extremes and would provide a structure for liquid and gaseous AHF spill containment.

A.3 OFF-GAS TREATMENT SYSTEMS

Routine hydrogen fluoride (HF) process emissions result from the purge and evacuation of lines and equipment during cylinder change-out and equipment maintenance activities. Several technologies using emissions control equipment were reviewed for the proposed AHF facility.

A.3.1 Condenser

A condenser could be effective in controlling and recycling AHF emissions, thereby minimizing waste production. However, the condenser's heat exchanger would require very low-temperature operations and a large surface area. Additionally, the system would have to be

continuously available. This alternative was not selected because of its higher costs compared to other alternatives and the difficulty in maintaining suitable system reliability.

A.3.2 Fixed-Bed Absorption Column

A fixed-bed absorption column is simple to design and operate, requires relatively modest capital investment, and has been widely used at the Oak Ridge Reservation to remove AHF from waste streams.* However, this design was not selected because the Venturi/packed-bed column scrubber that was selected to control fugitive and accidental release emissions (see Sect. A.4.4) could also be used for the off-gas treatment system.

A.3.3 Packed Column

A packed column would react the AHF with a liquid solution to effectively remove the AHF. This alternative would utilize proven technology. The Venturi/packed-bed column scrubber system is proposed to mitigate the effects of a design basis release. The off-gas scrubber system (see Sect. A.4.4) would be operated continuously during cylinder change-out and transfer activities.

A.4 FUGITIVE EMISSION ACCIDENTAL RELEASE CONTROL

A.4.1 Condenser

The volume of air exhausted from the proposed AHF containment enclosure would be too great to make a condenser a viable option. It would be cost prohibitive to provide the surface area and operating temperatures required to achieve adequate HF removal.

A.4.2 Deluge Systems

The AHF releases could be absorbed by either directly applying water or by spraying a water curtain from an overhead deluge system. Personnel involved in direct application would potentially be subject to HF exposure and would need to wear personal protective clothing and be trained in its use. The AHF release response would depend on personnel mobilization time. Response time could be minimized by using an automatic overhead deluge system. A petrochemical industry study of deluge systems concluded that a deluge system is only partially effective (Energy Systems 1993c). There is the additional problem of disposing of large quantities of an aqueous HF solution. Therefore, this alternative was not selected.

A.4.3 Fixed-Bed Absorption

Though fixed-bed absorption is a proven technology, it is not the preferred alternative for this use. Many absorbers would be required to treat the AHF exhaust air stream because the fixed-bed is not as efficient as a scrubber. The fixed-bed absorption system would require an induced draft fan. Use of this fan would generate an operational concern as to its reliability in a spill event.

A.4.4 Scrubber

Scrubbers are the most commonly used commercial treatment systems. Various types are available and could be used separately or in combination. The preferred alternative would use a combination Venturi/packed-bed column scrubber. This technology is proven in HF removal, is reliable, and has competitive operating costs and space requirements compared to the alternatives. The use of a Venturi with the scrubber would not require the use of a fan to move exhaust emissions through the scrubber. The scrubber solution would consist of either water or potassium hydroxide.

A.5 MULTIPLE VERSUS SINGLE REACTOR-BED DESIGN

Two fluidized-beds in series traditionally have been used to convert uranium trioxide to uranium tetrafluoride. As an alternative, both the reduction and hydrofluorination reactions could be carried out in a single reaction vessel. The advantage of this option, particularly in a batch cycle,* is that there would be significantly less material handling and fewer related contamination control problems. Cost would also be reduced because fewer process vessels, less instrumentation, and less supporting equipment would be required. The primary difficulty would be finding a construction material that could resist the extremely corrosive environment presented by hydrogen, HF, and the reactions by-product, water. Ultrapure product is required, and even minor amounts of corrosion could introduce significant levels of impurities. At present no material is known to be acceptable for a single reactor, dual-reaction configuration. Consequently, the two-stage fluidized-bed reactor system was the selected alternative.

A.6 HYDROFLUORINATION REACTOR OFF-GAS TREATMENT SYSTEMS

Several alternatives exist for the treatment of HF off-gas from the hydrofluorination fluidized-bed reactor. These include a condenser, a fixed-bed absorption column, and a scrubber.

A.6.1 Condenser

A condenser could effectively control HF so that emissions from the facility would be negligible. A series of heat exchangers would be required to remove heat from the off-gas and then condense the HF. Such a system would have to operate at very low temperatures and would require a relatively large surface area. The system would have to be continuously available and the cost of providing suitable system reliability could be prohibitive. Collection and disposal of the HF would also be a problem. Water would be produced as a by-product of the hydrofluorination reaction; therefore, the condensate collected would be aqueous hydrofluoric acid contaminated with uranium. There is no known use for this condensate in the plant, and disposing of it would be a problem. For these reasons, a condenser was not selected.

A.6.2 Fixed-Bed Absorption Column

Exhaust could also be treated by venting directly to a fixed-bed absorption column. This option would be simple to design and operate and would require relatively modest capital investment. The diffusion plants have employed fixed-bed absorbers ("chemical traps") for

recovery of HF from process streams so that there is considerable industrial precedent for their use in this application. A significant disadvantage with this option would arise from criticality safety considerations. The absorption columns would have to be of nuclear-safe geometry*. This limitation on their size would result in frequent change-out of the bed material. Conceivably, this could be required after every batch cycle. The operating cost of doing so would be very high. Also, the spent bed material would be contaminated with enriched uranium so that its disposal would be complicated. For these reasons, a fixed-bed absorber was not considered for further review.

A.6.3 Scrubber

The final option would be to scrub the exhaust. This proven technology is used in many similar applications, including some at the Y-12 Plant in enriched uranium applications. The major disadvantage of scrubbing would be the relatively high disposal costs of the spent scrub solution. However, compared to the other treatment alternatives, scrubbing would still be cost competitive and would avoid those problems with condensation and absorption that preclude their further consideration. Hence, installation of an off-gas scrubber is the preferred technology.

A.7 REACTOR DESIGN

Fluidized-bed reactors are currently used for the production of uranium tetrafluoride from uranium dioxide. Alternative reactor designs exist that could accomplish the same conversion. These include a screw reactor and a rotary kiln.

A.7.1 Screw Reactor

A screw reactor would consist of a nuclear-safe-geometry tube with a rotating auger inside. Oxide would be fed into one end and conveyed through the reaction tube by the screw. The reactant gas would be introduced at the product-removal end of the reactor and would be vented near the feed point. The effects of the heat produced by a reactor of this design could be a problem. One concern is the potential that the heat would cause the product to form clumps. A screw reactor would be mechanically complex and would be subject to frequent maintenance. This design was eliminated from further consideration because of concerns about potential radiological exposure associated with the likelihood of frequent maintenance.

A.7.2 Rotary Kiln Reactor

A rotary kiln reactor would consist of an inclined tube rotated by an external drive mechanism. Oxides would be fed at the elevated end of the tube, and reactant gas would be introduced at the product withdrawal point. As with the screw reactor, a rotary kiln would be mechanically complex compared to the fluidized-bed reactors. Though a rotary kiln would have much better thermal characteristics than a screw reactor, the maintenance of rotary seals, drive mechanisms, and heating elements in a very corrosive environment would be difficult. For this reason, it was not selected for further review.

A.7.3 Fluidized-Bed Reactor

Fluidized-bed reactors would provide the best heat transfer characteristics of any option. They would be simpler mechanically and have a long history of success in this application at the Y-12 Plant. For these reasons, the fluidized-bed reactor design was retained.

APPENDIX B

TRANSPORTATION RISK ANALYSIS

**Risk Analysis of Onsite Transport, Handling,
and Changeout of Anhydrous Hydrofluoric Acid Cylinders
at the Y-12 Plant**

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APPENDIX C

Limited Risk Analysis of One-Ton Anhydrous Hydrofluoric Acid
Cylinder Usage at the Y-12 Plant

The results of the risk assessment of 850-lb hydrogen fluoride (HF) cylinder handling, changeout, and onsite transport show that potential HF release scenarios associated with handling activities represent almost 100% of the total estimated risk from onsite transport, handling, and changeout. Y-12 Plant management is now considering the use of one-ton cylinders to bring HF to the two areas where it is used (Buildings 9206 and 9212). The 850-lb cylinders would still be used as the HF supply for process systems, but they would no longer be changed out when depleted. Instead, they would be refilled in place by transferring HF from a one-ton cylinder located nearby. The HF supplier would pick up depleted one-ton cylinders from Buildings 9206 and 9212 for refilling at their facility.

The purpose of this analysis is to provide updated risk results based on this proposed operating plan. To limit the cost of this analysis, we have taken advantage of some insights gained in conducting the original risk assessment. Specifically, we have not reanalyzed onsite transport operations because (1) the risks estimated for those operations were negligible compared to the risks estimated for cylinder handling and changeout and (2) the risks from transporting one-ton cylinders onsite are probably not significantly higher. (Using larger cylinders of HF will reduce the necessary number of transport operations and the frequencies of transportation accidents. But the consequences of a release would be greater for the larger cylinders.)

Even though we found it unnecessary to reanalyze any transportation accident scenarios, onsite transportation operations are considered to be within the scope of this analysis along with cylinder handling, changeout, and filling operations. Hydrogen fluoride releases occurring as a result of process operations are outside the scope of this analysis.

The following sections describe the basis for our analysis, the quantification of accident frequencies and consequences, and the results of the analysis.

C.1 ANALYSIS BASIS

We based our analysis on information provided by Energy Systems personnel. Marked-up operating procedures^{1,2} describe the changeout operations for the one-ton cylinder as well as the actions required to refill an 850-lb cylinder from a one-ton cylinder. These procedures also include revised flow diagrams for the HF supply systems. Common carriers will deliver one-ton cylinders to the plant site on trailer trucks. Upon arrival, the truck will be assigned a security escort and will proceed directly

to either Building 9206 or Building 9212 where it will back up to a loading dock and a forklift truck will drive aboard to unload a cylinder. The common carrier will also pick up depleted cylinders at these locations for return to the supplier. Unlike the 850-lb cylinders, the one-ton cylinders will not be stored in a central location. No further details are available concerning the loading and unloading of the trailer trucks. Energy Systems currently plans to place the one-ton cylinder used at Building 9206 in the pit area north of the HF supply station. This location would eliminate the need to handle cylinders with the monorail hoist installed at the supply station. The one-ton cylinder used at Building 9212 would be placed somewhere on Dock 8. Because the forklift would only be able to place the cylinder near the front of the dock (the dock is too congested to allow forklift access to the supply area), personnel would have to use the monorail hoist to position the cylinder on the dock.

With regard to the cylinder itself, we based our analysis on a vendor drawing supplied by Energy Systems personnel. A full cylinder will contain about 1,300 lb HF. The cylinder will be slightly pressurized (about 5 psig at 80 °F). The cylinder will be used in a horizontal position. Unlike the 850-lb cylinder, the one-ton cylinder has a rigid chime ring that protects the valves from side-on impacts. For valve damage to occur in a transportation or handling accident, an object would have to protrude inside the chime ring and impact a valve. While not impossible, this is considered to be an unlikely occurrence.

Drop tests of a nearly identical one-ton cylinder were performed for the U.S. Army at Dugway Proving Ground in July 1986.³ The results of these tests show that the cylinder can be expected to survive impacts on its side or end equivalent to a 40 ft drop onto an unyielding surface. These failure thresholds are higher than those we determined analytically for the 850 lb cylinder in Appendix A (15 ft side drop and 36 ft end drop). We believe that the Army data are valid for the one-ton HF cylinder.

Because a thermal analysis of the one-ton cylinder was not included in the scope of this study, fire-induced cylinder rupture is assumed to occur at an internal pressure of 458 psig as calculated for the 850-lb cylinder. This assumption is probably somewhat conservative considering the one-ton cylinder is more resistant to impact failure than the 850-lb cylinder.

C. 2 FREQUENCY ASSESSMENT

C.2.1 Handling Scenarios

Because the handling of the one-ton HF cylinders is expected to be very similar to handling of the 850-lb cylinders, we used the list of handling accident scenarios developed in Section 3 of this report as a basis for defining handling accident scenarios for this analysis. Because some differences between the handling operations do exist (e.g., the monorail hoist at the Building 9206 HF supply

area would no longer be used), many of the scenarios analyzed in Section 3 do not apply for the one-ton cylinders. Table C.1 lists the handling accident scenarios we analyzed along with their estimated frequencies of occurrence. The scenario ID is a three-part code in which the first character indicates whether the cylinder being handled is full (F) or depleted (D). The next four characters indicate the location of the release (Building 9206 or 9212), and the last two characters are a sequential identification number for the scenario. In general the scenario codes in Table C.1 do not match the ID codes for similar scenarios in Table 3.2 in the body of this report. An "e" in the frequency column indicates that the estimated frequency is negligible. The following paragraphs describe the quantification of each scenario.

Forklift Time Punctures Cylinder on Trailer Truck. A scenario fitting this description was analyzed in Section 3. For the one-ton cylinder case, fewer unloading operations will be required. Each facility requires about twelve 850-lb cylinders or 10,200 lb HF each year. The one-ton cylinders will each hold about 1,300 lb HF; thus, 7.9 cylinders will be used each year by each facility. In Section 3 the probability of puncture is estimated to be 1×10^{-5} per operation. Therefore, the frequencies of these scenarios are estimated as follows:

F (forklift time punctures full cylinder on trailer truck at Building 9206) = (7.9 operations/yr) (1×10^{-5} /operation) = 7.9×10^{-5} /yr; and

F (forklift time punctures full cylinder on trailer truck at Building 9212) = (7.9 operations/yr) (1×10^{-5} /operation) = 7.9×10^{-5} /yr.

Forklift Time Punctures Cylinder in Its Cradle. This scenario applies only to Building 9206, where the depleted cylinder is removed from its cradle (a support structure of low height) by the forklift. The progression of this scenario is the same as for the scenario "Forklift Time Punctures Cylinder in Lot" described in Section 3. From Section 3, the probability of puncture per operation is estimated to be 1×10^{-5} . Therefore, the frequency of this scenario is estimated as follows:

F (forklift time punctures depleted cylinder in its cradle at Building 9206) = (7.9 operations/yr) (1×10^{-5} /operation) = 7.9×10^{-5} /yr.

Forklift Time Punctures Cylinder on Loading Dock. This accident scenario applies only to the handling of depleted cylinders at Building 9212 Dock 8. Depleted cylinders will be

Table C.1. Handling accident scenarios

Scenario ID	Description	Frequency (yr ⁻¹)
F920601	Forklift tine punctures cylinder on trailer truck	7.9×10^{-5}
F921201		7.9×10^{-5}
D920601	Forklift tine punctures cylinder in its cradle	7.9×10^{-5}
D921201	Forklift tine punctures cylinder on loading dock	7.9×10^{-5}
D920602	Forklift collides with another vehicle; fire occurs; fire causes cylinder rupture	€
F920602		€
D921202		€
F921202		€
D920603	Forklift collides with another vehicle; impact causes cylinder rupture	€
F920603		€
D921203		€
F921203		€
D920604	Forklift collides with another vehicle; impact causes cylinder rupture; fire occurs	€
F920604		€
D921204		€
F921204		€
D920605	Forklift drops cylinder; cylinder ruptures	1.6×10^{-5}
F920605		1.6×10^{-5}
D921205		1.6×10^{-5}
F921205		1.6×10^{-5}
D921206	Hoist fails while moving cylinder over dock; cylinder ruptures	€
F921206		€
D921207	Operator improperly connects cylinder to hoist; cylinder falls onto dock and ruptures	€
F921207		€

placed near the front of the dock where they will be picked up by a forklift truck for loading onto a trailer truck that has backed up to the dock. Because the cylinder will be at ground level with respect to the forklift, this scenario is similar to the scenario "Forklift Tire Punctures Cylinder in Lot" described in Section 3. In Section 3, the probability a tire punctures a cylinder in this situation is estimated to be 1×10^{-5} per operation. For 7.9 pickup operations per year, the scenario frequency is estimated as follows:

$$F (\text{forklift tire strikes depleted cylinder on loading dock at Building 9212}) = (7.9 \text{ operations/yr}) (1 \times 10^{-5} / \text{operation}) = 7.9 \times 10^{-5} / \text{yr.}$$

Forklift Collides with Another Vehicle. In analyzing collision accidents, we used the accident probability of 1.23×10^{-9} per operation derived in Section 3 of this report. On the average, 15.8 forklift operations (half with full cylinders and half with depleted cylinders) will be conducted each year at both Building 9206 and Building 9212. In addition, the probability of cylinder rupture given impact is 0.01, and the probability of fire given a collision is 0.005 (see Section 3). Analysis of the 850-lb cylinder showed that a fire must last -12 min to cause overpressurization and rupture. As stated earlier, even though the one-ton cylinder is stronger, we conservatively assumed that the thermal failure thresholds of the two cylinders are the same. The probability of no fire suppression within 12 min is 0.37 as explained in Section 2.5.3.

Based on these inputs, we calculated expected frequencies for all relevant collision accident scenarios. All of these estimated frequencies are negligibly small ($<10^{-10}$ per year).

Forklift Drops Cylinder. From Section 3, the probability of a forklift dropping a cylinder is 2×10^{-4} per operation. An average of 15.8 forklift operations (half with full cylinders and half with depleted cylinders) will be conducted each year at both Building 9206 and Building 9212.

Falls from the heights involved in forklift operations would not cause cylinder failure unless the valves receive an impact. Unlike the 850-lb cylinder, the one-ton cylinder has a rigid chime ring designed to protect the valves from side-on impacts. Therefore, it is likely that no more than one out of every 100 drops will result in cylinder failure.

$$p (\text{impact sufficient to rupture cylinder}) = 0.01.$$

The accident scenario frequencies are given below.

F (forklift drops depleted cylinder at Building 9206; cylinder ruptures) = (7.9 operations/yr) (2×10^{-4} /operation) (0.01)
 = 1.6×10^{-5} /yr;

F (forklift drops full cylinder at Building 9206; cylinder ruptures) = (7.9 operations/yr) (2×10^{-4} /operation) (0.01)
 = 1.6×10^{-5} /yr;

F (forklift drops depleted cylinder at Building 9212; cylinder ruptures) = (7.9 operations/yr) (2×10^{-4} /operation) (0.01)
 = 1.6×10^{-5} /yr; and

F (forklift drops full cylinder at Building 9212; cylinder ruptures) = (7.9 operations/yr) (2×10^{-4} /operation) (0.01)
 = 1.6×10^{-5} /yr.

Hoist Fails While Moving Cylinder Over Dock or Operator Improperly Connects Cylinder to Hoist. Because of the low ceiling height at Building 9212 Dock 8, the hoist can only lift a cylinder a few feet off the dock if the cylinder is lifted in a horizontal position as planned. The cylinder could only be lifted a few inches in an upright position. A one-ton cylinder can easily withstand drops from these heights unless valve damage occurs. The path between the edge of the dock and the HF supply station should normally be free of debris. Thus, the likelihood of a probe protruding inside the cylinder's chime ring and damaging a valve, given a cylinder is dropped, should be extremely low. These accident scenarios are considered to be incredible.

C.2.2 Changeout Scenarios

We performed a human reliability analysis (HRA) of the one-ton cylinder hookup and disconnect tasks as described in marked-up operating procedures.^{1,2} The basic methods and error probabilities used are described in Section 4 of this report. Figures C.1 through C.4 present the HRA event trees developed for these tasks, and Tables C.2 through C.5 summarize the probabilities assigned to branches on the event trees.

Table C.6 presents the results of the HRA. The "Failure Probability" column presents the likelihood of an HF release each time the task is performed. The expected frequency of an HF release for a given task is the product of the failure probability and the task frequency (7.9 per year for all tasks).

Only one notable difference from the results reported in Section 4 for the 850-lb cylinders is noted. The probability of HF release for the Building 9206 hookup task is about 3.5 times less than the probability estimated for the 850-lb cylinders. This difference is attributed to the pigtail leak test specified for the one-ton cylinder. This test could detect poor valve-to-pigtail connections before cylinder valves are opened. The procedure for

Fig. C.1. HRA event tree for Building 9206 HF cylinder hookup.

Fig. C.2. HRA event tree for Building 9212 HF cylinder hookup.

Fig. C.2. HRA event tree for Building 9212 HF cylinder hookup (continued).

Fig. C.3. HRA event tree for Building 9206 HF cylinder disconnect.

Fig. C.4. HRA event tree for Building 9212 HF cylinder disconnect.

Table C.2. Human error probability data for Building 9206 HF cylinder hookup

Event Code	Description	Probability	Source
A	Operator fails to make a leak-free connection between pigtail and Valve 25	0.0025	Reference 4
B	Operator fails to make a leak-free connection between pigtail and Valve 24	0.0025	Reference 4
C	Operator fails to open Valve 35	0.01	Reference 5, Table 20-7, #4
B35	Valve 35 sticks closed	0.001	Reference 5, Table 20-14, footnote
D	Operator does not notice Valve 35 is stuck closed	0.01	Reference 5, Table 20-14, #4
E	Operator fails to open Valve 26	0.01	Reference 5, Table 20-7, #4
B26	Valve 26 sticks closed	0.001	Reference 5, Table 20-14, footnote
F	Operator does not notice Valve 26 is stuck closed	0.01	Reference 5, Table 20-14, #4

Table C.2. Human error probability data for Building 9206 HF cylinder hookup
(continued)

Event Code	Description	Probability	Source
G	Operator fails to open Valve 26	0.01	Reference 5, Table 20-7, #4
B28	Valve 28 sticks closed	0.001	Reference 5, Table 20-14, footnote
H	Operator does not notice Valve 28 is stuck closed	0.01	Reference 5, Table 20-14, #4
I	Operator does not check for leaks	0.005	High dependence with G (per Reference 5)

Table C.3. Human error probability data for Building 9212 HF cylinder hookup

Event Code	Description	Probability	Source
A	Operator fails to make a leak-free connection between pigtail and Valve T1	0.0025	Reference 4
B	Operator fails to make a leak-free connection between pigtail and Valve T2	0.0025	Reference 4
C	Operator fails to close Valve V-11	0.01	Reference 5, Table 20-7, #4
AV11	Valve V-11 sticks open	0.001	Reference 5, Table 20-14, footnote
D	Operator does not notice Valve V-11 is stuck open	0.01	Reference 5, Table 20-14, #4
E	Operator fails to close Valve V-10	0.01	Reference 5, Table 20-7, #4
AV10	Valve V-10 sticks open	0.001	Reference 5, Table 20-14, footnote
F	Operator does not notice Valve V-10 is stuck open	0.01	Reference 5, Table 20-14, #4

Table C.3. Human error probability data for Building 9212 HF cylinder hookup
(continued)

Event Code	Description	Probability	Source
G	Operator fails to close Valve V-6	0.01	Reference 5, Table 20-7, #4
AV6	Valve V-6 sticks open	0.001	Reference 5, Table 20-14, footnote
H	Operator does not notice Valve V-6 is stuck open	0.01	Reference 5, Table 20-14, #4
I	Operator fails to open Valve V-12	0.01	Reference 5, Table 20-7, #4
BV12	Valve V-12 sticks closed	0.001	Reference 5, Table 20-14, footnote
J	Operator does not notice Valve V-12 is stuck closed	0.01	Reference 5, Table 20-14, #4
K	Operator fails to open Valve P-2	0.01	Reference 5, Table 20-7, #4

Table C.3. Human error probability data for Building 9212 HF cylinder hookup
(continued)

Event Code	Description	Probability	Source
BP2	Valve P-2 sticks closed	0.001	Reference 5, Table 20-14, footnote
L	Operator does not notice Valve P-2 is stuck closed	0.01	Reference 5, Table 20-14, #4
M	Operator fails to open Valve 2	0.01	Reference 5, Table 20-7, #4
B2	Valve 2 sticks closed	0.001	Reference 5, Table 20-14, footnote
N	Operator does not notice Valve 2 is stuck closed	0.01	Reference 5, Table 20-14, #4
O	Operator fails to read nitrogen pressure gauge prior to leak test	0.01	Reference 5, Table 20-7, #4
P	Operator misreads nitrogen pressure gauge	0.0031	Reference 4
RN	Nitrogen pressure gauge fails low	0.006*	Reference 6

Table C.3. Human error probability data for Building 9212 HF cylinder hookup
(continued)

Event Code	Description	Probability	Source
Q	Operator fails to read leak check pressure gauge	0.01	Reference 5, Table 20-7, #4
R	Operator misreads leak check pressure gauge	0.0031	Reference 4
RL	Leak check pressure gauge fails low	0.006*	Reference 6
AL	Leak check pressure gauge fails high	0.006*	Reference 6
S	Operator fails to close Valve 2	0.01	Reference 5, Table 20-7, #4
A2	Valve 2 sticks open	0.001	Reference 5, Table 20-14, footnote
T	Operator does not notice Valve 2 is stuck open	0.01	Reference 5, Table 20-14, #4
U	Operator fails to read leak check pressure gauge after 5 min.	0.01	Reference 5, Table 20-7, #4
V	Operator misreads leak check pressure gauge	0.0031	Reference 4

*This probability is based on a failure rate of $2.6 \times 10^{-6}/h$, a 50/50 distribution between failures with high readings vs. low readings, and a test interval of 8760 h.

Table C.4. Human error probability data for Building 9206 HF cylinder disconnect

Event Code	Description	Probability	Source
A	Operator fails to close Valve 24	0.01	Reference 5, Table 20-7, #4
A24	Valve 24 sticks open	0.001	Reference 5, Table 20-14, footnote
B	Operator does not notice Valve 24 is stuck open	0.01	Reference 5, Table 20-14, #4
C	Operator fails to close Valve 25	0.01	Reference 5, Table 20-7, #4
A25	Valve 25 sticks open	0.001	Reference 5, Table 20-14, footnote
D	Operator does not notice Valve 25 is stuck open	0.01	Reference 5, Table 20-14, #4
E	Operator loosens Valve 24 pigtail quickly, eliminating potential for noticing HF escaping and retightening nut	0.05	Analyst judgment*
F	Operator loosens Valve 25 pigtail quickly, eliminating potential for noticing HF escaping and retightening nut	0.05	Analyst judgment*

*This error should be more likely than a simple error of omission for procedure-based actions (such as Event A above) but less likely than an error in checking the work of others (probability on the order of 0.1 or higher per Reference 5, Table 20-22).

Table C.5. Human error probability data for Building 9212 HF cylinder disconnect

Event Code	Description	Probability	Source
A	Operator fails to close Valve T1	0.01	Reference 5, Table 20-7, #4
AT1	Valve T1 sticks open	0.001	Reference 5, Table 20-14, footnote
B	Operator does not notice Valve T1 is stuck open	0.01	Reference 5, Table 20-14, #4
C	Operator fails to close Valve T2	0.01	Reference 5, Table 20-7, #4
AT2	Valve T2 sticks open	0.001	Reference 5, Table 20-14, footnote
D	Operator does not notice Valve T2 is stuck open	0.01	Reference 5, Table 20-14, #4
E	Operator loosens Valve T1 pigtail quickly, eliminating potential for noticing HF escaping and retightening nut	0.05	Analyst judgment*
F	Operator loosens Valve T2 pigtail quickly, eliminating potential for noticing HF escaping and retightening nut	0.05	Analyst judgment*

*This error should be more likely than a simple error of omission for procedure-based actions (such as Event A above) but less likely than an error in checking the work of others (probability on the order of 0.1 or higher per Reference 5, Table 20-22).

Table C.6. Human reliability analysis results

Task	Failure Probability	Expected Frequency (yr ⁻¹)
Building 9206 Hookup	1.0×10^{-4}	7.9×10^{-4}
Building 9212 Hookup	6.2×10^{-4}	4.9×10^{-3}
Building 9206 Disconnect	1.0×10^{-3}	7.9×10^{-3}
Building 9212 Disconnect	1.0×10^{-3}	7.9×10^{-3}

changing out 850-lb cylinders at Building 9206 did not specify such a test.

C.2.3 Cylinder Fill Scenarios

If the one-ton cylinders are used, the 850-lb cylinders will still be the primary source of HF for the processes. The 850-lb cylinders will be refilled as required by transferring HF from a one-ton cylinder using nitrogen padding. We reviewed the cylinder fill procedures to identify any possible HF release scenarios.

Nitrogen is supplied to the system at 30 psig. Even if the pressure regulator failed, the supply pressure would not exceed the failure threshold of the cylinders (458 psig).

An 850-lb cylinder could be overfilled, then isolated with no available vapor space for expansion. However, the temperature rise required to raise the pressure to 458 psig would be on the order of 100°C to 125°C. A temperature increase of this magnitude would never be expected to occur in ambient air. Thus, we conclude that this overfill scenario would not result in cylinder rupture.

No other potential HF release scenarios were identified for the filling operations.

2.3 CONSEQUENCE ASSESSMENT

For each of the credible scenarios described in the previous section, we estimated the expected numbers of fatalities and severe health effects. Estimating these consequences involved the following three tasks:

1. Source term estimation,
2. Atmospheric dispersion modeling, and
3. Exposure assessment.

The models and data used to accomplish these tasks are described in Section 5 of this report. Release rates from ruptured cylinders are the same as those calculated for similar scenarios in Section 5; however, the release durations are different because of the larger inventory of HF. For cases in which a liquid pool forms, the duration of the release from the cylinder affects the maximum pool size and, consequently, the maximum evaporation rate.

Table C.7 presents the consequence estimates for each of the credible scenarios. Note that none of the scenarios have the potential to cause fatalities. No scenario involving only a release from a depleted cylinder is expected to cause any severe health effects. Furthermore, none of the postulated releases are expected to have any notable impacts offsite. Although not analyzed in this effort, transportation accidents may have the potential to cause fatalities and significant numbers of severe health effects (see Section 5). Nevertheless, these scenarios are minor contributors to overall risk because they are very unlikely to occur.

C.4 RESULTS

Based on the frequency and consequence estimates presented in the preceding sections, the total expected value or mean risk for the HF cylinder handling, changeout, filling, and onsite transport operations is 2.9×10^{-4} severe health effects per year for the onsite population (about one severe health effect every 3,500 years). Only onsite transport operations have the potential to result in fatalities onsite. Transportation accident scenarios were not reanalyzed in this effort, but we expect the onsite fatality risk to be on the order of 1×10^{-6} fatalities per year based on analyses documented in the body of this report. None of the postulated accident scenarios are expected to cause any fatalities or severe health effects outside the plant boundary.

Figure C.5 presents the results of this limited risk analysis in the form of a frequency-consequence (F-N) curve. This curve shows the expected frequency of experiencing N or more severe health effects among the onsite population, where N is the number of severe health effects plotted on the horizontal axis. The curve shows that the expected frequency of HF releases resulting from cylinder transport, handling, changeout, and filling operations is 2.2×10^{-2} per year or about one release every 46 years of operation. However, this analysis did not consider small HF releases resulting from inadequate purging of pigtails, etc. because such releases should have negligible consequences.

Handling risks contribute ~100% to the total severe health effects risk. The major contributors (83%) to these risks are scenarios in which a forklift tine punctures a full one-ton cylinder while unloading it from a trailer truck.

Table C.7. Consequence estimates

Scenario ID	Severe Health Effects	Fatalities
F920601	1	0
D920601	0	0
F920605	1	0
D920605	0	0
F921201	2	0
D921201	0	0
F921205	2	0
D921205	0	0
Building 9206 Hookup	0	0
Building 9206 Disconnect	0	0
Building 9212 Hookup	0	0
Building 9212 Disconnect	0	0

Fig. C.5. Frequency - consequence curve

The total risk for the one-ton cylinder case is about two orders of magnitude lower than the total risk estimated for the 850-lb cylinder case. By not moving the 850-lb cylinders from their scales, several dominant scenarios involving pigtail damage from cylinders moving on the hoist at Building 9206 are eliminated.

C.5 REFERENCES

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