DOE/EIS-236-S2

U.S. Department of Energy

Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility

Volume II

Appendices A – H

May 2003

U.S. Department of Energy
National Nuclear Security Administration

COVER SHEET

***Responsible Agency*:** United States Department of Energy (DOE) National Nuclear Security Administration (NNSA)

***Title*:** Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility

***Contact*:** For additional information on this Draft Environmental Impact Statement (EIS), write or call:

James J. Rose
NA-53/Forrestal Building
NNSA
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585
Attention: MPF EIS
Telephone: (202) 586-5484
Web site: http://www.mpfeis.com

For general information on the DOE *National Environmental Policy Act* process, write or call:

Ms. Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
EH-42/Forrestal Building
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585
Telephone: (202) 586-4600 or
leave a message at (800) 472-2756

Abstract: DOE's NNSA is responsible for the safety and reliability of the U.S. nuclear weapons stockpile, including production readiness required to maintain that stockpile. Since 1989, DOE has been without the capability to produce certified plutonium pits, which are an essential component of nuclear weapons. NNSA, the Department of Defense, and Congress have highlighted the lack of long-term pit production capability as a national security issue requiring timely resolution. While a small interim capacity is currently being established at the Los Alamos National Laboratory (LANL), classified analyses indicate that long-term support of the nuclear stockpile, which is a cornerstone of U.S. national security policy, will require a long-term pit production capability.

Pursuant to *National Environmental Policy Act* of 1969, as amended (42 USC 4321 et seq.), and DOE Regulations Implementing *National Environmental Policy Act* (10 CFR Part 1021), NNSA has prepared a Supplement to the Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility (hereafter, referred to as the MPF EIS) to support a Record of Decision (ROD) by the Secretary of Energy on: (1) whether to proceed with a Modern Pit Facility (MPF); and (2) if so, where to locate a MPF. This MPF EIS evaluates the environmental impacts associated with constructing a new MPF at the following sites: (1) Los Alamos Site, New Mexico; (2) Nevada Test Site; (3) Carlsbad Site, New Mexico; (4) Savannah River Site, South Carolina; and (5) Pantex Site, Texas. The MPF EIS also evaluates an upgrade to the plutonium pit manufacturing capabilities currently being established at Technical Area 55 (TA-55) at LANL, and the No Action Alternative of relying on the small interim capacity at LANL. The MPF EIS evaluates a range of pit production capabilities consistent with national security requirements. Additional NEPA analysis will be required for

the specific siting of such a facility should the decision be made that a MPF is required. For this MPF Draft EIS, constructing and operating a MPF is the preferred alternative. A preferred site for a MPF has not yet been determined, but will be identified in the Final EIS.

Public Comments: In preparing this MPF Draft EIS, NNSA considered comments received during the public scoping period from September 20, 2002, through November 22, 2002. In addition, six public hearings were held to assist NNSA in defining the scope of the analysis. The first of these public hearings was held on October 8, 2002, in Amarillo, Texas. Hearings were also held in Carlsbad, New Mexico, on October 10, 2002, in Washington, DC, on October 15, 2002, in Las Vegas, Nevada, on October 17, 2002, in Los Alamos, New Mexico, on October 24, 2002, and in North Augusta, South Carolina, on October 29, 2002. Comments made at these hearings, as well as each comment received by fax, e-mail, and mail during the scoping period, were considered in the preparation of the MPF Draft EIS. A summary of the comments is included in this draft.

The comment period for this MPF Draft EIS will be from June 6, 2003 to August 5, 2003. Public meetings will also be held during this 60-day comment period. The dates, times, and locations of these meetings will be announced in the *Federal Register* and in local newspapers. All comments received during the comment period will be considered by NNSA in the Final EIS.

ACRONYMS AND ABBREVIATIONS

AC/MC	Analytical Chemistry and Materials Characterization
ACHP	Advisory Council on Historic Preservation
ALARA	as low as reasonably achievable
ALOHA	Aerial Location of Hazardous Atmospheres
AQCR	Air Quality Control Region
ARF	airborne release fraction
Bison-m	Biota Information System of New Mexico
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BNM	Bandelier National Monument
CAA	*Clean Air Act*
CAIRS	Computerized Accident/Incident Reporting System
CD-0	critical decision on mission need
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
CIF	Consolidated Incineration Facility
CMR	Chemistry and Metallurgy Research
CMRR	Chemistry and Metallurgy Research Building Replacement Project
CRT	Cargo Restraint Transporter
CWA	*Clean Water Act*
D&D	Decontamination and Decommissioning
DAF	Device Assembly Facility
DCGs	Derived Concentration Guidelines
DHHS	Department of Health and Human Services
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
DOT	U.S. Department of Transportation
DR	damage ratio
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
ECF	Entry Control Facility
EIS	Environmental Impact Statement
EOL	End-of-Life
EPA	U.S. Environmental Protection Agency

ER	Environmental Restoration
ESL	Effects Screening Level
EU	Enriched Uranium
FM	Farm-to-Market Road
FONSI	Finding of No Significant Impact
FPPA	*Farmland Protection Policy Act*
GB	glovebox
HAN	hydroxylamine nitrate
HANDSS-55	"handling and segregation system for 55-gallon drums"
HEPA	high efficiency particulate air
HEWTF	High Explosives Wastewater Treatment Facility
HI	Hazard Index
HQ	Hazard Quotient
HSC	Hazardous Materials Spill Center
HVAC	heating, ventilating, and air conditioning
HWDU	Hazardous waste disposal units
HWTPF	Hazardous Waste Treatment and Processing Facility
HYDEC	hydride/dehydride casting
I	Interstate Highway
ICD-9-CM	International Classification of Disease, 9th Revision, Clinical Modification
ICRP	International Commission on Radiological Protection
INEEL	Idaho National Engineering and Environmental Laboratory
IOM	Institution of Medicine
ISCST	Industrial Source Complex Short Term
ISD	Independent School District
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
LAC	Los Alamos County
LANL	Los Alamos National Laboratory
LANL SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory*
LANSCE	Los Alamos Neutron Science Center
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LOS	Level of Service
LPF	leak path factor
MACCS2	MELCOR Accident Consequence Code System Version 2
MAR	material at risk

MC&A	Material Control & Accountability
MCL	Maximum Contamination Level
MEI	Maximally Exposed Individual
MEK	methyl ethyl ketone
MOX	Mixed Oxide
MPF	Modern Pit Facility
MPF EIS	Modern Pit Facility Environmental Impact Statement
MSGP	Multi-Sector General Permit
MWDU	Mixed Waste Disposal Unit
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection Measurements
NEPA	*National Environmental Policy Act*
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHPA	*National Historic Preservation Act*
NMAQCR	New Mexico Air Quality Control Regulations
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NNSA	National Nuclear Security Administration
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPR	Nuclear Posture Review
NPT	Nuclear Nonproliferation Treaty
NRCS	Natural Resources Conservation Service
NRHP	National Registry of Historic Places
NTS	Nevada Test Site
NWSM	Nuclear Weapons Stockpile Memorandum
NWSP	Nuclear Weapons Stockpile Plan
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PAAA	*Price-Anderson Amendments Act*
Pantex	Pantex Site
PCB	polychlorinated biphenyls
pCi/L	picocuries per liter
PF-4	Plutonium Facility, Building 4
PIDAS	Perimeter Intrusion Detection and Assessment System
ppbv	parts per billion by volume
ppy	pits per year

PQL	Practical Quantitation Limit
PSD	Prevention of Significant Deterioration
Pu	Plutonium
PMDA	Plutonium Management and Disposition Agreement
PUREX	Plutonium-Uranium Extraction Process
R&D	Research and Development
RANT	Radioassay and Nondestructive Testing
RCRA	*Resource Conservation and Recovery Act*
RIMSII	Regional Input-Output Modeling System
RF	respirable fraction
RLWTF	Radioactive Liquid Waste Treatment Facility
ROD	Record of Decision
ROI	Region of Influence
RRF	respirable release fraction
RWMS	Radioactive Waste Management Sites
S.C.	South Carolina State Highway
SCDHEC	South Carolina Department of Health and Environmental Control
SEIS	Supplemental Environmental Impact Statement
SFNF	Santa Fe National Forest
SGT	Safeguards Transporters
SHEO	sentinel health event for occupation
SHPO	State Historic Preservation Officer
SMR	standardized mortality rate
SRS	Savannah River Site
SS&C	sand, slag and crucible
SSM	Stockpile Stewardship and Management
SSM PEIS	*Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
SST	Safe Secure Trailers
SVOC	Semi-volatile organic compound
SWEIS	Site-Wide Environmental Impact Statement
SWSC	Sanitary Wastewater Systems Consolidation
TA	Technical Area
TA-55	Technical Area 55
TBP	tributylphosphate
TCEQ	Texas Commission on Environmental Quality
TNRCC	Texas Natural Resource Conservation Commission
TPDES	Texas Pollutant Discharge Elimination System

TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic
TRUPACT-II	Transuranic Package Transporter
TSCA	*Toxic Substance Control Act*
TSP	total suspended particulates
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
VPP	Voluntary Protection Program
WCRRF	Waste Compaction, Reduction, and Repackaging Facility
WIPP	Waste Isolation Pilot Plant
WSRC	Westinghouse Savannah River Company
WWTF	Wastewater Treatment Facility

CHEMICALS AND UNITS OF MEASURE

BTEX	benzene, toluene, ethylbenzene, and xylenes
Bq	Becquerel
C	Celsius
Ci	curie
cm	centimeters
CFC	chlorofluorocarbons
CO	carbon monoxide
dB	decibel
dBA	decibel A-weighted
DCE	1, 2-dichloroethylene
DNA	deoxyribonucleic acid
F	Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
ft^3/s	cubic feet per second
g	grams
gal	gallons
ha	hectares
hr	hour
in	inches
kg	kilograms
km	kilometers
km^2	square kilometers
kV	kilovolts
kVA	kilovolt-ampere
kW	kilowatts
kWh	kilowatt hours
L	liters
lb	pounds
m	meters
m^2	square meters
m^3	cubic meters
m/s	meters per second
mg	milligram (one-thousandth of a gram)
mg/L	milligrams per liter

MGD	million gallons per day
MGY	million gallons per year
mi	miles
mi^2	square miles
mph	miles per hour
mrem	millirem (one-thousandth of a rem)
MVA	megavolt-ampere
MW	megawatt
MWe	megawatt electric
MWh	megawatt hour
NO_2	nitrogen dioxide
NOX	nitrogen oxides
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie (one-trillionth of a curie)
pCi/L	picocuries per liter
PM_{10}	particulate matter (less than 10 microns in diameter)
ppb	parts per billion
ppm	parts per million
rem	roentgen equivalent man
s	seconds
SO_2	sulfur dioxide
T	short ton
t	metric tons
TCA	1, 1, 1-trichloroethane
TCE	trichloroethylene
yd^3	cubic yards
yr	year
µCi	microcurie (one-millionth of a curie)
µCi/g	microcuries per gram
µg	microgram (one-millionth of a gram)
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

CONVERSION CHART

To Convert Into Metric			To Convert Into English		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inch	2.54	centimeter	centimeter	0.3937	inch
feet	30.48	centimeter	centimeter	0.0328	feet
feet	0.3048	meter	meter	3.281	feet
yard	0.9144	meter	meter	1.0936	yard
mile	1.60934	kilometer	kilometer	0.62414	mile
Area					
square inch	6.4516	square centimeter	square centimeter	0.155	square inch
square feet	0.092903	square meter	square meter	10.7639	square feet
square yard	0.8361	square meter	square meter	1.196	square yard
acre	0.40469	hectare	hectare	2.471	acre
square mile	2.58999	square kilometer	square kilometer	0.3861	square mile
Volume					
fluid ounce	29.574	milliliter	milliliter	0.0338	fluid ounce
gallon	3.7854	liter	liter	0.26417	gallon
cubic feet	0.028317	cubic meter	cubic meter	35.315	cubic feet
cubic yard	0.76455	cubic meter	cubic meter	1.308	cubic yard
Weight					
ounce	28.3495	gram	gram	0.03527	ounce
pound	0.45360	kilogram	kilogram	2.2046	pound
short ton	0.90718	metric ton	metric ton	1.1023	short ton
Force					
dyne	0.00001	newton	newton	100,000	dyne
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

METRIC PREFIXES

Prefix	Symbol	Multiplication Factor
exa-	E	1 000 000 000 000 000 000 = 10^{18}
peta-	P	1 000 000 000 000 000 = 10^{15}
tera-	T	1 000 000 000 000 = 10^{12}
giga-	G	1 000 000 000 = 10^{9}
mega-	M	1 000 000 = 10^{6}
kilo-	k	1 000 = 10^{3}
hecto-	h	l00 = 10^{2}
deka-	da	l0 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	µ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}
femto-	f	0.000 000 000 000 001 = 10^{-15}
atto-	a	0.000 000 000 000 000 001 = 10^{-18}

APPENDIX A
DETAILS OF PIT PRODUCTION PROCESS AND REQUIREMENTS

A.1 FACILITY SUMMARY

A Modern Pit Facility (MPF) would be capable of producing certified pits for the U.S. Nuclear Weapons Stockpile as defined by the National Nuclear Security Administration. The scope of the facility being planned would be as follows.

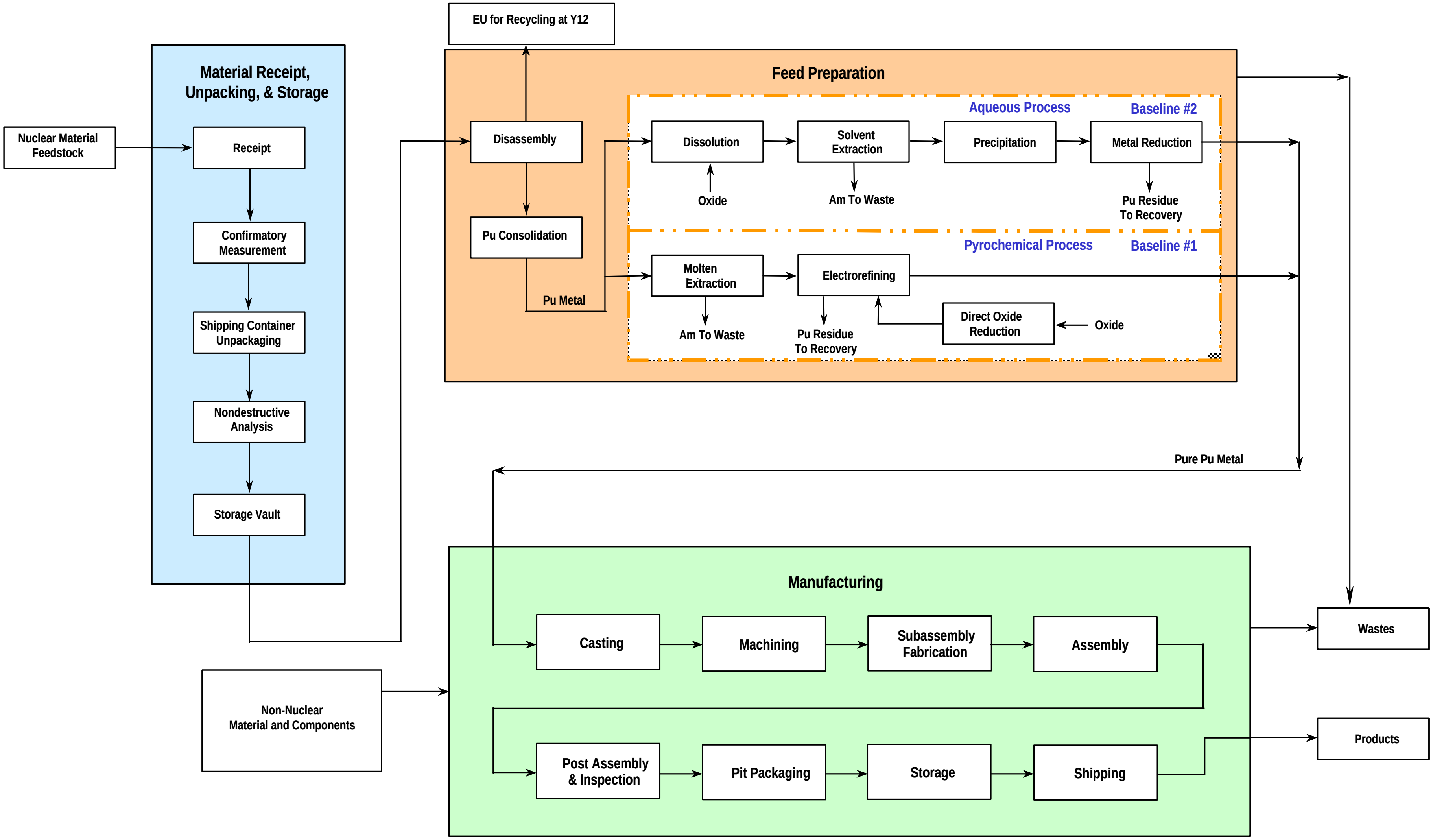
- MPF would be a newly constructed facility that provides long-term (past 2015) plutonium pit manufacturing capability.
- MPF would be designed with the goal of developing a safe, secure, and environmentally compliant facility based on modern manufacturing practices.
- MPF would be located at an existing DOE site and integrated, as appropriate, with other present and planned facilities at that site.
- MPF would be supported by one or more additional plutonium-capable facilities. Other plutonium facilities at Los Alamos National Laboratory or Lawrence Livermore National Laboratory are assumed to be available for complementary Research and Development or backup operations.
- MPF would be an integral part of a broader weapons production complex. It is assumed that existing production facilities now manufacturing some pit components (non-plutonium parts) would continue to be suppliers in the future.
- MPF would be capable of single-shift capacity of no less than 125, 250, or 450 pits per year (ppy) and surge capacity through the use of multiple shifts.
- MPF would be capable of manufacturing plutonium components and assembling all full pits (of current or new design) in the enduring stockpile. A full pit is defined as the complete assembly to be received by the Pantex Plant (Pantex) for incorporation into an operational weapon.

A.2 FACILITY OPERATIONS

Processing operations in the MPF plant would include the following major categories: Material Receipt, Unpacking, & Storage; Feed Preparation; and Manufacturing. Figure A.2–1 provides an overview of the MPF process.

A.2.1 Material Receipt, Unpacking & Storage

Plutonium feedstock material would be delivered from offsite sources in U.S. Department of Energy (DOE)/Department of Transportation-approved shipping containers. The shipping containers may be held in Cargo Restraint Transporters (CRT) and hauled by Safe Secure Trailers or Safeguards Transporters. The CRTs would be unloaded from the truck and the shipping packages unpacked from the CRT. Each shipment would be measured to confirm the plutonium content, entered into the facility’s Material Control & Accountability database, and placed into temporary storage. The shipping packages would later be removed from storage and



Source: Modified from NNSA 2002.

Figure A.2–1. Modern Pit Facility Process Flow

opened to remove the inner containment vessel. The containment vessels with the feedstock material would be accountability measured and then transferred to the Receipt Storage Vault pending transfer to the Pit Disassembly and Feed Preparation Area. In addition to the pits, many other components from throughout the Nuclear Weapons Complex would be shipped to the MPF. These interfaces are shown graphically in Figure A.2.1–1.

A.2.2 Feed Preparation

The containers would then be transferred through a secure transfer corridor to an adjacent Feed Preparation Facility where site return pits would be disassembled and the recovered plutonium would then be purified using either an aqueous or a pyrochemical process.

A.2.2.1 Disassembly

In the Disassembly process, pits will first be removed from the primary containment vessels. The mechanical disassembly of the pits would involve cutting the pit in half and removing all non-plutonium components. The non-plutonium components would then be declassified, packaged, and assayed prior to removal from the facility as waste or recyclable material. The plutonium components, including non-plutonium items containing residual plutonium that could not be removed mechanically from the pit, would be transferred to the Plutonium Recovery and Purification Area.

Uranium components that could be mechanically separated would be decontaminated to remove any residual plutonium prior to packaging for shipment. The decontamination would be accomplished electrochemically. The residues from this process could be dried and disposed as waste, or re-dissolved if plutonium recovery would be desired.

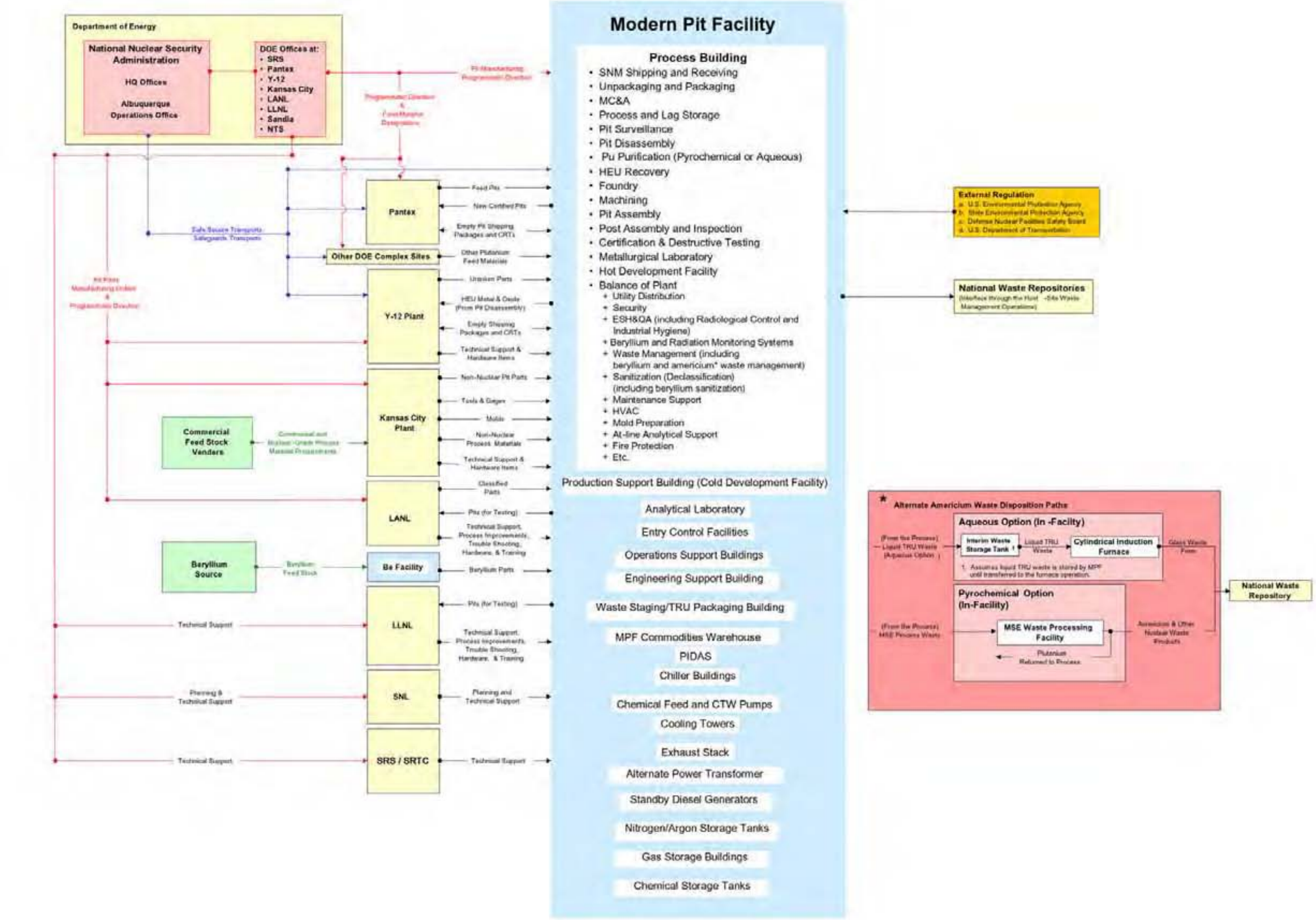
A.2.2.2 Plutonium Consolidation

Plutonium pieces would be charged to a casting furnace for conversion to a metal ingot. The metal ingot would then be transferred to the purification process.

A.2.2.3 Plutonium Purification

There are two baseline processes being evaluated for the purification of the plutonium metal. One baseline relies more heavily on aqueous chemistry (aqueous process) and the other on pyrochemical reactions (pyrochemical process). The primary difference between the two baselines is that the aqueous process does not employ chloride containing aqueous solutions which means conventional stainless steels can readily be used to contain all of its processes. On the other hand the pyrochemical process requires specialized materials to contain the corrosive chloride bearing solutions that it employs.

The primary process evaluated in this EIS is the aqueous process. This is a well-known process that has been successfully used at DOE sites for many years. It is comparatively simple and experiences few, well controlled corrosion problems. However, it is not as space efficient and does not produce as pure a product metal as the pyrochemical process. This lower purity



Source: NNSA 2002.

Figure A.2.1–1. Modern Pit Facility Interface with the Nuclear Weapons Complex

requires more complete processing and historically produces a great deal more waste. This provides a bounding analysis of the waste impact from the MPF. Residue from the aqueous process would be packaged, assayed, and sent to storage for recovery of plutonium during scrap recovery campaigns. If the plutonium content was acceptably low, this material could alternatively be packaged for disposal as waste.

The pyrochemical process is more complex than the aqueous process, employing seven versus four major processing steps. However, this can be done in less space with more processing flexibility. It also produces very pure metal and a lower volume of waste. The purity of metal allows the pyrochemical process to have the option of only partially processing metallic plutonium to obtain adequate production purity. Although it requires special materials of construction to contain the corrosive chloride solutions it appears to have the greatest potential for improvement based on the number and type of proposed development projects. Residue from the pyrochemical process would be packaged, assayed, and sent to storage for recovery of plutonium during scrap recovery campaigns. If the plutonium content was acceptably low, this material could alternatively be packaged for disposal as waste.

The pyrochemical process is being investigated because it has the potential to be environmentally more benign, thus having less environmental impact than the aqueous process. The impacts from both of these processes will therefore be bounded in this EIS. As the design of the MPF develops and a final purification method is chosen, the follow-on EIS will evaluate the impact of the actual process to be used.

A.2.3 Manufacturing

Plutonium metal from the recovery and purification processes would be used to fabricate new pits. Some plutonium metal from other sources could be used to supplement the plutonium recovered from the purification operations. The plutonium metal would then be transferred to the manufacturing area where it would be melted and cast into required shapes in a foundry operation. These castings would then be machined to proper dimensions, combined with other non-plutonium parts including beryllium and enriched uranium components and would be assembled into pits. Throughout the manufacturing operations, certification and inspection would be conducted to ensure that components meet specifications. The finished pits would then be prepared for storage and eventual shipment.

Residues from the manufacturing process would be recycled either to the melting/casting operation or sent back to the plutonium purification process to recycle the plutonium back through the entire process. Wastes from this process would be packaged, assayed, and sent to storage for recovery of plutonium during scrap recovery campaigns. If the plutonium content was acceptably low, this material could alternatively be packaged for disposal as waste.

A.3 FACILITY REQUIREMENTS

The design size of a MPF will be primarily affected by both the operational lifetime of pits and the size of the stockpile. Since there is uncertainty over both these issues, the final design size of a MPF has not yet been determined. These uncertainties have been evaluated in classified studies. Three levels of production are evaluated to provide a reasonable range for analysis in this MPF EIS. These are 125, 250, and 450 ppy in a single-shift operation. To accommodate these three production rates, this MPF EIS analyzes three different plant sizes. Another consideration is the contingency or surge use of two-shift operations for emergencies. The surge outputs of the 125 and 250 ppy plants would thus be approximately the same and have the same environmental impact as the 250 and 450 ppy single-shift scenarios. The impacts of surge output of the 450 ppy plant were evaluated in a qualitative manner for each resource.

A.3.1 Security

The majority of the facilities of a MPF would be located within a Perimeter Intrusion Detection and Assessment System (PIDAS). The PIDAS would be a multiple sensor system within a 9-m (30-ft) wide zone enclosed by two fences that runs around the entire Security Protection Area. In addition, there would be 6-m (20-ft) clear zones on either side of the PIDAS. There would be an Entry Control Facility at the entrance to the Security Protection Area.

A.3.2 Process Structures

The proposed concept being evaluated for a MPF divides the major plant components into three separate process buildings identified as Material Receipt, Unpacking & Storage, Feed Preparation, and Manufacturing that provide the services described in Chapter 3, Section 3.1.1. The process buildings would be two-story reinforced concrete structures located aboveground at grade. The exterior walls and roof would be designed to resist all credible man-made and natural phenomena hazards and comply with security requirements. The exterior walls of the first level would consist of a double reinforced concrete wall construction with loose aggregate backfill between the walls to satisfy security requirements.

The first level of each process building would include plutonium processing areas, manufacturing support areas, waste handling, control rooms, and support facilities for operations personnel. The second level of each of the three process buildings would include the heating, ventilation, and air conditioning (HVAC) supply fans, exhaust fans and high-efficiency particulate air filters, breathing/plant/instrument air compressor rooms, electrical rooms, process support equipment rooms, and miscellaneous support space. Interior walls would be typically reinforced concrete to provide personnel shielding and for durability in the 50-year facility design life. Each of these processing buildings would have its own Entry Control Facility, Truck Loading Docks, Operations Support Facility, and Safe Havens designed in accordance with applicable safety and security requirements. The three processing buildings would be connected with secure transfer corridors.

A.3.3 Support Structures Within the Perimeter Intrusion Detection and Assessment System

The major buildings located within the PIDAS would include the Analytical Support Building and the Production Support Building. The Analytical Support Building would contain laboratory equipment and instrumentation required to provide analytical support for the MPF processes, including radiological analyses. The Production Support Building would provide the capability for performing nonradiological classified work related to the development, testing, and troubleshooting of MPF processes and equipment during operations. A number of other smaller structures also supporting the MPF would include standby generator buildings, fuel and liquid gas storage tanks, HVAC chiller buildings, cooling towers, and the HVAC exhaust stack.

A.3.4 Support Structures Outside the Perimeter Intrusion Detection and Assessment System

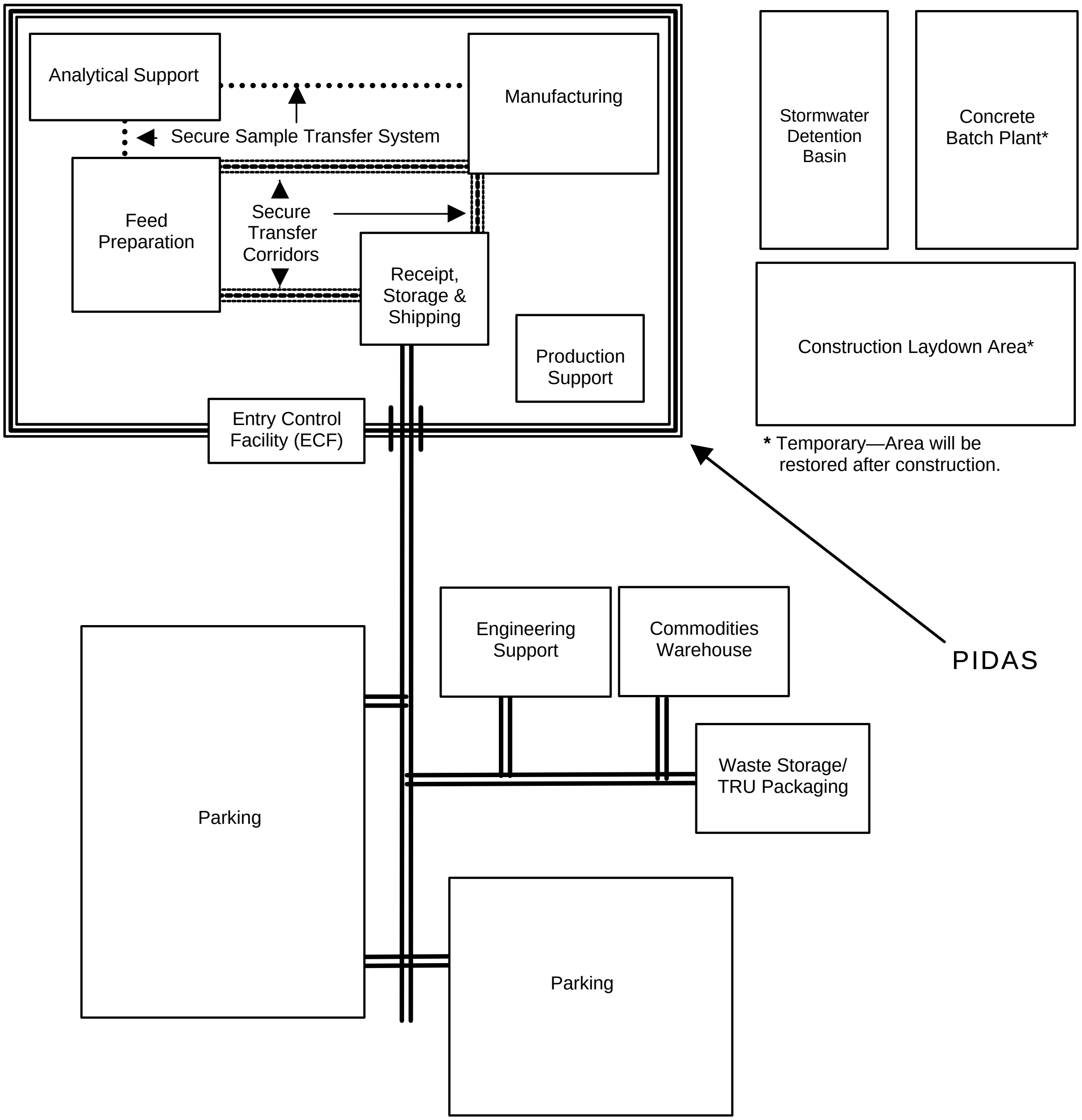
The major structures located outside the PIDAS would include the Engineering Support Building, the Commodities Warehouse, and the Waste Staging/TRU Packaging Building. This Waste Staging/TRU Packaging Building would be used for characterizing and certifying the TRU waste prior to packing and short-term lag storage prior to shipment to the TRU waste disposal site. Parking areas and stormwater detention basins would also be located outside the PIDAS. In addition, a temporary Concrete Batch Plant and Construction Laydown Area would be required during construction.

A generic layout showing the major structures and their relationship to each other is shown in Figure A.3.4–1. Table A.3.4–1 shows the dimensions involved with each of the plant capacities.

Table A.3.4–1. Dimensions for the Three Different MPF Capacities

	125 ppy	**250 ppy**	**450 ppy**
Processing Facilities Footprint (m^2)	28,600	32,800	44,900
Support Facilities Footprint (m^2)	26,000	26,200	29,900
Total Facilities Footprint (m^2)	54,600	59,000	74,800
Total Facilities Footprint (ha)	5.46	5.90	7.48
Area inside PIDAS (ha)	25.5	26.3	31.6
Area Developed During Construction (ha)	56.3	58.3	69.2
Post Construction Developed Area (ha)	44.5	46.5	55.8

Source: MPF Data 2003.



Source: Modified from MPF Data 2003.

Figure A.3.4–1. Generic Layout of the Modern Pit Facility

APPENDIX B
HUMAN HEALTH EFFECTS FROM NORMAL OPERATIONS

B.1 INTRODUCTION

This appendix provides a brief general discussion on radiation and its health effects. It also describes the methods and assumptions used for estimating the potential impacts and risks to individuals and the general public from exposure to releases of radioactivity during normal MPF operations.

B.2 RADIOLOGICAL IMPACTS ON HUMAN HEALTH

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this Environmental Impact Statement (EIS) places emphasis on the consequences of exposure to radiation, provides the reader with information on the nature of radiation, and explains the basic concepts used in the evaluation of radiation health effects.

B.2.1 Nature of Radiation and Its Effects on Humans

What Is Radiation?

Radiation is energy transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from space and the Earth's rocks and soil. This radiation contributes to the natural background radiation that always surrounds us. Man-made sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (central part of an atom) with a number of negatively charged electron particles in various orbits around the nucleus. There are two types of particles in the nucleus: neutrons that are electrically neutral and protons that are positively charged. Atoms of different types are known as elements. There are more than 100 natural and man-made elements. An element has equal numbers of electrons and protons. When atoms of an element differ in their number of neutrons, they are called isotopes of that element. All elements have three or more isotopes, some or all of which could be unstable (i.e., decay with time).

Unstable isotopes undergo spontaneous change, known as radioactive disintegration or radioactive decay. The process of continuously undergoing spontaneous disintegration makes the material radioactive. The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. An isotope's half-life is a measure of its decay rate. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

As unstable isotopes change into more stable forms, they often emit electrically charged particles. These particles may be either an alpha particle (a helium nucleus) or a beta particle (an electron), with various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The alpha and beta particles are frequently referred to as ionizing radiation. Ionizing radiation refers to the fact that the charged particle energy can ionize, or electrically charge, an atom by stripping off one of its electrons. Gamma rays, even though they do not carry an electric charge as they pass through an element, can ionize its atoms by causing it to eject electrons. Thus, they cause ionization indirectly. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element, one that may or may not be radioactive. Eventually a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, radium, which is a member of the radioactive decay chain of uranium, has a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of further decay steps to bismuth, and ultimately to a stable isotope of lead. Meanwhile, the decay products will build up and eventually die away as time progresses.

The characteristics of various forms of ionizing radiation are briefly described below.

Radiation Type	Typical Travel Distance in Air	Barrier
Alpha (a)	Few centimeters	Sheet of paper or skin’s surface
Beta (ß)	Few meters	Thin sheet of aluminum foil or glass
Gamma (?)	Very large	Thick wall of concrete, lead, or steel
Neutrons (n)	Very large	Water, paraffin, graphite

Alpha (a)—Alpha particles are the heaviest type of ionizing radiation. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the skin’s surface.

Beta (ß)—Beta particles are much (7,330 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. A high-energy beta particle can travel a few meters in the air. Beta particles can pass through a sheet of paper, but may be stopped by a thin sheet of aluminum foil or glass.

Gamma (?)—Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

Neutrons (n)—Neutrons are particles that contribute to radiation exposure both directly and indirectly. The most prolific source of neutrons is a nuclear reactor. Indirect radiation exposure occurs when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the weight of an alpha particle. It will travel in the air until it is absorbed in another element.

Units of Radiation Measure

During the early days of radiological experience, there was no precise unit of radiation measure. Therefore, a variety of units were used to measure radiation. These units were used to determine the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or effects using units of calories or degrees, quantities of radioactive material can be measured in units of curies, and its effects can be measured in units of radiation absorbed dose (rad), or dose equivalent (rem). The following summarizes those units.

Curie—The curie is the basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the same rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. The unit was named for Marie and Pierre Curie, who discovered radium in 1898.

Rad—The rad is the unit of measurement for the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as absorbed dose (or simply dose). As sunlight heats pavement by giving up an amount of energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram (kg) of absorbing material.

Radiation Units and Conversions to International System of Units
1 curie = 3.7×10^{10} disintegrations per second
= 3.7×10^{10} becquerels
1 becquerel = 1 disintegration per second
1 rad = 0.01 gray
1 rem= 0.01 sievert
1 gray = 1 joule per kilogram

Rem—A rem is a measurement of the dose equivalent from radiation based on its biological effects. The rem is used in measuring the effects of radiation on the body as degrees centigrade are used in measuring the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation. One rem is equal to 1,000 millirem (mrem).

In the International System of Units, the unit of radioactivity (source intensity) is becquerel, the unit of absorbed dose is gray, and the unit of dose equivalent (biological effect) is the sievert.

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, while an internal dose continues to be delivered as long as the radioactive source is in the body. The dose from internal exposure is calculated over 50 years following the initial exposure. Dose delivered by external radiation and by internally deposited radionuclides (internal dose) is presumed to be biologically equivalent. In practice, for long-lived radionuclides, internal doses are delivered slowly over 50 years and the biological harm is likely to be less.

Sources of Radiation

The average American receives a total of approximately 360 millirem per year (mrem/yr) from all sources of radiation, both natural and manmade, of which approximately 300 mrem/yr are from natural sources. The sources of radiation can be divided into six different categories: (1) cosmic radiation, (2) terrestrial radiation, (3) internal radiation, (4) consumer products, (5) medical diagnosis and therapy, and (6) other sources (National Council on Radiation Protection and Measurements [NCRP] 1987). These categories are discussed in the following paragraphs.

Cosmic Radiation—Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the Earth's atmosphere. These particles and the secondary particles and photons they create comprise cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to people in the United States from this source is approximately 27 mrem/yr.

External Terrestrial Radiation—External terrestrial radiation is the radiation emitted from the radioactive materials in the Earth's rocks and soils. The average dose from external terrestrial radiation is approximately 28 mrem/yr.

Internal Radiation—Internal radiation results from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributor to the annual dose equivalent for internal radioactivity is the short-lived decay products of radon, which contribute approximately 200 mrem/yr. The average dose from other internal radionuclides is approximately 39 mrem/yr.

Consumer Products—Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the product's operation. In other products, such as televisions and tobacco, the radiation occurs as the products function. The average dose from consumer products is approximately 10 mrem/yr.

Medical Diagnosis and Therapy—Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays result in an average exposure of 39 mrem/yr. Nuclear medical procedures result in an average exposure of 14 mrem/yr.

Other Sources—There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities (e.g., uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 mrem/yr. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 mrem/yr to the average dose to an individual. Air travel contributes approximately 1 mrem/yr to the average dose.

Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different ways that could result in radiation exposure to an individual are called exposure pathways. Each type of exposure is discussed separately in the following paragraphs.

External Exposure—External exposure can result from several different pathways, all having in common the fact that the source of radiation causing the exposure is external to the body. These pathways include exposure to a cloud of radioactive material passing over the receptor (i.e., an individual member of the public), standing on ground that is contaminated with radioactivity, and swimming or boating in contaminated water. If the receptor departs from the source of radiation exposure, the dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year. The appropriate dose measure is called the effective dose equivalent.

Internal Exposure—Internal exposure results from a radiation source entering the human body through either inhalation of contaminated air or ingestion of contaminated food or water. In contrast to external exposure, once a radiation source enters the body, it remains there for a period of time that varies depending on decay and biological half-life. The absorbed dose to each organ of the body is calculated for a period of 50 years following the intake. The calculated absorbed dose is called the committed dose equivalent. Various organs have different susceptibilities to harm from radiation. The quantity that takes these different susceptibilities into account is called the committed effective dose equivalent, and it provides a broad indicator of the risk to the health of an individual from radiation. The committed effective dose equivalent is a weighted sum of the committed dose equivalent in each major organ or tissue. The concept of committed effective dose equivalent applies only to internal pathways.

Radiation Protection Guides

Various organizations have issued radiation protection guides. The responsibilities of the main radiation safety organizations, particularly those that affect policies in the United States, are summarized below.

International Commission on Radiological Protection (ICRP)—This Commission has the responsibility for providing guidance in matters of radiation safety. The operating policy of this organization is to prepare recommendations to deal with basic principles of radiation protection and to leave to the various national protection committees the responsibility of introducing the detailed technical regulations, recommendations, or codes of practice best suited to the needs of their countries.

National Council on Radiation Protection and Measurements—In the United States, this Council is the national organization that has the responsibility for adapting and providing detailed technical guidelines for implementing the ICRP recommendations. The Council consists of technical experts who are specialists in radiation protection and scientists who are experts in disciplines that form the basis for radiation protection.

National Research Council/National Academy of Sciences—The National Research Council is an organization within the National Academy of Sciences that associates the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the Federal government.

Environmental Protection Agency (EPA)—The EPA has published a series of documents, *Radiation Protection Guidance to Federal Agencies*. This guidance is used as a regulatory benchmark by a number of Federal agencies, including the U.S. Department of Energy (DOE), in the realm of limiting public and occupational work force exposures to the greatest extent possible.

Limits of Radiation Exposure

Limits of exposure to members of the public and radiation workers are derived from ICRP recommendations. The EPA uses the NCRP and the ICRP recommendations and sets specific annual exposure limits (usually less than those specified by the Commission) in *Radiation Protection Guidance to Federal Agencies* documents. Each regulatory organization then establishes its own set of radiation standards. The various exposure limits set by DOE and the EPA for radiation workers and members of the public are given in Table B.2.1–1.

Table B.2.1–1. Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (Organization)	Public Exposure Limits at the Site Boundary	Worker Exposure Limits
10 CFR 835 (DOE)	—	5,000 mrem/yr [a]
10 CFR 835.1002 (DOE)	—	1,000 mrem/yr [b]
DOE Order 5400.5 (DOE) [c]	10 mrem/yr (all air pathways) 4 mrem/yr (drinking water pathway) 100 mrem/yr (all pathways)	—
40 CFR 61 (EPA)	10 mrem/yr (all air pathways)	—
40 CFR 141 (EPA)	4 mrem/yr (drinking water pathways)	—

[a] Although this is a limit (or level) which is enforced by DOE, worker doses must still adhere to as low as is reasonably achievable principles. Refer to footnote b.

[b] This is a control level. It was established by DOE to assist in effecting its goal to maintain radiological doses as low as is reasonably achievable. DOE recommends that facilities adopt a more limiting 500 mrem/yr Administrative Control Level (DOE 1999e). Reasonable attempts have to be made by the site to maintain individual worker doses below these levels.

[c] Derived from 40 CFR 61, 40 CFR 141, and 10 CFR 20.

B.2.2 Health Effects

Radiation exposure and its consequences are topics of interest to the general public. To provide the background for discussions of impacts, this section explains the basic concepts used in the evaluation of radiation effects.

Radiation can cause a variety of damaging health effects in people. The most significant effects are induced cancer fatalities. These effects are referred to as "latent" cancer fatalities because the cancer may take many years to develop. In the discussions that follow, all fatal cancers are considered latent; therefore, the term "latent" is not used.

The National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR) has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. *Health Effects of Exposure to Low Levels of Ionizing*

Radiation, BEIR V (NRC 1990), provides the most current estimates for excess mortality from leukemia and other cancers that are expected to result from exposure to ionizing radiation. BEIR V provides estimates that are consistently higher than those in its predecessor, BEIR III. This increase is attributed to several factors, including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional followup studies of the atomic bomb survivors and associated others. BEIR III employs constant, relative, and absolute risk models, with separate coefficients for each of several sex and age-at-exposure groups. BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. The BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population. BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data that included the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy (breast cancer) patients, New York postpartummastitis (breast cancer) patients, Israeli tinea capitis (thyroid cancer) patients, and Rochester thymus (thyroid cancer) patients. Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry, with an assumed relative biological effectiveness of 20 for neutrons, and were restricted to doses less than 400 rads. Estimates of risks of fatal cancers, other than leukemia, were obtained by totaling the estimates for breast cancer, respiratory cancer, digestive cancer, and other cancers.

The NCRP (NCRP 1993), based on the radiation risk estimates provided in BEIR V and the ICRP Publication 60 recommendations (ICRP 1991), has estimated the total detriment resulting from low dose[1] or low dose rate exposure to ionizing radiation to be 5.6×10^{-4} per rem for the working population and 7.3×10^{-4} per rem for the general population. The total detriment includes fatal and nonfatal cancer, which is severe hereditary (genetic) effects. The major contribution to the total detriment is from fatal cancer, which is estimated to be 4×10^{-4} and 5×10^{-4} per rem for radiation workers and the general population, respectively. The breakdowns of the risk estimators for both workers and the general population are given in Table B.2.2–1. Nonfatal cancers and genetic effects are less probable consequences of radiation exposure. To simplify the presentation of the impacts, estimated effects of radiation are calculated only in terms of cancer fatalities. For higher doses to an individual (20 rem or more), as could be associated with postulated accidents, the risk estimators given in Table B.2.2–1 are doubled.

---

[1] Low dose is defined as the dose level where deoxyribonucleic acid (DNA) repair can occur in a few hours after irradiation induced damage. Currently, a dose level of about 0.2 grays (20 rad), or a dose rate of 0.1 milligrays (0.01 rad) per minute is considered low enough to allow the DNA to repair itself in a short period (EPA 1999a).

The numerical estimates of fatal cancers presented in this EIS were obtained using a linear extrapolation from the nominal risk estimated for lifetime total cancer mortality that results from a dose of 0.1 gray (10 rad). Other methods of extrapolation to the low-dose region could yield higher or lower numerical estimates of fatal cancers. Studies of human populations exposed to low doses are inadequate to demonstrate the actual level of risk. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation, and the possibility of no risk cannot be excluded (DOE 1996c).

Table B.2.2–1. Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation

Exposed Individual	Fatal Cancer [a, c]	Nonfatal Cancer [b]	Genetic Disorders [b]	Total
Worker	0.0004	0.00008	0.00008	0.0005
Public	0.0005	0.0001	0.00013	0.00073

[a] For fatal cancer, the health effect coefficient is the same as the probability coefficient. When applied to an individual, the units are the lifetime probability of a cancer fatality per rem of radiation dose. When applied to a population of individuals, the units are the excess number of fatal cancers per person-rem of radiation dose.
[b] In determining a means of assessing health effects from radiation exposure, the ICRP has developed a weighting method for nonfatal cancers and genetic effects.
[c] For high individual exposures (greater than or equal to 20 rem), the health factors are multiplied by a factor of 2.
Source: NCRP 1993.

Health Effect Risk Estimators Used in This EIS

Health impacts from radiation exposure, whether from external or internal sources, generally are identified as “somatic” (i.e., affecting the exposed individual) or “genetic” (i.e., affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than genetic effects. The somatic risks of most importance are induced cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2-7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because fatal cancer is the most probable serious effect of environmental and occupational radiation exposures, estimates of cancer fatalities rather than cancer incidence are presented in this EIS. The numbers of fatal cancers can be used to compare the risks among the various alternatives.

Based on the preceding discussion and the values presented in Table B.2.2–1, the number of fatal cancers to the general public during normal operations and for postulated accidents in which individual doses are less than 20 rem are calculated using a health risk estimator of 5×10^{-4} per person-rem. For workers, a risk estimator of 4×10^{-4} excess fatal cancers per person-rem is used. (The risk estimators are lifetime probabilities that an individual would develop a fatal cancer per rem of radiation received.) The lower value for workers reflects the absence of children (who are more radiosensitive than adults) in the workforce. The risk estimators associated with nonfatal cancer and genetic disorders among the public are 20 and 26 percent, respectively, of the fatal cancer risk estimator. For workers, these health risk estimators are both 20 percent of the fatal cancer risk estimator. The nonfatal cancer and genetic disorder risk estimators are not used in this EIS.

For individual doses of 20 rem or more, as could be associated with postulated accidents, the risk estimators used to calculate health effects to the general public and to workers are double those given in the previous paragraph, which are associated with doses of less than 20 rem.

The fatal cancer estimators are used to calculate the statistical expectation of the effects of exposing a population to radiation. For example, if 100,000 people were each exposed to one-time radiation dose of 100 mrem (0.1 rem), the collective dose would be 10,000 person-rem. The exposed population would then be expected to experience five additional cancer fatalities from the radiation (10,000 person-rem × 5 × 10^{-4} lifetime probability of cancer fatalities per person-rem = 5 cancer fatalities).

Calculations of the number of excess fatal cancers associated with radiation exposure do not always yield whole numbers. These calculations may yield numbers less than 1, especially in environmental impact applications. For example, if a population of 100,000 were exposed to a total dose of only 0.001 rem per person, the collective dose would be 100 person-rem, and the corresponding estimated number of cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 5 × 10^{-4} cancer fatalities per person-rem = 0.05 cancer fatalities). The 0.05 means that there is one chance in 20 that the exposed population would experience one fatal cancer. In other words, the 0.05 cancer fatalities is the *expected* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person (0 people) would incur a fatal cancer from the 0.001 rem dose each member would have received. In a small fraction of the groups, one cancer fatality would result; in exceptionally few groups, two or more cancer fatalities would occur. The *average* expected number of deaths over all the groups would be 0.05 cancer fatalities (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 cancer fatalities.

The same concept is applied to estimate the effects of radiation exposure on an individual member of the public. Consider the effects of an individual's exposure to a 360 mrem (0.36 rem) annual dose from all radiation sources. The probability that the individual will develop a fatal cancer from continuous exposure to this radiation over an average life of 72 years (presumed) is 0.013 (1 person × 0.36 rem per year × 72 years × 5 × 10^{-4} cancer fatality risk per person rem = 0.013). This correlates to one chance in 77 that the individual would develop a fatal cancer.

B.3 HEALTH EFFECTS STUDIES: EPIDEMIOLOGY

Various epidemiologic studies have been conducted at some of the sites evaluated in this EIS because of the concern for potential adverse health effects associated with the manufacture and testing of nuclear weapons. These studies focus on the DOE workforce and residents of communities surrounding DOE sites.

B.3.1 Background

The health effects associated with ionizing radiation exposure were first published about 60 years ago. Studies published in the 1930s first documented cancer among painters who used radium to paint watch dials back in 1910 to 1920. Radiation therapy for disease has been used since the 1930s and studies have shown that the risk of cancer was related to the amounts of radiation received. Nuclear weapons research and manufacture, and consequent exposure to radiation occurred beginning in the late 1930s. Exposure to radionuclides has changed over time with higher levels occurring in the early days of research and production. Numerous epidemiologic studies have been conducted among workers who manufactured and tested nuclear weapons due to the concern with potential adverse health effects. More recently, concerns about radiologic contaminants offsite have resulted in health studies among communities that surround DOE facilities. The following section briefly gives an overview of epidemiology followed by a review of epidemiologic studies of sites evaluated in this Programmatic Environmental Impact Statement (PEIS).

Epidemiology is the study of the distribution and determinants of disease in human populations. The distribution of disease is considered in relation to time, place, and person. Relevant population characteristics should include the age, race, and sex distribution of a population, as well as other characteristics related to health, such as social characteristics (e.g., income and education), occupation, susceptibility to disease, and exposure to specific agents. Determinants of disease include the causes of disease, as well as factors that influence the risk of disease.

B.3.1.1 Study Designs

Ecologic Studies

Ecologic studies compare the frequency of a disease in groups of people in conjunction with simple descriptive studies of geographical information in an attempt to determine how health events among populations vary with levels of exposure. These groups may be identified as the residents of a neighborhood, a city, or a county where demographic information and disease or mortality data are available. Exposure to specific agents may be defined in terms of residential location or proximity to a particular area, such as distance from a waste disposal site. An example of an ecologic study is a comparison of the rate of heart disease among community residents by drinking water quality.

The major disadvantage of ecologic studies is that the measure of exposure is based on the average level of exposure in the community, when what is really of interest is each individual's exposure. Ecologic studies do not take into account other factors such as age and race that may also be related to disease. These types of studies may lead to incorrect conclusions, an “ecologic fallacy.” For the above example, it would be incorrect to assume that the level of water hardness influences the risk of getting heart disease. Despite the obvious problems with ecologic studies, they can be a useful first step in identifying possible associations between the risk of disease and environmental exposures. However, because of their potential for bias they should never be considered more than an initial step in investigation of disease causation.

Cohort Studies

The cohort study design is a type of epidemiologic study frequently used to examine occupational exposures within a defined workforce. A cohort study requires a defined population that can be classified as being exposed or not exposed to an agent of interest, such as radiation or chemicals that influence the probability of occurrence of a given disease. Characterization of the exposure may be qualitative (e.g., high, low, or no exposure) or very quantitative (e.g., radiation measured in Sv, chemicals in parts per million [ppm]). Surrogates for exposure, such as job titles, are frequently used in the absence of quantitative exposure data.

Individuals enumerated in the study population are tracked for a period of time and fatalities recorded. In general, overall rates of death and cause-specific rates of death have been assessed for workers at the EIS sites. Death rates for the exposed worker population are compared with death rates of workers who did not have the exposure (internal comparison), or compared with expected death rates based on the U.S. population or state death rates (external comparison). If the rates of death differ from what is expected, an association is said to exist between the disease and exposure. In cohorts where the exposure has not been characterized, excess mortality can be identified, but these deaths cannot be attributed to a specific exposure, and additional studies may be warranted. More recent studies have looked at other disease endpoints, such as overall and cause-specific cancer incidence (newly diagnosed) rates.

Most cohort studies at EIS sites have been historical cohort studies, that is, the exposure occurred some time in the distant past. These studies rely on past records to document exposure. This type of study can be problematic if exposure records are incomplete or were destroyed. Cohort studies require extremely large populations that have been followed for many (20-30) years. They are generally difficult to conduct and are very expensive. These studies are not well suited to studying diseases that are rare. Cohort studies do, however, provide a direct estimate of the risk of death from a specific disease, and allow an investigator to look at many disease endpoints.

Case-Control Studies

The case-control study design starts with the identification of persons with the disease of interest (case) and a suitable comparison (control) population of persons without the disease. Controls must be persons who are at risk for the disease and are representative of the population that generated the cases. The selection of an appropriate control group is often quite problematic. Cases and controls are then compared with respect to the proportion of individuals exposed to the agent of interest. Case-control studies require fewer persons than cohort studies, and therefore, are usually less costly and less time consuming, but are limited to the study of one disease (or cause of death). These types of studies are well suited for the study of rare diseases and are generally used to examine the relationship between a specific disease and exposure.

B.3.1.2 Definitions

Terms used in epidemiologic studies, including those used in this document, are defined below.

Age, gender, and cigarette smoking are the principal determinants of mortality. *Standardization* is a statistical method used as a control for the effects of age, gender, or other characteristics so that death rates may be compared among different population groups. There are two ways to standardize rates, the indirect or direct methods. In general, the indirect method of standardization is most frequently used.

Indirect Standardization—The disease rates in the reference (comparison) population are multiplied by the number of individuals in the same age and gender groups in the study population to obtain the expected rate of disease for the study population.

Direct Standardization—The disease rates in the study population are multiplied by the number of individuals in the same age and gender group in the reference (comparison) population. This gives the expected rates of disease for the reference population if these rates had prevailed in that group.

Standardized Mortality Ratio—The standardized mortality rate (SMR) is the ratio of the number of deaths observed in the study population to the number of expected deaths. The expected number of deaths is based on a reference (or comparison population). Death rates for the U.S. (or state) population are most frequently used as the comparison to obtain expected rates. An SMR of 1 indicates a similar risk of disease in the study population compared with the reference population. An SMR greater than 1 indicates excess risk of disease in the study population compared with the reference group, and an SMR less than 1 indicates a deficit of disease.

Relative Risk—The ratio of the risk of disease among the exposed population to the risk of disease in the non-exposed population. Relative risks are estimated from cohort studies.

Odds Ratio—The ratio of the odds of disease if exposed, to the odds of disease if not exposed. Under certain conditions, the odds ratio approximates the relative risk. Odds ratios are estimated from case-control studies.

B.3.2 Los Alamos Site

Los Alamos and adjacent counties comprise a unique setting and history. Los Alamos Site, for much of its existence, was a closed community where most of the residents had direct economic ties to the laboratory. Nearly all male residents and some of the female residents are employed at Los Alamos National Laboratory (LANL). Medical care in Los Alamos County had been centralized at the laboratory and a single community hospital. This is a unique, highly educated community situated adjacent to lands populated by Native Americans.

Surrounding Communities

Selected cancer mortality and incidence (newly diagnosed cancer) rates between 1950 and 1969, for 11 selected cancers among white males in Los Alamos County were compared with rates for the State of New Mexico, U.S. rates, and with rates of 5 socioeconomic and occupational control counties and 5 high-education western counties, based on U.S. Bureau of the Census information (ER 1981). The comparisons were made to identify cancer types that were greater than expected while taking into account important factors, such as income and education, associated with cancer patterns. Six cancer types were identified that had rates greater than cancer rates for one or more of the four comparison groups; they are: cancer of the bile ducts and liver, bladder, prostate, brain and nervous system, lympho- and reticulo-sarcoma, and leukemia. Cancer rates of the prostate, bladder, and leukemia were also greater than expected.

Compared with New Mexico white males, Los Alamos County Anglo-white males show nonstatistically significant excesses in cancer incidence from 1969-1974 for the stomach, colon, rectum, pancreas, lung, and bladder (ER 1981). All cancers combined show a 35-percent statistically significant excess. Los Alamos County white females show nonstatistically significant excesses for cancer of the stomach, large intestine, lymphosarcoma and reticulasarcoma, and leukemia. All cancers combined show a statistically significant 40-percent excess.

In 1991, the New Mexico Department of Health initiated epidemiologic studies in response to citizen concerns about an apparent excess of brain tumors among residents of the western area neighborhood of Los Alamos County as a result of historical LANL nuclear operations. The New Mexico Department of Health conducted a descriptive study of brain cancer incidence in Los Alamos County and for 22 other sites (NM DOH 1993). The study showed that during the mid- to late-1980s an excess of approximately 80 percent of brain cancer had occurred in Los Alamos County compared with a New Mexico reference population and national statistics. The excess incidence had disproportionately occurred among persons who were residents of the western area at the time of diagnosis or death; however, there were only three cases, and they were confined to the 2-year time period, 1986-1987. Additional descriptive studies showed that the brain cancer rates for Los Alamos County were within the range of rates observed across New Mexico counties from 1983-1987 and 1988-1991. A review of mortality statistics for benign or unspecified neoplasms of the brain and nervous system showed no deaths from these causes in western area residents during 1984-1990.

Los Alamos County breast cancer incidence rates remained level, but higher than New Mexico rates from 1970-1990. Reproductive and demographic factors associated with the risk of breast cancer were thought to account for the higher rates. A special study was conducted to examine the recent increase in breast cancer since 1988 (DOE 1996c). The New Mexico Tumor Registry concluded that the increase seen between 1988 and 1992 was primarily due to increased detection of early stage disease.

The incidence of ovarian cancer in Los Alamos County women was elevated from the mid-1970s to 1990. From 1986-1990, ovarian cancer incidence in Los Alamos County was roughly twofold higher compared with New Mexico reference population rates. The excess ovarian cancer rate was confined to a census tract corresponding to two neighborhoods and was four- to sixfold higher than that observed in the remaining Los Alamos County census tracts.

The incidence rates for melanoma (cancer of the skin) in Los Alamos County were elevated from 1970-1990, with peak elevations occurring from the mid- to late-1980s. There was approximately a twofold excess risk compared with a New Mexico state reference population. The excess melanoma incidence observed in Los Alamos County was thought to be related to the high ambient solar ultraviolet radiation intensity due to its high altitude.

A fourfold increase in thyroid cancer incidence during the late-1980s was noted in a study by Athas (NM DOH 1996). A case-series records review was initiated to examine data relating to the detection, diagnosis, and known risk factors for thyroid cancer. All cases of thyroid cancer diagnosed among Los Alamos County residents between 1970 and 1995 were identified through the New Mexico Tumor Registry. The incidence rate for thyroid cancer in Los Alamos County was slightly higher than New Mexico rates between 1970 and the mid-1980s. There was a statistically significant fourfold increase during the late-1980s and early 1990s compared with the state, but the rate began to decline in 1994 and 1995.

The higher-than-expected number of thyroid cancer cases could not be explained by changes in diagnosis of thyroid cancer among Los Alamos County residents. Additional analyses suggested that increased medical surveillance and greater access to medical care were responsible for the recent excess in Los Alamos County.

Potential risk factors for thyroid cancer including therapeutic irradiation, genetic susceptibility, occupational radiation exposure, and weight were also examined. However, the investigation did not identify a specific cause for the elevated rate of thyroid cancer in Los Alamos County.

Male Workers

A mortality study of 224 white males with the highest internal depositions of plutonium-239 (10 nanocuries [nCi] or more) at Los Alamos Site were examined by Voelz et al. (DOE 1996c). Followup was through April 1980. SMRs were low for all cause of death (SMR: 0.56, 95 percent; Confidence Interval [CI]: 0.40-0.75), all malignant neoplasms (SMR: 0.54, 95 percent; CI: 0.23-1.06), compared with U.S. white males and lung cancer (SMR: 20, 95 percent; CI: 0-110).

A cohort mortality study by Wiggs et al. examined the causes of death among 15,727 white males hired at LANL between 1943 and 1977 (HP 1994). The purpose of the study was to determine if plutonium deposition and external ionizing radiation were related to worker mortality. After nearly 30 years of followup, the LANL workforce experienced 37 percent fewer deaths from all causes, and 36 percent fewer deaths due to cancer than expected when compared with death rates for the U.S. population.

The researchers identified a subset of 3,775 workers who had been monitored for plutonium exposure; of these, 303 workers were categorized as “exposed” based on a urine bioassay for plutonium; the remainder were non-exposed. One case of rare bone cancer, osteogenic sarcoma, a type of cancer related to plutonium exposure in animal studies, was noted among the plutonium exposed group. The overall mortality and site-specific rates of cancer did not differ significantly between the two groups of workers. A nonstatistically significant increase in lung cancer among the exposed group was noted, but there was no information on cigarette use among the workers.

When researchers examined data for the 10,182 workers who were monitored for exposure to external ionizing radiation (including 245 workers exposed to plutonium) they observed a dose-response relationship for cancers of the brain/central nervous system, cancer of the esophagus, and Hodgkin's disease. When the 225 plutonium-exposed workers were excluded from the analysis, there was a statistically significant dose response between external ionizing radiation and kidney cancer and lymphocytic leukemia.

A special lifetime medical study was conducted on 26 of the workers who have the largest internal depositions of plutonium at LANL. Voelz and Lawrence reported on the 42-year followup of the 26 white males who designed and built the first atomic bomb and were determined to have had a significant deposition of plutonium-239 sometime in 1944 or 1945 based on job assignment, working conditions, and urine levels of plutonium (HP 1991). Their mortality experience was compared to U.S. white males adjusted for age and calendar time. The mortality rates were also compared with rates for a cohort of LANL workers hired at the same time and born between the same years; no significant differences were for all cause mortality and all cancer mortality. One of the seven reported deaths was due to bone sarcoma, the most frequent radiation-induced cancer observed in persons with radium depositions.

Wiggs reported on 6,970 women employed at LANL for at least 6 months from 1943-1979, with deaths determined through 1981 (DOE 1996c). The mortality rates for all causes of death combined and all cancers combined were 24 and 22 percent below the rate for the U.S. population, respectively. Although the overall rates are low, women occupationally exposed to ionizing radiation have elevated rates for cancer of the ovary and of the pancreas relative to those not exposed. An unusual finding was that female radiation workers experienced a statistically significant excess of death from suicide. In a special in-depth study, the suicides were compared to two control groups, deaths from other injuries, and deaths from non-injuries. History of employment as a radiation worker was significantly associated with death from suicide for both comparison groups. No significant associations for duration of employment, plutonium exposure, or martial status were seen (DOE 1996c).

As result of a reported threefold excess of malignant melanoma among laboratory workers at Lawrence Livermore National Laboratory (LLNL) in California and similarities between occupational exposures and prevailing sunshine conditions at LANL and LLNL, an investigation was undertaken to assess the risk of melanoma at LANL (Lancet 1981). Incidence data were obtained from the New Mexico Tumor Registry. No excess risk for melanoma was detected at LANL among 11,308 laboratory workers between 1969 and 1978. Six cases were identified where about 5.7 were expected (Lancet 1982). The rate for the total cohort, Hispanic males and females, non-Hispanic males and females were not significantly different from the corresponding New Mexico rates.

A special in-depth study of 15 cases diagnosed through 1982 did not detect an association between melanoma and exposure to any type of external radiation as measured by film badges, neutron exposures, plutonium body burden based on urine samples, or employment as a chemist or physicist (HP 1983). However, the workers with melanoma were more educated than the comparison group using the college and graduate degree as a measure of education, a finding consistent with other reports of malignant melanoma according to the authors. The numbers in this study are too small to detect any but large excesses.

Memorandum of Understanding

DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for managing or conducting the worker studies. The following multi-site studies that include LANL are currently underway: a study of mortality among female nuclear weapons workers, a case-control study of multiple myeloma, a leukemia study, and an exposure assessment of hazardous waste/cleanup workers.

B.3.3 Nevada Test Site

Surrounding Communities

Aboveground testing of nuclear weapons at Nevada Test Site (NTS) Test Range Complex in southern Nevada between 1951 and 1963 resulted in the dissemination of radioactive fallout over southeastern Nevada and southwestern Utah through wind dispersion. Several epidemiologic studies have been conducted to investigate possible adverse health effects of low-level radioactive fallout on residents of these states. These studies focused on leukemia and thyroid disease in children downwind of NTS.

A series of ecologic studies showed equivocal results in potentially exposed children. A cross-sectional review of thyroid nodularity among teenage children reported by Weiss et al. found no significant difference in the frequency of nodules among potentially exposed and non-exposed children (DOE 1996c). Exposure was defined in terms of county of residence. Rallison et al. reported no significant difference in any type of thyroid disease between Utah children exposed to fallout radiation in the 1950s and control groups drawn from Utah and Arizona (AJM 1974; JAMA 1975).

To investigate the possible relationship between childhood leukemia and radioactive fallout, Lyon et al. conducted a mortality study of Utah children under 15 years old who died in Utah between 1944 and 1975 (NEJM 1979). Lyon et al. selected this age group because of the reported increased susceptibility of children to the neoplastic effects of radiation and the lack of a comparison group over 14 years of age with suitable low exposures. Lyon et al. obtained death certificates from the Utah vital statistics registrar and based on year of death, categorized decedents into either high (fallout years) or low exposure periods (combined pre-fallout years and post-fallout years). From estimated fallout patterns contained in maps of 26 tests, Lyon et al. categorized 17 southern rural counties as high fallout area and the remaining northern urban counties as low fallout area. Age-specific mortality rates derived for deaths which occurred in the combined low exposure periods were compared with those in the high exposure period. For reasons unknown, leukemia mortality during the low exposure periods in high fallout counties was half that of the United States and Utah. A significant excess of leukemia occurred among children statewide who died during the high fallout period compared to those who died during the low fallout periods (SMR: 1.40, 95 percent; CI: 1.08-1.82, $p<0.01$). This excess was more pronounced among those who resided in the high fallout area (SMR: 2.44, 95 percent; CI: 1.18-5.03). No pattern was found for other childhood cancers in relation to fallout exposure. Actual radiation dosage was not available, and the effects of migration were not determined for this study.

Beck and Krey (Science 1983) reconstructed exposure of Utah residents studied by Lyon et al. (NEJM 1979) to external gamma-radiation from NTS fallout through measurements of residual cesium-137 and plutonium in soil. Beck and Krey found that residents in southwest Utah closest to NTS received the highest exposures, but noted that residents of urban northern areas received a higher mean dose and a significantly greater population dose than did residents of most counties closer to the test site. Northern Utah residents received higher average bone doses than southern Utah residents; therefore, distance from NTS should not be the sole criteria for dividing the state into geographic subgroups for the purpose of conducting epidemiologic studies. Beck and Krey concluded that bone doses to southern Utah residents were too low to account for the excess leukemia deaths identified by Lyon et al. They also determined that bone and whole body doses from NTS fallout were small relative to lifetime doses most Utah residents receive from background radiation, and that it was unlikely that these exposures would have resulted in any observed health effects.

Land et al. (Science 1984) attempted to confirm the association between leukemia and fallout reported by Lyon et al. (NEJM 1979) using cancer mortality data from the National Center for Health Statistics for the period 1950 through 1978. No statistically significant differences in mortality from leukemia or other childhood malignancies between northern and southern Utah were observed. The small observed difference in leukemia mortality between the border and interior counties was opposite in direction to that reported by Lyon et al. Results indicated a downward trend in childhood leukemia mortality over time. Eastern Oregon and the State of Iowa also were selected for comparison with Utah. The leukemia mortality rate for eastern Oregon was higher, and Iowa lower than the rate for Utah. Although both were not statistically significant, Land et al. concluded that these results suggest that the association reported by Lyon et al. merely reflects an unexplained low leukemia rate in southern Utah for the period 1944-1949.

Another study that assessed the development of cancer among individuals potentially exposed to radioactive fallout has been reported by Rallison et al. (HP 1990). This study examined the thyroid neoplasia risk in a cohort of children born between 1947-1954 in two counties near nuclear test sites, one in Utah and one in Nevada. A comparison group of Arizona children presumed to have no fallout exposures was also evaluated. The children (11-18 years of age) were examined between 1965-1968 for thyroid abnormalities and were re-examined in 1985 and 1986. Children living in the nuclear testing (Utah/Nevada) area had a higher rate of thyroid neoplasia than the comparison children (in Arizona), but the differences were not statistically significant. The authors concluded that living near NTS in the 1950s has not resulted in a statistically significant increase in thyroid neoplasms.

A study by Johnson examined cancer incidence in a cohort of Mormon families in southwest Utah near the NTS (JAMA 1984b). The study compared cancer incidence among all Utah Mormons during the period 1967-1975 with cancer incidence among two exposed populations: persons residing in a high fallout area and an exposure effects group residing in a broader area that received less intense exposure from radioactive fallout. Limitations of the study include: the inability to locate 40 percent of the defined population, the lack of verifying the reported diagnosis of cancer, and the inability to interview a comparable control group.

Cancer incidence for both exposed groups was compared with that of all Utah Mormons for two timeframes, 1958-1966 and 1972-1980. Johnson found an apparent increased incidence of leukemia and cancers of the thyroid and bone for residents of the high fallout area for both time periods. Additional analyses suggested that a higher proportion of the cancers among exposed groups were in radiosensitive tissues and the proportional excess increased with time compared with all Utah Mormons. The ratio of radiosensitive cancers to all other cancers from 1958-1966 was 24 percent higher among the high fallout area group and 29.6 percent higher among those in the fallout effects group. For 1972-80, the ratio was 53.3 percent higher in the high fallout area group and 300 percent higher in the fallout effects group.

Machado examined cancer mortality rates of a three-county region in southwestern Utah in comparison to the remainder of Utah (AJE 1987). There was no excess risk of cancer mortality in southwest Utah, with the exception of leukemia, which showed a statistically significant excess for all ages combined, and for children age 0-14. In fact, mortality from all cancer sites combined was lower in southwest Utah than the remainder of the state. The authors noted that their findings, including those for leukemia, were inconsistent with the cancer incidence study conducted by Johnson (JAMA 1984b).

Archer measured soil, milk, and bone strontium-90 levels to identify states with high-, intermediate-, and low-fallout contamination (AEH 1987). He then correlated the deaths from radiogenic and nonradiogenic leukemias with the time periods of aboveground nuclear testing both in the United States and Asia. The results show that leukemia deaths in children were higher in states with high exposure and lower in states with less exposure. He showed that leukemia deaths in children peaked approximately 5.5 years following nuclear testing peaks. The last leukemia peak in the United States occurred from 1968-1969, 5½ years after the last year of a 3-year period of intensive testing in Asia. The increases were seen in the radiogenic leukemias (myeloid and acute leukemias), and not with all other leukemias.

Kerber et al. updated a previously identified cohort of children living in portions of Utah, Nevada, and Arizona to estimate individual radiation doses and determine thyroid disease status through 1985-1986 (JAMA 1993). Of the 4,818 children originally examined between 1965-70, 2,473 were included in the followup exam. Outcomes of interest included thyroid cancers, neoplasms, and nodules based on physical examinations of the thyroid. Exposure of the thyroid to radioiodines was based on radionuclide deposition rates provided by DOE and surveys of milk producers. Children with questionable findings were referred to a panel of endocrinologists for further examination. The authors reported an excess number of thyroid neoplasms (combined benign and malignant) and a positive dose-response trend for neoplasms, both of which were statistically significant. The authors also reported a positive dose-response trend for thyroid nodules, not statistically significant, and a positive dose-response trend for thyroid carcinomas with marginal statistical significance. The authors estimated that an excess of between 1-12 neoplasms (between 0-6 excess malignancies) was probably caused by exposure to radioiodines from the nuclear weapons testing. A letter to the editor criticized Kerber et al. for relying on food histories obtained 22 years after the fact to depict radioiodine intake, and for the untested modeling approach for determining dose to the thyroid (JAMA 1994a). These concerns were addressed by Kerber et al., which acknowledged the uncertainties in the dose estimates, but concluded that their estimates were conservative (JAMA 1994b).

Till et al. estimated doses to the thyroid of 3,545 subjects who were exposed to radioiodine fallout from NTS (HP 1995). The U.S. Public Health Service first examined this cohort for thyroid disease between 1965-1970 and later in 1985-1986. Till et al. assigned individual doses based on age, residence histories, dietary histories, and lifestyle. Individualized dose and uncertainty was combined with the results of clinical examinations to determine the relationship between dose from NTS fallout and thyroid disease incidence.

Workers

Military personnel and civilian employees of the Department of Defense observed and participated in maneuvers at the NTS during atmospheric tests. An excess number of leukemia cases was reported (9 cases, 3.5 expected) among the 3,224 men who participated in military maneuvers in August 1957 at the time of the nuclear test explosion “Smoky” (JAMA 1980). The participants were located and queried on their health status, diseases, or hospitalizations as of December 1981. Various Federal records systems were linked, including clinical files, and next of kin were queried about cause of death for those participants who were deceased. Exposure information was available from film badges records, and the mean gamma dose for the entire cohort was 466.2 mrem. In a later report of the same cohort, the number of incident cases of leukemia had increased to 10 with 4 expected (JAMA 1983). No excess in “total cancers” was observed; however, four cases of polycythemia vera were reported where 0.2 were expected (JAMA 1984a). The excess in leukemia cancer incidence and mortality appear to be limited to the soldiers who participated in "Smoky."

The leukemia excess was not observed in a National Research Council mortality study of soldiers exposed to five series of tests at two sites: Nevada Test Site and the Pacific Proving Ground (DOE 1996c). The National Research Council reported that the number of leukemia cases in "Smoky" was greater, but the increase was considered nonsignificant when analyzed with the data from the other four tests. In 1989, however, it was discovered that the roster of the atomic veterans cohort on which the National Research Council based its 1985 study contained misclassification errors. As a result, this study was reanalyzed. In 1997, the Secretary of the Department of Health and Human Services (DHHS) asked the Institute of Medicine (IOM) and the National Research Council to undertake an independent assessment of the public health and medical implications of the estimated iodine-131 doses received by the American people from atmospheric testing and to advise the Department on steps that might be taken in response. Two committees were appointed to perform the assessment. Their results were published in 1999 in *Exposure of the American People to Iodine-131 from Nevada Nuclear-Bomb Tests: Review of the National Cancer Institute Report and Public Health Implications* (NAP 1999). The report's conclusions include:

- The estimate of the American people's collective dose from iodine-131 is consistent with the committee's analysis and is unlikely to greatly over- or understate the actual levels.

- The levels of detail presented in the report, specifically, county-specific estimates of iodine-131 thyroid doses, are probably too uncertain to be used in estimating individual exposure. For the most part, direct measures of fallout for any particular weapons test were made for only about 100 places nationwide (except near NTS itself). Estimates of county-specific exposures may also have little relevance to specific individuals for whom exposure depends on such critical factors as varying individual consumption of milk and other foods and variations in the source of those foods.

- Individual-specific estimates of past exposure to iodine-131 from the Nevada tests are possible but uncertain, often highly so, because critical data are often not available or of questionable reliability. A small minority of the population—those who were young children at the time of testing and who routinely drank milk from backyard cows or, especially, goats—had a significant exposure to iodine-131.

- Exposure to iodine-131 as a byproduct of nuclear reactions can cause thyroid cancer as shown conclusively by the 1986 nuclear accident in Chernobyl, which resulted in high level exposure for many people. The NCI dose reconstruction model indicates that the level of exposure to iodine-131 was sufficient to cause and continue to cause excess cases of thyroid cancer. Because of uncertainty about the doses and the estimates of cancer risk, the number of excess cases of thyroid cancer is impossible to predict except within a wide range.

- Epidemiological analyses of past thyroid cancer incidence and mortality rates provide little evidence of widespread increases in thyroid cancer risk related to the pattern of exposure to iodine-131 described in the NCI report. They suggest that any increase in the number of thyroid cancer cases is likely to be in the lower part of the ranges estimated by NCI. The epidemiologic analyses are, however, subject to many limitations and uncertainties.

- Given the uncertainties in both the dose reconstruction model and the epidemiological analyses, further epidemiologic studies will be necessary to clarify the extent to which Nevada tests increased the incidence of thyroid cancer. Pending these studies, it is prudent for DHHS to plan its responses as if excess cases of thyroid cancer have occurred.

- The type of thyroid cancer, papillary carcinoma, usually linked to radiation exposure is uncommon and rarely life threatening. Even among those with exposure to iodine-131, few will develop thyroid problems.

As a result of this assessment, the committee suggested that DHHS consider additional research in several areas. These areas include (1) the relative effectiveness of external radiation versus internal radiation in producing thyroid cancer; (2) the relative malignancy of radiation-related versus spontaneous thyroid neoplasms; (3) the role of genetic events in the development of thyroid cancer, in particular, the role of ret/PTC oncogene as it may affect the nature of the dose-response relationship for thyroid cancer; (4) people's perceptions of the benefits and risks of screening for thyroid and other cancers and the factors affecting such perceptions including the way quantitative information is presented; and (5) the effectiveness of existing programs to communicate radiation risks (NAP 1999).

B.3.4 Pantex Site

Surrounding Communities

A June 1994 study by the Texas Cancer Registry, Texas Department of Health, showed significant increases in prostate cancer mortality among Potter County and Randall County males, and leukemia mortality among Carson County males during the period between 1981-1992 (DOE 1996c). There were no statistically significant increases observed in site-specific cancer mortality among females during this period. For cancer incidence during the period between 1986-1992, no statistically significant excesses in males were seen; however, cancer of the prostate was slightly elevated in Potter/Randall County males. Analysis of the four major cell-specific types of leukemia, showed a significant excess in the incidence of chronic lymphocytic leukemia among Potter/Randall County females. This study was conducted in Carson, Potter, and Randall Counties, which are located near the Pantex Plant (Pantex). This study focused only on cancers of the breast, prostate, brain, thyroid, and leukemia, which were of specific concern to citizens in the area. Other radiation-associated cancers, such as bone and lung, were not included in this study. Although prostate cancer and chronic lymphocytic leukemia have not been linked to radiation exposure, further followup to this study was recommended.

Workers

An epidemiologic study of Pantex workers was published by Acquavella (HP 1985). This study compared total and cause-specific mortality for Pantex workers employed between 1951 and December 31, 1978, with expected cause-specific mortalities based on U.S. death rates. Significantly fewer deaths were observed in the workforce than would be expected based on U.S.

death rates for the following causes of death: all cancers, arteriosclerotic heart disease, and digestive diseases. No specific causes of death occurred significantly more frequently than expected. Slightly elevated mortality ratios were observed for brain cancer and leukemia; neither excess was statistically significant. The four deaths from brain cancer all occurred among those who had worked at the plant less than 5 years. The four deaths from leukemia occurred with equal frequency among those who had worked at the plant a short time and those who had worked more than 15 years.

Memorandum of Understanding

A followup of the 1985 mortality study of the Pantex workforce has been performed. The 1985 study of Pantex workers was limited by the small number of deaths and short followup, although the risk of several cancers was elevated. National Institute of Occupational Safety and Health performed an intramural study that updated vital status through 1995. An SMR analysis with examination of dose-response was conducted; however, it was not possible to update exposure information for the cohort (duration of employment was used as a surrogate for dose). A decision to return to the facility to conduct an updated analysis is pending. To date, study results have not been released pending communication to workers. As an operating facility that has not been downsized, Pantex will encounter similar exposures to both current and future workers.

Epidemiologic Surveillance

DOE's Office of Epidemiologic Studies Epidemiologic Surveillance Program was implemented at Pantex in 1993 in order to monitor the health of current workers. This program evaluates the occurrence of illness and injury in the workforce on a continuing basis and issues the results of the ongoing surveillance in annual reports. The program facilitates an ongoing assessment of the health and safety of the site's workforce and helps to identify any emerging health issues in a timely manner. Monthly data collection began on January 1, 1994, and the results of the first complete year of epidemiologic surveillance were presented to workers and other site stakeholder groups in spring 1996. The most recent annual report available for review if for the 2001 calendar year.

Currently operational at a number of DOE sites, including production sites and research and development laboratories, epidemiologic surveillance makes use of routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate areas in need of more detailed study or increased health and safety measures to ensure adequate protection for workers.

Epidemiologic surveillance monitors all illnesses and injuries among active workers because it is not always possible to determine which health effects are due to occupational exposures and which are due to other causes. Most illness and injury diagnoses were reported to the occupational medicine clinic by workers who required return-to-work clearances. An absence due to illness or injury may involve more than one diagnosis, and epidemiologic surveillance includes all reported diagnoses. In addition, the OSHA 200 Log provides information on recorded occupational injuries and illnesses whether or not they involve absences. number of days lost. The report organizes illness and injury categories based on a standard reference, the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM). This reference is used to classify health events for statistical purposes.

Cancer rates presented in this report are based on reported absences during the year. A worker may experience several periods of absence from one cancer diagnosis due to medical complications or treatment regimens. The likelihood that an individual in the United States develops cancer increases with age. Pantex data tend to reflect this observation among men. Nine men reported 11 absences due to cancer. Four men reported skin cancer, three reported prostate cancer, and one reported thyroid cancer. One man reported cancer of the pancreas that spread to the liver. Among the seven women reporting cancer, only two were over 50 years old. Thirteen absences for cancer were reported. Four women had only one absence, and three women accounted for nine absences. Six women had cancer of only one type: larynx, thyroid, colon, cervix, breast, and Hodgkin's lymphoma. The other woman had malignant melanoma that spread to the lymph nodes. The women with cancer of the colon and Hodgkin's lymphoma reported these same cancers in previous years. None of the other workers who reported cancer in 2001 had reported it previously.

A sentinel health event for occupation (SHEO) is a disease, disability, or death that is likely to be occupationally related. Its occurrence may serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required to reduce the risk of injury or illness among the work force. Sixty-four medical conditions associated with workplace exposures from studies of many different industries have been identified as sentinel health events. Although sentinel health events may indicate an occupational exposure, many may result from non-occupational exposures. Due to this uncertainty, sentinel health events are assessed in two categories:

Definite Sentinel Health Events—Diseases that are unlikely to occur in the absence of an occupational exposure. Asbestosis, a lung disease resulting from exposure to asbestos, is an example.

Possible Sentinel Health Events—Conditions such as lung cancer or carpal tunnel syndrome may or may not be related to occupation. Detailed occupational and nonoccupational information is required to determine the work-relatedness of the illness. For example, lung cancer may result from asbestos exposure or smoking. Carpal tunnel syndrome may result from a job requiring typing or from a hobby such as playing the piano.

Ten definite sentinel health diagnoses were identified among Pantex workers in 2001. Three workers reported five diagnoses of chronic beryllium disease. The five other diagnoses, reported by three workers, were identified as occupational injuries. One worker reported two absences resulting from a torn rotator cuff of the right shoulder. The other two workers each reported one absence for a knee injury and a fractured ankle with nerve damage. The 9 definite SHEO events accounted for 391 calendar days absent from work. Fifteen of 1,544 diagnoses (1 percent) were identified as possible sentinel health events. Ten of the possible sentinel health diagnoses were identified as carpal tunnel syndrome, reported by 8 workers (4 women and 4 men), and resulting in 175 lost calendar days. All these employees were aged 40 and older. Four of the workers were in the Office Management and Administration job category, two were in the Technical Support group, and two were Craft and Repair workers.

During 2001, four deaths occurred among Pantex workers. The two men and one woman were over 50 years old. The other woman was 40-49 years old. Each of the workers was in a different job category. The deaths were due to cancers of the colon and pancreas, respiratory failure, and a motor vehicle accident (Pantex 2001a).

Additionally, female workers at Pantex were included in a National Institute for Occupational Safety and Health funded multisite study of mortality among female nuclear weapons workers. A total of 67,976 women who worked at any of the following 12 Department of Energy sites before January 1, 1980: Oak Ridge (X-10, Y-12, K-25), Los Alamos National Laboratory, the Zia Company, Rocky Flats, Hanford, Mound, Savannah River, Fernald, Pantex, and Linde (closed in 1949).

The study examined the occurrence of deaths among female nuclear weapons workers who worked at any of the 12 sites included in the study. The number of deaths that occurred among these workers was compared with the number of deaths expected to occur based on the mortality experience of the United States female population. The study also attempted to determine if there is a relationship between exposure to ionizing radiation and deaths due to certain diseases. The study report and findings were externally peer reviewed.

For most causes of death, including cancers related to ionizing radiation, fewer female workers died than would be expected based on the U.S. female population. For the entire study population, researchers expected 18,106 deaths from the start of operations through 1993, but found only 13,671 deaths. At all of the sites, the number of deaths were either similar to or lower than expected. These findings are not unusual for worker populations.

A strong healthy worker effect, similar to that observed among male nuclear weapons workers is observed for the entire pooled cohort of female nuclear weapons workers, and for all of the individual subcohorts with the exception of Linde workers. Increased mortality from mental disorders (SMR=147, certain genito-urinary system diseases (SMR =129), as well as symptoms and ill-defined conditions (SMR=163) is found compared with deaths expected based on U.S. death rates. For most causes of death, mortality among female nuclear workers is lower than expected. The healthy worker effect is observed among workers who were badged and among those who were not badged for external radiation exposures. The SMR (observed/expected x 100) for all causes of death combined is 78 for unbadged and 69 for badged workers. Mortality is elevated among both badged and unbadged women for mental disorders. Increased mortality is experienced among unmonitored employees for deaths from symptoms and ill defined conditions, diseases of the genito-urinary system and for homicide. Among badged workers, deaths from ill-defined conditions does not differ from that expected, and is less than expected for diseases of the genito-urinary system and homicide.

The healthy worker effect is also observed in analyses that compare survival time among badged and unbadged workers. For instance, when we assess whether the hazard differs among workers who were issued a radiation badge compared with workers who were not issued a badge, an increased relative risk estimate is observed for all causes of death among women who were not monitored (RR=1.25). This relative risk estimate was slightly lower for deaths from all cancers (RR=1.17). The relative risk for unbadged women who were not monitored is also elevated for lung cancer deaths (RR=1.49).

For the entire pooled cohort, the relative risk of death from leukemia increases with increasing cumulative dose of external radiation (relative risk [RR]/rem = 1.13, 95 percent; CI=1.02- 1.25). Suggestive increases are observed for all cancers (RR/rem = 1.03, 95 percent; CI=0.99- 1.06), breast cancer (RR/rem = 1.05, 95 percent; CI=0.99-1.12), and for hematologic cancers (RR/rem = 1.08, 95 percent; CI=0.99-1.17) (Wilkinson et al. 2000).

B.3.5 Savannah River Site

SRS, established in 1953 in Aiken, South Carolina, produces plutonium, tritium, and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in surface and groundwater streams (DOE 1996c).

Surrounding Communities

In 1984, Sauer and Associates examined mortality rates in Georgia and South Carolina by distance from the Savannah River Plant (now known as SRS) (DOE 1996c). Rates for areas near the plant were compared with U.S. rates and with rates for counties located more than 80 km (50 mi) away. Breast cancer, respiratory cancer, leukemia, thyroid cancer, bone cancer, malignant melanoma of the skin, nonrespiratory cancer, congenital anomalies or birth defects, early infancy death rates, stroke, or cardiovascular disease in the populations living within 80 km (50 mi) of the Plant did not show any excess risk compared with the reference populations.

State Health Agreement Program

Under the State Health Agreement Program managed by DOE's Office of Epidemiologic Studies, a grant was awarded to the Medical University of South Carolina in 1991 to develop the Savannah River Region Health Information System. The purpose of the Savannah River Region Health Information System database was to assess the health of populations surrounding SRS by tracking cancer rates and birth defects rates in the area. Information from the registry is available to public and private health care providers for use in evaluating cancer control efforts. A steering committee provides advice to the Savannah River Region Health Information System and communicates public concerns to the System. It consists of 12 community members and persons with technical expertise representing South Carolina and Georgia. The meetings are open to the public.

Workers

A descriptive mortality study was conducted that included 9,860 white male workers who had been employed at least 90 days at the Savannah River Plant between 1952 and the end of 1974 (DOE 1996c). Vital status was followed through the end of 1980 and mortality was compared with the U.S. population. SMRs were computed separately for hourly and salaried employees. For hourly employees, nonstatistically significant increases were seen for cancer of the rectum (SMR: 1.09, 5 observed), cancer of the pancreas (SMR: 1.08, 10 observed), leukemia and aleukemia (SMR: 1.63, 13 observed), other lymphatic tissue (SMR: 1.06, 5 observed), benign neoplasms (SMR: 1.33, 4 observed), and motor vehicle accidents (SMR: 1.10, 63 observed). Salaried employees exhibited nonstatistically significant increases in cancer of the liver (SMR: 1.84, 3 observed), cancer of the prostate (SMR: 1.35, 5 observed), cancer of the bladder (SMR: 1.87, 4 observed), brain cancer (SMR: 1.06, 4 observed), leukemia and aleukemia (SMR: 1.05, 4 observed), and other lymphatic tissue (SMR: 1.23, 3 observed). No trends between increasing duration of employment and SMRs were observed. A statistically significant excess of leukemia deaths was observed for hourly workers employed at least 5, but less than 15 years (SMR: 2.75, 6 observed). Review of the plant records and job duties of the workers who died from leukemia indicated that two of the cases had potential routine exposure to solvents, four had potential occasional exposure to solvents, and one had potential for minimal exposure. Benzene, a known carcinogen, was reportedly not used at the plant.

Epidemiologic Studies

DOE's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at SRS to monitor the health of current workers. This program evaluates the occurrence of illness and injury in the workforce on a continuing basis, and the results will be issued in annual reports. The implementation of this program facilitates an ongoing assessment of the health and safety of the SRS workforce and will help identify emerging health issues.

Epidemiologic Surveillance has been conducted at SRS since 1994, and as a pilot project from 1992. The most current available annual report provides a summary of epidemiologic surveillance data collected from SRS from January 1, 2000, through December 31, 2000. The data were collected and submitted to the Epidemiologic Surveillance Data Center located at Oak Ridge Institute for Science and Education, where quality control procedures and preliminary data analyses were carried out. The analyses were interpreted and the final report prepared by the DOE Office of Health Programs. In addition, many factors can affect the completeness and accuracy of health information reported at the sites, thereby affecting the observed patterns of illness and injury.

Currently operational at a number of DOE sites, including production sites and research and development laboratories, epidemiologic surveillance makes use of routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and Occupational Safety and Health Administration (OSHA)-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate areas in need of more detailed study or increased health and safety measures to ensure adequate protection for workers.

Epidemiologic surveillance monitors all illnesses and injuries among active workers because it is not always possible to determine which health effects are due to occupational exposures and which are due to other causes. Most illness and injury diagnoses were reported to the occupational medicine clinic by workers who required return-to-work clearances. An absence due to illness or injury may involve more than one diagnosis, and epidemiologic surveillance includes all reported diagnoses. In addition, the OSHA 200 Log provides information on recorded occupational injuries and illnesses whether or not they involve absences. The report organizes illness and injury categories based on a standard reference, ICD-9-CM. This reference is used to classify health events for statistical purposes.

Cancer rates presented in this report are based on reported absences during the year. A worker may experience several periods of absence from one cancer diagnosis due to medical complications or treatment regimens. The likelihood that an individual in the United States develops cancer increases with age. SRS data reflect this observation, with higher rates noted among men and women aged 50 or older. Forty-two 5-day absences related to cancer were reported, 24 diagnoses among 19 men and 18 diagnoses among 15 women. One woman who reported cancer in 2000 reported the same cancer in 1998. No apparent relationship was noted between any specific type of cancer and a particular job category.

No consistent relationship between injuries (including non-occupational injuries) and age was seen among men or women. The highest injury rates were among women in the Nuclear Specialties/Power Operator group and among men in the Technical Support group. Compared with other job categories, Technical Support workers were 40 percent more likely to report an injury. These workers had the same increased risk of injury in 1999.

A SHEO is a disease, disability, or death that is likely to be occupationally related. Its occurrence may serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required to reduce the risk of injury or illness among the work force. Sixty-four medical conditions associated with workplace exposures from studies of many different industries have been identified as sentinel health events. Although sentinel health events may indicate an occupational exposure, many may result from non-occupational exposures. Due to this uncertainty, sentinel health events are assessed in two categories:

Definite Sentinel Health Events—Diseases that are an unlikely to occur in the absence of an occupational exposure. Asbestosis, a lung disease resulting from exposure to asbestos, is an example.

Possible Sentinel Health Events—Conditions such as lung cancer or carpal tunnel syndrome may or may not be related to occupation. Detailed occupational and non-occupational information is required to determine the work-relatedness of the illness. For example, lung cancer may result from asbestos exposure or smoking. Carpal tunnel syndrome may result from a job requiring typing or from a hobby such as playing the piano.

Twelve definite sentinel health diagnoses reported by four men and two women were identified in 2000. Diagnoses included three sprains and strains (shoulder and upper arm and neck), two open wounds (head and finger), two fainting episodes, and one each for back disorder, bruise of the chest wall, inguinal hernia, seizure disorder, and genito-urinary condition. The causes of these events included falls, overexertion and strenuous movements, being struck by an object, and being cut by a powered hand tool. Twenty-seven of 3,361 (1 percent) diagnoses were identified as possible sentinel health events. Twenty of the 27 diagnoses were carpal tunnel syndrome, reported by 19 workers and resulting in 366 lost calendar days. Ten of the workers reporting carpal tunnel syndrome worked in the Technical Support group. All the workers with this diagnosis were aged 40 or older.

Sixteen deaths occurred among SRS workers in 2000. The causes of death included five cancers (lung, stomach, breast, brain, and multiple myeloma); three injuries (one aircraft accident, one motor vehicle accident, and one self-inflicted gunshot wound); two heart attacks; and one each for heart/circulatory disorder, brain damage, viral infection, psychological disorder, and digestive (liver) condition. The cause of one death was not known. The variety of causes of death did not indicate a pattern among these workers (SRS 2000).

Additionally, female workers at SRS were included in a National Institute for Occupational Safety and Health funded multisite study of mortality among female nuclear weapons workers. A total of 67,976 women who worked at any of the following 12 DOE sites before January 1, 1980: Oak Ridge (X-10, Y-12, K-25), LANL, the Zia Company, Rocky Flats, Hanford, Mound, SRS, Fernald, Pantex, and Linde (closed in 1949).

The study examined the occurrence of deaths among female nuclear weapons workers who worked at any of the 12 sites included in the study. The number of deaths that occurred among these workers was compared with the number of deaths expected to occur based on the mortality experience of the United States female population. The study also attempted to determine if there is a relationship between exposure to ionizing radiation and deaths due to certain diseases. The study report and findings were externally peer reviewed.

For most causes of death, including cancers related to ionizing radiation, fewer female workers died than would be expected based on the U.S. female population. For the entire study population, researchers expected 18,106 deaths from the start of operations through 1993, but found only 13,671 deaths. At all of the sites, the number of deaths were either similar to or lower than expected. These findings are not unusual for worker populations.

A strong healthy worker effect, similar to that observed among male nuclear weapons workers is observed for the entire pooled cohort of female nuclear weapons workers, and for all of the individual subcohorts with the exception of Linde workers. Increased mortality from mental disorders (SMR=147), certain genito-urinary system diseases (SMR=129), as well as symptoms and ill-defined conditions (SMR=163) is found compared with deaths expected based on U.S. death rates. For most causes of death, mortality among female nuclear workers is lower than expected. The healthy worker effect is observed among workers who were badged and among those who were not badged for external radiation exposures. The SMR (observed/expected x 100) for all causes of death combined is 78 for unbadged and 69 for badged workers. Mortality is elevated among both badged and unbadged women for mental disorders. Increased mortality is experienced among unmonitored employees for deaths from symptoms and ill-defined conditions, diseases of the genito-urinary system and for homicide. Among badged workers, deaths from ill-defined conditions does not differ from that expected, and is less than expected for diseases of the genito-urinary system and homicide.

The healthy worker effect is also observed in analyses that compare survival time among badged and unbadged workers. For instance, when we assess whether the hazard differs among workers who were issued a radiation badge compared with workers who were not issued a badge, an increased relative risk estimate is observed for all causes of death among women who were not monitored (RR=1.25). This relative risk estimate was slightly lower for deaths from all cancers (RR=1.17). The relative risk for unbadged women who were not monitored is also elevated for lung cancer deaths (RR=1.49).

For the entire pooled cohort, the relative risk of death from leukemia increases with increasing cumulative dose of external radiation (RR/rem = 1.13, 95 percent; CI=1.02- 1.25). Suggestive increases are observed for all cancers (RR/rem = 1.03, 95 percent; CI=0.99- 1.06), breast cancer (RR/rem = 1.05, 95 percent; CI=0.99-1.12), and for hematologic cancers (RR/rem = 1.08, 95 percent; CI=0.99-1.17). Among the individual subcohorts, increased relative risks from all cancers and from radiation sensitive cancers combined are observed for female workers at the SRS (Wilkinson et al. 2000).

Memorandum of Understanding

DOE entered into a Memorandum of Understanding with the DHHS to conduct health studies at DOE sites. The Centers for Disease Control and Prevention's National Center for Environmental Health is responsible for dose reconstruction studies and the National Institute for Occupational Safety and Health is responsible for worker studies. These activities are funded by DOE.

A study of mortality among SRS workers employed from 1952-1974 to examine whether risks of death due to selected causes may be related to occupational exposures at SRS is being conducted by the National Institute for Occupational Safety and Health. SRS is also included in several multi-site studies managed by the institute. The first study is to assess the potential association between paternal work-related exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers. The second study is to examine causes of death among female workers at nuclear weapons facilities to develop risk estimates based on exposures to external and internal ionizing radiation and to hazardous chemicals. A third multisite project is a case-control study of multiple myeloma, a type of blood cell cancer.

A dose reconstruction project around SRS is being conducted by the National Center for Environmental Health to determine the type and amount of contaminants to which people living around the site may have been exposed, to identify exposure pathways of concern, and to quantify the doses people may have received as a result of SRS operations. The study will attempt to determine if the health of people who lived near the Site was affected by past releases of chemicals and radioactive materials from the Site. The study is divided into several stages, which are completed in a phased approach:

- Review historical records (Phase I)
- Select key materials to be evaluated further (Phase I)
- Reconstruct historical releases of key radioactive materials and chemicals (Phase II)
- Develop detailed methods for calculating environmental concentrations
- Estimate doses and risks from exposure to contaminants in the environment.

The study's release estimates are snapshots of what was studied during Phase II of this project. During this Phase II study, details on reactor, reprocessing canyon, and tritium production were located, which will be used in future phases of the study to fill data gaps. Uncertainties in release estimates are also reported, which had not previously been calculated. Some general statements can be made about what has been found. One objective of the Phase II study was to find out if there was enough information in the SRS records to make estimates about the key materials released to the environment. For the key radioactive materials, the answer to this question is yes. The available information for radioactive materials is adequate to develop estimates of dose to individuals living offsite during past SRS operations. However, for the key chemicals, information before the 1980s is very sparse. Rough estimates of chemical releases from SRS operations have been made, and it may be feasible to develop general ranges of chemical risk estimates for offsite residents living near the Site in the past. The Center for Disease Control will carefully evaluate all of this information to carry out Phase III of the study. Another finding of the study is that there are some differences between the estimates of releases reported for this study and those reported by the Site. For the important radioactive materials, these differences are not large in most cases. However, the release estimates to air for iodine-131 reported for this study correct for a measurement problem found in the early records, and they are larger than the SRS-reported values. For similar reasons, plutonium release values to air reported for this study are about 4 times higher than reported SRS numbers during certain time periods. At this time a draft report of Phase II activities has been produced. Dose reconstruction activities based on the site release determinations have not been completed (SRS 1999).

B.3.6 Carlsbad Site

Waste Isolation Pilot Plant (WIPP) received its first shipment of waste on March 26, 1999. Epidemiological reports related to DOE activities are primarily sponsored or conducted in conjunction with NIOSH-CDC and/or DOE-ES&H Health Programs. Since WIPP operations began in 1999, insufficient time has elapsed to generate data appropriate for an epidemiological evaluation. To date, neither NIOSH nor DOE-ES&H Health Programs have issued epidemiological reports for the Carlsbad Site. However, there are two independent DOE-funded research organizations that are currently monitoring the WIPP site from an environmental and epidemiological perspective. Brief descriptions of each organization and their research follow.

Carlsbad Environmental Monitoring & Research Center

The Carlsbad Environmental Monitoring & Research Center (CEMRC) was created in 1991, as a division of the Waste-Management Education & Research Consortium (WERC), in the College of Engineering at New Mexico State University (NMSU). The CEMRC was established with a grant entitled "Carlsbad Environmental Monitoring and Research Program" (CEMRP) from DOE to NMSU (CEMRC 2003).

The primary goals of the CEMRP are to establish a permanent center to anticipate and respond to emerging health and environmental needs, and to develop and implement an independent health and environmental monitoring program in the vicinity of the WIPP and make the results easily accessible to all interested parties (CEMRC 2003).

The CEMRC is monitoring the local residents and studying the environment through a project entitled the "WIPP Environmental Monitoring Project" which includes monitoring of air, soil, surface water, sediments, drinking water, plants, animals, and the human population (CEMRC 2003).

Additionally, the CEMRC, as part of its internal dosimetry program, is conducting an in vivo radiobioassay research project entitled “Lie Down and Be Counted.” The “Lie Down and Be Counted”project serves as a component of the WIPP EM that directly addresses the general concern about personal exposure to contaminants shared by residents who live near many DOE sites. The objective of the research is to characterize and monitor for internally deposited radionuclides in the general population living around the WIPP. The sampling design included solicitation of volunteers from all segments of the community, with sample sizes sufficient to meet or exceed a 15 percent range margin of error for comparisons between major population ethnicity and gender categories as identified in the 1990 census. The minimum sample size threshold was achieved for the major categories early in 1998, and is as low as 8 percent margin of error range for some categories. The data collected prior to the opening of the WIPP facility (March 26, 1999) serve as a baseline for comparisons with periodic follow-up measurements that are slated to continue throughout the 35-year operational phase of the WIPP. Participants in the project are monitored every 2 years (CEMRC 2003).

The Table B.3.6–1 summarizes the number of lung and whole body counts performed at CEMRC since the in vivo bioassay facility was commissioned in August 1997 (CEMRC 2003).

Table B.3.6–1. Lung and Whole Body Count Totals as of June 1, 2001

Total number of individuals who have participated in the project	546
Total number of counts of LD&BC participants (includes recounts of some individuals)	677
Total number of lung and whole body counts performed at the Center since July 1997	1832

Source: CEMRC 2003.

Results

The most current results, published June 1, 2001, indicate that operational monitoring results for all radionuclides are consistent with the baseline results. Based on these data, there is no evidence of a change in the frequency of detection of internally deposited radionuclides for citizens living within the vicinity of WIPP, since WIPP began receipt of radioactive waste (CEMRC 2003).

Environmental Evaluation Group of New Mexico

The Environmental Evaluation Group of New Mexico (EEG) is an interdisciplinary group of scientists and engineers that provides independent technical evaluation of the WIPP to ensure the protection of public health and safety, and the environment of New Mexico. The EEG was established in 1978 through a contract between the State of New Mexico and DOE (EEG 2003). A 1981 Agreement for Consultation and Cooperation (C&C) between DOE and the State of New Mexico and the *WIPP Land Withdrawal Act*, PL 102-579, also established EEG as an oversight organization for the WIPP Project on behalf of the State of New Mexico. Then, in 1989, Public Law 100-456, the *National Defense Authorization Act*, Fiscal Year (FY) 1989, Section 1433, assigned EEG to the New Mexico Institute of Mining and Technology and continued the original DOE contract. Finally, the *National Defense Authorization Act* for FY 1994, Public Law 103-

160, and the *National Defense Authorization Act* for FY 2000, Public Law 106-65, continued the authorization for an additional five years (EEG 2003).

EEG began its Environmental Monitoring Program in 1984 under the terms of the July 1981 C&C Agreement and a December 1982 Supplemental Stipulated Agreement. Environmental data collected by EEG before the opening of the WIPP has provided a baseline of environmental radionuclide background concentrations. Now that the facility is receiving waste, analytical results obtained from the effluent air and effluent water are being used to evaluate WIPP's regulatory compliance. EEG's Environmental Monitoring Program independently measures radioactivity in the air, water, and soil at the WIPP and in surrounding communities. Samples are analyzed for Americium-241, Cesium-137, Plutonium-238, Plutonium-239+240, and Strontium-90 (EEG 2003).

These particular radionuclides account for more than 98 percent of the potential public radiation dose from WIPP operations. In the event of WIPP-related transportation accidents or releases from WIPP facility operations, contamination of communities surrounding the WIPP facility can be assessed (EEG 2003).

Results

The most current results of EEG’s Environmental Monitoring Program indicate that operations at the WIPP site during 2001 did not result in detectable releases of radionuclides to the environment. There “was no increase when compared with 1993-1998 baseline measurements and operational measurements taken during 2001” (EEG 2003).

B.4 DESCRIPTION OF THE CAP-88 COMPUTER CODE

Emission monitoring and compliance procedures for DOE facilities (40 CFR 61.93 [a]) require the use of CAP-88 (which stands for *Clean Air Act* Assessment Package-1988) or AIRDOS-PC computer models, or other approved procedures, to calculate effective dose equivalents to members of the public. The CAP-88 computer model is a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to air.

CAP88-PC provides the CAP-88 methodology for assessments of both collective populations and maximally exposed individuals. CAP88-PC differs from the dose assessment software AIRDOS-PC in that it estimates risk as well as dose, offers a wider selection of radionuclide and meteorological data, provides the capability for collective population assessments, and allows users greater freedom to alter values of environmental transport variables. CAP88-PC version 1.0 was approved for demonstrating compliance with 40 CFR 61.93 (a) in February 1992.

B.4.1 Model Summary

CAP88-PC uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six emitting sources. The sources may be either elevated stacks, such as a smokestack, or uniform area sources, such as a pile of uranium mill tailings. Plume rise can be calculated assuming either a momentum or buoyant-driven plume.

Assessments are done for a circular grid of distances and directions for a radius of up to 80 km (50 mi) around the facility. The Gaussian plume model produces results that agree with experimental data as well as any model, is fairly easy to work with, and is consistent with the random nature of turbulence.

Sample population files are supplied with CAP88-PC, which the user may modify to reflect their own population distributions. When performing population dose assessments, CAP88-PC uses the distances in the population array to determine the sector midpoint distances where the code calculates concentrations. CAP88-PC only uses circular grids; square grids are not an option.

Agricultural arrays of milk cattle, beef cattle, and agricultural crop area are generated automatically, requiring the user to supply only the state name or agricultural productivity values. When a population assessment is performed, the arrays are generated to match the distances used in the population arrays supplied to the code, and use state-specific or user-supplied agricultural productivity values. Users are given the option to override the default agricultural productivity values by entering the data directly on the Agricultural Data tab form.

Organs and weighting factors follow the ICRP 26/30 Effective Dose Equivalent calculations, which eliminates flexibility on specifying organs and weighting factors. The calculation of deposition velocity and the default scavenging coefficient is also modified to incorporate current EPA policy. Deposition velocity is set to 3.5×10^{-2} meters per second (m/s) for iodine, 1.8×10^{-3} m/s for particulates, and 0.0 m/s for gases. The default scavenging coefficient is calculated as a function of annual precipitation.

Seven organs are valid for the Effective Dose Equivalent as follows: gonads: 25 percent; breast: 15 percent; red bone marrow: 12 percent; lungs: 12 percent; thyroid: 3 percent; lung, thyroid, bone surfaces: 3 percent; and remainder: 30 percent.

B.4.2 Validation

The CAP88-PC programs represent one of the best available validated codes for the purpose of making comprehensive dose and risk assessments. The Gaussian plume model used in CAP88-PC to estimate dispersion of radionuclides in air is one of the most commonly used models in government guidebooks. It produces results that agree with experimental data as well as any model, is fairly easy to work with, and is consistent with the random nature of turbulence.

The EPA Office of Radiation and Indoor Air has made comparisons between the predictions of annual-average ground-level concentration to actual environmental measurements, and found very good agreement. In the paper “Comparison of AIRDOS-EPA Prediction of Ground-Level Airborne Radionuclide Concentrations to Measured Values,” environmental monitoring data at five DOE sites were compared to AIRDOS-EPA predictions. EPA concluded that as often as not, AIRDOS-EPA predictions are within a factor of 2 of actual concentrations.

APPENDIX C
HUMAN HEALTH EFFECTS FROM FACILITY ACCIDENTS

C.1 INTRODUCTION

Accident analyses were performed to estimate the impacts on workers and the public from reasonably foreseeable accidents associated with the Modern Pit Facility (MPF). The analyses were performed in accordance with *National Environmental Policy Act* (NEPA) guidelines, including the process followed for the selection of accidents, definition of accident scenarios, and estimation of potential impacts. The sections that follow describe the methodology and assumptions, accident selection process, selected accident scenarios, and consequences and risks of the accidents evaluated.

C.2 OVERVIEW OF METHODOLOGY AND BASIC ASSUMPTIONS

An accident is a sequence of one or more unplanned events with potential unmitigated outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

- *Internal initiators* normally originate in and around the facility, but are always a result of facility operations. Examples include equipment or structural failures and human errors.
- *External initiators* are independent of facility operations and normally originate from outside the facility. Some external initiators affect the ability of the facility to maintain its confinement of hazardous materials because of potential structural damage. Examples include aircraft crashes, vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.
- *Natural phenomena initiators* are natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

If an accident were to occur involving the release of radioactive or chemical materials, workers, members of the public, and the environment would be at risk. Workers in the facility where the accident occurs would be particularly vulnerable to the effects of the accident because of their location. The offsite public would also be at risk of exposure to the extent that meteorological conditions exist for the atmospheric dispersion of released hazardous materials. Using approved computer models, the dispersion of released hazardous materials and their effects are predicted. However, prediction of latent potential health effects becomes increasingly difficult to quantify for facility workers as the distance between the accident location and the worker decreases. This is because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The worker also may be injured or killed by physical effects of the accident itself.

C.3 ACCIDENT ANALYSIS METHODOLOGY AND DATA SOURCES

The analysis of accidents followed a systematic process beginning with the identification of potentially hazardous conditions associated with the MPF, followed by the selection and definition of a representative set of accident scenarios, development of data requirements (source term, release duration, and estimate of frequency of accident condition), and the calculation of postulated accident consequences for the environment, members of the public, and site workers.

The accident analysis includes conservative assumptions to bound potential consequences and risks to workers and the public as well as to compensate for any uncertainties in the data and methods as required for NEPA purposes. In particular, no credit is taken for facility design features that would reduce accident damage to the material at risk (damage ratio = 1.0) and to confinement barriers that prevent materials from reaching the environment (leak path factor = 1.0). Realistically, the MPF would be designed and operated to protect the material at risk and confinement barriers that would significantly reduce the potential consequences and risks of accidents to workers and the public compared to the results presented in this EIS.

Data Sources

Major sources of data and information used for the development of accident scenarios included: (1) the best available documentation on postulated accidents at similar facilities, including recently completed NEPA documents for similar facilities; and (2) meetings and discussions with expert site representatives. Initial data regarding the MPF and its processing steps were obtained from the document *Modern Pit Facility Request for Approval of Mission Need—Critical Decision–0* (NNSA 2002).

Source Documents

Documentation on postulated accidents at similar facilities was the initial source of accident scenarios. Documents such as safety analysis reports and NEPA documents were reviewed for applicable accident scenarios. The review sought to identify a spectrum of accidents, initiated internally by operations or initiated externally. This spectrum of accidents included low-consequence/high-probability events (evaluation basis accidents) and high-consequence/low-probability events (beyond evaluation basis accidents). The initial set of documents that were reviewed included the following:

- *Topical Report – Supporting Documentation for the Accident Impacts Presented in the Modern Pit Facility Environmental Impact Statement* (Tetra Tech 2003)
- *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996c)
- *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (DOE 1999a)
- *Final Supplement Analysis for Pit Manufacturing Facilities at Los Alamos National Laboratory, Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE 1999f)

- *TA-55 Final Safety Analysis Report* (LANL 1995a)
- *Topical Report – Supporting Documentation for the Accident Impacts Presented in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (Maltese et al., 1996)
- *Modern Pit Facility Pre-Conceptual Design Radiological Hazards Evaluation* (WSRC 2002d)

Based on these documents, a candidate set of facility hazards and accident scenarios were defined that was judged to provide an adequate representation of the potential accidents that might occur at the MPF. This initial set of candidate accidents was screened to arrive at a final set of accident scenarios for analysis and documentation in this Environmental Impact Statement (EIS).

Following the review of applicable documents, the accident scenarios and source terms were further refined and confirmed through meetings and discussions with knowledgeable personnel familiar with similar facilities and processes.

C.4 ACCIDENT SCENARIO SELECTION PROCESS

This section describes the development of accident scenarios that were used to estimate the impacts of MPF operations. As discussed in Section C.2, accident scenarios were developed using all known applicable sources of information including safety analysis reports, previous NEPA documents and related backup information, and discussions with experts familiar with potential accidents for MPF operations.

Development of Accident Scenarios

A preliminary hazard evaluation for a MPF was performed that identified potential hazards associated with nuclear weapons pit manufacturing (WSRC 2002d). These identified hazards formed the basis for the selection and definition of a set of accident scenarios analyzed in the MPF EIS. The steps in the process were:

1) Assemble and review all available information and technical resources applicable to the MPF buildings, equipment, processes, and operations
2) Identify potential hazardous and accident conditions
3) Define a preliminary set of candidate accident scenarios
4) Select a final set of accidents, develop scenarios, and derive applicable data for analysis in the MPF EIS

Four general guidelines, listed below, were followed in the selection of the MPF accident scenarios.

1) Hazardous and accident conditions should include the largest source terms at risk and conditions for worker and public impacts.

2) The accident scenarios selected should cover a spectrum of accident situations ranging from high-probability/low-consequence events to low-probability/high-consequence events.
3) For each probability range the accident with bounding consequences should be selected as representative for the range.
4) The accident scenarios should reflect differences resulting from site-specific initiators, meteorology, and characteristics (e.g., distance from site boundary and other adjacent facilities). The accidents do not take credit for any of the safety systems required for the facility.

Hazards Evaluation

Based on available documentation and technical resources, potential hazard, and accidents associated with MPF site conditions, facilities, processes, and operations were identified. These fall in to three categories:

1) Accidents initiated internal to the MPF (e.g. MPF processes, equipment, operations and workers)
2) Accidents initiated external to the MPF
3) Accidents initiated by natural phenomena events (e.g. earthquake, flooding, high winds)

Internally initiated accidents in Category 1 will generally be the same for all sites where new construction is planned. Externally initiated accidents and natural phenomena events in Categories 2 and 3 are site specific.

Internally Initiated Hazards

Detailed design information was not yet available for use in the MPF EIS. However, for purposes of EIS hazards evaluation, the following process steps were assumed.

- Shipment/Storage
- Disassembly
- Enriched Uranium Processing
- Dissolution
- Solvent Extraction
- Precipitation
- Metal Reduction
- Electrorefining
- Accountability and Button Storage
- Foundry
- Machining

- Assembly, Post Assembly, and Inspection
- Laboratory
- Balance of Plant

MPF-related facility radiological and chemical accidents for three production cases (125 pits per year [ppy], 250 ppy, and 450 ppy) are described in Tables C.4–1 through C.4–4. These tables also identify the estimated maximum material at risk (MAR) and source term and accident frequency. Section C.5 provides additional data on release fractions such as damage ratio, leak path factor, and estimated respirable release fraction (RRF) for each postulated accident. The RRF is the mathematical product of the airborne release fraction (ARF) and the respirable fraction (RF) calculated by the equation RRF = ARF × RF (Tetra Tech 2003).

Natural Phenomena Accidents

Natural phenomena events have the potential for causing damage to the facility and the release of radioactive and other hazardous materials. Natural phenomena events that were considered include earthquake, tornado, high winds, flooding, wild fires, snow, and ice. Tables C.4–1 through C.4–4 identify natural phenomena accidents that were selected for further analysis based on their potential for causing the release of radioactive materials that would bound other natural phenomena events. These tables and Section C.5 also provide data on accident scenarios pertaining to MAR, source term, frequency, and release fractions.

Postulated Accidents

The accident scenarios shown in Tables C.4–1 through C.4–4 cover the types of hazardous situations appropriate for the MPF EIS. The list includes fires, spills, criticality and explosions events, site-specific externally initiated events, and natural phenomena events. For radiological accidents, the material at risk is plutonium and the predominant form of exposure is through inhalation. For some plutonium processes, such as pit disassembly and conversion, tritium, whose predominant form of exposure is through ingestion, may also be present. However, the pits associated with the MPF Facility do not present a tritium hazard because they do not contain residual amounts of tritium. For radiological accidents, the material at risk is plutonium and the predominant form of exposure is through inhalation. The list also includes the potential release of toxic chemicals used in MPF processes.

The results of the accident analysis indicate potential consequences that exceed the DOE exposure guidelines of 25 rem for a member of the public at the nearest site boundary. The analyses in these cases for NEPA purposes are based on unmitigated releases of radioactive material to select a site for the MPF. Following the ROD and selection of a site, additional NEPA action would be taken that would identify specific mitigating features that would be incorporated in the MPF design to ensure compliance with DOE exposure guidelines. These could include procedural and equipment safety features, HEPA filtration systems, and other design features that would protect radioactive materials from accident conditions and contain any material that might be released. Upon completion of MPF NEPA actions, DOE would prepare safety analysis documentation such as a safety analysis report to further ensure that DOE exposure guidelines would not be exceeded. The results of the safety analysis report are reflected in facility and equipment design and defines an operating envelope and procedures to ensure public and worker safety. Once specific mitigation measures are incorporated into the MPF design and operating procedures, the potential consequences will not exceed the DOE exposure guidelines of 25 rem for a member of the public at the nearest site boundary for any of the site alternatives.

The accident source terms shown in Tables C.4–1 through C.4–4 indicate the quantity of radioactive and chemical material released to the environment with a potential for harm to the public and onsite workers. The radiological source terms are calculated by the equation:

Source Term = MAR × ARF × RF × DR × LPF, where:

MAR—the amount and form of radioactive material at risk of being released to the environment under accident conditions.

ARF—the airborne release fraction reflecting the fraction of damaged MAR that becomes airborne as a result of the accident.

RF—the respirable fraction reflecting the fraction of airborne radioactive material that is small enough to be inhaled by a human.

DR—the damage ratio reflecting the fraction of MAR that is damaged in the accident and available for release to the environment.

LPF—the leak path factor reflecting the fraction of respirable radioactive material that has a pathway out of the facility for dispersal in the environment.

Table C.4–1. Postulated MPF-Related Facility Radiological Accidents for the 125 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and storage vaults containing the largest quantity of plutonium metal.	16,988 kg plutonium-239 equivalent: 99.65% metal 0.21 % powder, 0.14 % solution	4.23 kg metal 0.0021 kg oxide 0.048 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	7685 kg plutonium metal	1.92 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–1. Postulated MPF-Related Facility Radiological Accidents for the 125 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3–1[a]	See Table 3–1[a]	1.0×10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	600 kg plutonium metal	0.15 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr

[a] Tetra Tech 2003.

Source: Tetra Tech 2003.

Table C.4–2. Postulated MPF-Related Facility Radiological Accidents for the 250 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and to storage vaults containing the largest quantity of plutonium metal.	17,319 kg plutonium-239 equivalent: 99.44% metal 0.28 % powder 0.28 % solution	4.31 kg metal 0.00296 kg oxide 0.096 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room, or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	7943 kg plutonium metal	1.99 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–2. Postulated MPF-Related Facility Radiological Accidents for the 250 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3-1[a]	See Table 3–1[a]	1.0 × 10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	600 kg plutonium metal	0.15 kg plutonium	1.0 × 10^{-4} to 1.0 × 10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0 × 10^{-4} to 1.0 × 10^{-2} /yr

[a] Tetra Tech 2003.

Source: Tetra Tech 2003.

Table C.4–3. Postulated MPF-Related Facility Radiological Accidents for the 450 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and to storage vaults containing the largest quantity of plutonium metal.	33,447 kg plutonium-239 equivalent 99.51% metal 0.24 % powder 0.25 % solution	8.32 kg metal 0.0048 kg oxide 0.17 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room, or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	15420 kg plutonium metal	3.86 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over- pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–3. Postulated MPF-Related Facility Radiological Accidents for the 450 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3–1[a]	See Table 3-1[a]	1.0×10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	1200 kg plutonium metal	0.3 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr

[a] Tetra Tech 2003.

Source: Tetra Tech 2003.

Table C.4–4. Postulated MPF-Related Facility Chemical Accidents for All Production Cases

Chemical Release Events				
1. Nitric Acid release from bulk storage	Nitric acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	1.0×10^{-5} to 1.0×10^{-4} /yr
2. Hydrofluoric Acid Release from Bulk Storage	Hydrofluoric acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	1.0×10^{-5} to 1.0×10^{-4} /yr
3. Formic Acid Release from Bulk Storage	Formic acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	1.0×10^{-5} to 1.0×10^{-4} /yr

Source: Tetra Tech 2003.

The accident source terms for chemical accidents are shown in Table C.4–4. The impacts of chemical accidents are measured in terms of ERPG-2 and ERPG-3 concentration limits established by the American Industrial Hygiene Association. ERPG-2 is defined as the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective actions. ERPG-3 is defined as the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

C.5 ACCIDENT SCENARIO DESCRIPTIONS AND SOURCE TERMS

The final set of accidents scenarios for the MPF Alternative are described in Section C.5.1 for three pit production cases (125, 250, and 450 ppy). They include potential radiological and chemical accidents that are initiated by internal MPF mechanisms, events external to MPF and natural phenomena. The selected accidents are based on conservative assumptions in order to obtain bounding impacts. A summary of accident data for the MPF Alternative is presented in Table C.5–1. Accident information pertaining to the No Action Alternative and the TA-55 Upgrade Alternative are provided in Sections C.5.2 and C.5.3, respectively.

Table C.5–1. Summary of Potential Facility Accidents for the MPF Alternative

Accident	Material at Risk[a]	Source Term[a]
Beyond Evaluation Basis Earthquake with Fire	125 ppy 16,929 kg plutonium metal 35 kg plutonium oxide 24 kg plutonium solution 250 ppy 17,221.9 kg plutonium metal 49.1 kg plutonium oxide 48 kg plutonium solution 450 ppy 33,282.5 kg plutonium metal 80.5 kg plutonium oxide 84 kg plutonium solution	125 ppy 4.23 kg plutonium metal 0.0021 kg plutonium oxide 0.048 kg plutonium solution 250 ppy 4.31 kg plutonium metal 0.00295 kg plutonium oxide 0.096 kg plutonium solution 450 ppy 8.32 kg plutonium metal 0.00483 kg plutonium oxide 0.168 kg plutonium solution
Fire in a Single Building	125 ppy – 7,685 kg plutonium metal 250 ppy – 7,943 kg plutonium metal 450 ppy – 15,420 kg plutonium metal	125 ppy – 1.92 kg plutonium metal 250 ppy – 1.99 kg plutonium metal 450 ppy – 3.86 kg plutonium metal
Explosion in a Feed Casting Furnace	125 ppy – 31.5 kg molten plutonium metal 250 ppy – 31.5 kg molten plutonium metal 450 ppy – 31.5 kg molten plutonium metal	125 ppy – 2.25 kg molten plutonium metal 250 ppy – 2.25 kg molten plutonium metal 450 ppy – 2.25 kg molten plutonium metal

Table C.5–1. Summary of Potential Facility Accidents for the MPF Alternative (*continued*)

Accident	Material at Risk[a]	Source Term[a]
Nuclear Criticality	See Table 3-1	5 x 10^{17} fissions
Fire-Induced Release in the CRT Storage Room	125 ppy – 600 kg plutonium metal 250 ppy – 600 kg plutonium metal 450 ppy – 1,200 kg plutonium metal	125 ppy – 0.15 kg molten plutonium metal 250 ppy – 0.15 kg molten plutonium metal 450 ppy – 0.30 kg molten plutonium metal
Radioactive Material Spill	125 ppy – 4.5 kg molten plutonium metal 250 ppy – 4.5 kg molten plutonium metal 450 ppy – 4.5 kg molten plutonium metal	125 ppy – 0.045 kg molten plutonium metal 250 ppy – 0.045 kg molten plutonium metal 450 ppy – 0.045 kg molten plutonium metal
Nitric Acid Release from Bulk Storage[b]	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg
Hydrofluoric Acid Release from Bulk Storage[b]	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg
Formic Acid Release from Bulk Storage[b]	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg
Hydrochloric Acid[c]	125 ppy – 600 kg 250 ppy – 1,200 kg 450 ppy – 2,200 kg	125 ppy – 600 kg 250 ppy – 1,200 kg 450 ppy – 2,200 kg

[a] Plutonium-239 equivalent.
[b] Chemicals are used in the aqueous processing method.
[c] Chemical is used in the pyrochemical processing method.
Source: Tetra Tech 2003.

C.5.1 Modern Pit Facility Alternative

Postulated accident scenarios applicable to the MPF are described below. The accidents shown were analyzed and their consequences are presented in the Section C.7. The accidents shown are generally applicable to all sites although some reflect unique site-specific conditions that are not applicable to all sites.

C.5.1.1 Beyond Evaluation Basis Earthquake with Fire

The earthquake accident scenario postulates a seismic event and seismically induced failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas in the facility. Combustible materials in the area are ignited and the resulting fire propagates to multiple areas of the facility and including storage vaults in three buildings containing the largest quantity of plutonium metal. The plutonium-239 equivalent MAR for the 125 ppy production case includes 16,988 kilograms (kg) (37,452 pounds [lb]) metal, 35 kg (77 lb) oxide, and 24 kg (53 lb) solution. The plutonium-239 equivalent MAR for the 250 ppy production case includes 17,319 kg (38,182 lb) metal, 49.1 kg (108 lb) oxide, and 48 kg (106 lb) solution. The plutonium-239 equivalent MAR for the 450 ppy production case includes 33,447 kg (73,738 lb) of metal, 80.5 kg (177.5 lb) oxide, and 84 kg (185 lb) solution. The bounding seismic accident with fire conservatively assumes a damage ratio (DR) = 1.0 resulting in all of the MAR to be affected by the fire. The collapsed walls cause a loss of confinement resulting in an assumed leak path factor (LPF) = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4} (metal), 6×10^{-5} (oxide), and 2×10^{-3} (solution). No credit is taken for the mitigating effects of safety systems, fire suppression efforts and equipment, plutonium cladding, the shipping containers or the final building state (building collapse and rubble bed). The resulting plutonium-239 equivalent source term for the 125 ppy case is 4.23 kg (9.3 lb) of metal, 0.0021 kg (0.0046 lb) of oxide, and 0.048 kg (0.11 lb) of solution. The resulting plutonium-239 equivalent source term for the 250 ppy case is 4.31 kg (9.5 lb) metal, 0.00295 kg (0.0065 lb) oxide, and 0.096 kg (0.212 lb) solution. The resulting plutonium-239 equivalent source term for the 450 ppy case is 8.32 kg (18.3 lb) metal, 0.00483 kg (0.11 lb) oxide, and 0.168 kg (0.37 lb) solution. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-5} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-5} per year is assumed.

C.5.1.2 Air Transportation Accident

The air transportation accident is addressed in an Official Use Only document.

C.5.1.3 Ground Transportation Accident

The ground transportation accidents are addressed in Appendix D.

C.5.1.4 Fire in a Single Building

A fire is postulated to start within a glovebox, processing room, or storage vault. Possible causes of the fire include an electrical short, equipment failure, welding equipment, or human error. The fire propagates to multiple areas of the facility involving the largest quantities of plutonium metal. The material at risk is a maximum 7,685 kg (16,943 lb) of plutonium metal for the 125 ppy case; 7,943 kg (17,511 lb) plutonium metal for the 250 ppy case; and 15,420 kg (33,995 lb) plutonium for the 450 ppy case. The bounding fire accident conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for safety systems, building confinement, or filtration resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or the shipping containers. The resulting source term is a ground level, thermal release of 1.92 kg (4.23 lb), 1.99 kg (4.39 lb), and 3.86 kg (8.5 lb) of plutonium-239 equivalent for the three production cases 125, 250, and 450 ppy, respectively. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-4} per year is assumed.

C.5.1.5 Explosion in a Feed Casting Furnace

A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. The material at risk is the same for all three pit production cases. The furnace is assumed to contain 4.5 kg (9.9 lb) of plutonium in the form of molten metal. The airborne respirable release fraction was estimated to be ARF*RF = 0.5 for the 4.5 kg (9.9 lb) of plutonium. Negligible impacts from the shock/blast are postulated for 9 kg (19.8 lb) of solid plutonium metal in the glovebox. The bounding scenario assumes a DR = 1.0 and an LPF = 1.0. The resulting source for each of the three pit production cases is 2.25 kg (5.0 lb) plutonium-239 equivalent. The frequency of the accident is estimated to be in the range 1×10^{-4} to 1×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-2} was used.

C.5.1.6 Nuclear Criticality

An inadvertent criticality is postulated based on any one of several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios. Table 3–1 of Chapter 3 in Volume I of this EIS (Tetra Tech 2003) provides the radionuclide distribution for a 5×10^{17} fissions criticality involving weapons grade plutonium. The estimated frequency of a criticality is 1×10^{-2} per year.

C.5.1.7 Fire-Induced Release in the Cargo Restraint Transporter Storage Room

A fire is postulated to start in cargo restraint transporter storage room. The fire is confined to the room. The MAR in the room is 600 kg (1,322.8 lb) plutonium metal for the 125 and 250 ppy production cases and 1200 kg (2,645.6 lb) plutonium metal for the 450 ppy production case. The bounding scenario assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for building confinement or filtration resulting in an assumed LPF = 1.0. The airborne respirable fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or shipping containers. The resulting source term is a ground level, thermal release of 0.15 kg (0.33 lb), 0.15 kg (0.33 lb), and 0.3 kg (0.66 lb) of plutonium-239 equivalent for the three production cases 125, 250, and 450 ppy, respectively. The accident frequency is estimated to be in the range of 1×10^{-4} to 1×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-2} per year is assumed.

C.5.1.8 Radioactive Material Spill

A spill of radioactive material occurs in the metal reduction glovebox. A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace. The event does not impact any other material that may be in the glovebox. The spill is assumed to involve 4.5 kg (9.9 lb) molten plutonium metal for each of the three production cases. An airborne release from disturbed metal surfaces is assumed the release mechanism. The airborne respirable release fraction is estimated to be ARF*RF = 1 × 10^{-2}. A DR = 1.0 was conservatively assumed. For a bounding scenario, no credit is taken for safety systems, building confinement, or ventilation/filtration corresponding to LPF = 1.0. The resulting source term is a ground level release of 0.045 kg (9.9 lb) plutonium-239 equivalent for each of the three pit production cases. The accident frequency is estimated to be in the range of 1 × 10^{-4} to 1 × 10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1 × 10^{-2} per year is assumed.

C.5.1.9 Nitric Acid Release

An accidental release of nitric acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Nitric acid is corrosive and can cause severe burns to all parts of the body. Its vapors may burn the respiratory tract and may cause pulmonary edema, which could prove fatal. The nitric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of nitric acid that could be released is 10,500 kg (23,149 lb) for the 125 ppy production case, 21,000 kg (46,297 lb) for the 250 ppy production case, and 40,000 kg (88,185 lb) for the 450 ppy production case. The nitric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 6 and 78 parts per million (ppm), respectively. The estimated frequency of this accident is in the range of 1.0 × 10^{-5} to 1.0 × 10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0 × 10^{-4} is assumed.

C.5.1.10 Hydrofluoric Acid Release

An accidental release of hydrofluoric acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. Hydrofluoric acid is extremely toxic and may be fatal if inhaled or ingested. It is readily absorbed through the skin and skin contact may be fatal. It acts as a systemic poison, causes severe burns and is a possible mutagen. The hydrofluoric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrofluoric acid that could be released is 550 kg (1,212.5 lb) for the 125 ppy production case, 1,100 kg (2,425 lb) for the 250 ppy production case, and 2,000 kg (4,409 lb) for the 450 ppy production case. The hydrofluoric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 20 and 50 ppm, respectively. The estimated frequency of this accident is in the range of 1.0 × 10^{-5} to 1.0 × 10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0 × 10^{-4} per year is assumed.

C.5.1.11 Formic Acid Release

An accidental release of formic acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Formic acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. It is very destructive to mucous membranes and the upper respiratory tract, eyes, and skin. Inhalation may be fatal. The formic acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of formic acid that could be released is 1,500 kg (3,307 lb) for the 125 ppy production case, 3,000 kg (6,614 lb) for the 250 ppy production case, and 5,500 kg (12,125 lb) for the 450 ppy production case. The formic acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.1.12 Hydrochloric Acid Release

An accidental release of hydrochloric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrochloric acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. Inhalation may be fatal. The hydrochloric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrochloric acid that could be released is 1,497 kg (3,300 lb) for the 80 ppy production case. The hydrochloric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of $1.0 \text{ x } 10^{-5}$ to $1.0 \text{ x } 10^{-4}$ per year. For the purpose of risk calculations, a conservative frequency of $1.0 \text{ x } 10^{-4}$ per year is assumed.

C.5.2 No Action Alternative

Under the No Action Alternative, plutonium pit fabrication capabilities would be maintained at existing levels. Potential accident scenarios for the No Action Alternative are addressed in existing documentation included by reference (DOE 1999f, DOE 1996c, LANL 1995a).

C.5.3 TA-55 Upgrade Alternative

Under the TA-55 Upgrade Alternative, the Plutonium Facility, Building 4 (PF-4) at TA-55 would be upgraded to provide a capability to manufacture up to 80 ppy. The changes to PF-4 to achieve this capability are assumed to be equivalent to the operations, processes, and technology and safety systems planned for a MPF. As such, the potential hazards and accidents postulated for a MPF would be applicable to the upgraded PF-4 with appropriate adjustments for the reduced production capacity. Table C.5.3–1 summarizes the accident scenarios for the TA-55 Upgrade Alternative.

Table C.5.3–1. Summary of Potential Facility Accidents for the Upgrade Alternative

Accident	MAR[a]	Source Term[a]
Beyond Evaluation Basis Earthquake and Fire	11,160 kg plutonium metal 22.4 kg plutonium oxide 15.4 kg plutonium solution	2.7 kg plutonium metal 0.0014 kg plutonium oxide 0.03 kg plutonium solution
Fire in a Single Building	4,918 kg plutonium metal	1.23 kg plutonium-239 equivalent
Explosion in a Feed Casting Furnace	31.5 kg molten plutonium metal	2.52 kg plutonium-239 equivalent
Nuclear Criticality	See Table 3-1[b]	5 x 10^{17} fissions
Fire-Induced Release in the CRT Storage Room	384 kg plutonium metal	0.096 kg plutonium-239 equivalent
Radioactive Material Spill	4.5 kg molten plutonium metal	0.045 kg plutonium-239 equivalent
Nitric Acid Release from Bulk Storage	3,420 kg	3,420 kg
Hydrofluoric Acid Release from Bulk Storage	340 kg	340 kg
Hydrochloric Acid Release from Bulk Storage	1,497 kg	1,497 kg

[a] Plutonium-239 equivalent.
[b] Tetra Tech 2003.

C.5.3.1 Beyond Evaluation Basis Earthquake and Fire

The earthquake accident scenario postulates a seismic event and seismically induced failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas in the facility. Combustible materials in the area are ignited and the resulting fire propagates to multiple areas of the facility including storage vaults in three buildings containing the largest quantity of plutonium metal. The plutonium-239 equivalent material at risk for the 80 ppy production case is 11,160 kg (24,603 lb) metal, 22.4 kg (49.4 lb) oxide, and 15.4 kg (34 lb) solution. The bounding seismic accident with fire conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. The collapsed walls cause a loss of confinement resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4} (metal), 6.0×10^{-5} (oxide), and 2.0×10^{-3} (solution). No credit is taken for the mitigating effects of safety systems, fire suppression efforts, and equipment, plutonium cladding, or the shipping containers. The resulting plutonium-239 equivalent source term is 2.7 kg (6.0 lb) of metal, 0.0014 kg (0.0031 lb) of oxide, and 0.03 kg (0.066 lb) of solution. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-5} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-5} per year is assumed.

C.5.3.2 Air Transportation Accident

The air transportation accident is addressed in an Official Use Only document.

C.5.3.3 Ground Transportation Accident

The ground transportation accidents are addressed in Appendix B.

C.5.3.4 Fire in a Single Building

A fire is postulated to start within a glovebox, processing room or storage vault. Possible causes of the fire include an electrical short, equipment failure, welding equipment, or human error. The fire propagates to multiple areas of the facility involving the largest quantities of plutonium metal. The MAR is a maximum 4,918 kg (10,842 lb) of plutonium metal for the 80 ppy case. The bounding fire accident conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for safety systems, building confinement, or filtration resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or the shipping containers. The resulting source term is a ground-level, thermal release of 1.23 kg (2.7 lb) of plutonium-239 equivalent. The accident frequency is estimated to be in the range of 1.0×10^{-6} to 1×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.5 Explosion in a Feed Casting Furnace

A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. The furnace is assumed to contain 4.5 kg (9.9 lb) of plutonium in the form of molten metal. The airborne respirable release fraction was estimated to be ARF*RF = 0.5 for the 4.5 kg (9.9 lb) of plutonium. Negligible releases from the shock/blast are postulated for 9 kg (19.8 lb) of solid plutonium metal in the glovebox. The bounding scenario assumes a DR = 1.0 and an LPF = 1.0. The resulting source for each of the three pit production cases is 2.25 kg (5.0 lb) plutonium-239 equivalent. The frequency of the accident is estimated to be in the range 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} was used.

C.5.3.6 Nuclear Criticality

An inadvertent criticality is postulated based on any one of several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios. Table 3-1 provides the radio nuclide distribution for a 5×10^{17} fissions criticality involving weapons grade plutonium. The estimated frequency of a criticality is 1.0×10^{-2} per year.

C.5.3.7 Fire-Induced Release in the Cargo Restraint Transporter Storage Room

A fire is postulated to start in cargo restraint transporter storage room. The fire is confined to the room. The MAR in the room is 384 kg (847 lb) plutonium metal for the 80 ppy production case. The bounding scenario assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for building confinement or filtration resulting in an assumed LPF = 1.0. The airborne respirable fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or shipping containers. The resulting source term is a ground-level, thermal release of 0.096 kg (0.21 lb) of plutonium metal. The accident frequency is estimated to be unlikely in the range of 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} per year is assumed.

C.5.3.8 Radioactive Material Spill

A spill of radioactive material occurs in the metal reduction glovebox. A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace. The event does not impact any other material that may be in the glovebox. The spill is assumed to involve 4.5 kg (9.9 lb) molten plutonium metal. An airborne release from disturbed metal surfaces is assumed the release mechanism. The airborne respirable release fraction is estimated to be ARF*RF = 1.0×10^{-2}. A DR =1.0 was conservatively assumed. For a bounding scenario, no credit is taken for building confinement or ventilation/filtration corresponding to LPF = 1.0. The resulting source term is a ground-level release of 0.045 kg (0.099 lb) plutonium-239 equivalent. The accident frequency is estimated to be unlikely in the range of 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} per year is assumed.

C.5.3.9 Nitric Acid Release

An accidental release of nitric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Nitric acid is corrosive and can cause severe burns to all parts of the body. Its vapors are corrosive to the respiratory tract and may cause pulmonary edema, which could prove fatal. The nitric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of nitric acid that could be released is 3,420 kg (7,540 lb) for the 80 ppy, production case. The nitric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 6 and 78 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.10 Hydrofluoric Acid Release

An accidental release of hydrofluoric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrofluoric acid is extremely toxic and may be fatal if inhaled or ingested. It is readily absorbed through the skin and skin contact may be fatal. It acts as a systemic poison, causes severe burns, and is a possible mutagen. The hydrofluoric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrofluoric acid that could be released is 340 kg (750 lb) for the 80 ppy, production case. The hydrofluoric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 20 and 80 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.11 Hydrochloric Acid Release

An accidental release of hydrochloric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrochloric acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. It is very destructive to mucous membranes and the upper respiratory tract, eyes, and skin. Inhalation may be fatal. The hydrochloric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of formic acid that could be released is 1,497 kg (3,300 lb) for 80 ppy production case. The hydrochloric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.6 CONSEQUENCE ANALYSIS METHODOLOGY

Radiological Releases

Consequences of accidental radiological releases were determined using the MACCS2 computer code (Chanin and Young 1998). MACCS2 is a DOE/Nuclear Regulatory Commission (NRC)-sponsored computer code that has been widely used in support of probabilistic risk assessments for the nuclear power industry and in support of safety and NEPA documentation for facilities throughout the DOE complex.

The MACCS2 code uses three distinct modules for consequence calculations. The ATMOS module performs the calculations pertaining to atmospheric transport, including dispersion, deposition, and decay. The EARLY module performs the exposure calculations corresponding to the period immediately following the release; this module also includes the capability to simulate evacuation from areas surrounding the release. The EARLY module exposure pathways include inhalation, cloud shine, and groundshine. The CHRONC module considers the time period following the early phase, i.e., after the plume has passed (usually 7 days). CHRONC exposure pathways include groundshine, resuspension inhalation, and ingestion of contaminated food and water; land use interdiction (e.g., decontamination, interdiction) can be simulated in this module. Other supporting input files include a meteorological data file and a site data file containing distributions of the population and agriculture surrounding the release site.

All of the code's capabilities were not used because of assumptions used in the MPF EIS analysis. It was assumed that there would be no evacuation or protection of the surrounding population following an accidental release of radionuclides. In addition, the food pathway was not included. The former assumption is not expected to significantly affect the calculated doses; the amount of warning preceding a release is likely to be small. The latter assumption is made to simplify the calculation process and yet not significantly affect the results. A conservative assumption, that the deposition velocity of all radioactive material was set to zero, was instead made.

The source terms were handled by the code by considering the MAR as the inventory. The release fraction of each scenario was then the product of the various factors (DR, ARF, RF, and LPF) that describe the material available to actually impact a receptor. The meteorological data consisted of sequential hourly wind speed, wind direction, stability class and precipitation for one year.

Each 4-hour period of the annual meteorological site specific data set for each site was randomly sampled, assuring a good representation of the entire meteorological data set. The results from each of these samples were then ranked and combined (according to their frequency of occurrence) and a distribution of results is presented by the code. This distribution includes statistics such as 95th percentile, 50th percentile, and mean dose. The latter is presented in the MPF EIS. The doses were converted into latent cancer fatalities (LCFs) using the International Commission on Radiological Protection (ICRP) factor of 5×10^{-4} LCF/person-rem for members of the general public. For workers, the ICRP factor of 4×10^{-4} LCF/person-rem was used.

Chemical Releases

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 1999b). ALOHA is an EPA/National Oceanic and Atmospheric Administration (NOAA)-sponsored computer code that has been widely used in support of chemical accident responses and also in support of safety and NEPA documentation for DOE facilities.

The ALOHA code is a deterministic representation of atmospheric releases of toxic and hazardous chemicals. The code can predict the rate at which chemical vapors escape (e.g., from puddles or leaking tanks) into the atmosphere; a specified direct release rate is also an option. In the case of the MPF EIS, the chemical direct release rates were determined based on a 30-minute release as part of the scenario development.

Either of two dispersion algorithms are applied by the code, depending on whether the release is neutrally buoyant or heavier than air. The former is modeled similarly to radioactive releases in that the plume is assumed to advect with the wind velocity. The latter considers the initial slumping and spreading of the release because of its density. As a heavier-than-air release becomes more dilute, its behavior tends towards that of a neutrally buoyant release.

The ALOHA code uses a constant set of meteorological conditions (e.g., wind speed, stability class) to determine the downwind atmospheric concentrations. The sequential meteorological data sets used for the radiological accident analyses were re-ordered from high to low dispersion by applying a Gaussian dispersion model (such as that used by ALOHA) to the closest site boundary at each site. The median set of hourly conditions for each site (i.e., mean wind speed and mean stability) was used for the analysis; this is roughly equivalent to the conditions corresponding to the mean radiological dose estimates of MACCS2.

ALOHA contains physical and toxicological properties for the chemical spills included in the EIS and for approximately 1,000 additional chemicals. The physical properties were used to determine which of the dispersion models and accompanying parameters were applied. The toxicological properties were used to determine the levels of concern. Atmospheric concentrations at which health effects are of concern (e.g., ERPG-2) are used to define the footprint of concern because the meteorological conditions specified do not account for wind direction (i.e., it is not known *a priori* in which direction the wind would be blowing in the event of an accident) the areas of concern are defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern. The fraction of the area of concern actually exposed to the concentration of concern (footprint area/circle area) was noted. In addition, the concentration at 1,000 m (3,281 ft) (potential exposure to a non-involved worker) and at the nearest site boundary distance (exposure to maximum exposed offsite individual) are calculated and presented.

C.7 ACCIDENT ANALYSES CONSEQUENCES AND RISK RESULTS

The following sections describe the radiological and chemical impacts of potential accidents associated with MPF alternatives at LANL, NTS, Pantex, SRS, and WIPP and with the TA-55 Upgrade Alternative at LANL. Impacts for the MPF alternatives are provided for 125 ppy, 250 ppy, and 450 ppy production cases. Impacts for the TA-55 Upgrade Alternative are provided for an 80 ppy production case.

The impacts to humans that could result from potential radiological accident scenarios were evaluated in terms of dose units (such as rem or person-rem) and excess LCFs. The dose-to-risk conversion factors used were 0.0005 LCFs per rem (or person-rem) and 0.0004 LCFs per rem, respectively, for the public and workers. The lower value for workers reflects the absence of children (who are more radiosensitive than adults) in the workforce. For individuals, such as a worker or the maximum exposed offsite individual, the dose-to-rem conversion factors were doubled to 0.0008 and 0.001, respectively, when the dose exceeded 20 rem.

C.7.1 Modern Pit Facility Radiological Accident Frequency and Consequences

This section describes the impacts for each of the five MPF site alternatives. Impacts are shown in terms of dose and LCFs for the maximally exposed offsite individual, offsite population, and non-involved worker. The risks of LCFs are also shown for the maximally exposed offsite individual, offsite population, and non-involved worker.

C.7.1.1 Los Alamos Site Alternative

Table C.7.1.1–1. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	41.4	0.041	36,300	18.2	244	0.2
1.0×10^{-5}						
Fire in a Single Building	32.7	0.033	21,400	10.7	301	0.24
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.4	0.0012	1,670	0.84	23.5	0.019
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.1	0.0028
1.0×10^{-2}						

CRT = Cargo Restraint Transporter.

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

[b] Increased likelihood of a LCF.

[c] Increased likelihood of LCFs.

Table C.7.1.1–2. Annual Cancer Risks for the MPF Alternative at LANL for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	4.1×10^{-7}	0.00018	2.0×10^{-6}
Fire in a Single Building	3.3×10^{-6}	0.0011	2.4×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0084	0.00019
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.

[b] Increased likelihood of LCFs.

[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

Table C.7.1.1–3. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	42.6	0.043	37,400	18.7	251	0.2
1.0×10^{-5}						
Fire in a Single Building	33.9	0.034	22,200	11.1	312	0.25
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.4	0.0012	1,670	0.84	23.5	0.019
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.1	0.0028
1.0×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.1–4. Annual Cancer Risks for the MPF Alternative at LANL for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	4.3×10^{-7}	0.00019	2.0×10^{-6}
Fire in a Single Building	3.4×10^{-6}	0.0011	2.5×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0084	0.00019
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

Table C.7.1.1–5. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 450 ppy

Frequency (per year)	**Maximally Exposed Offsite Individual**		**Offsite Population**[a]		**Non-involved Worker**	
	Dose (rem)	**LCFs**[b]	**Dose (person-rem)**	**LCFs**[c]	**Dose (rem)**	**LCFs**[b]
Beyond Evaluation Basis Earthquake with Fire	82.1	0.082	72,000	36	484	0.39
1.0×10^{-5}						
Fire in a Single Building	65.7	0.066	43,000	21.5	605	0.48
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	5.1	0.0024	3,340	1.67	47	0.038
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.05	0.0028
1.0×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.1–6. Annual Cancer Risks for the MPF Alternative at LANL for 450 ppy

Accident	**Maximally Exposed Offsite Individual**[a]	**Offsite Population**[b,c]	**Non-involved Worker**[a]
Beyond Evaluation Basis Earthquake with Fire	8.2×10^{-7}	0.00036	3.9×10^{-6}
Fire in a Single Building	6.6×10^{-6}	0.0022	4.8×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	2.4×10^{-5}	0.017	0.00038
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

C.7.1.2 Nevada Test Site Alternative

Table C.7.1.2–1. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	2.71	0.0014	1,120	0.56	239	0.19
1.0×10^{-5}						
Fire in a Single Building	1.27	0.00064	504	0.25	124	0.099
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.099	5.0×10^{-5}	39.4	0.02	9.69	0.0048
1.0×10^{-2}						
Radioactive Material Spill	0.03	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–2. Annual Cancer Risks for the MPF Alternative at NTS for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.4×10^{-8}	5.6×10^{-6}	1.9×10^{-6}
Fire in a Single Building	6.4×10^{-8}	2.5×10^{-5}	9.9×10^{-6}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	5.0×10^{-7}	0.0002	4.8×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

Table C.7.1.2–3. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	2.8	0.0014	1,150	0.58	246	0.2
1.0×10^{-5}						
Fire in a Single Building	1.32	0.00066	522	0.26	129	0.1
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.099	5.0×10^{-5}	39.4	0.02	9.69	0.0048
1.0×10^{-2}						
Radioactive Material Spill	0.03	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–4. Annual Cancer Risks for the MPF Alternative at NTS for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.4×10^{-8}	5.8×10^{-6}	2.0×10^{-6}
Fire in a Single Building	6.6×10^{-8}	2.6×10^{-5}	1.0×10^{-5}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	5.0×10^{-7}	0.0002	4.8×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

Table C.7.1.2–5. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	5.38	0.0027	2,220	1.11	474	0.38
1.0×10^{-5}						
Fire in a Single Building	2.55	0.0013	1,010	0.51	249	0.2
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.5×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.20	9.9×10^{-5}	78.8	0.039	19.4	0.0097
1.0×10^{-2}						
Radioactive Material Spill	0.030	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–6. Annual Cancer Risks for the MPF Alternative at NTS for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.7×10^{-8}	1.1×10^{-5}	3.8×10^{-6}
Fire in a Single Building	1.3×10^{-7}	5.1×10^{-5}	2.0×10^{-5}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	9.9×10^{-7}	0.00039	9.7×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

C.7.1.3 Pantex Site Alternative

Table C.7.1.3–1. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	29.1	0.029	8,320	4.16	232	0.19
1.0×10^{-5}						
Fire in a Single Building	15	0.0075	3,920	1.96	140	0.11
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.3	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.4×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.2	0.00059	306	0.15	10.9	0.0044
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–2. Annual Cancer Risks for the MPF Alternative at Pantex for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.9×10^{-7}	4.2×10^{-5}	1.9×10^{-6}
Fire in a Single Building	7.5×10^{-7}	0.0002	1.1×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	5.9×10^{-6}	0.0015	4.4×10^{-5}
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

Table C.7.1.3–3. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	30	0.03	8,570	4.29	239	0.19
1.0×10^{-5}						
Fire in a Single Building	15.5	0.0078	4,060	2.0	145	0.12
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.3	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.4×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.2	0.00059	306	0.15	10.9	0.0044
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–4. Annual Cancer Risks for the MPF Alternative at Pantex for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	3.0×10^{-7}	4.3×10^{-5}	1.9×10^{-6}
Fire in a Single Building	7.8×10^{-7}	0.0002	1.2×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	5.9×10^{-6}	0.0015	4.4×10^{-5}
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

Table C.7.1.3–5. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	57.7	0.058	16,500	8.25	460	0.37
1.0×10^{-5}						
Fire in a Single Building	30.2	0.03	7,880	3.94	281	0.23
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.0	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.3×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-6}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.34	0.0012	6.3	0.31	21.9	0.018
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–6. Annual Cancer Risks for the MPF Alternative at Pantex for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.8×10^{-7}	8.3×10^{-5}	3.7×10^{-6}
Fire in a Single Building	3.0×10^{-6}	0.0004	2.3×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0031	0.00018
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

C.7.1.4 Savannah River Site Alternative

Table C.7.1.4–1. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	3.16	0.0016	13,100	6.55	207	0.17
1.0×10^{-5}						
Fire in a Single Building	1.64	0.00082	5,930	3.0	127	0.1
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.5	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.13	6.4×10^{-5}	463	0.23	9.92	0.004
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	2.98	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.4–2. Annual Cancer Risks for the MPF Alternative at SRS for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.6×10^{-8}	6.6×10^{-5}	1.7×10^{-6}
Fire in a Single Building	8.2×10^{-8}	0.0003	1.0×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	6.4×10^{-7}	0.0023	4.0×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

Table C.7.1.4–3. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	3.26	0.0016	13,500	6.75	213	0.17
1.0×10^{-5}						
Fire in a Single Building	1.7	0.00085	6,150	3.07	132	0.11
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.47	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.13	6.4×10^{-5}	463	0.23	9.92	0.004
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	3.0	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

[b] Increased likelihood of a LCF.

[c] Increased likelihood of LCFs.

Table C.7.1.4–4. Annual Cancer Risks for the MPF Alternative at SRS for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.6×10^{-8}	6.8×10^{-5}	1.7×10^{-6}
Fire in a Single Building	8.5×10^{-8}	0.00031	1.1×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	6.4×10^{-7}	0.0023	4.0×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.

[b] Increased likelihood of LCFs.

[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

Table C.7.1.4–5. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	6.27	0.0031	26,000	13	411	0.33
1.0×10^{-5}						
Fire in a Single Building	3.3	0.0017	11,900	5.96	255	0.2
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.47	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.26	1.3×10^{-4}	927	0.46	19.8	0.0079
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	2.98	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.4–6. Annual Cancer Risks for the MPF Alternative at SRS for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	3.1×10^{-8}	0.00013	3.3×10^{-6}
Fire in a Single Building	1.7×10^{-7}	0.0006	2.0×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	1.3×10^{-6}	0.0046	7.9×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

C.7.1.5 Carlsbad Site Alternative

Table C.7.1.5–1. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	50.3	0.05	3,000	1.5	331	0.27
1.0×10^{-5}						
Fire in a Single Building	26.5	0.027	1,380	0.69	206	0.17
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.00076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.1	0.001	108	0.054	16.1	0.0064
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–2. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.0×10^{-7}	1.5×10^{-5}	2.7×10^{-6}
Fire in a Single Building	2.7×10^{-6}	6.9×10^{-5}	1.7×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	1.0×10^{-5}	0.00054	6.4×10^{-5}
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

Table C.7.1.5–3. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	51.8	0.052	3,090	1.55	341	0.27
1.0×10^{-5}						
Fire in a Single Building	27.5	0.028	1,430	0.72	214	0.17
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.0076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.1	0.001	108	0.054	16.1	0.0064
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–4. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.2×10^{-7}	1.6×10^{-5}	2.7×10^{-6}
Fire in a Single Building	2.8×10^{-6}	7.2×10^{-5}	1.7×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	1.0×10^{-5}	0.00054	6.4×10^{-5}
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

Table C.7.1.5–5. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	99.8	0.1	5,950	2.98	657	0.53
1.0×10^{-5}						
Fire in a Single Building	53.3	0.053	2,770	1.39	414	0.33
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.00076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	4.14	0.0021	216	0.11	322	0.026
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–6. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.0×10^{-6}	3.0×10^{-5}	5.3×10^{-6}
Fire in a Single Building	5.3×10^{-6}	0.00014	3.3×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	2.1×10^{-5}	0.0011	0.00026
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

C.7.2 Modern Pit Facility Chemical Accident Frequency and Consequences

The chemicals selected for evaluation are based on the aqueous feed preparation process, as noted in each table, and are considered the most hazardous of all the chemicals used in this process. Determination of a chemical’s hazardous ranking takes into account quantities available for release, protective concentration limits (ERPG-2) and evaporation rate. The most hazardous chemical used in an alternative method, the pyrochemical processing method is also analyzed as noted in the tables.

This section describes the impacts of potential chemical accidents at each of the five MPF alternatives and for the 125 ppy, 250 ppy, and 450 ppy production cases. The tables show the name of the chemical and the quantity released during a severe accident. The impacts of chemical releases are measured in terms of ERPG-2 protective concentration limits given in ppm. The distances at which the limit is reached are also provided for the ERPG-2 limit. The concentration of the chemical at 1,000 m (3,281 ft) from the accident is shown for comparison with the concentration limit for ERPG-2. The distance to the site boundary and the concentration at the site boundary are also shown for comparison with the ERPG-2 concentration limits and for determining if the limits are exceeded offsite.

C.7.2.1 Los Alamos Site Alternative

This section describes the impacts associated with the MPF LANL Alternative.

Table C.7.2.1–1. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	10,500	6	0.68	3.16	1.28	10^{-4}
Hydrofluoric acid[b]	550	20	0.61	6.98	2.43	10^{-4}
Formic acid[b]	1,500	10	0.19	0.51	0.202	10^{-4}
Hydrochloric Acid[c]	600	20	2	69.2	24.8	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.1–2. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	Site Boundary at 1.75 km (ppm)	
Nitric acid[b]	21,000	6	1.4	11.4	3.31	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.83	13.4	4.02	10^{-4}
Formic acid[b]	3,000	10	0.26	0.975	0.34	10^{-4}
Hydrochloric acid[c]	1,200	20	2.7	124	46.4	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.1–3. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	40,000	6	1.9	20.3	7.29	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.1	23.7	8.42	10^{-4}
Formic acid[b]	5,500	10	0.36	1.73	0.694	10^{-4}
Hydrochloric acid[c]	2,200	20	3.5	188	77.7	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.2 Nevada Test Site Alternative

This section describes the impacts associated with the MPF NTS Alternative.

Table C.7.2.2–1. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	10,500	6	0.28	0.5	0.01	10^{-4}
Hydrofluoric acid[b]	550	20	0.35	2.0	0.016	10^{-4}
Formic acid[b]	1,500	10	0.08	0.07	0	10^{-4}
Hydrochloric acid[c]	600	20	1.1	26.3	0.35	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.2–2. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	21,000	6	0.4	0.98	0.02	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.48	3.9	0.03	10^{-4}
Formic acid[b]	3,000	10	0.12	0.14	0	10^{-4}
Hydrochloric acid[c]	1,200	20	1.6	50.9	0.68	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.2–3. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	40,000	6	0.54	1.8	0.038	10^{-4}
Hydrofluoric acid[b]	2,000	20	0.64	6.93	0.056	10^{-4}
Formic acid[b]	5,500	10	0.15	0.25	0.0054	10^{-4}
Hydrochloric acid[c]	2,200	20	2.1	90.7	1.22	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.3 Pantex Site Alternative

This section describes the impacts associated with the MPF Pantex Alternative.

Table C.7.2.3–1. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	10,500	6	0.59	2.49	0.58	10^{-4}
Hydrofluoric acid[b]	550	20	0.59	5.25	0.99	10^{-4}
Formic acid[b]	1,500	10	0.16	0.37	0.87	10^{-4}
Hydrochloric acid[c]	600	20	1.8	60.8	10.4	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.3–2. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	21,000	6	0.88	4.82	1.14	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.83	10.2	1.94	10^{-4}
Formic acid[b]	3,000	10	0.22	0.72	0.17	10^{-4}
Hydrochloric acid[c]	1,200	20	2.5	117	20	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.3–3. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	40,000	6	1.3	8.89	2.11	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.1	18.2	3.46	10^{-4}
Formic acid[b]	5,500	10	0.3	1.28	0.3	10^{-4}
Hydrochloric acid[c]	2,200	20	3.3	202	35.1	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.4 Savannah River Site Alternative

This section describes the impacts associated with the MPF SRS Alternative.

Table C.7.2.4–1. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	10,500	6	0.44	1.27	0.017	10^{-4}
Hydrofluoric acid[b]	550	20	0.49	3.35	0.03	10^{-4}
Formic acid[b]	1,500	10	0.13	0.19	0	10^{-4}
Hydrochloric acid[c]	600	20	1.5	42.2	0.361	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.4–2. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	21,000	6	0.62	2.45	0.032	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.66	6.51	0.06	10^{-4}
Formic acid[b]	3,000	10	0.18	0.37	0	10^{-4}
Hydrochloric acid[c]	1,200	20	2.1	81	0.71	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.4–3. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	40,000	6	0.86	4.52	0.06	10^{-4}
Hydrofluoric acid[b]	2,000	20	0.83	11.5	0.11	10^{-4}
Formic acid[b]	5,500	10	0.24	0.66	0.0084	10^{-4}
Hydrochloric acid[c]	2,200	20	2.8	144	1.28	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.5 Carlsbad Site Alternative

This section describes the impacts associated with the MPF Carlsbad Site Alternative.

Table C.7.2.5–1. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	10,500	6	1.0	6.18	1.57	10^{-4}
Hydrofluoric acid[b]	550	20	0.81	12.7	2.49	10^{-4}
Formic acid[b]	1,500	10	0.28	0.97	0.24	10^{-4}
Hydrochloric acid[c]	600	20	2.4	97.6	20.6	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.5–2. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	21,000	6	1.5	11.9	3.04	10^{-4}
Hydrofluoric acid[b]	1,100	20	1.1	24.6	4.86	10^{-4}
Formic acid[b]	3,000	10	0.39	1.88	0.47	10^{-4}
Hydrochloric acid[c]	1,200	20	3.3	174	38.7	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.5–3. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	40,000	6	2.3	21.9	5.64	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.5	43.7	8.71	10^{-4}
Formic acid[b]	5,500	10	0.54	3.36	0.85	10^{-4}
Hydrochloric acid[c]	2,200	20	4.3	262	66.2	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.

[b] Chemicals used in the aqueous processing method.

[c] Chemical used in the pyrochemical processing method.

C.7.3 Radiological Accident Frequency and Consequences for the TA-55 Upgrade Alternative

This section describes the radiological accident impacts associated with the TA-55 Upgrade Alternative at LANL.

Table C.7.3–1. Upgrade Alternative Radiological Accident Frequency and Consequences at LANL for 80 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	26.4	0.026	23,200	11.6	156	0.13
1.0×10^{-5}						
Fire in a Single Building	20.9	0.021	13,700	6.85	193	0.15
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.6	0.0008	1,070	0.54	151	0.006
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.05	0.0028
1×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

[b] Increased likelihood of a LCF.

[c] Increased likelihood of LCFs.

Table C.7.3–2. Annual Cancer Risks for the Upgrade Alternative at LANL for 80 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.6×10^{-7}	0.00012	1.3×10^{-6}
Fire in a Single Building	2.1×10^{-7}	0.00069	1.5×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.13	0.0028
Nuclear Criticality	5.6×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	8.0×10^{-6}	0.0054	6.0×10^{-5}
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

C.7.4 Chemical Accident Frequency and Consequences for the TA-55 Upgrade Alternative

This section describes the chemical accident impacts for the TA-55 Upgrade Alternative at LANL for the single production case of 80 ppy.

Table C.7.4–1. Upgrade Alternative Chemical Accident Frequency and Consequences for 80 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	3,420	6	0.37	1.08	0.44	10^{-4}
Hydrofluoric acid[b]	340	20	0.5	4.44	1.54	10^{-4}
Hydrochloric acid[c]	384	20	1.6	47.1	16.6	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemical used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.5 Chemical Dispersion Plumes

The chemical accident scenario postulates a release of the chemical and the formation of a chemical pool of one-inch depth in the area surrounding the release. The release could be a result of a pipe or tank rupture. Based on the chemical's properties, evaporation will take place producing an airborne plume that travels in the direction of the wind at the time of the accident. This section provides a graphic representation of the plume with respect to on site and offsite locations.

The plumes for two chemicals have been evaluated, nitric acid for the aqueous plutonium process and hydrochloric acid for the pyrochemical plutonium process. These two chemicals are considered the most hazardous for the indicated process. They are also based on the maximum pit production case of 450 pits per year.

The plume (Figures C.7.5-1 through C.7.5-10) is shown as emanating from the point of release in a direction towards where the maximum exposed individual for radiological accidents would be located. The farthest end of the plume is the point where the ERPG-2 concentration level is no longer exceeded. Concentrations closer to the point of release will be higher then ERPG-2 and at some point exceed the higher concentration limit defined by ERPG-3.

Although the direction of the plume is graphically positioned towards the site boundary where the maximum exposed individual for radiological accidents would be located, in reality the plume will travel in a direction determined by the wind direction at the time of the accident. Thus, the plume could be positioned in a direction anywhere in the circle surrounding the point of release. In the event of an accident, all individuals in the plume as determined by the wind direction at the time will be exposed to harmful chemical concentrations in excess of ERPG-2 and in some cases, in excess of ERPG-3.

Plumes for the TA-55 upgrade case are not shown because the plume concentrations are smaller than the TA-55 MPF Alternative at LANL.

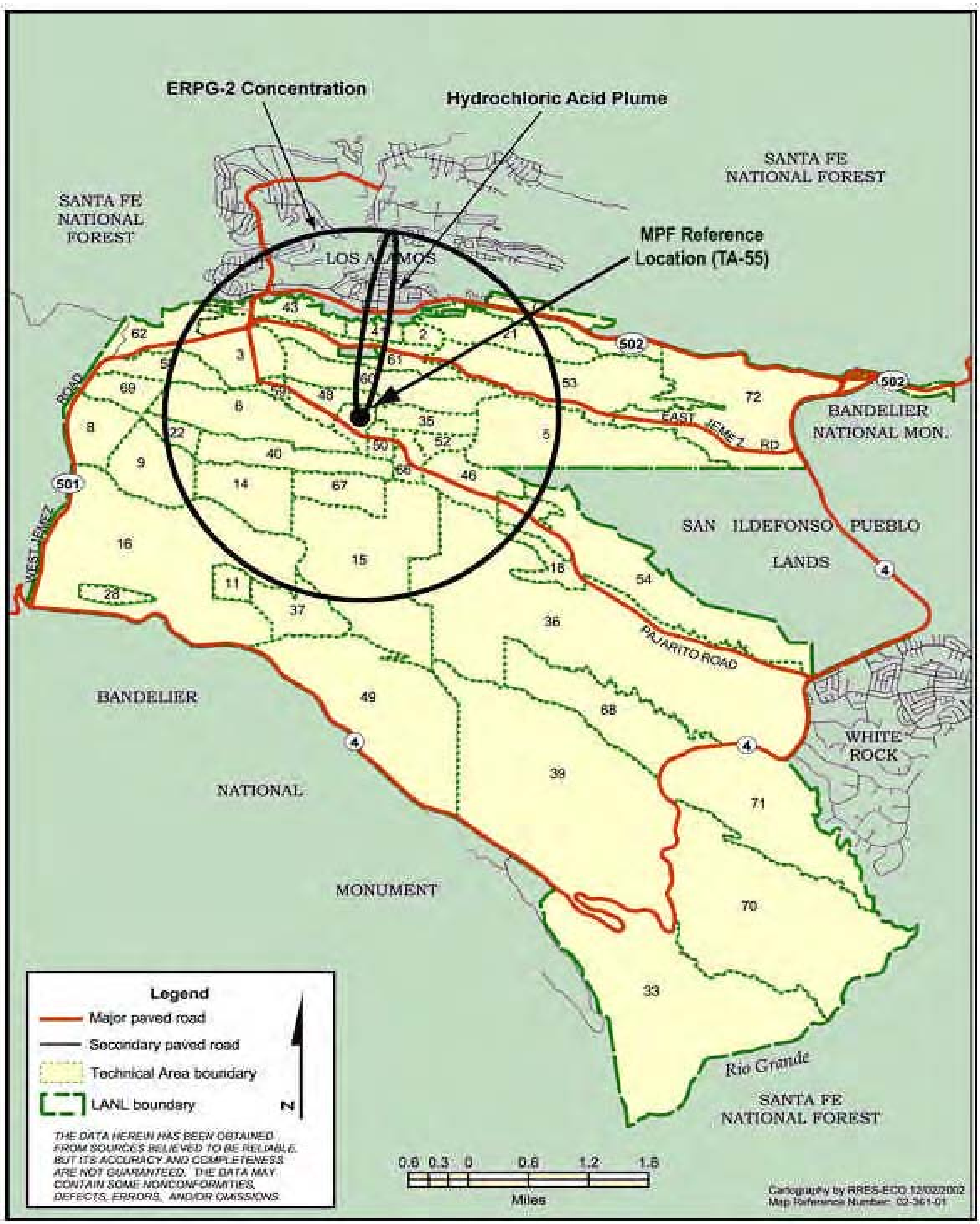
C.8 ANALYSIS CONSERVATISM AND UNCERTAINTY

The analysis of accidents is based on calculations relevant to hypothetical sequences of events and models of their potential impacts. The models provide estimates of the frequencies, source terms, pathways for dispersion, exposures, and the effects on human health and the environment as realistic as possible within the scope of the analysis. In many cases, the scarcity of experience with the postulated accidents leads to uncertainty in the calculation of the consequences and frequencies. This fact has promoted the use of models or input values that yield conservative estimates of consequences and frequency. Additionally, since no credit is taken for safety systems that may function during this event, these events do not represent expected conditions within the facility at any point in its lifetime.

Due to the layers of conservatism built into the accident analysis for the spectrum of postulated accidents, the estimated consequences and risks to the public represent the upper limit for the individual classes of accidents. The uncertainties associated with the accident frequency estimates are enveloped by the analysis conservatism.

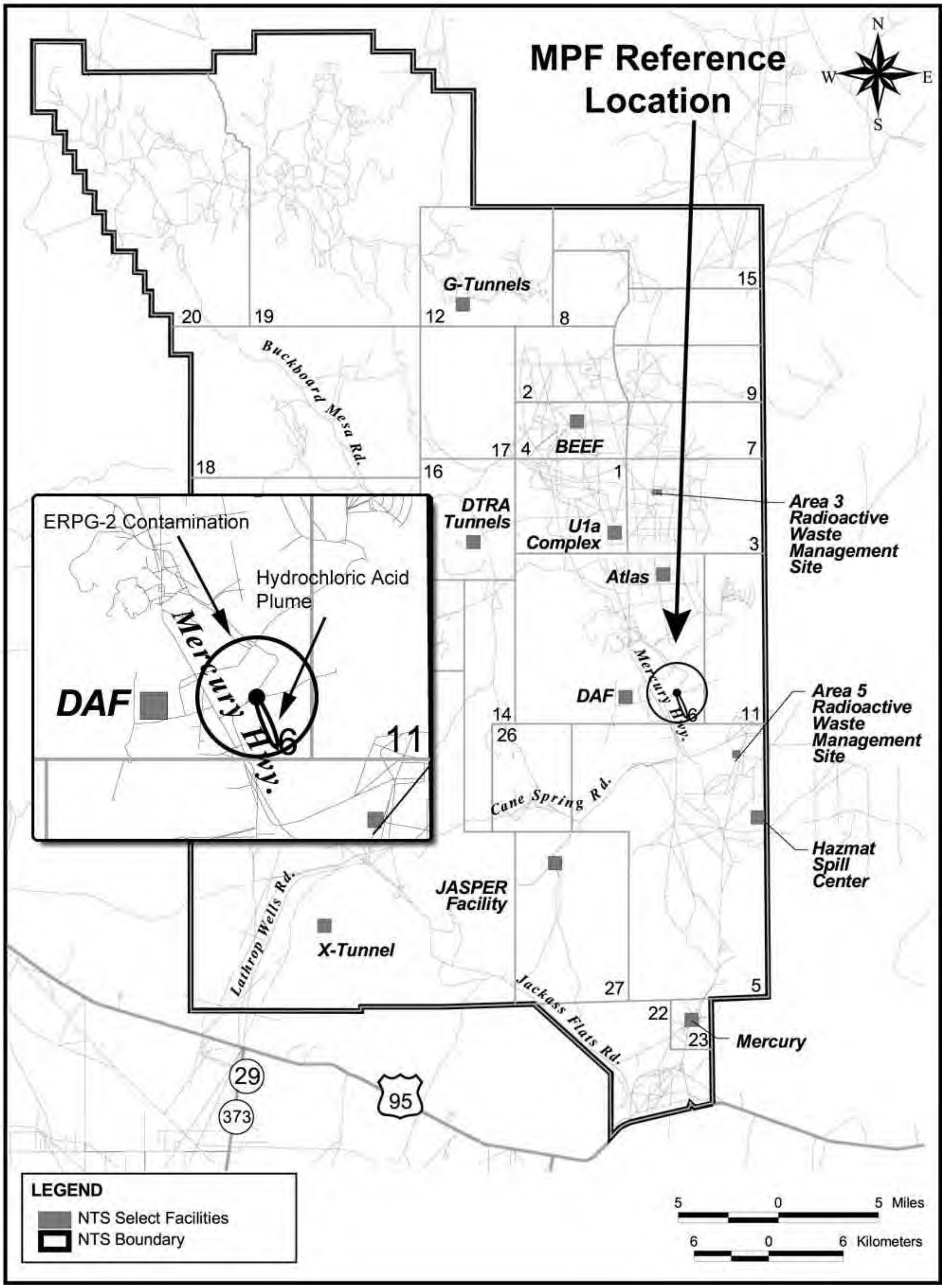
Of particular interest are the uncertainties in the estimates of cancer fatalities from exposure to radioactive materials. The numerical values of the health risk estimators used in this EIS were obtained by linear extrapolation from the nominal risk estimate for lifetime total cancer mortality resulting from exposures of 10 rad, because the health risk estimators are multiplied by conservatively calculated radiological doses to predict fatal cancer risks. The fatal cancer values presented in this EIS are expected to be overestimates.

For the purposes of this EIS, the impacts calculated from the linear model are treated as an upper-bound case, consistent with the widely used methodologies for quantifying radiogenic health impacts. This does not imply that health effects are expected. Moreover, in cases where the upper-bound estimators predict a number of LCFs greater than 1, this does not imply that the LCF risk can be determined for a specific individual.



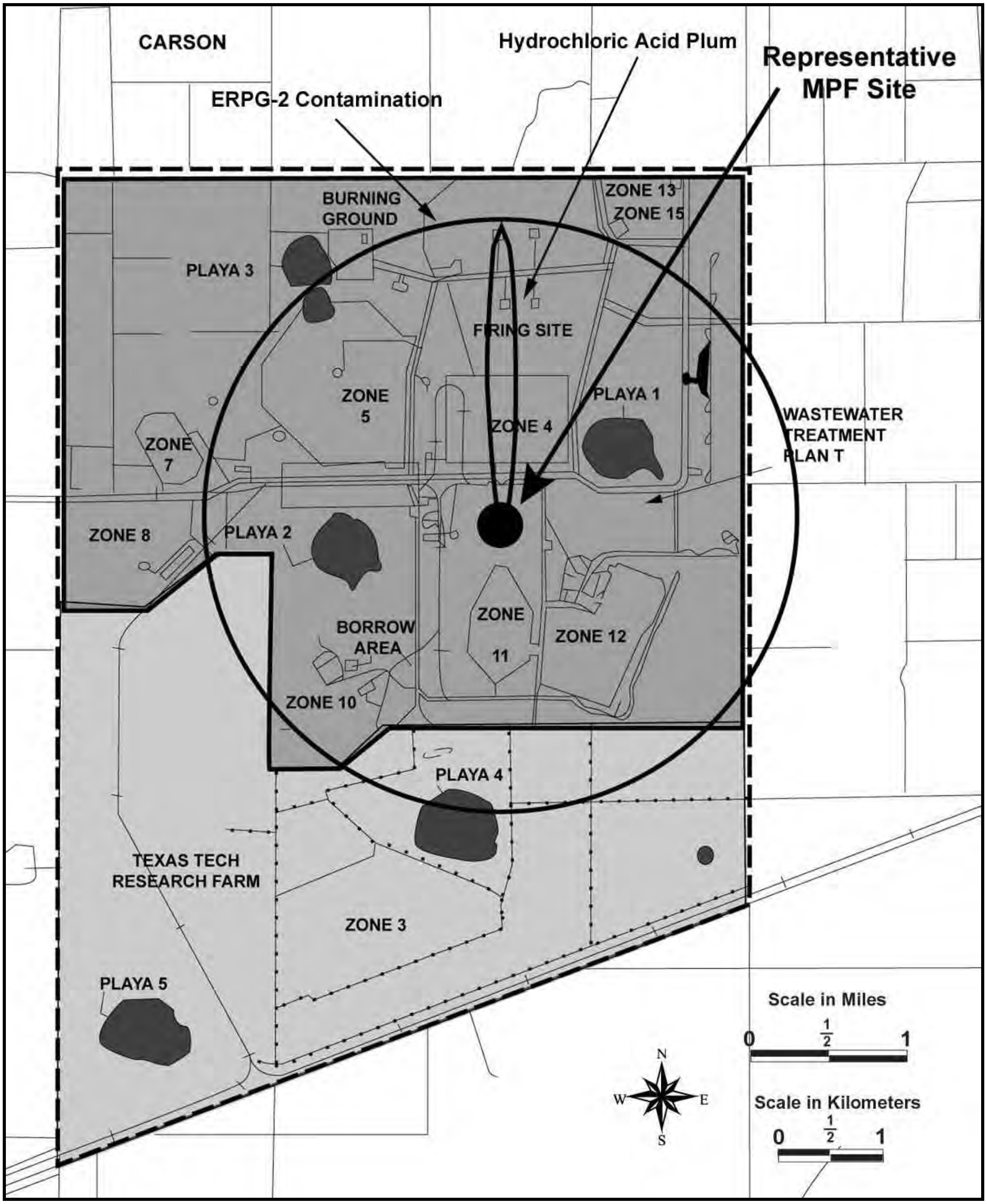
An accidental release of hydrochloric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 3.5 km (2.2 mi) from the source.

Figure C.7.5–1. Accidental Release of Hydrochloric Acid at the MPF at LANL



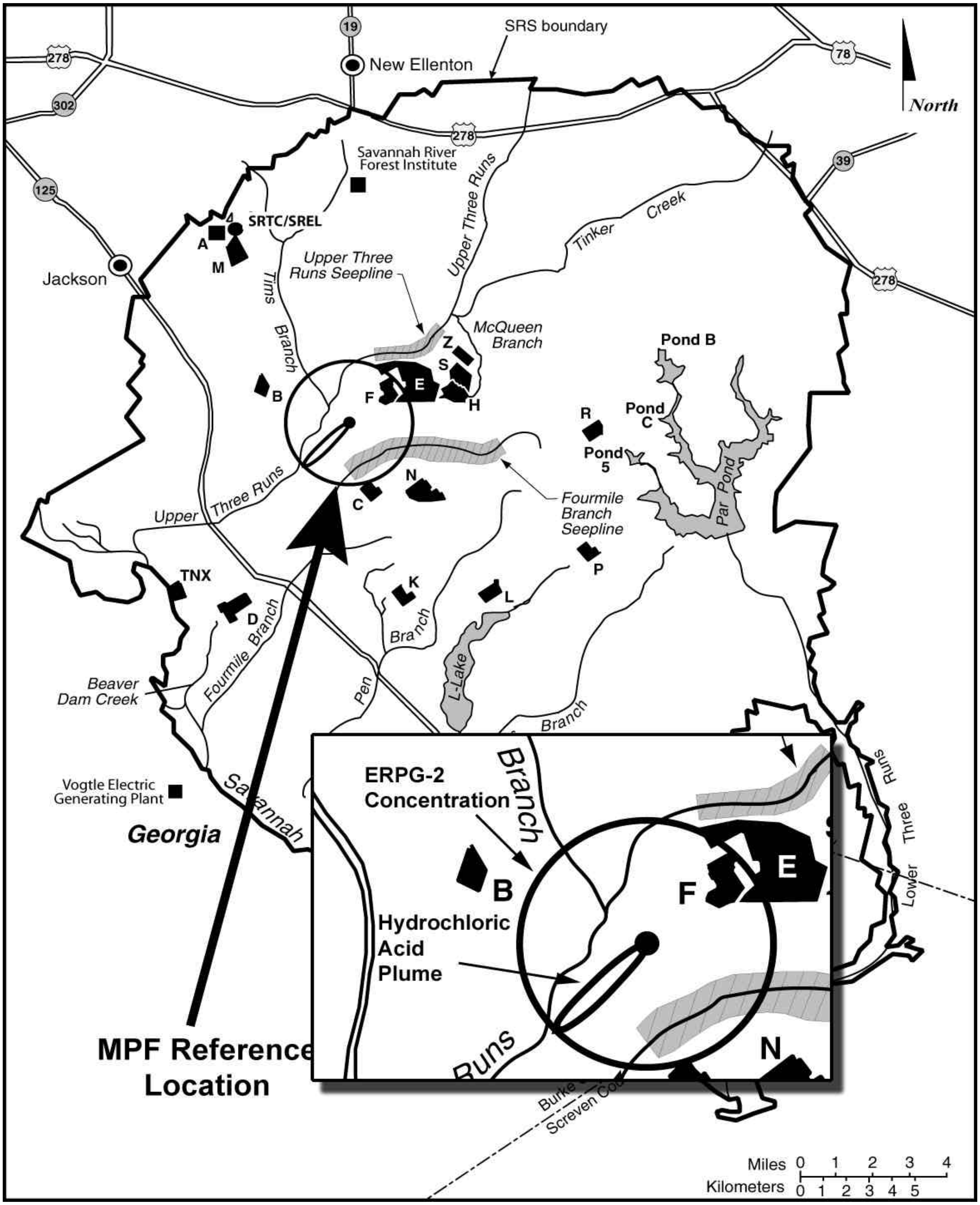
An accidental release of hydrochloric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 2.1 km (1.3 mi) from the source.

Figure C.7.5–2. Accidental Release of Hydrochloric Acid at the MPF at NTS



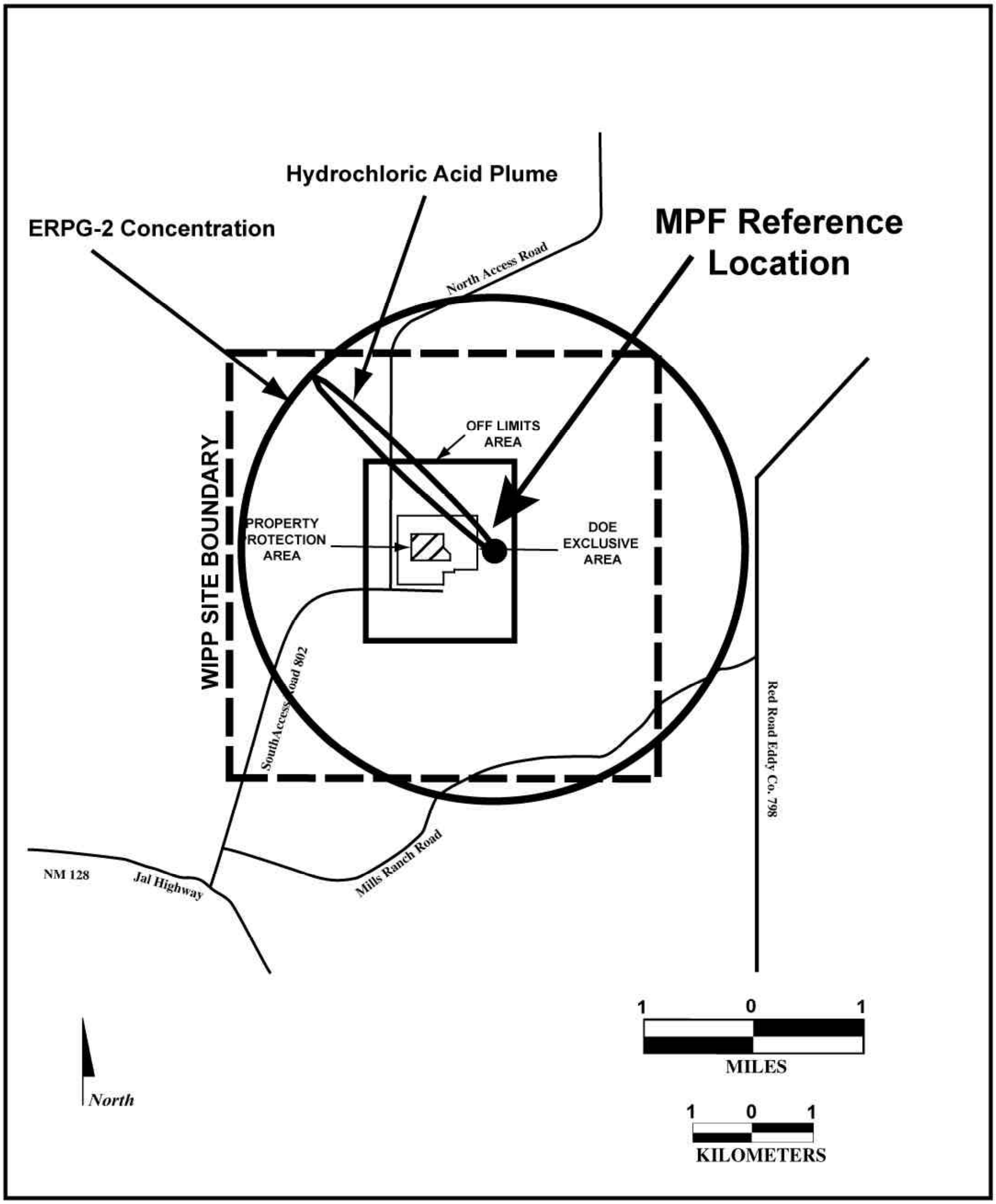
An accidental release of hydrochloric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 3.3 km (2.05 mi) from the source.

Figure C.7.5–3. Accidental Release of Hydrochloric Acid at the MPF at Pantex



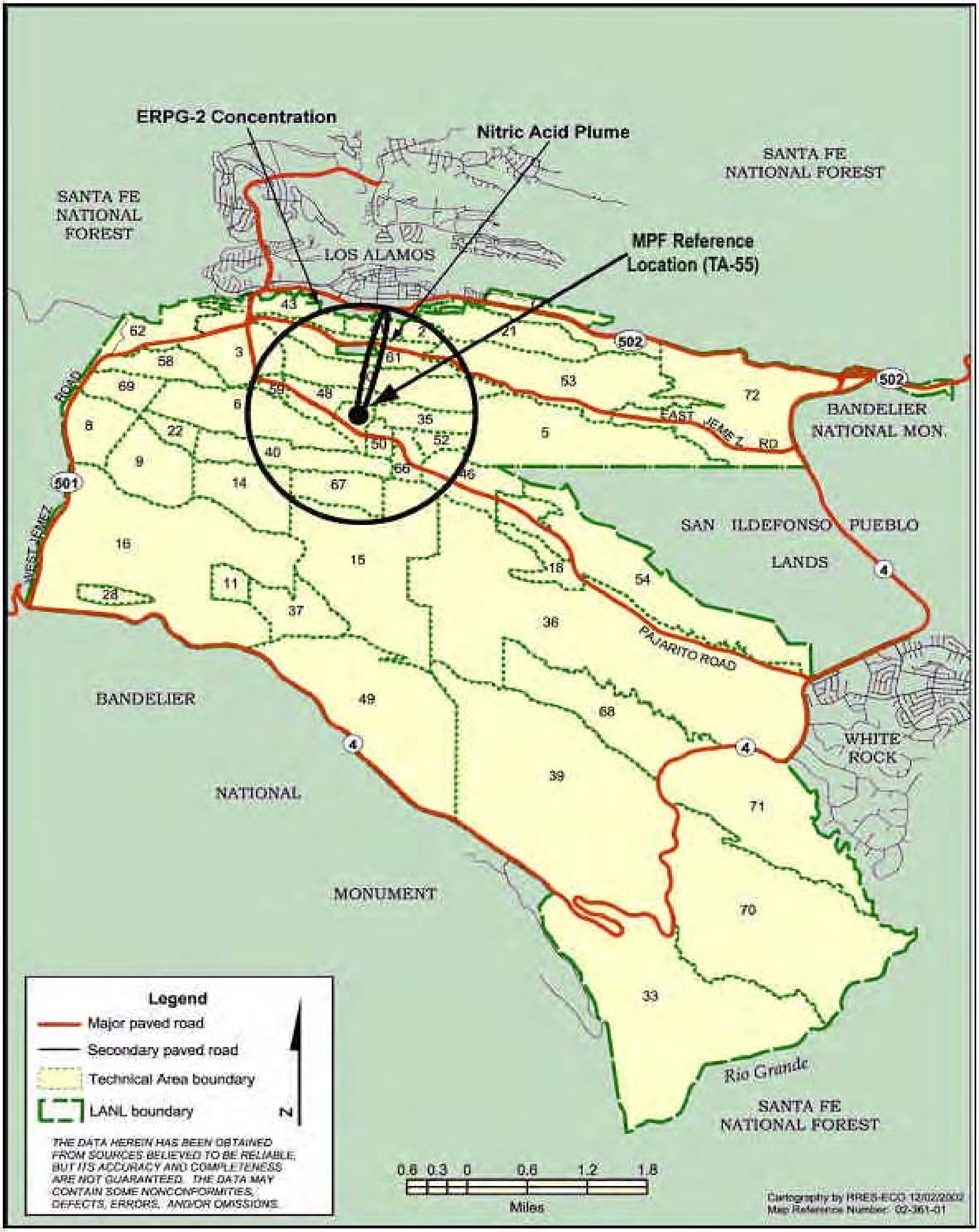
An accidental release of hydrochloric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 2.8 km (1.7 mi) from the source.

Figure C.7.5–4. Accidental Release of Hydrochloric Acid at the MPF at SRS



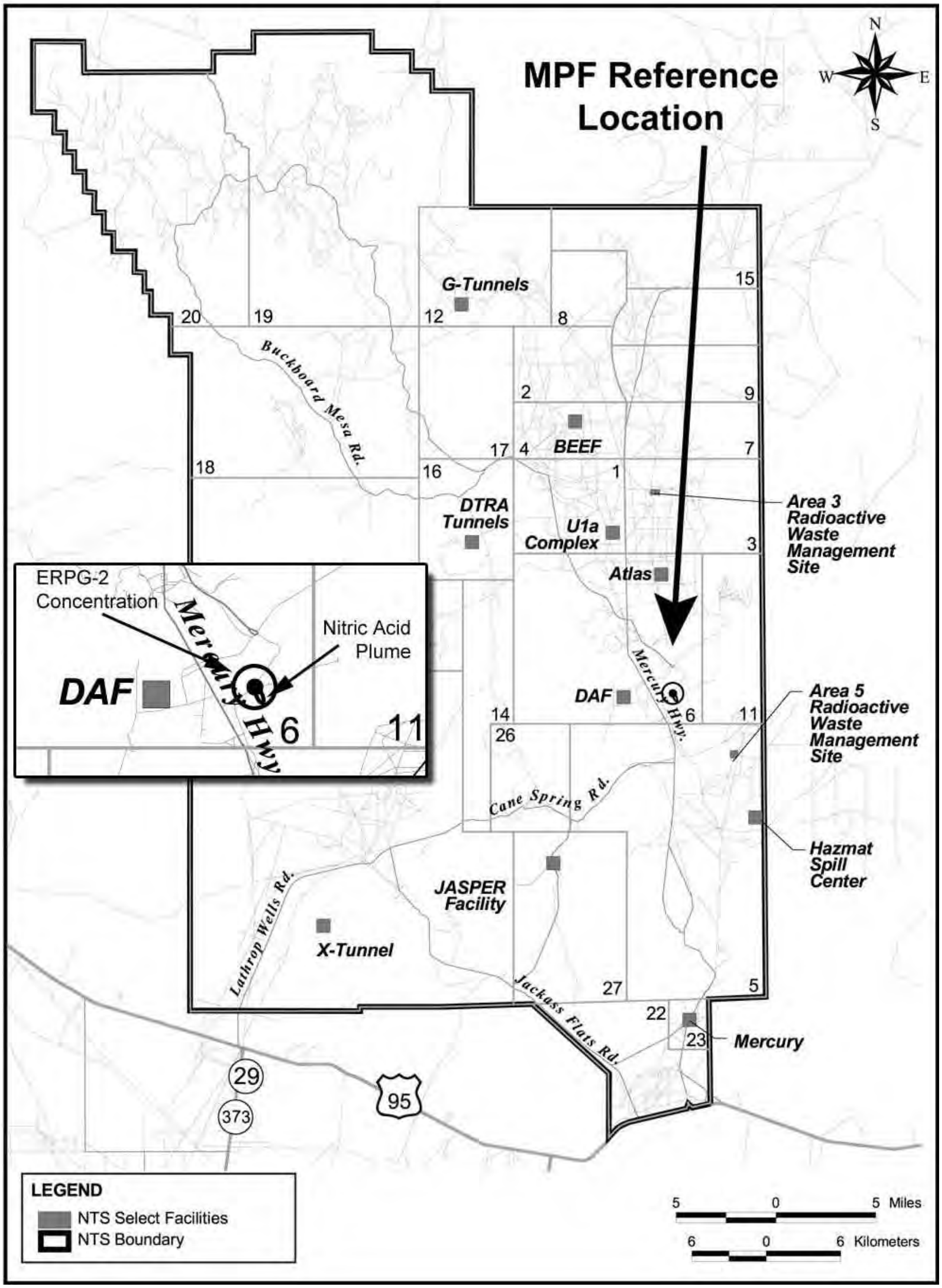
An accidental release of hydrochloric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 4.3 km (2.7 mi) from the source.

Figure C.7.5–5. Accidental Release of Hydrochloric Acid at the MPF at Carlsbad Site



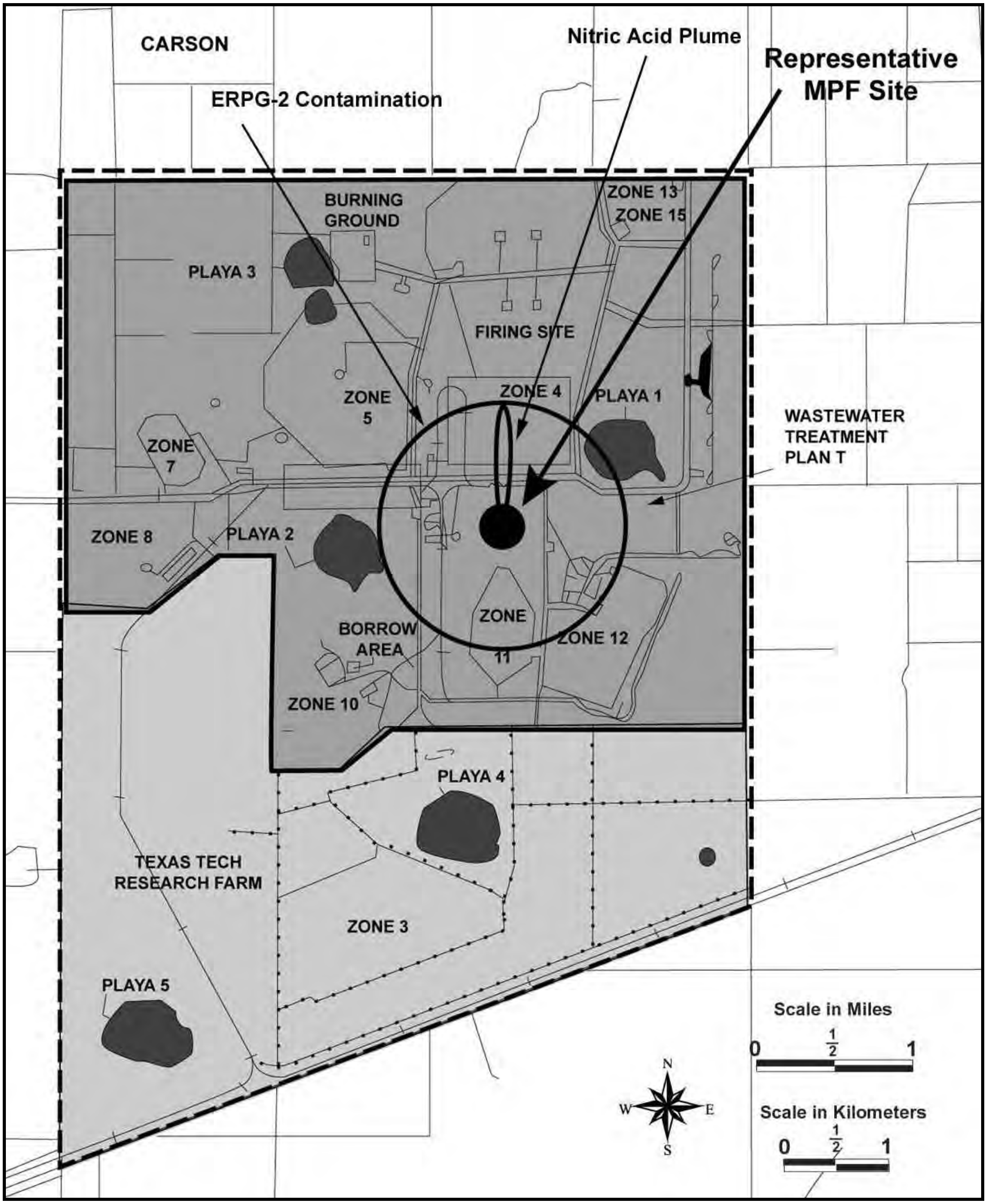
An accidental release of nitric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 1.9 km (1.2 mi) from the source.

Figure C.7.5–6. Accidental Release of Nitric Acid at the MPF at LANL



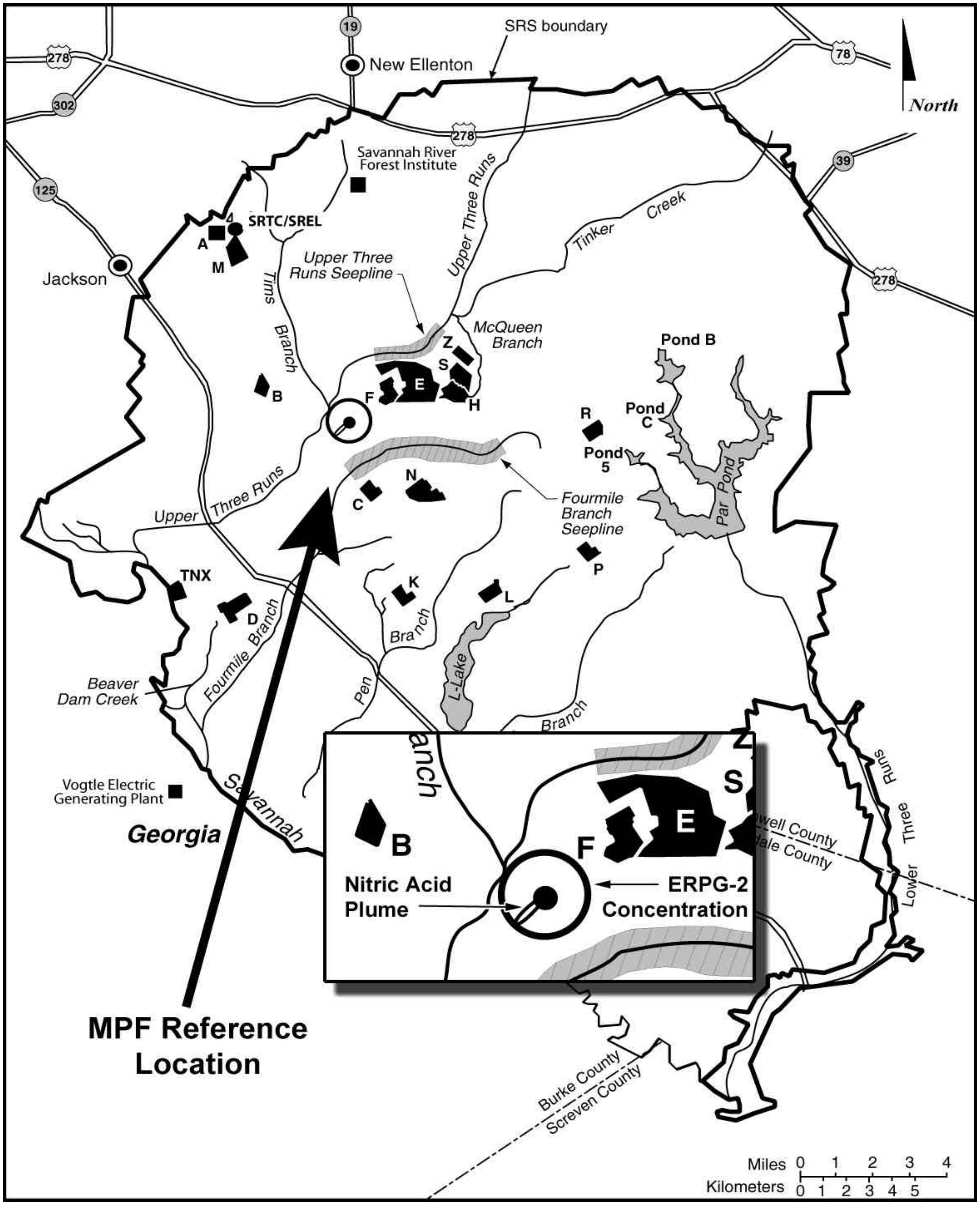
An accidental release of nitric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 0.54 km (0.34 mi) from the source.

Figure C.7.5–7. Accidental Release of Nitric Acid at the MPF at NTS



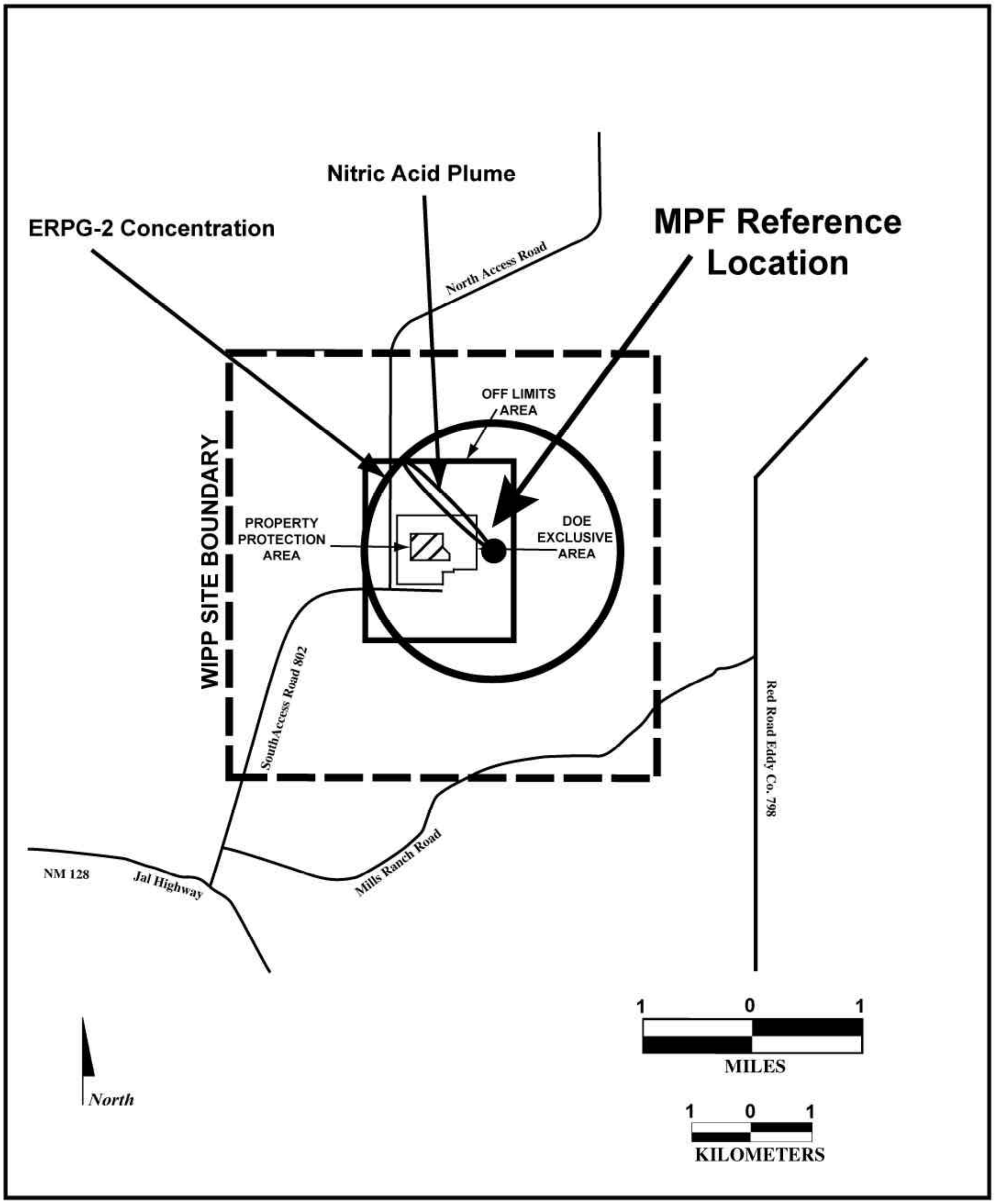
An accidental release of nitric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 1.3 km (0.8 mi) from the source.

Figure C.7.5–8. Accidental Release of Nitric Acid at the MPF at Pantex



An accidental release of nitric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 0.86 km (0.53 mi) from the source.

Figure C.7.5–9. Accidental Release of Nitric Acid at the MPF at SRS



An accidental release of nitric acid from the MPF could affect an area with ERPG-2 levels of exposure extending as far as 2.3 km (1.4 mi) from the source.

Figure C.7.5–10. Accidental Release of Nitric Acid at the MPF at Carlsbad Site

APPENDIX D
RADIOLOGICAL TRANSPORTATION ANALYSIS METHODOLOGY

D.1 SHIPMENT SCENARIOS

D.1.1 Proposed Action for Transportation

The Modern Pit Facility (MPF) Alternative, as described in Chapter 3, includes transportation as a major component. Aged plutonium pit assemblies would be shipped from Department of Energy (DOE) Pantex Plant in Amarillo, Texas to the MPF site under consideration. Enriched uranium (EU) parts would be disassembled from the pit assemblies and shipped to the Y-12 National Security Complex (Y-12) near Oak Ridge, Tennessee. The reworked EU parts would then be shipped back to MPF. The pit assemblies would be returned to Pantex. During startup, and potentially at other infrequent times, plutonium metal would be shipped from either the Savannah River Site (SRS) or Los Alamos National Laboratory (LANL) to the MPF site.

Both transuranic (TRU) waste and low-level waste (LLW) would be generated at the MPF site. It would have to be disposed at another location if facilities at the MPF site were not available. DOE’s Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico would be the destination for TRU waste from all potential MPF sites. Three potential MPF sites, LANL, Nevada Test Site (NTS), and SRS, have LLW disposal facilities. Neither WIPP nor Pantex have such disposal capacity and would have to ship LLW to NTS.

A matrix depicting the origins, destinations, and materials shipped is provided in Table D.1.1–1. The matrix also includes shipments under the No Action and TA-55 Upgrade Alternatives, which are subsets of those for the MPF Alternative.

Table D.1.1–1. Origins, Destinations, and Material Shipped Under the MPF Alternative

Shipment Type	SRS	Pantex	LANL	NTS	Carlsbad Site
SRS Plutonium in	SRS ⇒ SRS	SRS ⇒ Pantex	SRS ⇒ LANL	SRS ⇒ NTS	SRS ⇒ Carlsbad Site
LANL Plutonium in	LANL ⇒ SRS	LANL ⇒ Pantex	LANL ⇒ LANL	LANL ⇒ NTS	LANL ⇒ Carlsbad Site
Pits in	Pantex ⇒ SRS	Pantex ⇒ Pantex	Pantex ⇒ LANL	Pantex ⇒ NTS	Pantex ⇒ Carlsbad Site
EU in	Y-12 ⇒ SRS	Y-12 ⇒ Pantex	Y-12 ⇒ LANL	Y-12 ⇒ NTS	Y-12 ⇒ Carlsbad Site
EU out	SRS ⇒ Y-12	Pantex ⇒ Y-12	LANL ⇒ Y-12	NTS ⇒ Y-12	Carlsbad Site ⇒ Y-12
Pits out	SRS ⇒ Pantex	Pantex ⇒ Pantex	LANL ⇒ Pantex	NTS ⇒ Pantex	Carlsbad Site ⇒ Pantex
TRU waste out	SRS ⇒ WIPP	Pantex ⇒ WIPP	LANL ⇒ WIPP	NTS ⇒ WIPP	Carlsbad Site ⇒ WIPP
LLW out	SRS ⇒ SRS	Pantex ⇒ NTS	LANL ⇒ LANL	NTS ⇒ NTS	Carlsbad Site ⇒ NTS

D.1.2 Materials Shipped

The materials shipped are described as follows.

> **SRS plutonium/LANL plutonium:** Whether from SRS or LANL, this material is plutonium metal that is primarily plutonium-239, but contains other plutonium isotopes in small amounts. It is used for start-up testing and will be infrequently shipped in currently undefined quantities. Because of the relatively small volume of material and lack of specific data on the shipments, analysis of this material is limited to a determination of person-miles for a single shipment, as described in Section D.2.
>
> **pits:** Pits are the feed and product stream of the MPF. A pit is actually an assembly of plutonium metal with EU parts. The plutonium is primarily plutonium-239, and the uranium is primarily uranium-235. A single shipment of pits contains approximately 110 kilograms (kg) (243 pounds [lb]) of plutonium and 450 kg (992 lb) of uranium. Under each of the MPF capacity options of 125, 250, and 450 pits per year (ppy), there will be 7, 14, and 25 roundtrip shipments per year, respectively.
>
> **EU:** The EU parts from disassembled pits are shipped to the Y-12 National Security Complex (Y-12) for processing and returned to the MPF. A single shipment of EU contains approximately 630 kg (1,389 lb) of uranium.
>
> **TRU waste:** Processing of plutonium pits produces contact-handled TRU waste, primarily americium-241. Under the MPF capacity options of 125, 250, and 450 ppy, there will be 74, 93, and 142 shipments per year of TRU waste, respectively.
>
> **LLW:** This waste would consist of job control waste and decontamination wastes. The radioisotopes would primarily be transuranics, but their concentrations would be sufficiently low to classify the waste as LLW. Under the MPF capacity options of 125, 250, and 450 ppy, there will be 136, 217, and 331 shipments per year of LLW, respectively.

D.1.3 Packaging

For purposes of this analysis, the National Nuclear Security Administration (NNSA) used two general package types: Type A and Type B. A Type A package is designed to protect and retain their contents under normal transport conditions and must maintain sufficient shielding to limit radiation exposure to handling personnel. These packages are used to transport LLW. A Type B package is used to transport material with the highest radioactivity levels and to protect and retain their contents under transportation accident conditions.

DOE adopts Nuclear Regulatory Commission standards for Type B packages, which include certification of packages against stringent testing standards (10 CFR 71). The testing or other analysis must certify that the contents of the package will not be released under the following tests:

> **Free Drop:** The cask drops 9 meters (m) (30 feet [ft]) onto a flat, horizontal, unyielding surface so that it strikes at its weakest point.

> **Puncture:** The cask drops 102 centimeters (cm) (40 inches [in]) onto a 15-cm (6-in) diameter steel bar at least 20 cm (8 in) long. The bar strikes the cask at its most vulnerable spot.
>
> **Fire:** After the impact tests, the cask is totally engulfed in an 808 ^{o}C (1,475 ^{o}F) thermal environment for 30 minutes. The cask is then completely submerged under at least 102 cm (40 in) of water for 8 hours. Undamaged packages must withstand more severe immersion tests.

There are numerous designs of Type B packages that the NNSA uses for transporting radioactive materials. The NNSA would select packages that are appropriate for the purpose and contents for which it would be used. Most likely, plutonium pits would use one kind of Type B package and EU parts would use another. The NNSA would use the Transuranic Package Transporter (TRUPACT-II) for contact-handled TRU waste shipments. The TRUPACT-II is a large casks that can contain 14 208-L (55-gal) drums. It includes armor, impact limiters, and thermal insulation and is shipped up to three to a truck.

Type B packages for pits and EU are shipped in specially designed Safe Secure Trailers/Safeguards Transports (SST/SGT). The SST/SGT contains enhanced structural and security features that are classified. They operate under operational security procedures and emergency plans that include armed escort, satellite tracking, and advanced communications.

D.2 ROUTING AND DEMOGRAPHICS

NNSA used the computer code TRAGIS (Transportation Routing Analysis Geographic Information System) (Johnson and Michelhaugh 2000) to determine representative routes for the transportation indicated in Table D.1.1–1. Designed by Oak Ridge National Laboratory, TRAGIS gives routes from an origin to destination based on user-selected criteria. The NNSA selected criteria consistent with transport of radioactive material by preferred routes as described in 49 CFR 397, Subpart D, i.e., highway route-controlled quantities.

TRAGIS provides route information such as nodes, segments, miles per segment, miles per state, miles per highway type, miles per population density category, population within 800 m (0.5 mi) of the route, and other parameters of interest. Some of the output is specifically designed for direct input into the RADTRAN computer code (see Section D.3).

TRAGIS runs were performed for the unique origin-destination pairs indicated in Table D.1.1–1. Pairs with origin the same as the destination were eliminated. Duplicates and pairs already represented by a reverse-direction pair were also eliminated. Unique TRAGIS runs reduced to those in Table D.2–1.

Table D.2–1. Unique TRAGIS Runs

ID No.	Origin-Destination Pair	Material Shipped
1	LANL ⇔ SRS	Plutonium metal
2	Pantex ⇔ SRS	Pits; plutonium metal
3	Y-12 ⇔ SRS	EU
4	LANL ⇔ Pantex	Pits; plutonium metal
5	Y-12 ⇔ Pantex	EU
6	Y-12 ⇔ LANL	EU
7	SRS ⇔ NTS	Plutonium metal
8	LANL ⇔ NTS	Plutonium metal
9	Pantex ⇔ NTS	Pits; LLW
10	Y-12 ⇔ NTS	EU
11	SRS ⇔ Carlsbad Site/WIPP	Plutonium metal; TRU
12	LANL ⇔ Carlsbad Site/WIPP	Plutonium metal; TRU
13	Pantex ⇔ Carlsbad Site/WIPP	Pits; TRU
14	Y-12 ⇔ Carlsbad Site	EU
15	NTS ⇔ WIPP	TRU; LLW

Note: WIPP and Carlsbad Site were modeled as the same location.

The following tabulations provide the resulting RADTRAN input data for each unique TRAGIS run.

LANL Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	29.7	860.5	5,902.2	
People/km^2	11.5	332.2	2,278.8	
Distance				
Miles	1,241.2	430.6	64.5	1,736.1
Kilometers	1,997.5	692.9	103.8	2,794.0
Percentages	71.5	24.8	3.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 GA 226,097 NM 84,915 OK 80,578 SC 4,642 TN 185,926 TX 39,756			
Total Population within 800-m (0.5-mi)Buffer Zone:				**699,082**

Pantex Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	34.96	861.0	5,882.0	
People/km^2	13.4	332.4	2,271.0	
Distance				
Miles	918.2	385.9	50.1	1,354.1
Kilometers	1,477.6	621.1	80.5	2,179.1
Percentages	67.8	28.5	3.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 GA 226,097 OK 80,578 SC 4,642 TN 185,926 TX 2,186			
Total Population within 800-m (0.5-mi) Buffer Zone:				**576,597**

Y-12 Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	48.8	920.9	5,917.6	
People/km^2	18.9	355.6	2,284.8	
Distance				
Miles	188.4	170.8	22.8	382.0
Kilometers	303.3	274.8	36.7	614.7
Percentages	49.3	44.7	6.0	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	GA 226,097 SC 4,642 TN 34,368			
Total Population within 800-m (0.5-mi) Buffer Zone:				**264,408**

LANL Û Pantex

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.2	835.5	5,972.2	
People/km^2	6.2	322.6	2,305.9	
Distance				
Miles	342.1	46.6	14.4	403.0
Kilometers	550.5	74.9	23.2	648.6
Percentages	84.9	11.6	3.6	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM 84,915 TX 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:				**123,335**

Y-12 Û Pantex

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	33.5	776.2	5,788.5	
People/km^2	13.0	299.7	2,235.0	
Distance				
Miles	811.7	252.3	26.1	1,090.1
Kilometers	1,306.3	406.0	42.1	1,754.2
Percentages	74.5	23.1	2.4	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 OK 80,578 TN 168,225 TX 2,186			
Total Population within 800-m (0.5-mi) Buffer Zone:				**328,157**

Y-12 Û LANL

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	28.5	788.2	5,853.9	
People/km^2	11.0	304.3	2,260.2	
Distance				
Miles	1,134.7	296.9	40.6	1,472.1
Kilometers	1,826.1	477.8	65.3	2,369.1
Percentages	77.1	20.2	2.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 NM 84,915 OK 80,578 TN 168,225 TX 39,756			
Total Population within 800-m (0.5-mi) Buffer Zone:				**450,642**

SRS Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	28.9	864.4	6,105.2	
People/km^2	11.2	333.7	2,357.2	
Distance				
Miles	1,987.3	554.8	82.7	2,624.8
Kilometers	3,198.1	892.9	133.1	4,224.1
Percentages	75.7	21.1	3.2	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 287 GA 226,097 IL 37,937 IA 9,881 KY 13,961 MO 185,917 NE 59,486 NV 74,850 SC 4,642 TN 99,201 UT 159,595 WY 32,573			
Total Population within 800-m (0.5-mi) Buffer Zone:				**904,426**

LANL Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	17.9	861.3	6,261.4	
People/km^2	6.9	332.6	2,417.5	
Distance				
Miles	860.7	98.7	17.6	977.1
Kilometers	1,385.2	158.8	28.4	1,572.5
Percentages	88.1	10.1	1.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032 CA 15,433 NV 61,906 NM 76,780			
Total Population within 800-m (0.5-mi) Buffer Zone:				**190,151**

Pantex Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.9	897.6	6,153.3	
People/km^2	6.5	346.6	2,375.8	
Distance				
Miles	1,063.2	104.0	23.0	1,190.3
Kilometers	1,711.1	167.4	37.0	1,915.5
Percentages	89.3	8.7	1.9	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032			
	CA 15,433			
	NV 61,906			
	NM 83,907			
	TX 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:				**235,698**

Y-12 Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	24.0	814.2	5,959.3	
People/km^2	9.3	314.3	2,300.9	
Distance				
Miles	1,861.6	354.3	49.2	2,265.0
Kilometers	2,995.8	570.3	79.1	3,645.1
Percentages	82.2	15.6	2.2	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168			
	AZ 36,032			
	CA 15,433			
	NM 83,907			
	NV 61,906			
	OK 80,578			
	TN 168,225			
	TX 39,756			
Total Population within 800-m (0.5-mi) Buffer Zone:				**563,005**

SRS Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	34.0	815.1	5,632.2	
People/km^2	13.1	314.7	2,174.6	
Distance				
Miles	1,072.5	401.1	39.4	1,512.8
Kilometers	1,726.0	645.5	63.4	2,434.6
Percentages	70.9	26.5	2.6	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AL 67,186 GA 155,168 LA 53,453 MS 47,944 NM 1,150 SC 4,642 TX 186,722			
Total Population within 800-m (0.5-mi) Buffer Zone:				**516,265**

LANL Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	15.2	727.5	4,948.3	
People/km^2	5.9	280.9	1,910.5	
Distance				
Miles	347.2	23.1	3.1	373.5
Kilometers	558.8	37.2	5.0	601.0
Percentages	93.0	6.2	0.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM 29,512			
Total Population within 800-m (0.5-mi) Buffer Zone:				**29,512**

Pantex Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	12.1	961.7	5,317.1	
People/km^2	4.7	371.3	2,052.9	
Distance				
Miles	419.8	20.3	6.9	447.0
Kilometers	675.6	32.7	11.1	719.4
Percentages	93.9	4.5	1.5	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM 19,291 TX 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:				**57,711**

Y-12 Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	32.4	851.1	5,879.8	
People/km^2	12.5	328.6	2,270.2	
Distance				
Miles	1,018.4	319.3	41.3	1,379.0
Kilometers	1,638.9	513.9	66.4	2,219.3
Percentages	73.8	23.2	3.0	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 63,457 NM 1,150 TN 168,225 TX 248,611			
Total Population within 800-m (0.5-mi) Buffer Zone:				**481,443**

NTS Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.6	879.1	6,148.9	
People/km^2	6.4	339.4	2,374.1	
Distance				
Miles	1,084.0	100.6	20.8	1,205.3
Kilometers	1,744.4	161.9	33.4	1,939.8
Percentages	89.9	8.3	1.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032 CA 15,433 NV 61,906 NM 97,394			
Total Population within 800-m (0.5-mi) Buffer Zone:				**210,765**

Based on these data, it is possible to construct a ranking of relative impacts for the various sites with respect to the infrequent plutonium shipments that were not analyzed. The results are presented in Table D.2–2. SRS and LANL logically tied for least impact because they are suppliers of the plutonium metal. Rankings are listed by total person-miles and then re-ranked by selecting only the nearest plutonium supplier.

Table D.2–2. Ranking of Relative Impacts for Plutonium Metal Shipments

Ranking By Total Person Miles			
MPF site	**Person-miles from SRS**	**Person-miles from LANL**	**Total person-miles**
1. LANL	788,000	0	788,000
1. SRS	0	788,000	788,000
2. Pantex	659,000	130,000	789,000
3. Carlsbad Site	585,000	214,000	800,000
4. NTS	1,040,000	211,000	1,250,000

Ranking by Person-Miles to Nearest Supplier		
MPF site	**Nearest supplier**	**Person-miles from nearest supplier**
1. LANL	LANL	0
1. SRS	SRS	0
2. Pantex	LANL	130,000
3. NTS	LANL	211,000
4. Carlsbad Site	LANL	214,000

D.3 INCIDENT-FREE ANALYSIS

NNSA used RADTRAN 5 (Neuhauser and Kanipe 2000) to calculate collective dose from incident-free transportation of radioactive materials by truck. RADTRAN was developed and is maintained by Sandia National Laboratories. It is capable of analyzing both incident-free and accident impacts for highway, rail, ship and barge, and air transport. For incident-free analysis, the code calculates collective doses to persons along the route (e.g., residents), persons sharing the route, persons at stops, and drivers. Important inputs to RADTRAN are the demographic and route data described in Section D.2, the dose rate from the truck, and other parameters.

For incident-free analysis, a principal RADTRAN input is the radiation dose rate one meter from the truck. To determine dose rates from the truck, the NNSA made assumptions about the packages and the truck loading configuration and then used the computer code Microshield (Grove Engineering 1996) to determine doses. For pits, the NNSA selected the gross characteristics of the FL package, a Type B package certified for transport of pits. For EU shipments, the NNSA selected the gross characteristics of the 6M package, also a Type B package certified for the purpose. Contact-handled TRU waste was assumed to be packaged in the TRUPACT-II cask, three to a truck. LLW was assumed to be placed in a Type A 208 L (55-gal) drum, loaded 80 to a truck. For all four materials, actual shipments might involve different but similar packaging.

Microshield calculations of arrays of pit and EU packages placed into SST/SGTs yielded very low dose rates. For conservatism, the NNSA selected a larger dose rate to model, 1 mrem/hr. Years of experience shipping weapons-related fissile materials have demonstrated that the 1 mrem/hr dose rate is not likely to be exceeded. Dose rates for TRU waste were not calculated but taken from the WIPP SEIS (DOE 1997b). LLW was assumed to be 1 mrem/hr based on information in the Waste Management Programmatic EIS (PEIS) (DOE 1997a). The shielding analyses made many simplifying, but conservative, assumptions to arrive at dose rates for analysis that would be higher than those actually encountered.

Individual RADTRAN runs needed for the analysis are indicated in Table D.3–1. (Except for the dose rate, Table D.3–1 also applies to accident analyses.) Results of the shielding analysis are also provided. The index numbers correspond to the TRAGIS runs for the relevant origin-destination pair. The plutonium metal analyses were not performed because of their small contribution to the overall analysis.

Results of the incident-free analysis for a single, one-way shipment are provided in Table D.3–2. They are keyed to the run numbers provided in Table D.2–1. These results can be aggregated into values for the three alternatives, three capacity options, and for the five sites as described in Section D.5 and reported in Sections 5.2.12, 5.3.12, 5.4.12, 5.5.12, and 5.6.12.

Table D.3–1. RADTRAN Runs and Dose Rates for Incident-Free Analysis

No.	Origin-Destination	Material	Dose Rate
1	LANL ⇔ SRS	Plutonium metal	No Run
2a	Pantex ⇔ SRS	Pits	1
2b	SRS ⇒ Pantex	Plutonium metal	No Run
3	Y-12 ⇔ SRS	EU	1
4a	LANL ⇔ Pantex	Pits	1
4b	LANL ⇒ Pantex	Plutonium metal	No Run
5	Y-12 ⇔ Pantex	EU	1
6	Y-12 ⇔ LANL	EU	1
7	SRS ⇒ NTS	Plutonium metal	No Run
8	LANL ⇒ NTS	Plutonium metal	No Run
9a	Pantex ⇔ NTS	Pits	1
9b	Pantex ⇒ NTS	LLW	1
10	Y-12 ⇔ NTS	EU	1
11a	SRS ⇒ Carlsbad Site	Plutonium metal	No Run
11b	SRS ⇒ WIPP	TRU waste	4
12a	LANL ⇒ Carlsbad Site	Plutonium metal	No Run
12b	LANL ⇒ WIPP	TRU waste	4
13a	Pantex ⇔ Carlsbad Site	Pits	1
13b	Pantex ⇒ WIPP	TRU waste	4
14	Y-12 ⇒ Carlsbad Site	EU	1
15a	NTS ⇒ WIPP	TRU waste	4
15b	Carlsbad Site ⇒ NTS	LLW	1

Table D.3–2. Results of Incident-Free RADTRAN Runs (Person-Rem) for a Single Shipment

RADTRAN Run No.	Public Collective Dose				Worker Collective Dose	Total Dose
	Stops	Sharing Route	Along Route	Total Public	Drivers	
1	-	-	-	-	-	-
2a	6.7×10^{-3}	1.6×10^{-2}	2.2×10^{-3}	2.5×10^{-2}	1.6×10^{-2}	4.1×10^{-2}
2b	-	-	-	-	-	-
3	1.4×10^{-3}	6.7×10^{-3}	1.0×10^{-3}	9.1×10^{-3}	5.4×10^{-3}	1.4×10^{-2}
4a	1.4×10^{-3}	3.7×10^{-3}	2.7×10^{-4}	5.3×10^{-3}	4.1×10^{-3}	9.5×10^{-3}
4b	-	-	-	-	-	-
5	5.4×10^{-3}	9.9×10^{-3}	1.3×10^{-3}	1.7×10^{-2}	1.2×10^{-2}	2.9×10^{-2}
6	6.7×10^{-3}	1.4×10^{-2}	1.6×10^{-3}	2.2×10^{-2}	1.6×10^{-2}	3.8×10^{-2}
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9a	5.4×10^{-3}	7.6×10^{-3}	6.5×10^{-4}	1.4×10^{-2}	1.2×10^{-2}	2.5×10^{-2}
9b	6.3×10^{-3}	8.9×10^{-3}	7.6×10^{-4}	1.6×10^{-2}	2.5×10^{-2}	4.1×10^{-2}
10	1.2×10^{-2}	1.8×10^{-2}	1.9×10^{-3}	3.2×10^{-2}	2.4×10^{-2}	5.5×10^{-2}
11a	-	-	-	-	-	-
11b	2.3×10^{-2}	4.3×10^{-2}	6.1×10^{-3}	7.2×10^{-2}	3.8×10^{-2}	1.1×10^{-1}
12a	-	-	-	-	-	-
12b	7.7×10^{-3}	4.6×10^{-3}	3.5×10^{-4}	1.3×10^{-2}	7.3×10^{-3}	2.0×10^{-2}
13a	2.7×10^{-3}	2.3×10^{-3}	1.4×10^{-4}	5.2×10^{-3}	4.1×10^{-3}	9.2×10^{-3}
13b	7.7×10^{-3}	6.6×10^{-3}	4.0×10^{-4}	1.5×10^{-2}	8.8×10^{-3}	2.3×10^{-2}
14	8.1×10^{-3}	1.4×10^{-2}	1.8×10^{-3}	2.4×10^{-2}	1.6×10^{-2}	3.9×10^{-2}
15a	1.9×10^{-2}	2.1×10^{-2}	1.8×10^{-3}	4.2×10^{-2}	2.5×10^{-2}	6.6×10^{-2}
15b	7.9×10^{-3}	8.5×10^{-3}	7.2×10^{-4}	1.7×10^{-2}	2.6×10^{-2}	4.3×10^{-2}

"-" = no RADTRAN run needed.

D.4 ACCIDENT ANALYSIS

The NNSA used RADTRAN 5 for the accident analysis and employed the conservative methodology of NUREG 0170, *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes* (NRC 1977). The method considers eight categories of potential accidents with severity levels based on increasing levels of impact, crush, fire, and puncture. As done for many other RADTRAN analyses of radioactive materials transport, the NNSA has selected parameters for the eight categories consistent with NUREG 0170 and the RADTRAN 5 User Guide. This simple approach with standard inputs based on the materials, packaging, and mode of transport, is appropriate for this programmatic evaluation to distinguish between the five sites.

The results of a RADTRAN accident analysis are based on a sum of the risks over various segments of the transportation route, taking into account differing accident frequencies and severity categories in urban, suburban, and rural population zones. Demographic information is taken from TRAGIS. Accident rates are taken from Saricks and Tompkins (1999) for standard truck transport. Analyses involving SST/SGT transport used actual accident rates that are lower. The final risk output is a product of the collective dose and the probability of the accident occurring, summed over all accident severity categories and population zones. Therefore, although the units of the results are in person-rem, the unitless probability is also a factor in the results.

Results of the RADTRAN runs are provided in Table D.4–1. The results of the RADTRAN runs must be multiplied by the number of shipments per year to give an annual risk value.

Table D.4–1. Results of RADTRAN Accident Runs for a Single Shipment

RADTRAN Run No.	Dose Risk (person-rem)	RADTRAN Run No.	Dose Risk (person-rem)
1	-	9b	4.8×10^{-6}
2a	3.5×10^{-8}	10	2.9×10^{-11}
2b	-	11a	-
3	9.3×10^{-12}	11b	1.5×10^{-4}
4a	6.2×10^{-9}	12a	-
4b	-	12b	2.3×10^{-6}
5	1.8×10^{-11}	13a	4.4×10^{-9}
6	2.2×10^{-11}	13b	6.3×10^{-6}
7	-	14	2.3×10^{-11}
8	-	15a	1.2×10^{-5}
9a	1.6×10^{-8}	15b	3.2×10^{-6}

"-" = no RADTRAN run needed.

NNSA also calculated the traffic accident fatality rate for all radiological transportation associated with the Proposed Action and alternatives. The state-specific miles for each shipment campaign (route mileage time number of trips) was multiplied by state-specific truck accident and fatality rates from Saricks and Tomkins (1999) and the summed for all states. Although the national average accident rate for SST/SGT shipments are much less than that for SST/SGTs, state-specific rates for SST/SGTs are not available. Accordingly, NNSA used commercial truck accident rates for all shipment campaigns. Results are reported in Chapter 5.

D.5 CONSTRUCTION OF ALTERNATIVES

The RADTRAN results presented in Sections D.3 and D.4 must be combined into alternatives, impacts for a given site, and capacity options.

D.5.1 No Action Alternative

Radiological transportation under the No Action Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. For purposes of transportation analysis, these pits are assumed to arrive in two shipments. Recycle shipments of EU would also be sent and received in two shipments.

Therefore, the No Action Alternative includes:

- 2 roundtrip shipments of pits under RADTRAN run 4a
- 2 roundtrip shipments of EU under RADTRAN run 6
- 20 one-way shipments of TRU waste under RADTRAN run 12b

D.5.2 Modern Pit Facility Alternative

D.5.2.1 Los Alamos Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. NNSA’s analysis includes options for 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at LANL, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 4a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 6
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 12b

D.5.2.2 Nevada Test Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for NTS would include transport of pits from Pantex to NTS, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at NTS. NNSA’s analysis includes options for 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at NTS, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 9a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 10
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 15a

D.5.2.3 Pantex Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for Pantex would include recycle of EU parts to and from the Y-12 in Oak Ridge, shipment of TRU waste to WIPP, and shipment of LLW to NTS. The pits would already reside at Pantex. NNSA's analysis includes options for processing 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to result in EU recycle shipments that would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at NTS, the following RADTRAN runs would be selected:

- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 5
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 13b
- 136, 217, 331 one-way shipments of LLW under RADTRAN run 9b

D.5.2.4 Savannah River Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for SRS would include transport of pits from Pantex to SRS, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at SRS. NNSA's analysis includes options for 125, 250, and 450 ppy for purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at SRS, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 2a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 3
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 11b

D.5.2.5 Carlsbad Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for the Carlsbad Site would include transport of pits from Pantex to the Carlsbad Site, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of LLW to NTS. TRU waste would be disposed of at WIPP. The NNSA's analysis includes options for processing 125, 250, and 450 ppy for purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively, each with 18 packages. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively, each with 25 packages.

Therefore, for the MPF Alternative at the Carlsbad Site, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 13a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 14
- 136, 217, 331 one-way shipments of LLW under RADTRAN run 15b

D.5.3 TA-55 Upgrade Alternative

Radiological transportation under the TA-55 Upgrade Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. For purposes of transportation analysis, these pits are assumed to arrive in five shipments. Recycle shipments of EU would be sent and received in four shipments.

Therefore, for the TA-55 Upgrade Alternative, the following RADTRAN run would be selected:

- 5 roundtrip shipments of pits under RADTRAN run 4a
- 3 roundtrip shipments of EU under RADTRAN run 6
- 55 one-way shipments of TRU waste under RADTRAN run 12b

D.6 Calculation of Latent Cancer Fatalities

In Chapter 5 of this EIS, DOE reports human health effects from transportation of radioactive materials in terms of latent cancer fatalities (LCFs). Consistent with recommendations of the International Commission on Radiological Protection (ICRP 1991), DOE uses factors to convert collective dose in person-rem to numbers of latent cancer fatalities. For workers, the value is 4×10^{-4} LCFs per person-rem and for the general population the value is 5×10^{-4} LCFs per person-rem.

APPENDIX E
SUMMARY OF PUBLIC SCOPING COMMENTS

E.1 PUBLIC SCOPING PROCESS

As a preliminary step in the development of an environmental impact statement (EIS), regulations established by the Council on Environmental Quality (40 CFR 1501.7) and the U.S. Department of Energy (DOE) require "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action." The purpose of this scoping process is: (1) to inform the public about a proposed action and the alternatives being considered, and (2) to identify and/or clarify issues that are relevant to the EIS by soliciting public comments.

On September 23, 2002, the National Nuclear Security Administration (NNSA), a separately organized agency within DOE, published a Notice of Intent (NOI) in the *Federal Register* announcing its intent to prepare a *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (67 FR 59577). During the *National Environmental Policy Act* (NEPA) process, there are opportunities for public involvement (see Figure E.1–1). The NOI listed the issues initially identified by DOE for evaluation in the EIS. Public citizens, civic leaders, and other interested parties were invited to comment on these issues and to suggest additional issues that should be considered in the EIS. The NOI informed the public that comments on the proposed action could be communicated via U.S. mail, via electronic mail, a fax line, or in person at public meetings to be held near the alternative location sites.

Figure E.1–1. NEPA Process

Public meetings were held near each of the five alternative location sites and DOE Headquarters: (1) Pantex Site on October 8, 2002, in Amarillo, Texas; (2) Carlsbad Site on October 10, 2002 in Carlsbad, New Mexico; (3) U.S. Department of Energy, on October 15, 2002 in Washington, DC; (4) Nevada Test Site (NTS) on October 17, 2002 in Las Vegas, Nevada; (5) Los Alamos Site on October 24, 2002 in Los Alamos, New Mexico; and (6) Savannah River Site (SRS) on October 29, 2002 in North Augusta, South Carolina (see Figure E.1–2).

As a result of previous experience and positive responses from attendees of other DOE NEPA public meetings and hearings, DOE chose an interactive format for the scoping meetings. Each meeting began with a presentation by a DOE representative who explained the background, purpose and need for the proposed Modern Pit Facility (MPF), the alternatives and NEPA and EIS process. Afterwards, the floor was opened to questions, comments, and concerns from the

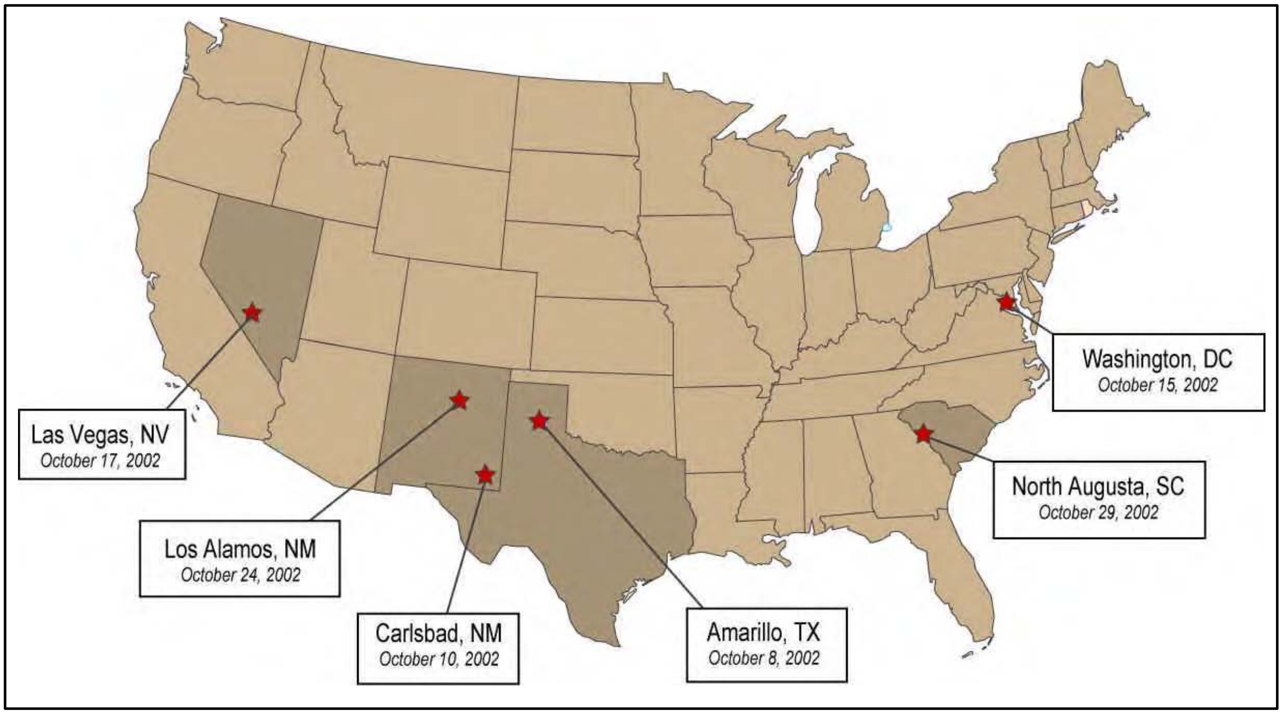


Figure E.1–2. Public Scoping Meeting Locations and Dates

audience. DOE representatives were available to respond to questions and comments as needed. The proceedings and formal comments raised at each meeting were recorded verbatim, and a transcript for each meeting was produced. The public was also encouraged to submit written or verbal comments during the meetings or to submit comments via letters (U.S. mail or electronic mail), or fax line, until the end of the scoping period.

It should be noted that, for EIS public scoping purposes, a comment is defined as a single opinion concerning a specific issue. An individual commentor's public statement may contain several such comments. Most of the verbal and written public statements submitted during the EIS scoping period contained multiple comments on various specific issues. These issues are summarized in the following section.

E.2 SCOPING PROCESS RESULTS

Nearly 1,600 comments were received from individuals, interested groups, and Federal, state, and local officials during the public scoping period, including approximately 480 oral comments made during the public meetings. The remainder of the comments (1,106) was submitted at the public meetings in written form, or submitted via U.S. mail, e-mail, or fax over the entire scoping period. Some commentors who spoke at the public meetings also prepared written statements that were later submitted during or after the meetings. Where this occurred, each comment provided by an individual commentor in both oral and written form was counted as a single comment.

Many of the oral and written comments questioned the need for the MPF. In particular, commentors questioned why the facility was needed since the NOI stated that no problems that would require pit replacements had been found to date. Commentors also quoted several previous DOE documents and DOE and other government officials who stated that both the nuclear and nonnuclear parts of pits in the stockpile were stable and reliable into the foreseeable future.

Other commentors cited a number of studies done by both DOE and independent researchers that demonstrated the stability of plutonium, a main component of a pit, over time; thus commentors felt that until conclusive evidence on pit aging is established, a MPF is not necessary.

Several commentors dismissed the need for the proposed action by stating that the Plutonium Facility, Building 4 (PF-4), the current interim production plutonium machining facility at the Los Alamos Site, analyzed in the 1996 *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996c) for production of up to 80 pits per year, already met the needs of pit refurbishment for the nuclear stockpile. Many commentors also felt that the NOI statement that "…DOE has been without the capability to produce plutonium pits…" is alarmist and false, considering PF-4.

Many commentors raised the issue of international treaties and decisions, particularly the Nuclear Nonproliferation Treaty, the Strategic Offensive Nuclear Reduction Treaty (Moscow Treaty), the Comprehensive Test Ban Treaty, and International Court of Justice Decision, July 1996 opinion, questioning whether a MPF would break international law. Commentors specifically stated that since the United States had agreed, under the Moscow Treaty, to reduce its number of nuclear weapons to approximately 1,700-2,200, the PF-4 was more than sufficient to meet pit refurbishment needs, thus a MPF would not be necessary. Furthermore, commentors wanted clarity on why "agility," defined in the NOI as the ability to change and expand pit production types and plutonium pit designs simultaneously, was necessary at all considering the United States had committed, under the Moscow Treaty, to reduce its number of weapons.

Other issues raised regarding need included questions on why the several thousand pits in reserve at the Pantex Plant could not be used to replace any potentially deteriorating pits in the active nuclear stockpile. Others questioned why a MPF was necessary at all since DOE had created the Stockpile Stewardship Program to monitor the nuclear stockpile. They went on to question that if the MPF was built, why would it be necessary to have both the Stockpile Stewardship Program and a MPF.

A significant number of commentors also expressed concern about the costs associated with building the MPF. Commentors wanted to see the full costs associated with each phase of the MPF: design, construction, operation, transportation of materials, waste handling and final disposition of waste, security, decommissioning, destruction and return of land to its original condition.

Several commentors expressed concern about environmental, health and safety risks associated with the MPF, particularly the transportation of pit materials and waste across the Nation's highways. DOE representatives were urged to thoroughly evaluate the potential consequences of the Proposed Action on local wildlife, water resources, air quality, the potential for accidents and their consequences, and the health and safety of residents near a prospective site and along transportation routes. Commentors suggested that the EIS quantify all radionuclide and chemical emissions associated with the MPF Alternative. Many were concerned that a MPF would not avoid the waste and contamination problems of the old pit facility at the Rocky Flats Plant, which ceased operations in 1989.

Many commentors also expressed concern about the safety and security of the MPF from terrorist actions both from on the ground and from the sky and wanted to know what measures DOE would implement to prevent such actions.

Many commentors expressed support for the No Action Alternative. More than seventy of the comments received were part of a write-in postcard campaign objecting to nuclear weapons. A number of commentors expressed support for the MPF. Other commentors also expressed favor or opposition to the MPF Alternative, reasons for which included security, cost, and workforce advantage.

The transcripts of the six public scoping meetings and all other public comments and materials submitted during the public scoping period were logged, categorized, analyzed, put up on the MPF EIS website (http://www.mpfeis.com), and placed in the Administrative Record.

E.3 COMMENT DISPOSITION AND ISSUE IDENTIFICATION

Comments received during the scoping period were systematically reviewed by DOE. Where possible, comments on similar or related topics were grouped under comment issue categories as a means of summarizing the comments. The comment issue categories were used to identify specific issues of public concern. After the issues were identified, they were evaluated to determine whether they fell within or outside the scope of the EIS. Some issues were found to be already "in scope," among the EIS issues initially identified by DOE for inclusion in the EIS. Table E.3-1 lists these issues along with where the issues are addressed in the EIS.

During the scoping process, DOE received many comments that were judged to be beyond the scope of the MPF EIS. The purpose and scope of the MPF EIS are only to evaluate the potential environmental impacts associated with the proposed siting of a MPF at one of five potential DOE sites, the TA-55 Upgrade Alternative at Los Alamos Site to expand pit production capacity, or the No Action Alternative. Comments judged to be beyond the scope of the EIS included: (1) new weapons development activities; (2) concerns regarding current U.S. foreign policy and national security matters; (3) concerns about the handling of waste and spread of contamination at DOE facilities in the past; and (4) concerns about cost and schedule overruns. Detailed design safety questions not covered in this MPF EIS would be covered in the site-specific tiered-EIS.

Table E.3-1. Issues Included in the EIS (In Scope)

Issues	EIS References
Address the possibility that the MPF would put the U.S. in violation of international laws and treaties.	Chapter 2
Address/review the possibility of having pits made for the U.S. in other nations (e.g., England).	Chapter 3
Address if LANL has the necessary acreage for the MPF.	Chapter 5
Include the long term disposition impacts on land use.	Chapter 5
Address the direction of the prevailing winds at all the alternative sites, specifying if the winds are in the direction of population centers.	Chapter 5
Address the potential for radioactive and non-radioactive air emissions from the MPF.	Chapter 5
Address the potential hurricanes and tornadoes pose to the MPF at each of the five alternative sites.	Chapter 4
Address each site's susceptibility to earthquakes and damage potential.	Chapter 4
Address the potential for the MPF to contaminate the high-yield agricultural lands in the Texas Panhandle and farmland in South Carolina and Georgia.	Chapter 5
Address the potential for the MPF to contaminate both surface and groundwater at all five alternative sites, particularly the movement of plutonium through groundwater.	Chapter 5
Address the potential for the MPF, if sited at the Pantex Site, to contaminate the Ogalla Aquifer (which extends from South Dakota to Texas).	Chapter 5
Address the water needs of the MPF, highlighting whether the current water supply, with the addition of the MPF, would be sufficient to meet both DOE's and the local communities' water needs.	Chapter 5
Address the potential of contamination in groundwater to leak to the rivers and Atlantic Ocean at SRS.	Chapter 4
Address the potential for contaminates in wastewater released from the LANL site to reach the ravines in the valleys below the site where organic farms are located.	Chapter 4
Address the affect of construction and operation of the MPF on Federal and state-listed endangered species and the actions taken to prevent harm as required under the *Endangered Species Act.*	Chapter 5
Due to its isolation from agricultural, urban or industrial activities for the last 50 years, SRS has one of the most biologically diverse suites of regional habitats in the Atlantic and Gulf Coastal Plain. Address how these habitats would be protected if the MPF were to be sited at SRS.	Chapter 5
Discuss all actions DOE would take to protect migratory birds, nests and eggs under the *Migratory Bird Treaty Act.*	Chapter 5
Discuss all actions DOE would take to protect wetlands and floodplains under Executive Orders 11988, 11990 and section 404 of the *Clean Water Act.*	Chapter 5

Table E.3-1. Issues Included in the EIS (In Scope) *(continued)*

Issues	EIS References
Include the epidemiological distribution of cancer, birth defects, infant mortality and other health related effects on the employees and local population at the five alternative sites and project any change with the siting of the MPF at those sites.	Chapter 5, all Human Health and Safety sections; Appendix B
Include a review of occupational and public safety measures to avoid potential criticality incidents; discuss all safety and oversight measures to be taken to avoid a nuclear criticality incident.	Chapter 5; Appendix C
Discuss the potential use of the aqueous process for the MPF.	Chapter 3; Appendix A
Discuss/address the health effects on workers and the local population if an accident or other incident were to occur either during the transportation of materials or at the MPF.	Chapter 5; Appendices C and D
Address the potential impacts on the MPF and its safety from the possible loss of electric power.	Chapter 5; Appendix c
Discuss the potential for airplanes to crash into the MPF.	Classified Appendix
Discuss how as low as reasonably achievable procedures would be implemented at the MPF.	Chapter 5,
Discuss the potential and consequences of a pit explosion.	Chapter 5; Appendix C
Include Rio Arriba County, New Mexico (near Los Alamos Site) in the analysis on environmental justice.	Chapter 5
Include a discussion on number of minorities living near SRS.	Chapter 5
Address/discuss all materials (radioactive, nonradioactive, and waste) to be the transported and the potential accidents that could occur during transportation.	Chapter 5; Appendices C and D
Discuss the potential of an avalanche or rock slide on materials transported on narrow, mountainous, two-lane highways within the State of Nevada (because the state does not have a north-south interstate highway or a interstate highway connecting the state’s two largest cities).	Chapter 5; Appendix D
Considering the high number of Driving While Intoxicated offenses in the State of New Mexico, and past traffic accidents involving DOE transported materials, discuss the measures DOE would take to avoid such accidents in the future.	Chapter 5; Appendix D
Address/discuss all safety and security measures that would be put in place for transporting plutonium pits and related pit parts between DOE sites.	Chapter 5; Appendix D
Address the safety of the TRUPACT shipment containers, which DOE has confirmed, emits radiation within a 5-mile radius (without accidents) as the shipments pass through towns.	Chapter 5; Appendix D
Discuss the routes of the transported materials (so citizens along those routes can be fully informed).	Chapter 5; Appendix D
Address/discuss the lifecycle of all waste streams, including storage and ultimate disposition.	Chapter 5
Address/discuss all permits that would be required for waste disposition	Chapter 5; Chapter 6
Address/discuss the accelerated closure of the WIPP facility, which would be closed either before or soon after the MPF, begins operation and where the waste WIPP is currently taking would then be disposed.	Chapter 6

Table E.3-1. Issues Included in the EIS (In Scope) *(continued)*

Issues	EIS References
Discuss the cumulative impacts on human health and the environment from waste streams and contamination already at each of the sites and with the addition of the MPF.	Section 5.8
Discuss all aspects of decommissioning and deconstructing the MPF once its useful life is finished; discuss how the land to be used for the MPF would be returned to its original condition.	Section 5.7
Discuss whether the amount of waste that would be generated at the MPF is similar to the amount that was generated at Rocky Flats.	Chapter 3; Chapter 5
Address safeguard and security measures to be put in place to protect the MPF and shipments of materials to and from the MPF from different types of terrorist attacks (e.g., from the air, from the ground).	Classified Appendix
Address/discuss the potential consequences of a terrorist attack on the MPF to the communities downwind and downstream from the site and the measures DOE would put in place to mitigate those consequences.	Classified Appendix
Address/discuss all applicable Federal and state laws and regulations that DOE would have to follow to build the MPF.	Chapter 6
Address the limitations on land use under *WIPP Land Withdrawal Act* and the U.S. Environmental Protection Agency's role and responsibilities under the Act.	Chapter 6
Address/discuss the role of all other governmental agencies involved with the MPF project.	Chapters 5 and 6
Discuss a number of studies done by both DOE and independent researchers on the stability of plutonium over time.	Chapter 2
Address MPF's potential need for a waste solidification facility; the NRC has stated that the Mixed Oxide Fuel Fabrication Facility (MOX), using similar materials to MPF, would need such a facility.	Chapter 3
Address what would happen to pits if they are shipped to the selected site, but the MPF project is halted. Discuss the long-term storage plans for pits.	Chapter 3
MPF at the Los Alamos Site: Address in the EIS any integration of the CMRR and PF-4 with MPF.	Chapter 3
MPF at SRS - MOX Facility: Address/Review restrictions on use of the MOX plant at SRS for a pit mission, including constraints of the U.S.-Russian plutonium disposition agreement and international agreements on control of "dual-use" civilian military equipment. Address availability of MOX plant for MPF use after MOX mission has ended and NRC licensing terminated. Address any correlations between the failure of the MOX missions and pit production plans. Address dual-use controls and safeguards established by International Atomic Energy Agency, Nuclear Suppliers Group and Zangger Committee when discussing all possible overlaps between MOX and pit programs.	Chapter 3
MPF at SRS - Other Facilities: Address/review the viability of using other facilities at SRS in support of or in conjunction with the MPF: Pit Disassembly and Conversion Facility (PDCF), K Area Materials Storage.	Chapter 3

Table E.3-1. Issues Included in the EIS (In Scope) *(continued)*

Issues	EIS References
Address/review the ability of the Kansas City Plant and Oak Ridge to make nonnuclear parts for pit production.	Chapter 3; Appendix A
Include the site screening report in the EIS so the public can review the how DOE has already evaluated and eliminated potential sites for the MPF.	Appendix G
Address/discuss the reasons for eliminating the Y-12 National Security Complex (Y-12) as the MPF site. A 1997 DOE Report, "Rapid Reconstruction of Pit Production Capacity: Systems Studies and Recommendations" stated that "a combined SRS/Y-12 site is the technically superior multi-site option for the MPF." Address/discuss how Y-12's traditional mission of fabricating highly enriched uranium components may intersect with pit production.	Chapter 3; Appendix G
Discuss the additional energy use needed for the MPF and the additional environmental impacts due to increased power generation.	Chapter 5
Address the reliability of HEPA filters in preventing plutonium transport: specifically their reliability in case of a fire, during a nuclear criticality event, the potential of alpha recoil of plutonium through HEPA filters, and vaporized plutonium.	Chapter 5
Discuss how DOE would prevent at the MPF the types of accidents that occurred at the pit production facility at Rocky Flats, including new technology to be used to prevent accidents and contamination.	Chapter 3
Discuss the exposure pathways that would occur if a rain storm occurred during the release of contaminates via air (radiological and non-radiological) and the potential health affects on the population exposed.	Chapter 5
Discuss recent studies that have shown that continuous low levels of radiation exposure over a specific area are much more damaging than previously believed (see studies by Dr. Bertell); address/discuss radiation's cumulative effect, commonly called the Petcau effect.	Chapter 5; Appendix B
Address the potential risk of exposure to contamination and the exposure pathways to individuals and communities that would be downwind and downstream from the MPF, particularly children, pregnant women and senior citizens who are especially susceptible.	Chapter 5; Appendix B

APPENDIX F
ENVIRONMENTAL IMPACT METHODOLOGY

This appendix briefly describes the methods used to assess the potential direct, indirect, and cumulative effects of the alternatives in the *Modern Pit Facility Environmental Impact Statement* (MPF EIS). Included are impact assessment methods for land use, visual resources, site infrastructure, air quality and noise, water resources, geology and soils, biological resources, cultural and paleontological resources, socioeconomics, human health and safety, accidents, environmental justice, transportation, waste management, and cumulative impacts. Each section includes descriptions of the affected resources, region of influence (ROI), and impact assessment methods.

F.1 LAND USE/VISUAL RESOURCES

F.1.1 Land Use

F.1.1.1 Description of Affected Resources and Region of Influence

The analysis of impacts to land use will consider land use plans and policies, zoning regulations, and existing land use as appropriate for each site analyzed. The potential impacts associated with changes to land use as a result of the alternatives will be discussed.

F.1.1.2 Description of Impact Assessment

Land use changes associated with construction and operation of the MPF could potentially affect both developed and undeveloped land. The analysis of land use will consider impacts that could result from the construction and operation of the MPF on each site. Potential changes in land use, if any, would likely occur within the existing boundaries of the alternative sites. However, the use of lands adjacent to or in the vicinity of U.S. Department of Energy (DOE) sites (i.e., non-DOE land) could be affected by these changes, including new or expanded safety zones.

The degree to which the MPF could affect future use or development of land at each DOE site will be considered. Land use impacts will be assessed based on the extent (relative to the immediate surroundings and the plant site, as a whole) and type of land that would be affected. The land use analysis will also consider potential direct impacts resulting from the conversion of land and/or the incompatibility of land use changes with special status lands such as national parks or monuments, and other protected lands such as Federal- and state-controlled lands (e.g., public land administered by the Bureau of Land Management [BLM] or other government agencies).

F.1.2 Visual Resources

F.1.2.1 Description of Affected Resources and Region of Influence

Visual resources include natural and man-made physical features that give a particular landscape its character and value. The feature categories that form the overall impression a viewer receives of an area include landform, vegetation, water, color, adjacent scenery, rarity, and man-made (cultural) modifications.

F.1.2.2 Description of Impact Assessment

Criteria used in the visual resources analysis will include scenic quality, visual sensitivity, distance, and/or visibility zones from key public viewpoints. The analysis will be comparative in nature and consist of a qualitative examination of potential changes in visual resources, scenic values (attractiveness), and view corridors (visibility). Aspects of visual modification to be examined will include site development or modification activities that could alter the visibility of structures at each of the alternative sites or obscure views of the surrounding landscape, and changes in land cover that could make structures more visible.

F.2 SITE INFRASTRUCTURE

F.2.1 Description of Affected Resources and Region of Influence

This section describes the impact on Los Alamos National Laboratory (LANL) site infrastructure for the No Action Alternative and the modifications that would be needed for the construction and operation of the MPF Alternative and the TA-55 Upgrade Alternative. These impacts are evaluated by comparing current site infrastructure to key facility resource needs for the No Action, MPF, and TA-55 Upgrade Alternatives.

F.2.2 Description of Impact Assessment

The assessment of potential impacts to site infrastructure, which includes electrical power, fuels, and process gases, addresses whether there is sufficient available and peak capacity to support the MPF Alternative and pit production capacities. Projections of electricity availability, site development plans, and other DOE mid- and long-range planning documents are used to project site infrastructure conditions. Tables are presented that depict the additional infrastructure requirements resulting from the alternatives. Mitigation considerations that could reduce impacts due to changes in infrastructure are identified on a site-by-site basis.

F.3 AIR QUALITY AND NOISE

F.3.1 Nonradiological Air Resources

F.3.1.1 Description of Affected Resources and Region of Influence

The air quality assessment evaluates the consequences of criteria and hazardous/toxic air pollutants associated with each alternative at each candidate site. The criteria pollutants are specified in 40 CFR 50, the U.S. Environmental Protection Agency (EPA) Regulations on National Primary and Secondary Ambient Air Quality Standards. The hazardous/toxic air pollutants are listed in Title III of the 1990 *Clean Air Act* (CAA) Amendments, the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61), and standards or guidelines proposed or adopted by the respective states.

Current information on emissions from existing operations and ambient air concentrations will be obtained from each alternative site's information (e.g., site Annual Reports, recent EISs).

F.3.1.2 Description of Impact Assessment

Atmospheric dispersion of pollutant emissions from construction activities (e.g., engine exhaust and fugitive dust emissions), operations, and maintenance activities will be estimated with conventional modeling techniques, such as those included in the EPA's SCREEN3 and Industrial Source Complex Short Term (ISCST) models. The estimated concentrations of these pollutants at facility boundaries will be compared with existing air quality standards for criteria pollutants or with guidelines for pollutants that do not have corresponding standards.

EPA guidelines are conservatively applied in the air quality assessment. The "highest-high" will be selected for comparison to applicable standards and guidelines for all averaging times, instead of the EPA-recommended "highest-high" and "highest second highest" concentration for long-term and short-term averaging times, respectively. The concentrations to be evaluated are the maximum occurring at or beyond the site boundary or public access roads. Chemical release rates and modes (e.g., pounds per year, stack height and velocity) will be defined fro the project alternatives. It will also be assumed that the toxic/hazardous emissions for the alternative sites with incomplete source characteristics originate from a single point source. This assumption generally results in higher concentrations than would actually occur since emission sources are commonly geographically separated from one another.

A more detailed and quantitative assessment will be performed in site-specific *National Environmental Policy Act* (NEPA) documents designed to support a construction-level siting decision. This EIS assessment of impacts from the No Action Alternative and the other alternatives will use a screening level analysis based on conservative assumptions for modeling of potential impacts. The screening level modeling analysis to be presented in the EIS is a programmatic approach intended to provide a comparison of the air quality among each of the alternative sites. Modeled concentrations of air pollutants to be presented in the EIS that exceed the Federal or state air quality standards provide an indication of a potential problem. Detailed modeling and/or monitoring at each site would be required in order to obtain more accurate estimates of pollutant concentrations. The assessment in followon site-specific NEPA documents would be more refined with detailed design, source characteristics, and exact source locations.

Health risks from hazardous chemical releases during normal operation at the respective sites will be assessed. A model such as ISCST or SCREEN3 will be used to assess concentrations to the population, to maximum exposed individuals (MEIs), and to non-involved workers. Hazard Index (HI) values will be used to screen for additional analysis. Site boundary concentrations will be used to develop hazard quotients (HQs) for noncancer risks for comparison to reference concentration values, such as the EPA Integrated Risk Information System. The cancer risk to the maximally exposed individual is calculated from the doses derived from modeling exposure levels, using slope factors or unit risks for individual chemicals published in the Integrated Risk Information System or the health effects summary tables. The health effects summary tables are the yearly summary of EPA's regulatory toxicity data.

The HIs and cancer risks are used to identify potential health concerns that may require further analysis. If the HI and/or cancer risk exceed acceptable limits, then these sites or activities become candidates for further analysis. The in-depth analysis should identify the individual chemicals that contribute to substantial adverse HI and/or cancer risk impacts, starting with those chemicals showing the highest HQs and/or cancer risk and grouping them according to their specific health effects. These chemicals may then be identified for inclusion in more specific site analyses. HIs and/or the cancer risk default values exceeding Occupational Health and Safety Administration (OSHA) standards do not necessarily indicate that a health concern exists. The calculated HIs and cancer risk only establish a baseline for comparison of alternatives among different sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action Alternative HI and cancer risk to the public at each site.

F.3.2 Radiological Air Resources

F.3.2.1 Description of Affected Resources and Region of Influence

It is expected that radiological impacts from the MPF to workers and surrounding populations will be predominantly via the air pathway. Current information on dose to non-involved workers, MEI, and collective dose to surrounding population due to radiological releases from existing operations will be obtained from each alternative site's information (e.g., site Annual Reports, recent EISs). Impacts from operation of the MPF at each site will be calculated using a model such as GENII or CAP-88.

F.3.2.2 Description of Impact Assessment

The impacts from operation of the MPF at each site are based on a combination of site-specific and technology-specific data. Site-specific data required for modeling include meteorology (e.g., wind speed, wind direction, precipitation), population distribution (for impacts on population), agricultural production (distribution about the release, types and quantity produced), and distances and directions to the fenceline (or other locations at which the public could be exposed; for MEI calculations). All distances and directions (population and agricultural distribution, fenceline) are relative to the assumed location of the MPF at each alternative site.

Operations data required for the calculations include release rates (i.e., curies per year by nuclide) and modes of release (e.g., stack height, stack velocity, diffuse release area). Doses will be calculated for the general population and for non-involved workers (i.e., onsite workers not directly involved in the pit manufacturing operations). The latter will be assumed to be 1,000 meters (m) (3,281 feet [ft]) from the release.

F.3.3 Noise

F.3.3.1 Description of Affected Resources and Region of Influence

Current information on noise from existing operations will be obtained from each alternative site's information (e.g., site Annual Reports, recent EISs).

F.3.3.2 Description of Impact Assessment

The methodology used to determine environmental impacts of the MPF at each of the alternative sites with respect to noise will involve a two-step analysis. The first step will be to identify noise levels associated with construction and operation of the MPF and determine if they are likely to exceed noise levels defining ambient background conditions. If these noise levels could exceed ambient conditions, the analysis will determine whether the impacts are significant, using a qualitative assessment of the increase or decrease in noise level experienced by receptors near the source.

A subjective response to changes in sound levels based upon judgments of sound presented within a short time span indicate that a change of ±5 A-weighted decibels (dBA) may be quite noticeable, although changes that take place over a long period of time of this magnitude or greater may be "barely perceptible." Changes in sound levels of ±10 dBA within a short time span may be perceived as "dramatic" and changes in sound levels of ±20 dBA within a short time span may be perceived as "striking." Dramatic or striking changes in sound level could be considered significant impacts.

F.4 WATER RESOURCES

F.4.1 Surface Water

F.4.1.1 Description of Affected Resources and Region of Influence

Surface waters include rivers, streams, lakes, ponds, playas, and reservoirs. An inventory of surface water resources in the project ROI, a description of areas in the ROI currently using surface water, general flow characteristics, reservoirs, and an identification of classifications applicable to the surface water will be used to determine the affected environment at each alternative site. Emphasis will be placed on those waterbodies that have the potential to be impacted during the facility's operations over the timeframe analyzed. Current wastewater treatment facilities and discharges also will be described as a baseline.

The affected environment descriptions for water quality of potentially affected receiving waters for each site will be developed by reviewing current monitoring data to identify parameters that exceed water quality criteria. Monitoring reports for discharges permitted under the National Pollutant Discharge Elimination System (NPDES) program and state regulations will be examined for exceeding permit limits or requirements. In addition, surface water quality will be evaluated in terms of whether the water body supports the designated use assigned by the individual states under the *Clean Water Act* (CWA).

F.4.1.2 Description of Impact Assessment

The assessment of potential water quality impacts will include evaluation of the type (wastewater effluent), rate, and potential discharge constituents. Environmental consequences may result if: (1) the surface water flow rate is decreased to the point where the capacity of the receiving waterbody to assimilate discharges is noticeably diminished; (2) the proposed increases in discharge cannot comply with NPDES permit limits on flow rates; (3) the proposed increases in discharges contribute to receiving waters already identified as exceeding applicable surface water quality criteria; or (4) the proposed increases in effluent cannot comply with pre-treatment limits on flow rates or specific constituent contributions without additional treatment. In addition, any expected increases in surface water runoff will be discussed along with the potential impact to surface water features at each site.

F.4.2 Groundwater

F.4.2.1 Description of Affected Resources and Region of Influence

As part of the affected environment section of the EIS, groundwater will be described in terms of the local aquifers' extent and yield, thickness, EPA classification, and recharge and discharge areas for each site. Areas in the ROI currently experiencing groundwater overdraft and related problems, and areas that have experienced large water table declines, will be described if applicable. Current potable and process water supplies and systems, water rights agreements, and water allocation of the site areas also will be described. The latest environmental data, including maps, reports, and other literature, will be used to the maximum extent possible to evaluate these conditions.

The affected environment groundwater quality at the site will be evaluated by reviewing current monitoring data and identifying any parameters that exceed state water quality standards, drinking water standards, and DOE-derived concentration guides for radionuclides in water. Parameters that exceed water quality criteria will be further described and contaminant plumes delineated, where possible.

F.4.2.2 Description of Impact Assessment

An assessment of potential groundwater quality environmental consequences will be associated with pollutant discharges during facility modification and operation phases (e.g., process wastes and sanitary wastes) and will be examined for each site to determine if a direct input to groundwater could occur. The results of the groundwater quality projections will then be discussed relative to Federal and state groundwater quality standards, effluent limitations, and safe drinking water standards to assess the acceptability of each alternative. Operation parameters from the alternatives with the potential to further degrade existing groundwater quality will be identified.

The potential effects to groundwater availability will be assessed for each alternative at each candidate site by evaluating whether the proposed project: (1) increases groundwater withdrawals in areas already experiencing overdraft and other related problems (e.g., land subsidence); (2) potentially decreases groundwater levels causing a substantial depletion of the resource; (3) water requirements exceed the allotment, water rights, or available supply limits, if present; or (4) reduces or ceases the flow of one or more major springs. Suitable mitigation measures to reduce impacts will be identified and discussed.

F.4.3 Floodplains

Floodplains include any lowlands that border a stream and encompass areas that may be covered by the stream's overflow during flood stages. As part of the affected environment discussion at each site, floodplains will be identified from maps and environmental documents. Any potential facility location within a 100-year floodplain or a critical action in a 500-year floodplain would be assessed for environmental consequence. The 500-year floodplain evaluation is of concern for activities determined to be critical actions for which even a slight chance of flooding would be intolerable. Appropriate mitigation measures would be identified to minimize potential floodplain impacts.

F.5 GEOLOGY AND SOILS

F.5.1 Description of Affected Resources and Region of Influence

The analysis of geology and soils examines the ROI, or lands occupied by and immediately surrounding each alternative site. Information on the regional structural geology, stratigraphy, and soils will be collated and summarized.

In addition, the seismicity of the region surround each site will be evaluated to provide a perspective on the probability of earthquakes in the area and their likely severity. This information will used to provide input to the evaluation of accidents due to natural phenomena.

F.5.2 Description of Impact Assessment

The proposed project areas being evaluated at each site will be evaluated for the amount of disturbance that may affect the geology and/or soils of the areas under study. These impacts may include, among others, potential erosion impacts and impacts to potential geologic economic resources. Impacts, if any, will be evaluated and a determination made as to severity. Possible mitigation will also be identified for adverse impacts.

F.6 BIOLOGICAL RESOURCES

F.6.1 Description of Affected Resources and Region of Influence

Biological resources will be described within the ROI, which is defined by the lands occupied by and immediately surrounding each alternative site. In the case of threatened and endangered species and other special interest species, biotic information will include species distribution within the county of each alternative site location. Information on biological resources will be complied, collated and summarized from existing documentation. No site-specific biological surveys will be conducted. Site-specific quantitative analyses would be performed in support of follow-on site- and project-specific NEPA analysis. Descriptions will be at a summary level and focus within four categories: Terrestrial Resources, Wetlands, Aquatic Resources, and Threatened and Endangered Species.

F.6.2 Description of Impact Assessment

During construction, impacts to biotic resources, including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species, may result from land-clearing activities, erosion and sedimentation, and human disturbance and noise. Operations may affect biotic resources as a result of changes in land use, emission of radionuclides, water withdrawal, wastewater discharge, and human disturbance and noise. In general, potential impacts will be assessed based on the degree to which various habitats or species could be effected by an alternative. Where appropriate, impacts will be evaluated with respect to Federal and state protection regulations and standards.

The analysis of impacts of MPF project alternatives to biological resources will be addressed at a level that is appropriate to the specificity of available information. In general, the analysis of impacts to biological resources presented in the MPF EIS will be qualitative rather than quantitative. Quantitative analyses would be performed in follow-on site- and project-specific NEPA documentation.

Terrestrial Resources

Impacts of the MPF proposed alternatives on terrestrial plant communities will be evaluated by comparing data on site vegetation communities to proposed land requirements for construction and operation. The analysis of impacts to wildlife is based to a large extent on plant community loss or modification, which directly affects animal habitat. The loss of important or sensitive habitats and species is considered more important than the loss of regionally abundant habitats or species. Impacts on biotic resources from the release of radionuclides will not be evaluated. Radiological releases associated with the various alternatives would generally be at or below natural background levels and would be within limits established to protect workers and the public. Since humans have generally been shown to be the most sensitive organism to radiation release, radiological levels should also be protective of biota.

Wetlands

The potential direct loss of wetlands resulting from construction and operation of the proposed MPF will be addressed in a way similar to the evaluation of impacts on terrestrial plant communities; that is, by comparing data on site or area wetlands to proposed land requirements. Sedimentation impacts will be evaluated based on the proximity of wetlands to the MPF project area. Impacts resulting from wastewater discharge into a wetland system will be evaluated, recognizing that effluents would be required to meet applicable Federal and state standards.

Aquatic Resources

Impacts to aquatic resources resulting from sedimentation and wastewater discharge will be evaluated as described for wetlands. Potential impacts from radionuclides will not be addressed for the same reasons described for terrestrial resources.

Threatened and Endangered Species

Impacts on threatened and endangered species and other special interest species will be determined in a manner similar to that used to describe terrestrial and aquatic resources since the sources of potential impacts are similar. A list of species potentially present on each candidate site or in proximity to the candidate site or area will be developed using information obtained from the U.S. Fish and Wildlife Service (USFWS) and appropriate state agencies databases. This list, along with consideration of site environmental and engineering data, and provisions of the *Endangered Species Act*, will be used to evaluate whether the various MPF siting alternatives could impact any threatened or endangered plant or animal (or its habitat).

F.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

F.7.1 Description of Affected Resources and Region of Influence

Cultural resources are those aspects of the physical environment that relate to human culture and society, and those cultural institutions that hold communities together and link them to their surroundings. For this EIS, cultural resources are divided into three general categories: prehistoric resources, historic resources, and Native American resources. A cultural resource can fall into more than one of these categories due to use through a long period of time or multiple functions.

Prehistoric resources are material remains, structures, and items used or modified by people before the establishment of a European presence in the area. By definition, these resources pre-date written records. Historic resources include the material remains and landscape alterations that have occurred since the arrival of Europeans to the area. Due to the focus of this EIS on DOE facilities, historic resources often include resources associated with the Manhattan Project, World War II, and the Cold War. Native American resources are material remains, locations, and natural materials important to Native Americans for traditional religious or heritage reasons. These resources are rooted in the community's history or are important in maintaining cultural identity.

Paleontological resources are the physical remains, impressions, or traces of plant or animal species that date to former geological epochs or the early Holocene. These resources may be sources of information on ancient environments and the evolutionary development of plants and animals.

The ROI for the cultural and paleontological resource analyses encompass the entire DOE site, since analyses include the possibility of locating the MPF anywhere within each DOE site.

F.7.2 Description of Impact Assessment

The analyses of potential impacts to cultural and paleontological resources are very similar because the two types of resources can be affected by the alternatives in much the same manner. The analyses address potential direct and indirect impacts at each candidate site from construction activities and operation of the facility. Most potential impacts are those resulting from groundbreaking activities; however, other types of impacts are considered, such as reduced access by practitioners to resources, introduction of visual, audible, or atmospheric elements out of character with the resources, and increased visitation to sensitive areas. Analyses of impacts take into consideration the location of the reference site, the acreage required for the proposed facility, and the likelihood of resources being located in that area.

F.8 SOCIOECONOMICS

The analysis of socioeconomics will describe impacts on local and regional socioeconomic conditions and factors including employment, economy, population, housing and community services at each alternative site considered in the MPF EIS. The potential for socioeconomic impacts is greatest in those local jurisdictions immediately adjacent to each site and those that are potential residential locations for future DOE site employees at a new or expanded MPF.

Therefore, potential socioeconomic impacts are assessed using a geographic ROI. ROIs are used to assess potential effects on the economy as well as effects that are more localized in political jurisdiction surrounding the sites.

Region of Influence

The ROI for each site encompasses an area that involves trade among and between regional industrial and service sectors. It is characterized by strong economic linkages between the communities located in the region. These linkages determine the nature and magnitude of multiplier effects on economic activity (i.e., purchases, earnings, and employment) at each candidate site.

The U.S. Bureau of Economic Analysis measures multiplier effects of inter-industry linkages with the Regional Input-Output Modeling System (RIMS II). RIMS II is based on an accounting framework called an input-output table. An input-output table shows, for each industry, industrial distributions of input purchased and outputs sold. RIMS II Total Direct-Effect Multipliers will be used in the MPF EIS to estimate additional regional employment and income generated by employment and income directly associated with the Proposed Action.

Additional potential demographic impacts will be assessed on the area where the housing market and community services would be most affected. The ROI is defined as those counties where approximately 90 percent of the current DOE and contractor employees reside. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site, and is used to estimate the future distribution of direct workers with the Proposed Action. The evaluation of impacts is based on the degree to which changes in employment and population affect the regional economy, housing market, and community services. It is assumed that most new jobs would occur within the ROI where the majority of DOE and contractor employees live.

F.9 HUMAN HEALTH AND SAFETY

F.9.1 Occupational Radiation Health

F.9.1.1 Description of Affected Resources and Region of Influence

Potential impacts to human health and safety posed by the MPF include radiological and nonradiological exposure pathways and occupational injuries, illnesses, and fatalities resulting from construction activities and normal (accident-free) operations of the completed facility. Exposures pathways include inhalation, immersion, ingestion, and exposure to external sources. Occupational regions of influence include involved and uninvolved workers. Non-occupational ROIs for the public include the MEI and the general population surrounding the candidate sites.

F.9.1.2 Description of Impact Assessment

Occupational Radiation Health

Radiological impacts will be assessed for workers (both involved and non-involved in MPF operations) and for the public (MEI and population). Health impacts to involved workers from

MPF operations will be based on either information from MPF specific technology data reports or from similar (radiation) workers at the alternative sites. It is expected that the same dose will be applied to involved workers at each alternative site and, therefore, that this will not be a discriminator among sites (although it may be compared to the No Action Alternative).

Health impacts to non-involved workers will be based on doses calculated by the radiological air analyses. Doses will be converted to health effects (fatal cancer risk) using the multiplier of 400 fatal cancers per 10^6 person-rem. A 40-hour, 50-week worker exposure will be assumed.

Similarly, health impacts to the MEI and population will be based on doses calculated by the radiological air analyses. In this case, 500 fatal cancers per 10^6 person-rem will be used in order to reflect the more diverse population with respect to age and health (as opposed to workers). Continuous exposure over the year will be assumed. Furthermore, while inhalation and immersion will be the pathways of interest for workers, the general population may also be exposed through food pathways. Radiological impacts to drinking water, as assessed by hydrological analyses, will be included.

Occupational Safety

Occupational injury, illness, and fatality estimates will be evaluated using occupational incidence rates of major industry groups, DOE, and DOE contractors. When site-specific evaluations are performed, DOE Computerized Accident/Incident Reporting System (CAIRS) data will be used. Since activities similar to MPF operations or facility construction are not being performed at all of the potential MPF sites, U.S. Department of Labor, Bureau of Labor Statistics injury, illness and fatality information for similar activities will be used to determine bounding rates. These rates will be compared to person-hour estimates for the project. Occupational injury, illness, and fatality categories used in this analysis will be in accordance with OSHA definitions. Incident rates will be developed for facility construction and facility operations.

Health risks from hazardous chemical releases during normal operation at the respective DOE sites will be assessed by evaluating facility chemical source term inventories and engineered facility safety features used to mitigate personnel exposures during normal (accident-free) operations. HI values will be used to screen for additional analysis. If required, site boundary concentrations, derived through modeling (i.e., ISCST or equivalent) will be used to develop HQs for noncancer risks for comparison to reference concentration values, such as the EPA Integrated Risk Information System. The cancer risk to the MEI will be calculated from the doses derived from modeling exposure levels, using slope factors or unit risks for individual chemicals published in the Integrated Risk Information System or the health effects summary tables. The health effects summary tables are the yearly summary of EPA's regulatory toxicity data.

The HIs and cancer risks are used to identify potential health concerns that may require further analysis. If the HI and/or cancer risk exceed acceptable limits, then these sites or activities become candidates for further analysis. An in-depth analysis would identify the individual chemicals that contribute to substantial adverse HI and/or cancer risk impacts, starting with those chemicals showing the highest HQs and/or cancer risk and grouping them according to their specific health effects. These chemicals then may be identified for inclusion in more specific site analyses. HIs and/or the cancer risk default values exceeding OSHA standards do not necessarily indicate that a health concern exists. The calculated HIs and cancer risk only establish a baseline for comparison of alternatives among different sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action Alternative HI and cancer risk to the public at each site.

F.10 ACCIDENT ANALYSIS

F.10.1 Description of Affected Resources and Region of Influence

Potential impacts to human health and safety from postulated MPF accidents include radiological and nonradiological exposures. For both radiological and chemical accidents associated with the MPF, the affected resources are the facility and site workers and the offsite population. Specifically, for radiological accidents, the impact is incremental adverse health effects (i.e., latent cancer fatalities [LCFs]) for a non-involved worker, the maximally exposed offsite individual, and the offsite population within 80 kilometers (km) (50 miles [mi]) of each alternative site. In addition, a qualitative assessment will be made of the potential adverse health effects to workers in the MPF. For nonradiological accidents, airborne concentrations and potential health effects will be calculated for the non-involved worker and the maximally exposed offsite individual.

F.10.2 Description of Impact Assessment

Postulated accidents can be initiated by internal operations (e.g., fire, spill, criticality), external events (e.g., airplane crash), or natural phenomena (e.g., earthquake, flood). The MPF EIS will address a spectrum of unmitigated accident scenarios chosen to reflect the range and kinds of accidents that are postulated. The range of accidents is from low frequency-high consequence to high frequency-low consequence events in order to envelop potential risks. Accidents with estimated initiating event frequencies less than 10^{-7} per year will not be considered, unless their exclusion would affect decisionmaking. The spectrum of accidents and their calculated impacts should provide a baseline for each site that can be used to judge the environmental implications at alternative sites. The accident analysis will be performed in accordance with the *Recommendations for Analyzing Accidents Under the National Environmental Policy Act* (July 2002).

For radiological accidents, point estimates of radiation dose and, for the offsite population, corresponding incremental LCFs will be calculated for a hypothetical non-involved worker (located 1,000 m [3,281 ft] from the MPF release point), the maximally exposed offsite individual, and the offsite population within 80 km (50 mi) of each alternative site. For nonradiological accidents, estimates of airborne concentrations of chemical substances will be calculated for a hypothetical non-involved worker and the maximally exposed offsite individual.

It should be noted that the purpose of this EIS is to assist the decisionmaker in making site selection decisions. Since the activities at the MPF would be the same regardless of location, the risk to involved workers would be independent of site location and would not be a discriminating factor for programmatic siting decisions. Risks to involved workers may be addressed in greater detail in site-specific tiered NEPA documents if more detailed information is available.

For radiological and chemical accidents, the following general analytical steps will be followed:

1. Screen operations within the MPF to identify those with the potential to contribute to offsite risk.
2. Identify and screen postulated accident scenarios associated with those operations.
3. Calculate source terms (release rates and frequencies) for these unmitigated scenarios.
4. Calculate the onsite and offsite consequences (impacts to the health and safety of site workers and the general public) of these scenarios as follows.

The unmitigated consequences of accidental releases of radioactivity will be calculated using the MELCOR Accident Consequence Code System Version 2 (MACCS2) with the radiological source term values described above. In addition to the source term data, the following input data for the MACCS2 code will be obtained:

- Estimated location of specific MPF facilities and their distance from the site boundary
- Release heights (i.e., stack release, building release, or ground level release)
- Local meteorological conditions
- Offsite population distribution (using the 2000 census data)
- Offsite agricultural and economic data

The consequences of accidental releases of hazardous chemicals will be calculated using the Aerial Location of Hazardous Atmospheres (ALOHA) code with the chemical source term values described above. In addition to the source term data, input data for the ALOHA code is similar to that required for the radiological accident analysis, with the exception that offsite agricultural and economic data are not required.

For accident scenarios involving multiple operations within the MPF, such as those that might be caused by natural phenomena, estimates of radiation dose and corresponding incremental LCFs and estimates of airborne concentrations of chemical substances will be calculated for the same receptors as described previously.

F.11 ENVIRONMENTAL JUSTICE

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, signed by President Clinton in February 1994, requires each Federal agency to formulate a strategy for addressing environmental issues in human health- and environment-related programs, policies, planning and public participation processes, enforcement, and rulemaking. The White House memorandum accompanying the Executive Order directs Federal agencies to “analyze the environmental effects…of Federal actions, including effects on minority communities and low income communities when such analysis is required by NEPA.”

Any disproportionately high and adverse human health effects on minority populations or low-income populations that could result from siting the MPF at any of the proposed alternative sites will be analyzed. The minority population and low-income population composition of the area surrounding the proposed alternative sites will be compared to that of a larger geographic area to determine whether the possible impacts of siting the MPF at a particular site will have a disproportionately high and adverse impact on minority or low-income populations.

F.12 TRAFFIC AND TRANSPORTATION

F.12.1 Description of Affected Resources and Region of Influence

Transportation routes in the vicinity of the proposed MPF location will be identified, in text and on a map, to indicate which highways would be impacted by MPF traffic, including commuters and shipments. Where available, traffic data, such as annual average daily traffic, will be presented as a baseline for a subsequent qualitative analysis of increased traffic congestion. Traffic data will be derived from recent DOE environmental documentation or from state agencies.

F.12.2 Description of Impact Assessment

The MPF EIS is programmatic in scope and will be used to support site selection and operation capacity. A tiered EIS on construction and operation will examine impacts at the selected site. Accordingly, the range of potential analytical endpoints for this siting EIS will be been reduced to those necessary to provide discrimination among the sites and operation alternatives. The full range of analytical endpoints will be reconsidered in the tiered EIS for construction and operation. The shipments under consideration would be limited to product inputs/outputs and waste associated with pit processing.

Incident-Free Transportation Impacts

Using the TRAGIS code, routes and routing characteristics will be determined for the origin-destination pairs associated with each of the alternative sites. Worker and population collective dose and latent cancer fatalities will be calculated using the RADTRAN 5 code. Results will be presented on an annual basis.

Transportation Accident Impacts

Using the RADTRAN 5 code, the total annual risk for each of the shipment campaigns (product and waste) will be calculated and analyzed for incident-free impacts.

Traffic Impacts

Traffic flow will be analyzed to determine whether or not the flow would be adversely impacted by the addition of new commuters for the MPF at each of the potential sites for both construction and operations phases. The number of new commuters will be determined based on construction and operations employment. If the data support a level of service (LOS) calculation, then changes in LOS will be calculated for each site. If LOS cannot be determined for all the sites, then semi-quantitative or qualitative arguments will be used with an attempt to rank the sites by the result. Depending upon availability of data, a fraction of an increase in traffic at peak times could be an important indicator in lieu of LOS changes.

F.13 WASTE MANAGEMENT

F.13.1 Description of Affected Resources and Region of Influence

A key goal of the MPF project is to develop a safe, secure, environmentally compliant facility based on modern manufacturing procedures. Waste minimization will also be a goal of the MPF. The production of waste requiring offsite disposal will be reduced to as low as reasonably achievable (ALARA) consistent with cost-benefit analyses. The MPF siting alternatives would incorporate waste minimization and pollution prevention practices to the maximum extent practicable. Waste minimization efforts and the management of MPF-related wastes will be analyzed for each alternative site. The impact assessment will address the projected waste types and volumes from the MPF at each site compared to the No Action Alternative.

MPF construction wastes are similar to those generated by any construction project of comparable scale. Wastes generated during MPF operations would consist of five primary types: transuranic (TRU) waste, low-level waste (LLW), mixed LLW, hazardous waste, and nonhazardous waste. Waste management facilities supporting the MPF would treat and package the waste into forms that would enable long-term storage or disposal. The MPF would include the capability to process liquid TRU waste to a form suitable for disposal at Waste Isolation Pilot Plant (WIPP). Other waste types generated by the MPF would be transferred to existing facilities and managed in accordance with current practices at the DOE site.

F.13.2 Description of Impact Assessment

To provide a framework for addressing the impacts of waste management for the MPF, descriptive information will be presented on each site’s waste management capabilities. The volumes of each waste type generated will be estimated. These estimates, obtained from the MPF data call, will include consideration of concepts for waste minimization. Impacts will be assessed in the context of existing site practices for treatment, storage, and disposal including the applicable regulatory requirements. Permits, compliance agreements, and other site-specific practices will be reviewed and analyzed to assess the ability to conduct the MPF-related waste management activities.

DOE generates both “routine” waste (e.g., job control, maintenance) and waste associated with environmental restoration (ER) and decontamination and decommissioning (D&D) activities. The ER/D&D waste volumes can vary greatly from year to year and often exceed the routine waste volumes. ER/D&D waste is fundamentally different (more volume, less contamination) from routine wastes and is frequently managed at separate facilities. The estimated waste volumes for MPF construction and operations will be compared to the routine waste generation at each site to identify potential impacts to the site’s waste management infrastructure.

For all sites except WIPP, the number of additional shipments required to transport TRU waste to the WIPP will be estimated. The risks associated with additional TRU waste shipments will be addressed as part of the transportation impacts assessment.

For sites under consideration for the MPF that do not have existing or planned onsite LLW disposal, the number of additional shipments required to transport LLW from the site to a DOE LLW disposal facility will be estimated. For example, for purposes of this analysis, it will be assumed that the Pantex Plant would ship its LLW to the Nevada Test Site as per current practice. The risks associated with additional LLW shipments will be addressed as part of the transportation impacts assessment.

F.14 CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations implementing the NEPA define cumulative effects as "the impact on the environment which results from the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The regulations further explain "cumulative effects can result from individually minor but collectively significant actions taking place over a period of time." Other DOE programs and other Federal, state, and local development programs all have the potential to contribute to cumulative effects on DOE sites.

The methodology for the analysis of cumulative effects for the MPF EIS was developed from the guidelines and methodology in the CEQ's *Considering Cumulative Effects Under the National Environmental Policy Act*. The major components of the CEQ methodology include:

- Scoping, including identifying the significant potential cumulative effects issues associated with the proposed action, identifying the ROI and timeframe for the analysis, and identifying other actions affecting the resources
- Describing the affected environment
- Determining the environmental consequences, including the impacts from the proposed action and other activities in the ROI, and the magnitude and significance of the cumulative effects

The cumulative effects of the MPF EIS alternatives will be analyzed for each alternative site by reviewing and analyzing data from existing NEPA documents and other DOE documents. To update the data and to supplement this information, Internet searches, literature reviews of environmental documents for the regions surrounding the proposed sites, and personal contacts with local government planning departments will be undertaken, as needed, to obtain information on the potential cumulative effects for each resource area. For some resource areas, the analysis will include the cumulative regional impacts. For example, the air analysis must examine air quality in the region for each potential site in order to access the impacts of the proposed action.

Environmental impacts for other DOE programs and other Federal, state, and local development programs for each potential site will be reviewed and the cumulative impacts analyzed. The analysis will include impacts from previous actions at each of the sites and the region of influence, current actions, and actions planned for the future. These impacts, combined with the impacts from the MPF EIS, form the basis of the analysis of cumulative effects. Where possible, quantifiable data will be used. The level of analysis for each resource area will be commensurate to the importance of the potential cumulative impacts on that resource. The data and analysis is then summarized and potential cumulative impacts for each site identified.

APPENDIX G
PROJECT NOTICES AND STUDIES

This appendix includes project notices and some of the studies that were either performed in relation to, or used as reference materials, in the preparation of the Modern Pit Facility Environmental Impact Statement (MPF EIS). These notices and studies are not intended to be an all-inclusive list. Chapter 8 of this EIS provides an all-inclusive list of the references used to prepare this EIS.

The following are included as part of this appendix:

- *Notice of Intent to Prepare a Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility*

- *Modern Pit Facility Site Screening Report*

- *Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as no Longer Required for Defense Purposes and Related Cooperation*

- *Summary of TA-55/PF-4 Upgrade Evaluation for Long-term Pit Manufacturing Capacity*

- *Plutonium Aging: Implications for Pit Lifetimes* temporary items). Extra copies of fire reports and related documentation as well as electronic copies of documents created using electronic mail and word processing. Recordkeeping copies of these files are proposed for permanent retention.

2. Department of Defense, National Imagery and Mapping Agency (N1–537–02–2, 2 items, 2 temporary items). Individual procurement appointment files relating to participants in purchase card programs. Also included are electronic copies of records created using word processing and electronic mail.

3. Department of Justice, Federal Bureau of Investigation (N1–65–02–5, 1 item, 1 temporary item). Hard copy fingerprint cards generated in connection with background investigations of military enlistees.

4. Department of Justice, National Drug Intelligence Center (N1–523–02–1, 8 items, 6 temporary items). Staff meeting files, firearms training records, and training materials that do not pertain to law enforcement. Also included are electronic copies of records created using electronic mail and word processing. Proposed for permanent retention are recordkeeping copies of executive level meeting files and training materials for law enforcement training.

5. Department of Justice, National Drug Intelligence Center (N1–523–02–2, 6 items, 3 temporary items). Policy files that do not pertain to the agency's mission, including electronic copies of records created using electronic mail and word processing. Proposed for permanent retention are recordkeeping copies of mission-related policy files and records that pertain to agreements.

6. Department of the Navy, Agency-wide (N1-NU–02–03, 5 items, 4 temporary items). Records relating to international agreements accumulated by the International Programs Office. The records include Navy annexes to data exchange agreements, newsletters, and charts. Also included are electronic copies of records created using electronic mail and word processing. Recordkeeping copies of case files pertaining to agreements are proposed for permanent retention.

7. Department of the Navy, Agency-wide (N1–NU–02–04, 13 items, 13 temporary items). Records relating to security assistance policy accumulated by the International Programs Office. Included are budgetary documents, case files relating to such matters as foreign military sales and other assistance programs, and inter-service agreements for administrative services. Also included are electronic copies of records created using electronic mail and word processing.

8. Department of State, Bureau of Human Resources (N1–59–00–8, 23 items, 21 temporary items). Records accumulated by the Office of the Executive Director relating to administrative oversight and support. Included are such records as subject files, the personnel action handbook master, performance files, and several databases containing personnel data for employees, including Foreign Service Nationals. Also included are electronic copies of documents created using electronic mail and word processing. Proposed for permanent retention is the master file of the main personnel system and microfilm copies of employee service record cards from 1940 to 1975.

9. Department of State, Assistant Secretary for Intelligence and Research (N1–59–02–7, 2 items, 1 temporary item). Electronic copies of documents created using electronic mail and word processing that are associated with the office's subject files. Proposed for permanent retention are the recordkeeping copies of these files.

10. Department of State, Office of the Secretary of State (N1–59–02–8, 2 items, 1 temporary item). Electronic copies of documents created using electronic mail and word processing that pertain to memorandums of conversations. Recordkeeping copies of these files are proposed for permanent retention.

11. Department of State, Office of Information Technology Operations and Management for the Bureau of Educational and Cultural Affairs and the Coordinator of International Information Programs (N1–59–02–9, 26 items, 26 temporary items). Records relating to information technology operations and management, including such matters as the management of computer equipment and software, tape libraries, system backups, data security, and user support. Also included are electronic copies of records created using electronic mail and word processing.

12. Department of the Treasury, Financial Management Service (N1–425–02–2, 4 items, 4 temporary items). Electronic copies of documents created using electronic mail and word processing relating to foreign claim files and to closed court cases concerning forgery and alteration of government checks. This schedule also increases retention period for recordkeeping copies of these files, which were previously approved for disposal.

13. Court Service and Offender Supervision Agency, Community Supervision Services Division (N1–562–02–1, 3 items, 3 temporary items). Case files for offenders in the District of Columbia Superior Court system who are under parole, supervised release, and/or probation supervision. Included are electronic copies of documents created using electronic mail and word processing.

14. Peace Corps, Management Division (N1–490–02–1, 1 item, 1 temporary item). Electronic records accumulated by the Office of Information Resources Management that are used for tracking staff access to and use of agency automated systems.

Dated: September 12, 2002.

Michael J. Kurtz,

Assistant Archivist for Record Services, Washington, DC.

[FR Doc. 02–24038 Filed 9–20–02; 8:45 am]

BILLING CODE 7515–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Intent to Prepare a Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility

AGENCY: Department of Energy, National Nuclear Security Administration.

ACTION: Notice of intent.

SUMMARY: The Department of Energy's (DOE) National Nuclear Security Administration (NNSA) is responsible for the safety and reliability of the U.S. nuclear weapons stockpile, including protection of production readiness to maintain that stockpile. Since 1989, the DOE has been without the capability to produce plutonium pits (the portion of a nuclear weapon which generates the fission energy to drive modern thermonuclear weapons). The NNSA, the Department of Defense (DOD), and Congress have highlighted the lack of long-term pit production capability as a national security issue requiring timely resolution. While an interim capability is currently being established at the Los Alamos National Laboratory (LANL), classified analyses indicate that this capability will not suffice to maintain, long-term, the nuclear deterrent that is a cornerstone of U.S. national security policy. Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*), and the DOE Regulations Implementing NEPA (10 CFR Part 1021), the NNSA is announcing its intent to prepare a Supplement to the Programmatic Environmental Impact Statement (EIS) on Stockpile Stewardship and Management (SSM) for

a Modern Pit Facility (MPF) in order to decide: (1) whether to proceed with the MPF; and (2) if so, where to locate the MPF. This NOI also sets forth the dates, times, and locations for public scoping meetings on the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility.

DATES: NNSA is inviting comments related to its intention to prepare a Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. Comments should be submitted within November 22, 2002. Comments submitted during the 60-day comment period following publication of this NOI will assist the NNSA in developing the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. Public scoping meetings to discuss issues and receive comments on the scope of the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility will be held in the vicinity of sites that may be affected by the proposed action, as well as in Washington, DC. The public scoping meetings will provide the public with an opportunity to present comments, ask questions, and discuss concerns with NNSA officials regarding the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. The locations, dates, and times for these public scoping meetings are as follows:

Pantex—October 8, 2002 , 7 p.m.–10 p.m., College Union Building, Oak Room, Amarillo College, Washington Street Campus, 24th and Jackson Streets, Amarillo, TX 79178, (806) 371–5100

Carlsbad, NM—October 10, 2002, 7 p.m.–10 p.m., U.S. Department of Energy, Carlsbad Area Office, 4021 National Parks Highway, Carlsbad, NM 88220, (505) 234–7227

Washington, DC—October 15, 2002, 2 p.m.–5 p.m., U.S. Department of Energy, 1000 Independence Avenue, SW., Room 1E–245, Washington, DC 20585, (202) 586–0821

Nevada Test Site—October 17, 2002, 7 p.m.–10 p.m., U.S. Department of Energy, Nevada Operations Office, Auditorium, 232 Energy Way, Las Vegas, NV 89030, (702) 295–3521

Los Alamos National Laboratory—October 24, 2002, 7 p.m.–10 p.m., Duane W. Smith Auditorium, 1400 Diamond Drive, Los Alamos, NM 87544, (505) 663–2510

Savannah River Site—October 29, 2002, 7 p.m.–10 p.m., North Augusta Community Center, 495 Brookside Avenue, North Augusta, SC 29841, (803) 441–4290

The NNSA will publish additional notices on the dates, times, and locations of the scoping meetings in local newspapers in advance of the scheduled meetings. Any necessary changes will be announced in the local media. Any agency, state, pueblo, tribe, or unit of local government that desires to be designated a cooperating agency should contact Mr. Jay Rose at the address listed below by October 15, 2002.

ADDRESSES: General questions concerning this Notice of Intent for the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility can be asked by calling 1–800–832–0885, ext. 65484, or by writing to: Mr. Jay Rose, Supplement to the Programmatic EIS on SSM for a Modern Pit Facility Document Manager, NA–53, Forrestal Building, U.S. Department of Energy/NNSA, 1000 Independence Avenue, SW., Washington, D.C. 20585. Comments can be submitted to Mr. Rose at the address above; or faxed to: 1–202–586–5324; or e-mailed to *James.Rose@nnsa.doe.gov.* Please mark envelopes, faxes, and E-mail: ''Supplement to the Programmatic EIS on SSM for a Modern Pit Facility Comments.''

FOR FURTHER INFORMATION CONTACT: For general information on the NNSA NEPA process, please contact: Mr. James J. Mangeno, NNSA NEPA Compliance Officer, NA–3.6, Forrestal Building, U.S. Department of Energy/NNSA, 1000 Independence Avenue, SW., Washington, D.C. 20585; or telephone 1–800–832–0885, ext. 6–8395. For general information on the DOE NEPA process, please contact: Ms. Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, EH–42, Forrestal Building, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, telephone 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: Plutonium pits are essential components of nuclear weapons. Prior to the shutdown of its production activities in 1989, plutonium pits for the nuclear weapons stockpile were manufactured at the DOE Rocky Flats Plant in Colorado. No stockpile-certified pits have been produced by this country since that shutdown. During the mid-1990s, the DOE conducted a comprehensive analysis of the capability and capacity needs for the entire Nuclear Weapons Complex and evaluated alternatives for maintaining the Nation's nuclear stockpile in the Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (SSM PEIS, DOE/EIS–0236). Issued in September 1996, the SSM PEIS looked extensively at pit manufacturing capability and capacity needs, and evaluated reasonable alternatives for re-establishing interim pit production capability on a small scale. A large pit production capacity—in line with the capacity planned for other manufacturing functions—was not evaluated in the PEIS ''because of the small current demand for the fabrication of replacement pits, and the significant, but currently undefined, time period before additional capacity may be needed.'' In the SSM PEIS Record of Decision (ROD) (61 FR 68014, December 26, 1996), the Secretary of Energy decided to re-establish an interim pit fabrication capability, with a small capacity, at LANL. That decision limited pit fabrication to a facility ''sized to meet programmatic requirements over the next ten or more years.'' In the ROD, DOE committed to ''performing development and demonstration work at its operating plutonium facilities over the next several years to study alternative facility concepts for larger capacity.''

Subsequent to the SSM PEIS ROD, a number of citizen groups filed suit challenging the adequacy of the SSM PEIS. In August 1998, the SSM PEIS litigation was resolved. As a result of that litigation, DOE agreed to entry of a court order that required, ''[p]rior to taking any action that would commit DOE resources to detailed engineering design, testing, procurement, or installment of pit production capability for a capacity in excess of the level that has been analyzed in the SSM PEIS [50 pits per year under routine conditions, 80 pits per year under multiple-shift operations], DOE shall prepare and circulate a Supplemental PEIS, in accordance with DOE NEPA Regulation 10 CFR 1021.314, analyzing the reasonably foreseeable environmental impacts of and alternatives to operating such an enhanced capacity, and shall issue a Record of Decision based thereon.'' This Supplement to the SSM PEIS is being prepared in part to satisfy that obligation.

Following the SSM PEIS, in January 1999, the Department prepared the LANL Site-Wide EIS (SWEIS) (DOE/EIS–0238), which evaluated site-specific alternatives for implementing pit production at LANL. Consistent with the SSM PEIS ROD, the LANL SWEIS evaluated alternatives that would implement pit production with a capacity up to 50 pits per year under single-shift operations and 80 pits per year using multiple shifts. In the ROD for the LANL SWEIS (64 FR 50797, September 20, 1999), DOE decided to produce up to 20 pits per year at LANL, and deferred any decision to expand pit manufacturing beyond that level.

Consistent with the 1996 SSM PEIS ROD and the 1999 LANL SWEIS ROD, NNSA has been re-establishing a small pit manufacturing capability at LANL. The establishment of the interim pit production capacity is expected to be completed in 2007. However, classified analyses indicate that the capability being established at LANL will not support either the projected capacity requirements (number of pits to be produced over a period of time), or the agility (ability to rapidly change from production of one pit type to another, ability to simultaneously produce multiple pit types, or the flexibility to produce pits of a new design in a timely manner) necessary for long-term support of the stockpile. In particular, any systemic problems that might be identified in an existing pit type or class of pits (particularly any aging phenomenon) could not be adequately addressed today, nor could it be with the capability being established at LANL. Although no such problems have been identified, the potential for such problems increases as pits age. NNSA's inability to respond to such issues is a matter of national security concern. NNSA is responsible for ensuring that appropriate pit production capacity and agility are available when needed, and this Supplement to the SSM PEIS is being undertaken to assist NNSA in discharging this responsibility.

NEPA Strategy and EIS Alternatives

Currently, the NNSA envisions the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility as a ''programmatic document'' that will support two decisions: (1) Whether to proceed with the MPF; and (2) if so, where to locate the MPF. A tiered, project-specific EIS is expected to be prepared after the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility if the Secretary decides to proceed with such a facility. That tiered EIS, which would utilize detailed design information to evaluate site-specific alternatives at any site selected as a potential location for a MPF, would ultimately support a decision for construction and operation of the MPF. As described below, the NNSA has developed preliminary alternatives for the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility.

Alternatives: The NNSA has prepared, and will continue to prepare mission, requirements, and planning documents required to support an NNSA decision on whether to proceed with the MPF, and has conducted a site screening analysis to assure that potential sites meet program requirements. Initially, all existing, major DOE sites were considered to serve as potential host location for the MPF. The site screening analysis considered the following criteria: population encroachment, mission compatibility, margin for safety/security, synergy with existing/future plutonium operations, minimizing transportation of plutonium, NNSA presence at the site, and infrastructure. The first two criteria were deemed to be ''exclusionary'' criteria; that is, a site either passed or failed on each of these two criteria. The sites that passed the exclusionary criteria were then scored against all criteria. Based upon results from the site screening analysis, the following sites were determined to be reasonable alternatives for the MPF: (1) Los Alamos National Laboratory at Los Alamos, New Mexico; (2) Nevada Test Site near Las Vegas, Nevada ; (3) Pantex Plant at Amarillo, Texas; (4) Savannah River Site at Aiken, South Carolina; and (5) the Waste Isolation Pilot Plant at Carlsbad, NM. The Supplement to the Programmatic EIS on SSM for a Modern Pit Facility will also evaluate the no-action alternative of maintaining the current plutonium pit capabilities at LANL, and the reasonableness of upgrading the existing facilities at LANL to increase pit production capacity. Additionally, the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility will evaluate a range of pit production capacities consistent with national security requirements.

Identification of Environmental and Other Issues

The environmental impacts of constructing and operating the MPF, including the impacts that might occur at each potential site, will be addressed in the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. These impacts will be presented along with environmental baseline information to enable the reader to discern the differences between alternatives. The NNSA has identified the following issues for analysis in the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. Additional issues may be identified as a result of the scoping process.

1. *Public and Worker Safety, Health Risk Assessment:* Radiological and non-radiological impacts, including projected effects on workers and the public from construction, normal operations and accident conditions, and decommissioning and decontamination activities associated with constructing and operating the MPF.

2. Impacts from releases to air, water, and soil associated with constructing and operating the MPF.

3. Impacts to plants, animals, and habitats, including threatened or endangered species and their habitats, associated with constructing and operating the MPF.

4. The consumption of natural resources and energy associated with constructing and operating the MPF.

5. Socioeconomic impacts to affected communities from construction and operation of the MPF.

6. Environmental justice: Disproportionately high and adverse human health or environmental effects on minority and low-income populations associated with constructing and operating the MPF.

7. Impacts to cultural resources such as historic, archaeological, scientific, or culturally important sites associated with constructing and operating the MPF.

8. Impacts associated with transportation and storage of nuclear materials.

9. Status of compliance with all applicable Federal, state, and local statutes and regulations; required Federal, state, and tribe environmental consultations and notifications; and DOE Orders on waste management, waste minimization, and environmental protection.

10. Cumulative impacts from the proposed action and other past, present, and reasonably foreseeable actions at the alternative sites.

11. Potential irreversible and irretrievable commitments of resources associated with constructing and operating the MPF.

12. Pollution prevention and waste management practices, including characterization, storage, treatment and disposal of wastes associated with constructing and operating the MPF. NNSA anticipates that certain classified information will be utilized in preparing the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility and considered by the NNSA in deciding whether to construct and operate MPF, and if so, where the facility would be located. Accordingly, the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility will likely contain a classified appendix. To the extent allowable, the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility will summarize this information in an unclassified manner.

Supplement to the Programmatic EIS on SSM for a Modern Pit Facility Schedule

The proposed Supplement to the Programmatic EIS on SSM for a Modern Pit Facility schedule is as follows:

Notice of Intent: September 2002.

Public Scoping Meetings: October 2002.

Publish Draft EIS: May 2003.

Draft EIS Public Hearings: June–July 2003.

Publish Final EIS: March 2004.

Record of Decision: April 2004.

Public Scoping Process

To assist in defining the appropriate scope of the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility and to identify significant environmental issues to be addressed, NNSA representatives will conduct public scoping meetings at the dates, times, and locations described above under **DATES.** At these meetings, the NNSA will present a short summary of the project, indicate the alternatives to be considered, and present the proposed scope of the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. Following the initial presentation at each site, NNSA representatives will answer questions and accept comments, and the public will have a chance to offer their comments on the proposal, alternatives to be studied and the scope of the Supplement to the Programmatic EIS on SSM for a Modern Pit Facility. Copies of handouts from the meetings will be available to those unable to attend, by contacting the NNSA as described above under **ADDRESSES.**

Issued in Washington, DC, this 16th day of September 2002.

Spencer Abraham,

Secretary of Energy.

[FR Doc. 02–24076 Filed 9–20–02; 8:45 am]

BILLING CODE 6450–01–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50–237, 50–249, 50–254, and 50–265]

Exelon Generation Company, LLC; Dresden Nuclear Power Station, Units 2 and 3, Quad Cities Nuclear Power Station, Units 1 and 2; Environmental Assessment and Finding of No Significant Impact

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of an exemption from certain requirements of 10 CFR 50.71(e)(4) for Facility Operating License Nos. DPR–19 and DPR–25, issued to Exelon Generation Company, LLC (the licensee), for operation of the Dresden Nuclear Power Station, Units 2 and 3, located in Grundy County, Illinois, and for Facility Operating License Nos. DPR–29 and DPR–30, issued to the licensee, for operation of the Quad Cities Nuclear Power Station, Units 1 and 2, located in Rock Island County, Illinois. Therefore, as required by 10 CFR 51.21, the NRC is issuing this environmental assessment and finding of no significant impact.

Environmental Assessment

Identification of the Proposed Action

The proposed action would grant a schedular extension for Dresden Nuclear Power Station (Dresden), Units 2 and 3, and for Quad Cities Nuclear Power Station (Quad Cities), Units 1 and 2, for submittal of revised Updated Final Safety Analysis Reports (UFSARs) from the regularly scheduled dates. 10 CFR 50.71(e)(4) requires that subsequent revisions to the UFSAR be submitted periodically to the NRC provided that the interval between successive updates does not exceed 24 months. The Dresden and Quad Cities UFSAR revisions are currently submitted on a 24-month cycle. The next scheduled date for submittal of the revised UFSAR for Dresden is June 30, 2003, and for Quad Cities is October 20, 2003. However, the licensee plans to submit revised UFSARs along with Operating License Renewal Applications (LRAs) for Dresden and Quad Cities in January 2003. The licensee plans to resume the established schedule for submittal of the UFSAR revisions in 2005 for both stations. The licensee requests a one-time exemption to postpone submittal of the revised Dresden and Quad Cities UFSARs until 2005.

The proposed action is in accordance with the licensee's application dated August 9, 2002.

The Need for the Proposed Action

The licensee proposes to submit revised UFSARs with LRAs in January 2003, and to resume the established schedule for submittal of UFSAR revisions for Dresden on June 30, 2005, and for Quad Cities on October 20, 2005. An exemption is required because 10 CFR 50.71(e)(4) requires that subsequent revisions to the UFSAR be submitted periodically to the NRC provided that the interval between successive updates does not exceed 24 months.

Environmental Impacts of the Proposed Action

The NRC has completed its evaluation of the proposed action and concludes that there are no significant adverse environmental impacts associated with the proposed action.

The proposed action will not significantly increase the probability or consequences of accidents, no changes are being made in the types of effluents that may be released off site, and there is no significant increase in occupational or public radiation exposure. Therefore, there are no significant radiological environmental impacts associated with the proposed action.

With regard to potential nonradiological impacts, the proposed action does not have a potential to affect any historic sites. It does not affect nonradiological plant effluents and has no other environmental impact. Therefore, there are no significant nonradiological environmental impacts associated with the proposed action.

Accordingly, the NRC concludes that there are no significant environmental impacts associated with the proposed action.

Environmental Impacts of the Alternatives to the Proposed Action

As an alternative to the proposed action, the staff considered denial of the proposed action (*i.e.*, the ''no-action'' alternative). Denial of the application would result in no change in current environmental impacts. The environmental impacts of the proposed action and the alternative action are similar.

Alternative Use of Resources

The action does not involve the use of any different resource than those previously considered in the Final Environmental Statement for the Dresden Nuclear Power Station, Units 2 and 3, dated November 1973, and for the Quad Cities Nuclear Power Station, Units 1 and 2, dated September 1972.

Agencies and Persons Consulted

On August 22, 2002, the staff consulted with the Illinois State official, Mr. F. Niziolek of the Department of Nuclear Safety, regarding the environmental impact of the proposed action. The State official had no comments.

Finding of No Significant Impact

On the basis of the environmental assessment, the NRC concludes that the proposed action will not have a significant effect on the quality of the human environment. Accordingly, the

Modern Pit Facility Site Screening Report

INTRODUCTION

Based on the May 24, 2002 approval of the critical decision on mission need (CD-0) by the Secretary of Energy, the National Nuclear Security Administration (NNSA) is planning to design, construct and operate a new modern pit facility (MPF) that will provide a significantly larger capacity than the interim production capacity being established at Los Alamos National Laboratory (LANL). As a key step in the planning, the NNSA will prepare a Supplemental Environmental Impact Statement (SEIS) to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS) [hereafter, that SEIS will be referred to as the MPF EIS]. The MPF EIS will support the following decisions: (1) whether to proceed with the MPF; and (2) if so, where to locate the MPF. A tiered, project-specific EIS is expected to be prepared after the MPF EIS if the Secretary decides to proceed with such a facility. That tiered EIS, which would utilize detailed design information to evaluate site-specific alternatives at any site selected as a potential location for a MPF, would ultimately support a decision for construction and operation of the MPF. The purpose of this paper is to describe the results of the site screening process used to develop the reasonable site alternatives that will be evaluated in the MPF EIS.

OVERVIEW OF SITE SCREENING

The purpose of the site screening process was two-fold: (1) to identify reasonable site alternatives for the MPF EIS; and (2) to identify unsuitable site alternatives and document why these alternatives were not reasonable for the MPF EIS. A two-step screening process was employed: first, all potential sites were judged against Ago/no go@ criteria; and second, those sites satisfying the go/no go criteria were judged against desired, weighted criteria. The desired criteria and weights were developed by members of the MPF project office. Federal employees from the NNSA and other relevant DOE program offices then Ascored@ the potential sites using the desired criteria. Aggregate scores for the alternatives were then tallied, and the reasonable site alternatives were determined.

SITES UNDER CONSIDERATION

Existing, major Department of Energy (DOE) sites were considered to serve as the host location for the MPF. Non-DOE or new sites were not considered to avoid potential contamination issues at a new location that had not previously been associated with plutonium or plutonium-bearing waste operations. Many DOE sites did not satisfy the go/no-go criteria and were eliminated during the first step of the screening process. The seven sites that were evaluated through both steps of the screening process were: Idaho National Engineering and Environmental Laboratory (INEEL), Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), Pantex (PX), Savannah River Site (SRS), Waste Isolation Pilot Plant (WIPP) site at Carlsbad, and Y-12 on the Oak Ridge Reservation.

SITE SCREENING PROCESS

The first step in the site screening process was to develop go/no go criteria that any potential site had to satisfy to be judged further as a reasonable site alternative for the MPF. Sites not satisfying these go/no go criteria were not judged any further in the screening process. Members of the MPF project office determined that security and safety to workers and the public were the two most important factors. Accordingly, population encroachment and mission compatibility were deemed the appropriate go/no go criteria for siting the MPF, as explained below.

With respect to population encroachment, two types of data were factored into the criterion: density of surrounding population and nearness to a major city. Sites surrounded by populations greater than 1,000,000 people (based on a 50-mile radius population) were determined to be unsuitable. Sites contiguous to major cities were also determined to be unsuitable, due to the potential for future population encroachment and economic disruption and deleterious health impacts in the unlikely event of a major accident.

With respect to mission compatibility, it was decided that sites not currently conducting ADOE nuclear operations@ were unsuitable for the MPF. Sites that currently conduct ADOE nuclear operations@ have an established nuclear facility Environment, Safety, and Health (ES&H) and security infrastructure that were determined to be essential. Non-DOE nuclear sites were eliminated from consideration because of concerns regarding long-term mission compatibility and the absence of an existing DOE ES&H and security infrastructure. Sites predominantly engaged in Aclean-up@ missions were also determined to be unsuitable for the MPF because proposing a major new nuclear facility had the potential to distract from efforts related to site clean-up.

Sites that satisfied the go/no go criteria were then judged against desired, weighted criteria to determine the comparative reasonableness of each site alternative. The following weighted criteria were utilized: population encroachment, mission compatibility, margin for safety/security, synergy with existing/future plutonium operations, minimizing transportation of plutonium, NNSA site, and infrastructure.

Technical judgments were utilized to establish criterion weighting. The most important criteria were assigned a relative weight of 5, the remaining criterion were assigned a weight of 3. Of the desired criteria, the NNSA determined that population encroachment, mission compatibility, margin for safety/security, and synergy with existing/future plutonium operations were of greatest importance and thus, were assigned the highest weighting of 5. Minimizing transportation of plutonium, current use as an NNSA site, and infrastructure were assigned a weighting of 3.

SITE SCREENING CRITERIA

Population Encroachment: Population encroachment considered the population density within a fifty-mile radius of the site. The population density near the site boundary and population centers within 10 miles of the site boundary were also considered. Because population encroachment has strong security implications, as well the potential to affect ES&H risks to the public, this criterion was rated one of the most important criterion and assigned a weighting of 5.

> Sites with the smallest population at the greatest distance from the MPF received the highest rating of 10.

Sites with the highest population closest to the MPF received the lowest rating of 0.

Sites in-between received a rating of 2.5, 5, or 7.5, depending upon the relative population encroachment

These scores were then multiplied by a factor of five to determine the final score for this criterion.

Mission Compatibility: Mission compatibility referred to the capability of the MPF to be constructed and operated in harmony with a site's existing missions. For example, a site conducting similar operations to those of the MPF, i.e., receipt and storage of Category I quantities of plutonium, large scale plutonium chemical processing operations, plutonium foundry, plutonium machining and joining, assembly, post assembly testing, extensive analytical and metallurgical laboratories, and waste handling of high level and TRU waste, was expected to be more suitable for constructing and operating the MPF compared to a site without such operations. Sites conducting similar missions were expected to have a higher likelihood of successfully accomplishing the MPF mission on schedule and on budget; thus, this criterion was rated one of the most important criterion and assigned a weighting of 5.

Sites with existing missions most similar to those of the MPF received the highest score of 10.

Sites with existing missions least similar to those of the MPF received the lowest score of 0.

Sites in-between received ratings of 2.5, 5, or 7.5, depending upon the relative similarity of their missions to those of the MPF.

These scores were then multiplied by a factor of five to determine the final score for this criterion.

Synergy with Plutonium Operations: While similar to mission compatibility, this criterion took into account specific attributes associated with plutonium manufacturing and processing, including potential synergies with existing/future plutonium missions that have the potential to improve the efficiency/reduce the costs of constructing/operating the MPF. Factors such as the extent of existing/future plutonium manufacturing and processing, experience with plutonium manufacturing and processing, existing/future plutonium radiological labs and analytical capability, existence of emergency operation personnel and equipment are examples of factors that were considered. This criterion was rated one of the most important criterion and assigned a weighting of 5.

Sites which conduct the most plutonium manufacturing and processing, or which have the potential to conduct the most plutonium manufacturing and processing in the future, or which have or may have the greatest plutonium infrastructure received the highest score of 10.

Sites which conduct the least plutonium manufacturing and processing, or which have the potential to conduct the least plutonium manufacturing and processing in the future, or which have or may have the least plutonium infrastructure received the lowest score of 0.

Sites in-between received scores of 2.5, 5, or 7.5, depending upon the relative amount of plutonium manufacturing and processing/infrastructure afforded by the site.

These scores were then multiplied by a factor of five to determine the final score for this criterion.

Margin for Safety/Security: Margin for safety and security referred to a site's inherent ability to provide a safe and secure operating environment against threats and to minimize potential effects of accidents. Factors such as remoteness, terrain, proximity to military bases, controlled air space, proximity to commercial flight paths, and visibility from public highways are examples of factors that were considered. Sites with greatest margins for safety/security provided a higher likelihood of successfully accomplishing the MPF mission; thus, this criterion was rated one of the most important criterion and assigned a weighting of 5.

Sites with the greatest margin for safety/security received the highest score of 10.

Sites with the lowest margin for safety/security received the lowest score of 0.

Sites in-between received scores of 2.5, 5, or 7.5, depending upon the relative margin for safety/security afforded by the site.

These scores were then multiplied by a factor of five to determine the final score for this criterion.

Minimization of Transportation: Candidate sites were scored, on a relative basis, according to their geographic location and the amount of hazardous material transportation that would be required to support the location of the MPF at that site. Reducing the total distance that plutonium feedstock, manufactured product, and radioactive waste are transported has potentially substantial operational, cost, safety, and security benefits. This criterion was assigned a weighting of 3.

Sites requiring the least plutonium transportation received the highest score of 10.

Sites requiring the most plutonium transportation received the lowest score of 0.

Sites in-between received scores of 2.5, 5, or 7.5, depending upon the relative amount of plutonium transportation associated with the site.

These scores were then multiplied by a factor of three to determine the final score for this criterion.

NNSA Sites: Existing NNSA sites (including non-NNSA sites that conduct a significant amount of NNSA work) with NNSA procedures, NNSA management, safety, security, and administrative procedures in place were deemed more desirable than sites that do not conduct a significant amount of NNSA work. This criterion was assigned a weighting of 3.

NNSA sites (including non-NNSA sites that conduct a significant amount of NNSA work) received the highest score of 10.

Non-NNSA sites that do not conduct a significant amount of NNSA work received the lowest score of 0.

Sites in-between received scores of 2.5, 5, or 7.5, depending upon the relative amount of NNSA work associated with the site.

These scores were then multiplied by a factor of three to determine the final score for this criterion.

Existing Infrastructure: Candidate sites were scored, on a relative basis, on the amount of existing relevant infrastructure. Factors such as existing security forces and structures, existing administrative facilities, existing safety equipment and personnel, available utilities, existence of on-site technical capability to provide applied R&D and manufacturing technical support, and existence of a waste handling infrastructure for both higher level and TRU waste are examples of factors that would make a site a more desirable location for the MPF. This criterion was assigned a weighting of 3.

Sites with the greatest existing infrastructure received the highest score of 10.

Sites with the least existing infrastructure received the lowest score of 0.

Sites in-between received scores of 2.5, 5, or 7.5, depending upon the relative amount of infrastructure at the site.

These scores were then multiplied by a factor of three to determine the final score for this criterion.

RESULTS OF SITE SCREENING PROCESS

All major DOE sites were initially considered. Many DOE sites did not satisfy the go/no-go criteria. For example, Hanford, although remote, did not satisfy the mission compatibility criteria. Hanford is clearly a remediation site which no longer has a weapons mission. Siting a new weapons production facility at Hanford would clearly conflict with the future plans for the site. Kansas City Plant did not satisfy either of the two go/no-go criteria as it is a non-nuclear facility located in the midst of a large urban setting. Both SNL and LLNL, due to their proximity to large, rapidly growing populations, did not satisfy the go/no-go criterion for population encroachment. Rocky Flats did not satisfy either of the go/no-go criterion. This facility is in close proximity to a large population, no longer has a weapons mission, and is considered to be a remediation site. Other major DOE sites, such as ANL-East or BNL, that do not have national security-related missions and/or are close to major urban centers were eliminated for similar reasons.

Seven DOE sites remained after initial go/no-go screening. These remaining DOE sites (Carlsbad, INEEL, LANL, Nevada Test Site, Oak Ridge Reservation (Y-12), Pantex and Savannah River site) were then ranked, on a relative basis, using each of the site screening criteria and the weighting factors described above. Each of the DOE reviewing officials independently scored these seven

sites using the criteria described above. Scores of each reviewer were then averaged for each criteria. Weighted scores for the sites were then tallied, yielding the results shown below:

Average Weighted Site Selection Scores

	LANL	**SRS**	**NTS**	**Pantex**	**Carlsbad**	**INEEL**	**Y-12**
Population Encroachment	23.5	14	50	23.5	47	40.5	0
Mission Compatibility	48.5	47	9.5	28	11	6.5	9.5
Margin for Safety/Security	20.5	29.5	50	17	33	31.5	8
Synergy With Pu Ops	48.5	47	12.5	19	11	6.5	0
Transportation Minimization	20.7	0.9	8.4	30	29.1	6.6	3.9
NNSA Site	28.8	28.2	28.2	28.2	3.9	3.9	25.2
Infrastructure	28.2	28.8	10.2	15.9	8.4	8.4	11.4
TOTAL WEIGHTED SCORE	**218.7**	**195.4**	**168.8**	**161.6**	**143.4**	**103.9**	**58**

CONCLUSION

Based on the weighted scores shown above, Y-12 and INEEL scored significantly less than the other five sites, thereby creating a significant break among the seven sites. Carlsbad, LANL, NTS, Pantex and SRS all received scores of at least 28% higher than INEEL, and at least 60% higher than Y-12. The average score for the five highest ranked sites was 178, and the five highest-scoring sites were within 20% of this average. INEEL and Y-12 were 42% and 67% below this average respectively.

In addition, the results of the site screening scoring process were reviewed to determine if one or more Avariant@ scores influenced the results. A sensitivity analysis was performed in which both the high and low scores were eliminated in an attempt to add more consistency to the average scores. The results determined that no single individual score influenced the final results of the process. Another sensitivity analysis was performed to examine the importance of the weighting factor for transportation that is a criterion that could have broad interest from citizens in several states. This criterion was assessed using a weighting factor of 5 instead of 3. The increased weighting yielded higher scores for Carlsbad and Pantex (which were already score the highest for this criterion based on a weighting factor of 3), while not changing the relative ranking of any of the sites. The net result was an even more significant break between the top 5 sites and the bottom 2 sites, thus, corroborating the original results.

The results of these sensitivity analyses confirmed both the relative rankings of the seven sites and the significant Abreak point@ between the top five sites and the bottom two sites. As a result of the site screening process, it was determined that Carlsbad, LANL, NTS, Pantex and SRS represented a reasonable range of alternatives sites that should be evaluated in detail in the MPF EIS.

AGREEMENT
BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND
THE GOVERNMENT OF THE RUSSIAN FEDERATION
CONCERNING THE MANAGEMENT AND DISPOSITION OF PLUTONIUM DESIGNATED AS NO LONGER REQUIRED FOR DEFENSE PURPOSES AND RELATED COOPERATION

The Government of the United States of America and the Government of the Russian Federation, hereinafter referred to as the Parties,

Guided by:

The Joint Statement of Principles for Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes, signed by the President of the United States of America and the President of the Russian Federation on September 2, 1998, affirming the intention of each country to remove by stages approximately 50 metric tons of plutonium from their nuclear weapons programs and to convert this plutonium into forms unusable for nuclear weapons;

Taking into account:

The Agreement between the Government of the United States of America and the Government of the Russian Federation on Scientific and Technical Cooperation in the Management of Plutonium That Has Been Withdrawn from Nuclear Military Programs, signed on July 24, 1998 (hereinafter referred to as the Scientific and Technical Cooperation Agreement);

Continuation by the Parties of their cooperation within the framework of the Scientific and Technical Cooperation Agreement and the importance of that work for making decisions concerning technologies for plutonium conversion and mixed uranium-plutonium fuel fabrication, as well as for reactor modification for the use of such fuel;

The statement of the President of the United States of America on March 1, 1995, announcing that 200 tons of fissile material will be withdrawn from the U.S. nuclear stockpile and directing that these materials will never again be used to build a nuclear weapon;

The statement of the President of the Russian Federation to the 41st Session of the General Conference of the International Atomic Energy Agency, on September 26, 1997, on step-by-step removal from nuclear military programs of up to 500 tons of highly enriched uranium and up to 50 tons of plutonium released in the process of nuclear disarmament; and

The Joint Statement by the Parties concerning non-separation of weapon-grade plutonium in connection with the signing of this Agreement;

Have agreed as follows:

Article I

For the purposes of this Agreement, the terms specified below are defined as follows:

1. “Weapon-grade plutonium” means plutonium with an isotopic ratio of plutonium 240 to plutonium 239 of no more than 0.10.

2. “Disposition plutonium” means weapon-grade plutonium that has been

   a) withdrawn from nuclear weapon programs,

   b) designated as no longer required for defense purposes, and

   c) declared in the Annex on Quantities, Forms, Locations, and Methods of Disposition, which is an integral part of this Agreement.

3. “Blend stock” means any plutonium other than disposition plutonium that is received at a disposition facility for mixing with disposition plutonium.

4. “Spent plutonium fuel” means fuel that was manufactured with disposition plutonium and irradiated in nuclear reactors.

5. “Immobilized forms” means disposition plutonium that has been imbedded in a glass or ceramic matrix and encapsulated with high-level radioactive waste in a can-in-canister system suitable for geologic disposal, or any other immobilization system agreed in writing by the Parties.

6. “Disposition facility” means any facility that is constructed, modified or operated under this Agreement or that stores, processes, or otherwise uses disposition plutonium, spent plutonium fuel, or immobilized forms, including any such conversion or conversion/blending facility, fuel fabrication facility, immobilization facility, nuclear reactor, and storage facility (other than storage facilities specified in Section III of the Annex on Quantities, Forms, Locations, and Methods of Disposition).

Article II

1. Each Party shall, in accordance with the terms of this Agreement, dispose of no less than thirty-four (34) metric tons of disposition plutonium.

2. Each Party’s declaration on quantities, forms, locations, and methods of disposition for disposition plutonium is set forth in the Annex on Quantities, Forms, Locations, and Methods of Disposition.

3. The Parties shall cooperate in the management and disposition of disposition plutonium, implementing their respective disposition programs in parallel to the extent practicable.

4. The reciprocal obligations set forth in paragraph 1 of this Article shall not prejudice consideration by the Parties of what additional quantities of plutonium may be designated by each Party in the future as no longer required for defense purposes.

5. The Parties shall cooperate with a view to ensuring that additional quantities of weapon-grade plutonium that may be withdrawn from nuclear weapon programs and designated in the future by the Parties as no longer required for defense purposes are:

    a) brought under and disposed of in accordance with the terms of this Agreement; or

    b) subject to other measures as agreed by the Parties in writing that provide for comparable transparency and disposition.

6. Each Party shall have the right to mix blend stock with disposition plutonium provided that for nuclear reactor fuel containing disposition plutonium the mass of blend stock shall:

    a) be kept to a minimum, taking into account the protection of classified information, safety and economic considerations, and obligations of this Agreement; and

    b) in no case exceed twelve (12) percent of the mass of disposition plutonium with which it is mixed.

    The resulting mixture of disposition plutonium and blend stock shall be weapon-grade plutonium.

7. Each Party's disposition plutonium shall count toward meeting the thirty-four (34) metric ton obligation set forth in paragraph 1 of this Article once the other Party confirms in accordance with agreed procedures that the spent plutonium fuel or immobilized forms meet the criteria specified in the Annex on Technical Specifications, which is an integral part of this Agreement. Blend stock shall not count toward meeting that thirty-four (34) metric ton obligation.

Article III

1. Disposition shall be by one or more of the following methods:

    a) irradiation of disposition plutonium as fuel in nuclear reactors;

    b) immobilization of disposition plutonium into immobilized forms; or

    c) any other methods that may be agreed by the Parties in writing.

2. The following are the nuclear reactors that may be used for irradiation of disposition plutonium under this Agreement: light water reactors in the United States of America and in the Russian Federation; the BOR-60 at Dimitrovgrad and the BN-600 at Zarechnyy in the Russian Federation; and any other nuclear reactors agreed by the Parties in writing.

Article IV

1. Each Party shall take all reasonable steps, including completion of necessary technical and other preparatory activities and feasibility studies, to complete construction and modification and to begin operation of disposition facilities necessary to dispose of no less than two (2) metric tons per year of its disposition plutonium in accordance with

Article III of this Agreement, if the assistance specified in the multilateral agreement referred to in paragraph 8 of Article IX of this Agreement for this disposition rate is being provided for achievement of milestones in the Russian Federation specified in the Annex on Schedules and Milestones, which is an integral part of this Agreement.

2. Each Party shall seek to begin operation of facilities referenced in paragraph 1 of this Article not later than December 31, 2007.

3. Pending conclusion of the multilateral agreement referred to in paragraph 8 of Article IX of this Agreement for the disposition rate specified in paragraph 1 of this Article, the Parties shall proceed with research, development, demonstrations, design and licensing activities under this Agreement, on the condition that assistance for such activities is being provided pursuant to paragraph 1 of Article IX of this Agreement.

4. Each Party shall notify the other Party whenever it reaches a milestone set forth in the Annex on Schedules and Milestones or, if not reached at the specified time, the reasons for that delay. If a Party does not reach a milestone at the specified time, it shall make every effort to minimize the delay. In these circumstances, the Parties shall establish in writing a revised mutually-agreed schedule of work for achieving the milestone.

5. Once facilities specified in paragraph 1 of this Article are constructed or modified and begin operations, each Party shall proceed to dispose of disposition plutonium to achieve a disposition rate of no less than two (2) metric tons per year at the earliest possible date.

6. If, prior to December 31, 2007, a Party begins to dispose of disposition plutonium, such plutonium may count toward meeting the thirty-four (34) metric ton obligation set forth in paragraph 1 of Article II of this Agreement if:

   a) the criteria specified in the Annex on Technical Specifications are met; and

   b) monitoring and inspection measures agreed in writing by the Parties are applied to such disposition activities.

Article V

1. Promptly upon entry into force of this Agreement, the Parties shall undertake to develop a detailed action plan, including efforts with other countries as appropriate, to at least double the disposition rate specified in paragraphs 1 and 5 of Article IV of this Agreement at the earliest practicable date. The Parties shall seek to complete this detailed action plan within one year after entry into force of this Agreement. The development of the action plan and the development of arrangements provided for in paragraph 7 of Article IX of this Agreement will, for the Government of the United States of America and the Government of the Russian Federation, proceed in the channels that have negotiated this Agreement.

2. In developing the action plan pursuant to paragraph 1 of this Article, consideration may be given to:

   a) expanding the capability of existing nuclear reactors to utilize mixed uranium-plutonium fuel or using such fuel in additional nuclear reactors, including nuclear reactors outside the Russian Federation, and using such fuel or other plutonium fuel in advanced nuclear reactors within the Russian Federation, if they prove practical in light of available resources within the time frame of this Agreement;

b) consistent with the expansion of capabilities mentioned in subparagraph (a) of this paragraph, increasing the capacity of conversion or conversion/blending facilities, fuel fabrication facilities and/or immobilization facilities, or constructing additional facilities; and

c) any other approaches as the Parties may agree.

3. Each Party shall proceed at the earliest possible date to dispose of disposition plutonium at the disposition rate specified in the action plan referred to in paragraph1 of this Article if the assistance specified in the provisions supplementing the multilateral agreement referred to in paragraph 8 of Article IX of this Agreement for this rate in the Russian Federation is being provided.

Article VI

1. Disposition plutonium and blend stock, once received at any disposition facility, shall not be:

   a) used for the manufacture of nuclear weapons or any other nuclear explosive device, for research, development, design or testing related to such devices, or for any other military purpose; or

   b) exported to a third country, including for disposition, except by agreement in writing of the Parties to this Agreement and subject to international safeguards and other applicable international agreements or arrangements, including INFCIRC/274/Rev. 1, The Convention on the Physical Protection of Nuclear Material.

2. Neither Party shall separate plutonium contained in spent plutonium fuel until such time as that Party has fulfilled the obligation set forth in paragraph1 of Article II of this Agreement.

3. Neither Party shall separate disposition plutonium contained in immobilized forms.

4. Disposition facilities shall be utilized only in ways consistent with the terms and conditions of this Agreement.

5. Disposition plutonium and blend stock shall be the only plutonium received at or processed by disposition facilities that are conversion or conversion/blending facilities, or fuel fabrication facilities.

Article VII

1. Each Party shall have the right to conduct and the obligation to receive and facilitate monitoring and inspection activities in accordance with this Article and the Annex on Monitoring and Inspections, which is an integral part of this Agreement, in order to confirm that the terms and conditions of this Agreement with respect to disposition

plutonium, blend stock, spent plutonium fuel and immobilized forms, and disposition facilities are being met.

2. Disposition plutonium and blend stock shall become subject to monitoring and inspection under this Agreement, in accordance with the Annex on Monitoring and Inspections and procedures developed pursuant to that Annex, either (a) after receipt but before processing at a conversion or conversion/blending facility, or (b) upon receipt at a fuel fabrication or an immobilization facility, whichever (a) or (b) occurs first for any given disposition plutonium or blend stock.

3. Each Party shall begin consultations with the International Atomic Energy Agency (IAEA) at an early date and undertake all other necessary steps to conclude appropriate agreements with the IAEA to allow it to implement verification measures beginning not later in the disposition process than: (a) when disposition plutonium or disposition plutonium mixed with blend stock is placed into the post-processing storage location of a conversion or conversion/blending facility; or (b) when disposition plutonium is received at a fuel fabrication or an immobilization facility, whichever (a) or (b) occurs first for any given disposition plutonium.

4. If agreed in writing by the Parties, the exercise of each Party's right set forth in paragraph 1 of this Article may be suspended in whole or in part by the application of equivalent IAEA verification measures under the agreements referred to in paragraph 3 of this Article. The Parties shall, to the extent practicable, avoid duplication of effort of monitoring and inspection activities implemented under this Agreement and appropriate agreements with the IAEA.

Article VIII

1. Each Party shall be responsible within the territory of the United States of America and the Russian Federation, respectively, for:

   a) ensuring safety and ecological soundness of disposition plutonium activities under the terms of this Agreement; and

   b) effectively controlling and accounting for disposition plutonium, blend stock, spent plutonium fuel and immobilized forms, as well as providing effective physical protection of such material and facilities containing such material taking into account the recommendations published in the IAEA document INFCIRC/225/Rev. 4, The Physical Protection of Nuclear Material, or a subsequent revision accepted by the Parties.

Article IX

1. The Government of the United States of America shall make available up to two hundred (200) million United States dollars in assistance for the activities to be undertaken in the Russian Federation pursuant to this Agreement and such other amounts as may be agreed in writing by the Parties for these purposes in the future, subject to the availability of appropriated funds and the fulfillment of United States legal and administrative requirements. Assistance provided by the Government of the United States of America shall be for such activities as the research, design, development, licensing, construction

and/or modification of facilities (including modification of nuclear reactors), and technological processes, systems and associated infrastructure for such activities. This assistance will be in addition to any other assistance that may be provided by the Government of the United States of America under the Scientific and Technical Cooperation Agreement.

2. Assistance provided by the Government of the United States of America may include research and development, scientific and technical experimentation, design for facility construction or modification, general and specialized equipment, replacement and spare parts, installation services, licensing and certification costs, initial operations and testing, aspects of facility operations, and other assistance directly related to the management and disposition of plutonium in accordance with the provisions of this Agreement.

3. Equipment, supplies, materials, services, and other assistance provided or acquired by the Government of the United States of America, its contractors, subcontractors, and their personnel, for the implementation of this Agreement in the Russian Federation, are considered free technical assistance.

4. Assistance provided by the Government of the United States of America for activities to be undertaken in the Russian Federation pursuant to this Agreement shall be provided in accordance with the terms and conditions set forth in this Agreement, including the Annex on Assistance, which is an integral part of this Agreement.

5. The activities of each Party under this Agreement shall be subject to the availability of appropriated funds.

6. Activities to be undertaken in the Russian Federation pursuant to this Agreement may be supported by contributions by the Government of the Russian Federation and by assistance provided by the Government of the United States of America and, as may be specified in the multilateral agreement referred to in paragraph 8 of this Article, by other countries or groups of countries (including equipment, supplies, materials, services, and other assistance provided by them). Activities may also be supported from other sources, including non-government and private sector funds, under terms and conditions agreed in writing by the Parties.

7. The Parties shall seek to develop near-term and long-term international financial or other arrangements for the support of activities to be undertaken in the Russian Federation pursuant to this Agreement sufficient, in combination with contributions by the Government of the Russian Federation and assistance provided by the Government of the United States of America, to achieve and maintain:

   a) the two (2) metric ton per year disposition rate specified in paragraphs 1 and 5 of Article IV of this Agreement; and

   b) the disposition rate resulting from the action plan developed pursuant to paragraph 1 of Article V of this Agreement.

8. For the disposition rate referred to in paragraph 7(a) of this Article, the Parties shall cooperate with a view toward concluding within one (1) year after entry into force of this Agreement a multilateral agreement that documents the assistance arrangements necessary for that rate. For the disposition rate resulting from the action plan developed pursuant to paragraph 1 of Article V of this Agreement, the Parties shall cooperate with a view to

supplementing such multilateral agreement with provisions recording assistance arrangements necessary for that rate.

9. As part of the multilateral agreement referred to in paragraph 8 of this Article, the Parties shall seek to provide for:

    a) notifications, explanations and immediate consultations in the event that a recorded assistance commitment is not fulfilled; and

    b) those consultations to include consideration of resumption of assistance, measures to mitigate any consequences of such non-fulfillment, including costs associated with nuclear safety, physical protection and facility conservation, and other measures as deemed appropriate by the participants in the consultations.

10. If conclusion of the multilateral agreement referred to in paragraph 8 of this Article for assistance arrangements necessary for the disposition rate set forth in paragraph 7(a) of this Article is not completed within eighteen (18) months after entry into force of this Agreement for any reason, the Parties shall consult on whether to adjust the schedules for their respective programs, including any necessary adjustments to the milestones set forth in the Annex on Schedules and Milestones, and any other steps, or whether to terminate the Agreement in accordance with Article XIII of this Agreement.

11. Pending conclusion of the multilateral agreement referred to in paragraph 8 of this Article and conclusion of necessary arrangements with the Government of the Russian Federation for the disposition rate set forth in paragraph 7(a) of this Article, neither Party shall be obligated to construct, modify or operate facilities to dispose of disposition plutonium pursuant to this Agreement. Notwithstanding this, each Party shall proceed under this Agreement with activities in accordance with paragraph 3 of Article IV of this Agreement necessary for construction, modification or operation of disposition facilities.

12. If one or more parties to the multilateral agreement referred to in paragraph 8 of this Article decide to terminate implementation of their assistance commitments recorded in that agreement, and as a result the Government of the Russian Federation is unable to fulfill its obligations with respect to the achievement of a milestone set forth in the Annex on Schedules and Milestones or of the annual disposition rate specified in paragraphs 1 and 5 of Article IV or paragraph 3 of Article V of this Agreement, whichever is applicable, the Government of the Russian Federation shall have the right, consistent with the requirements of paragraphs 13 and 15 of this Article, to suspend those implementation activities under this Agreement that are affected by such termination.

13. If the Government of the Russian Federation intends to exercise its right pursuant to paragraph 12 of this Article, it shall notify the Government of the United States of America through diplomatic channels at least fourteen (14) days prior to any such suspension of implementation activities and identify what activities are to be suspended, and the Parties shall immediately start consultations. In the event implementation of the recorded assistance commitments referred to in paragraph 12 of this Article is not resumed within one hundred and eighty (180) days after the start of consultations, the Parties will consider whether to resume implementation of or to terminate the Agreement in accordance with Article XIII of this Agreement.

14. In the event the Government of the Russian Federation suspends any implementation activities pursuant to paragraph 12 of this Article, the Government of the United States of

America shall have the right to suspend proportionately its implementation activities under this Agreement.

15. During the consultations referred to in paragraph 13 of this Article, unless otherwise agreed by the Parties in writing, neither Party shall take any action that:

    a) could break the continuity in the other Party's knowledge of disposition plutonium or disposition facilities, that had become subject to monitoring and inspection under this Agreement, in a manner that would prevent that Party from confirming that such disposition plutonium or disposition facilities are not being used in ways inconsistent with the Agreement; or

    b) would be inconsistent with the terms and conditions for assistance that had been provided under this Agreement.

Article X

1. Under this Agreement, no United States classified information or Russian Federation state secret information shall be exchanged, except as may be agreed in writing by the Parties for purposes of exchanging information pursuant to this Agreement related to the quantities and locations of disposition plutonium and blend stock at disposition facilities.

2. The information transmitted under this Agreement or developed as a result of its implementation and considered by the United States of America as "sensitive" or by the Russian Federation as "konfidentsial'naya" must be clearly designated and marked as such.

3. "Konfidentsial'naya" or "sensitive" information shall be handled in accordance with the laws of the state of the Party receiving the information, and this information shall not be disclosed and shall not be transmitted to a third party not participating in the implementation of this Agreement without the written consent of the Party that had transmitted such information.

    a) According to the laws and regulations of the Russian Federation, such information shall be treated as "limited-distribution official information". Such information shall be protected in accordance with the laws and regulations of the Russian Federation.

    b) According to the laws and regulations of the United States of America, such information shall be treated as "foreign government information," provided in confidence. Such information shall be protected in accordance with the laws and regulations of the United States of America.

4. Information transmitted under this Agreement shall be used solely in conformance with this Agreement.

5. The Parties shall minimize the number of persons having access to information that is designated "konfidentsial'naya" or "sensitive" information in accordance with paragraph 2 of this Article.

6. The Parties shall ensure effective protection and allocation of rights to intellectual property, transferred or created under this Agreement, as set forth in this Agreement, including the Annex on Intellectual Property, which is an integral part of this Agreement.

Article XI

1. The Parties shall designate Executive Agents for implementation of this Agreement. The Executive Agent for the United States of America shall be the U.S. Department of Energy. The Executive Agent for the Russian Federation shall be the Ministry of the Russian Federation for Atomic Energy.

2. With the exception of the notification referred to in paragraph1 of Article XIII of this Agreement, notifications between the Parties that are provided for by this Agreement shall be transmitted between the Executive Agents unless otherwise specified.

3. The Executive Agents may enter into implementing agreements and arrangements as necessary and appropriate to carry out the provisions of this Agreement. When appropriate, the Executive Agents may utilize other agencies or entities to assist in the implementation of this Agreement, such as government agencies, academies, universities, science and research centers, institutes and institutions, and private sector firms.

Article XII

1. The Parties shall establish a Joint Consultative Commission for this Agreement to:

    a) consider and resolve questions regarding the interpretation or application of this Agreement;

    b) consider additional measures as may be necessary to improve the viability and effectiveness of this Agreement; and

    c) consider and resolve such other matters as the Parties may agree are within the scope of this Agreement.

2. The Joint Consultative Commission shall meet within twenty-one (21) days of a request of either Party or its Executive Agent.

3. Each Party shall designate its Co-Chairman to the Joint Consultative Commission. Each Party shall notify the other Party of its designated Co-Chairman in writing within thirty (30) days after entry into force of this Agreement. Decisions of the Joint Consultative Commission shall be made on the basis of consensus.

Article XIII

1. This Agreement shall be applied provisionally from the date of signature and shall enter into force on the date of the last written notification that the Parties have fulfilled the national procedures required for its entry into force.

2. This Agreement may only be amended by written agreement of the Parties, except that the Annex on Schedules and Milestones may be updated as specified in Section II of that Annex.

3. Except as provided in paragraph 4 of this Article, this Agreement shall terminate on the date the Parties exchange notes confirming that thirty-four (34) metric tons of disposition plutonium have been disposed by each Party in accordance with this Agreement, unless terminated earlier by written agreement of the Parties.

4. If additional quantities of weapon-grade plutonium are brought under this Agreement pursuant to paragraph 5 of Article II of this Agreement, this Agreement shall terminate on the date the Parties exchange notes confirming that thirty-four (34) metric tons of disposition plutonium and all such additional quantities of weapon-grade plutonium have been disposed in accordance with this Agreement, unless terminated earlier by written agreement of the Parties.

5. Notwithstanding termination of this Agreement in accordance with paragraph 3 or 4 of this Article:

   a) neither Party shall use plutonium, once it is received at any disposition facility, for the manufacture of nuclear weapons or any other nuclear explosive device, for research, development, design or testing related to such devices, or for any other military purpose;

   b) neither Party shall export to a third country plutonium, once it is received at any disposition facility, except by agreement in writing of the Government of the United States of America and the Government of the Russian Federation and subject to international safeguards and other applicable international agreements or arrangements, including INFCIRC/274/Rev. 1, The Convention on the Physical Protection of Nuclear Material;

   c) neither Party shall (i) use any plutonium separated from spent plutonium fuel for the manufacture of nuclear weapons or any other nuclear explosive device, for research, development, design or testing related to such devices, or for any other military purpose, or (ii) export spent plutonium fuel, immobilized forms, or any plutonium separated from spent plutonium fuel to a third country, except by agreement in writing of the Government of the United States of America and the Government of the Russian Federation and subject to international safeguards and other applicable international agreements or arrangements, including INFCIRC/274/Rev. 1, The Convention on the Physical Protection of Nuclear Material;

   d) each Party shall continue to effectively control and account for spent plutonium fuel and immobilized forms, as well as to provide effective physical protection of such material taking into account the recommendations published in the IAEA document INFCIRC/225/Rev. 4, The Physical Protection of Nuclear Material, or subsequent revisions accepted by the Parties;

   e) the obligations set forth in paragraph 3 of Article VI of this Agreement, Article X of this Agreement, paragraphs 6 and 7 of this Article, paragraphs 5, 6, and 7 of the General Assistance Section of the Annex on Assistance, and the Liability Section of the Annex on Assistance shall remain in force unless otherwise agreed in writing by the Government of the United States of America and the Government of the Russian Federation;

f) the Parties shall consult concerning implementation of existing contracts and projects between the Parties and settlement of any outstanding costs between the Parties; and

g) for any activities under this Agreement and any importation or exportation by the Government of the United States of America, its personnel, contractors and contractors' personnel of equipment, supplies, materials or services that had been required to implement this Agreement, no retroactive taxes shall be imposed in the Russian Federation.

6. At an appropriate early date, but in any event not fewer than five (5) years prior to termination of this Agreement, the Parties shall begin consultations to determine what international monitoring measures shall be applied, after termination, to spent plutonium fuel, immobilized forms, and disposition facilities that are conversion or conversion/blending facilities or fuel fabrication facilities, as well as to any reprocessing of spent plutonium fuel. In the event the Parties do not reach agreement on such monitoring measures prior to the termination of this Agreement, each Party shall:

   a) make such fuel and forms available for inspection by the other Party under established procedures, if the other Party has a question or concern regarding changes in their location or condition; and

   b) unless it can be demonstrated that such facilities have been decommissioned and can no longer be operated, make such facilities available for inspection by the other Party under established procedures, if the other Party has a question or concern regarding the use of such facilities.

7. No spent plutonium fuel shall be reprocessed by either Party after termination of this Agreement unless such reprocessing is subject to monitoring agreed by the Parties pursuant to paragraph 6 of this Article.

8. Nothing in this Agreement shall alter the rights and obligations of the Parties under the Scientific and Technical Cooperation Agreement.

DONE at ___________ and ____________, the ___ and ___ days of __________, 2000, in duplicate in the English and Russian languages, both texts being equally authentic.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:	FOR THE GOVERNMENT OF THE RUSSIAN FEDERATION:

List of Annexes

Annex on Quantities, Forms, Locations, and Methods of Disposition
Annex on Technical Specifications
Annex on Schedules and Milestones
Annex on Monitoring and Inspections
Annex on Assistance
Annex on Intellectual Property

ANNEX
ON
QUANTITIES, FORMS, LOCATIONS, AND METHODS OF DISPOSITION

This Annex to the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, sets forth each Party's declaration of disposition plutonium.

Section I -- Quantities and Methods of Disposition

For the United States of America:

Quantity (metric tons)	Form	Method of Disposition
25.00	Pits and Clean Metal	Irradiation
0.57	Oxide	Irradiation
2.70	Impure Metal	Immobilization
5.73	Oxide	Immobilization

For the Russian Federation:

Quantity (metric tons)	Form	Method of Disposition
25.00	Pits and Clean Metal	Irradiation
9.00	Oxide	Irradiation

Section II -- Forms

1. Pits and Clean Metal: plutonium in or from weapon components or weapon parts, and plutonium metal prepared for fabrication into weapon parts.

2. Impure Metal: plutonium alloyed with one or more other elements in the form of a homogeneous metal, and unalloyed plutonium metal that is not clean metal.

3. Oxide: plutonium in the form of plutonium dioxide.

Section III -- Locations

The Government of the United States of America declares that:

1) all the "pits and clean metal" it declared in Section I of this Annex will be shipped to the Pit Disassembly and Conversion Facility in the United States of America directly from Zones 4 or 12 of the Pantex Plant in Texas, Technical Area 55 at the Los Alamos National Laboratory in New Mexico (LANL TA-55), the Plutonium Finishing Plant complex at 200 West Area the Hanford Site in Washington (Hanford PFP), the Plutonium Building at Lawrence Livermore National Laboratory in California (LLNL Plutonium Building), and the F and K areas at the Savannah River Site in South Carolina (Savannah River F and K Areas);

2) all the "oxide" it declared in Section I of this Annex to be irradiated in reactors as mixed uranium-plutonium fuel will be shipped to its fuel fabrication facility in the United States of America directly from LANL TA-55, LLNL Plutonium Building, and Savannah River F and K Areas;

3) all the "impure metal" it declared in Section I of this Annex will be shipped directly to its immobilization facility in the United States of America from LANL TA-55, Savannah River F and K Areas, Hanford PFP, and LLNL Plutonium Building; and

4) all the "oxide" it declared in Section I of this Annex to be immobilized will be shipped directly to its immobilization facility in the United States of America from LANL TA-55, LLNL Plutonium Building, Savannah River F and K Areas, and Hanford PFP.

The Government of the Russian Federation declares that:

1) all the "pits and clean metal" it declared in Section I of this Annex will be shipped to the conversion/blending facility in the Russian Federation under the Agreement directly from the Fissile Material Storage Facility at Mayak being constructed under the Agreement between the Department of Defense of the United States of America and the Ministry of the Russian Federation for Atomic Energy Concerning the Provision of Material, Services, and Training Relating to the Construction of a Safe, Secure and Ecologically Sound Storage Facility for Fissile Material Derived from the Destruction of Nuclear Weapons of September 2, 1993; and

2) all the "oxide" it declared in Section I of this Annex will be shipped directly to the conversion/blending facility in the Russian Federation from the places where such oxide was stored pursuant to the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation Regarding Plutonium Production Reactors, of September 23, 1997.

ANNEX
ON
TECHNICAL SPECIFICATIONS

This Annex to the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, sets forth the criteria for determining that disposition plutonium is disposed.

Section I -- Light Water Reactors

Disposition plutonium irradiated under the Agreement in light water reactors shall be considered disposed when the resulting spent plutonium fuel meets the following criteria:

1. Each spent plutonium fuel assembly contains a unique identifier that demonstrates it to be a fuel assembly produced with disposition plutonium;

2. Each spent plutonium fuel assembly is irradiated to a fuel burn-up level of no less than 20,000 megawatt days thermal per metric ton of heavy metal; and

3. The radiation level from each spent plutonium fuel assembly is such that it will become no less than 1 sievert per hour one meter from the accessible surface at the centerline of the assembly 30 years after irradiation has been completed.

Section II -- Immobilization

Disposition plutonium in immobilized forms shall be considered disposed when the system meets the following criteria:

1. Each can containing disposition plutonium immobilized in a glass or ceramic form designated to be inserted into a canister is marked with a unique identifier that allows for confirming the presence of the can as it is inserted into the canister;

2. Each canister containing cans of disposition plutonium is marked with a unique identifier that allows it to be identified during and after the immobilization process;

3. Each canister does not contain more than 30 kilograms of disposition plutonium; and

4. The radiation level from each canister is such that it will become no less than 1 sievert per hour one meter from the accessible surface at the centerline of the canister 30 years after the canister has been filled with high-level radioactive waste.

Section III -- BN-600 Reactor

Disposition plutonium irradiated under the Agreement in the BN-600 reactor shall be considered disposed when the resulting spent plutonium fuel meets the following criteria:

1. Each spent plutonium fuel assembly contains a unique identifier that demonstrates it to be a fuel assembly produced with disposition plutonium;

2. Each spent plutonium fuel assembly is irradiated to an average fuel burn-up level of no less than nine (9) percent of heavy atoms, unless the Parties agree in writing for safety reasons to a lower average level; and

3. The radiation level from each spent plutonium fuel assembly is such that it will become no less than 1 sievert per hour one meter from the accessible surface at the centerline of the assembly 30 years after irradiation has been completed.

ANNEX
ON
SCHEDULES AND MILESTONES

This Annex to the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, sets forth schedules and milestones for each Party.

Section I -- Schedules and Milestones

For the program of the United States of America:

Date	Milestone
January 2002	Completion of the design of the Pit Disassembly and Conversion Facility
March 2002	Completion of the design of the mixed uranium oxide-plutonium oxide (MOX) Fuel Fabrication Facility
March 2002	Start of excavation for the Pit Disassembly and Conversion Facility
July 2003	Start of excavation for the Immobilization Facility
October 2003	Start of excavation for the MOX Fuel Fabrication Facility
June 2004	Completion of the design of the Immobilization Facility
March 2005	Completion of construction of the Pit Disassembly and Conversion Facility
March 2006	Start of industrial-scale operations of the Pit Disassembly and Conversion Facility
April 2006	Completion of construction of the MOX Fuel Fabrication Facility
December 2006	Completion of construction of the Immobilization Facility
March 2007	Start of operations of the MOX Fuel Fabrication Facility
September 2007	Start of MOX Reactor operations/Irradiation of first batch of MOX in Reactor
March 2008	Start of full-scale production-operations of Immobilization Facility

For the program of the Russian Federation:

Date	Milestone
January 2002	Completion of modification of the State-Scientific-Center Experimental-Research-Complex Research Institute of Atomic Reactors (OIK GNTs RIAR) for fabrication of VIPAC fuel for BN-600 (hybrid core)

October 2002	Completion of the test-fuel line for fabrication of initial VVER-1000 lead-test MOX assemblies (3 MOX LTAs)
January 2003	Completion of modification of the PAKET facility for fabrication of BN-600 pellet fuel (hybrid core)
January 2003	Completion of the Demonstration Conversion Facility (for weapon-grade plutonium to oxide)
July 2003	Start construction of industrial-scale Conversion Facility
July 2003	Start construction of industrial-scale MOX fuel Fabrication Facility
April 2004	Begin transition of BN-600 to a MOX hybrid core
April 2004	Fabrication of initial VVER-1000 MOX lead-test assemblies
August 2004	Completion of the design of industrial-scale Conversion Facility
October 2004	Completion of the design of industrial-scale MOX Fuel Fabrication Facility
July 2006	Completion of construction of industrial-scale Conversion Facility
July 2006	Start of operation of industrial-scale Conversion Facility
December 2007	Completion of construction of industrial-scale MOX Fuel Fabrication Facility
December 2007	Start of operation of industrial-scale MOX Fuel Fabrication Facility
October 2007	Decision on BN-600 life-extension
2008	Fabrication of an industrial batch of VVER-1000 MOX-fuel
2009	Beginning of operations of storage facility for BN-600 spent plutonium fuel

Section II -- Notification of Updates

1. Each Party shall update as necessary the information it has provided in Section I of this Annex in accordance with the following:

   a) the updating Party's Executive Agent shall notify the Executive Agent of the other Party in writing with explanation of the reason for such an update; and

   b) the updating Party's Executive Agent shall provide such notification in writing not later than 90 days after the associated change occurs.

Section III -- Completion Criteria

The Executive Agents will develop an agreed set of completion criteria for the milestones set forth in this Annex by not later than six (6) months after the signature of the Agreement.

ANNEX
ON
MONITORING AND INSPECTIONS

This Annex sets forth principles and provisions to govern the development of procedures for, and the implementation of, monitoring and inspection activities pursuant to Article VII of the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement.

Section I -- Definitions

For purposes of the Agreement, the following definitions shall apply:

1. "Monitoring" means a set of measures and activities, including inspections, use of special equipment, and review of documents (records and reports), that together provide data to the monitoring Party on disposition plutonium, blend stock, spent plutonium fuel, immobilized forms, or disposition facilities.

2. "Inspection" means a monitoring activity conducted by the monitoring Party on-site at a facility in order to obtain data and make observations on disposition plutonium, blend stock, spent plutonium fuel, immobilized forms, or disposition facilities.

Section II -- General Principles

1. *Scope*: Monitoring and inspection activities shall be conducted in accordance with the Agreement, this Annex, and procedures to be agreed by the Parties pursuant to Section V of this Annex.

2. *Purpose*: In accordance with paragraph 1 of Article VII of the Agreement, monitoring and inspection activities shall be designed and implemented to ensure that the monitoring Party has the ability independently to confirm that the terms and conditions of the Agreement with respect to disposition plutonium, blend stock, spent plutonium fuel, immobilized forms, and disposition facilities are being met, specifically: paragraphs 1, 6 and 7 of Article II; paragraph 2 of Article III; Article VI; and paragraph 2 of Article VII of the Agreement.

3. *Systems of Control and Accounting*: The Parties shall implement national systems of control and accounting for nuclear materials to account for and keep records of disposition plutonium, blend stock, spent plutonium fuel, and immobilized forms. Operators of disposition facilities shall use this national system of control and accounting in order to prepare agreed data to be included in their reports. Such reports shall be provided to the monitoring Party according to procedures to be developed pursuant to Sections III and V of this Annex.

4. *Inspections*: The number, intensity, duration and timing of inspections, and the intensity of other monitoring activities, shall be kept to the minimum consistent with the effective

implementation of agreed monitoring activities pursuant to the Agreement and this Annex. Procedures for monitoring shall be designed so as to minimize, to the extent possible, interference with the operation of facilities, and to avoid affecting their nuclear safety or the safety of inspectors. Specific inspection procedures shall be developed pursuant to Section V of this Annex.

5. Inspectors shall be permitted access to disposition facilities sufficient for them to be able to attain the agreed goals of the inspection, using agreed procedures designed to avoid disclosure of United States classified information and Russian Federation state secret information in accordance with the provisions of paragraph1 of Article X of the Agreement. The monitored Party shall take every necessary measure, in accordance with agreed procedures, to ensure the access of the monitoring Party's inspectors to those facilities, and shall undertake to provide all necessary conditions for successful inspection implementation.

6. Each Party shall treat with due respect the inspectors of the other Party present on its territory in connection with monitoring activities under the Agreement and shall take all appropriate measures, consistent with its national law, to prevent any attack on the person, freedom and dignity of such personnel.

7. Each Party, in accordance with agreed procedures, shall facilitate the procurement of required services and use of equipment, the entry and exit of personnel of the other Party into and out of its territory, and the import into and export from its territory of materials and equipment for carrying out monitoring and inspection activities in accordance with the Agreement including this Annex.

8. *Relationship to Other Monitoring Regimes*: For disposition plutonium that comes from a facility subject to another U.S.-Russian bilateral monitoring regime, or an international monitoring regime that has been agreed by the Parties, monitoring under the Agreement shall take into account that other monitoring regime, and shall not conflict with the transfer requirements of that other monitoring regime. In developing monitoring and inspection procedures in accordance with the Agreement, the Parties should avoid duplicating the efforts of such other monitoring regimes.

9. *Pu-240/Pu-239 Ratio*: The monitoring Party shall be allowed to confirm, using an agreed method, that the Pu-240/Pu-239 ratio of the disposition plutonium is no greater than 0.10. Confirmation of this ratio shall occur after receipt but before processing of disposition plutonium at a conversion facility, or upon receipt at a fuel fabrication facility or immobilization facility, whichever occurs first for any given disposition plutonium.

10. *Protection of Information*: Measurements on plutonium, if required to protect United States classified information or Russian Federation state secret information from disclosure, shall be made by techniques using information barriers. Such measurements shall not be required, however, for any disposition plutonium in containers for which such measurements:

    a) had already been made under another agreement accepted by the monitoring Party; and

    b) are confirmed by the monitoring Party to remain valid.

11. *Blend Stock Measurements*: The monitoring Party shall have the right to confirm that the mass of any blend stock does not exceed what is allowed pursuant to paragraphs 6 and 7 of Article II of the Agreement, upon receipt of such blend stock at a disposition facility, using agreed procedures developed pursuant to Section V of this Annex. Information concerning the composition of the blend stock shall not be provided to, or obtained by, the monitoring Party.

12. *Procedures at Specific Facilities*: Each Party shall provide and update as appropriate a list of its disposition facilities as their specific locations are determined. The monitoring Party shall have the right to conduct monitoring activities, including inspections and other measures, at disposition facilities. These measures shall provide continuity of knowledge of disposition plutonium and blend stock necessary for the monitoring Party to determine whether the objectives of the Agreement are being met.

13. Pursuant to paragraph 1 of Article X of the Agreement, inspectors shall not have access to any parameters that are United States classified information or Russian Federation state secret information because of their relationship to nuclear weapon design or manufacturing.

14. *Conversion Product*: The blended or unblended plutonium-oxide at the post-processing storage location within a conversion or conversion/blending facility (hereinafter referred to as the "conversion product") shall have no characteristics that are considered classified by the United States of America or state secret by the Russian Federation.

15. The monitoring Party shall have the right to confirm the mass and relevant isotopic composition of the conversion product (even if it contains United States "sensitive" information or Russian Federation "konfidentsial'naya" information), using agreed measurement procedures, without the application of "yes/no" techniques or information barriers.

16. *Design Information*: For the purpose of developing agreed measures pursuant to Section V of this Annex, the Parties shall identify an agreed set of design information to be provided to the monitoring Party for disposition facilities. Once the set of design information is identified, that information shall be provided to the monitoring Party at an agreed time. The monitoring Party shall be allowed access to disposition facilities before operations and thereafter, as necessary to confirm design information, using agreed procedures.

17. *Unexpected Circumstances*: Procedures developed pursuant to Section V of this Annex shall include provisions, including monitoring activities as appropriate, concerning unexpected technical circumstances.

Section III -- Records and Reports

1. Based on its national system of control and accounting, each Party shall periodically submit to the other Party reports that were agreed upon in accordance with Section V of this Annex. Such reports shall at a minimum contain information on the quantity of plutonium at each disposition facility, as well as the quantities of plutonium received or shipped from that facility (including the plutonium in spent plutonium fuel, but not that in other spent fuel).

2. The Parties shall develop agreed methods of recording for disposition plutonium, blend stock, spent plutonium fuel, and immobilized forms, and the formats of reports to the monitoring Party on disposition activities.

Section IV -- General Approach to Confirm Disposition of Disposition Plutonium

1. The monitoring Party shall have the right, using agreed procedures, to confirm that spent plutonium fuel assemblies and immobilized forms meet the criteria specified in the Annex on Technical Specifications.

2. Monitoring rights on spent plutonium fuel and immobilized forms shall include procedures, designed with a view to minimize costs, that will allow confirmation that such fuel and forms remain in their declared locations.

Section V -- Development of Specific Procedures and Administrative Arrangements

1. The Parties shall seek to complete by December 2002 an agreed set of detailed measures, procedures, and administrative arrangements, consistent with the terms of the Agreement (including this Annex), for monitoring and inspections of disposition plutonium, blend stock, spent plutonium fuel, immobilized forms, and disposition facilities. This set of detailed measures, procedures, and administrative arrangements shall be completed in writing prior to beginning construction of industrial-scale disposition facilities in the Russian Federation. The development of these measures, procedures, and administrative arrangements shall be coordinated at an early stage with, and be made compatible with, the design effort for the disposition facilities.

2. Procedures agreed pursuant to paragraph 1 of this Section shall specify, among other things, the rights and responsibilities of the facility personnel and inspectors, types of and content of reports, how measurements are to be done, and how independent conclusions are to be arrived at, including, among other things, appropriate procedures for applying containment and surveillance measures, and technical goals for monitoring, with a view to minimizing costs. These agreed procedures shall include, but not be limited to, measures to:

   a) provide assurance that at all times prior to completion of the disposition of the thirty-four (34) metric tons of disposition plutonium under the Agreement: (i) conversion product resulting from the blending of those thirty-four (34) metric tons with the allowed additional quantity of blend stock under the Agreement is the only plutonium that enters disposition facilities that are fuel fabrication facilities in the United States of America and the Russian Federation; and (ii) all plutonium (including the plutonium in spent plutonium fuel, but not that in other spent fuel) entering or leaving disposition facilities does so in accordance with the Agreement, appropriately taking into account waste, as necessary;

   b) confirm the fulfillment of the criteria specified in the Annex on Technical Specifications; and

   c) allow each Party to distinguish spent plutonium fuel from other spent fuel that may be located in the same storage area.

ANNEX
ON
ASSISTANCE

This Annex to the Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, sets forth the agreed procedures and provisions to govern assistance provided by the Government of the United States of America for the activities to be undertaken in the Russian Federation as provided for in Article IX of the Agreement.

Section I -- General Assistance Provisions

1. The steps and estimated funding levels for assistance provided by the Government of the United States of America are set forth in the attachment to this Annex. The estimated allocation in that attachment may be revised and updated as the Executive Agents may agree in writing.

2. All equipment, supplies, materials or other assistance provided under the Agreement shall be delivered to mutually-agreed points of entry, unless otherwise agreed in writing. The provider of such equipment, supplies, materials or other assistance shall notify the recipient of the planned date of arrival and point of entry in advance. The recipient shall take possession of all such equipment, supplies, materials and other assistance upon its arrival at the point of entry, unless otherwise agreed in writing.

3. Title to all equipment and facilities provided under the Agreement to, and accepted by, the Government of the Russian Federation, or entities under its jurisdiction or control, shall pass to the Government of the Russian Federation or entities under its jurisdiction or control unless agreed otherwise in writing by the Parties.

4. Equipment, supplies, materials, services, technology or other assistance provided under the Agreement shall be utilized only in accordance with the terms and purposes of the Agreement.

5. Equipment, supplies, materials, services, technology, or other assistance provided under the Agreement shall not be used for the production of nuclear weapons or any other nuclear explosive device, for research or development, design or testing related to such devices, or for any other military purpose.

6. Equipment, supplies, materials, services, technology, or other assistance provided under the Agreement, or developed with assistance provided under the Agreement, shall not be exported, re-exported, or transferred from the jurisdiction of the recipient without the written consent of the Parties.

7. Prior to the export to a third party of any equipment, supplies, materials, services, technology, or other assistance provided under the Agreement, the Parties by mutual agreement in writing shall define the conditions in accordance with which such items will be exported, re-exported, or transferred from the jurisdiction of the third party.

8. The Government of the Russian Federation notes that the Government of the United States of America intends to seek accreditation, as administrative and technical staff of the Embassy of the United States of America in Moscow, of United States Government personnel present in the territory of the Russian Federation on a regular basis for activities related to assistance provided under the Agreement, and hereby confirms that the Government of the Russian Federation will accredit such personnel. Upon entry into force of the Agreement, the Parties will consult on the overall number of United States Government assistance-related personnel envisioned for activities under the Agreement. Each Party shall treat with due respect the unaccredited personnel of the other Party present on its territory in connection with activities related to assistance under the Agreement and shall take all appropriate measures, consistent with its national law, to prevent any attack on the person, freedom and dignity of such personnel.

9. Each Party shall facilitate the movement of persons and the transfer of currencies as necessary for implementation of the Agreement.

10. Facilities in the Russian Federation that have been constructed or modified using assistance provided under the Agreement shall be used only for mutually-agreed purposes.

11. A Party, its Executive Agent, or other agents authorized to act on behalf of a Party or its Executive Agent, that awards contracts for the acquisition of articles and services, including construction, research and development, licensing, design, or other activities to implement the Agreement, shall select suppliers or contractors in accordance with the laws and regulations of that Party.

12. The Executive Agents shall establish and maintain a register of equipment, supplies, materials, services, technology and other assistance subject to the provisions of this Annex.

Section II -- Liability

1. The Parties shall continue negotiations on liability provisions to apply to all claims that may arise from activities undertaken pursuant to the Agreement and shall seek to conclude an agreement in writing containing such provisions at the earliest practicable date, and, in any event, not later than entry into force of the multilateral agreement referred to in paragraph 8 of Article IX of the Agreement.

2. Until entry into force of the agreement containing liability provisions referred to in paragraph 1 of this Section:

   a) assistance activities under the Agreement shall be limited to appropriate pre-construction design work;

   b) neither Party shall be obligated under the Agreement to construct, modify, or operate disposition facilities, including reactors; and

   c) the Russian Federation shall not utilize in any way the pre-construction design work conducted under the Agreement including for the construction, modification, or operation of disposition facilities (including reactors).

Section III -- Taxation of Assistance

1. The Government of the United States of America, its personnel, contractors and contractors' personnel shall not be liable to pay any tax or similar charge by the Russian Federation or any of its instrumentalities on activities undertaken in accordance with this Agreement. The provisions of this paragraph shall not exempt any contractor's personnel who are nationals of or permanently resident in the Russian Federation, and are present in the Russian Federation in connection with such activities, from income, social security, or any other taxes imposed by the Russian Federation, or by any instrumentalities thereof, regarding income received in connection with the implementation of programs of assistance provided by the Government of the United States of America.

2. The Government of the United States of America, its personnel, contractors, and contractors' personnel may import into, and export out of, the Russian Federation any equipment, supplies, materials or services required to implement this Agreement. Such importation and exportation shall be exempt from any license fees, restrictions, customs duties, taxes or any other charges by the Russian Federation or any of its instrumentalities, but not from the procedures called for by the export control system.

Section IV -- Audits and Examinations

1. Upon request, representatives of the Government of the United States of America shall have the right to examine the use of any equipment, supplies, materials, training or other services provided under the Agreement, if possible at sites of their location or use, and shall have the right to inspect any and all related records or documentation during the period of the Agreement and for three (3) years thereafter.

2. Appropriate arrangements in support of the conducting of audits and examinations shall be developed by the Executive Agents. The right to conduct the audits and examinations set forth in paragraph 1 of this Section shall not be contingent upon the development of these arrangements.

Section V -- Equipment Certification

1. The Executive Agent or designated agent of the Government of the Russian Federation shall examine all equipment, supplies, and other materials in each shipment received pursuant to this Agreement and within ten (10) days of receipt shall provide written confirmation to the Executive Agent of the Government of the United States of America, its designated agent or contractor of acceptance or rejection based on whether the equipment, supplies, or other materials conform to specifications mutually coordinated in advance for said equipment, supplies or other materials. Upon request, one or more representatives of the Government of the United States of America or its designated agent may be present at the examination of the equipment, supplies, materials, or other assistance being delivered. Basic certification procedures shall be agreed in writing by the Executive Agents.

Attachment to Annex on Assistance

Provision of assistance in accordance with paragraph1 of Article IX of the Agreement will begin in calendar year 2000 and will continue thereafter to support disposition of disposition plutonium of the Russian Federation, in accordance with the steps and quantities below. Development of the disposition process will continue to be funded under the Scientific and Technological Cooperation Agreement.

Purpose	Funding Level	Time Frame
Design of Industrial-scale Facilities	Up to U.S.$70 Million	2000-2003
Construction of Industrial-scale Facilities	Up to U.S.$130 Million plus future appropriations including non-U.S. sources	2003-2007
Operation of Industrial-scale Facilities	Future appropriations including non-U.S. sources	2007 and onward

ANNEX
ON
INTELLECTUAL PROPERTY

This Annex to the Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, sets forth the procedures governing the protection and allocation of rights to intellectual property transferred or created under the Agreement.

The Parties shall ensure adequate and effective protection of intellectual property created or furnished under this Agreement. The Parties agree to notify one another in a timely fashion of all intellectual property created and results of scientific and technical work obtained under this Agreement and to seek protection for such intellectual property in a timely fashion. Rights to such intellectual property shall be allocated in keeping with the provisions of this Annex.

Section I -- Definitions

1. The term "intellectual property" shall have the meaning found in Article 2 of the Convention Establishing the World Intellectual Property Organization, which was signed in Stockholm on July 14, 1967.

2. The term "participants" shall mean natural persons or legal entities participating in joint activities within the framework of implementation of the Agreement.

3. The term "background intellectual property" shall mean intellectual property created outside the Agreement and belonging to the participants, the use of which is necessary for the implementation of activities under the Agreement.

Section II -- Scope

1. This Annex is applicable to all cooperative activities undertaken pursuant to the Agreement, except as otherwise agreed by the Parties or their Executive Agents.

2. This Annex addresses the allocation of intellectual property rights and takes into consideration the interests of the Parties.

3. Each Party shall ensure that the other Party can obtain the rights to intellectual property allocated in accordance with this Annex. If necessary, each Party shall obtain those rights from its own participants through contracts, license agreements or other legal documents. This Annex does not in any other way alter or prejudice the allocation of rights between a Party and its participants.

4. Disputes concerning intellectual property arising under the Agreement shall be resolved through discussions between the participants, or, if necessary, the Parties or their Executive Agents, which may for these purposes utilize the Joint Consultative Commission. Upon mutual agreement of the Parties or participants, a dispute shall be

submitted to an arbitral tribunal for binding arbitration in accordance with the Agreement and the applicable rules of international law. Unless the Parties or their designees agree otherwise in writing, the arbitration rules of UNCITRAL shall govern.

Section III -- Allocation of Rights

1. Each Party, its Executive Agent or other authorized representative designated by a Party shall be entitled to a nonexclusive, irrevocable, royalty-free license for non-commercial purposes in all countries to translate, reproduce, and publicly distribute scientific and technical journal articles, papers, reports, and books directly resulting from cooperation under this Agreement. All publicly distributed copies of a copyrighted work prepared under this provision shall indicate the names of the authors of the work unless an author explicitly expresses the desire to remain anonymous.

2. Rights to all forms of intellectual property created under the Agreement, other than those rights set forth in paragraph 1 of this Section, shall be allocated as follows:

   a) For intellectual property created during joint research, for example, if the Parties or their participants have agreed in advance on the scope of work, each Party, its Executive Agent or other authorized representative designated by a Party shall be entitled to all rights and interests in its own country. Rights and interests in third countries shall be determined in implementing agreements, taking into consideration the following factors, as appropriate:

      1) the nature of the cooperation,

      2) the contributions of each of the Parties and its participants to the work to be performed, including background intellectual property,

      3) the intentions, capabilities, and obligations of each of the Parties and its participants to provide legal protection of intellectual property created, and

      4) the manner in which the Parties and their participants will provide for the commercialization of intellectual property created, including, where appropriate and possible, joint participation in commercialization.

      In addition, each person named as an inventor or author shall be entitled to receive rewards in accordance with the policies of each Party's participating institution.

   b) Visiting researchers not involved in joint research, for example, scientists visiting primarily in furtherance of their education, shall receive intellectual property rights under arrangements with their host institutions. In addition, each such visiting researcher shall be entitled to receive rewards in accordance with the policies of the host institution.

   c) In the event either Party believes that a particular joint research project under the Agreement will lead, or has led, to the creation or furnishing of intellectual property of a type that is not protected by the applicable laws of the United States of America or the Russian Federation, the Parties shall immediately hold consultations to determine the allocation of the rights to the said intellectual property. Such joint activities shall be suspended during the consultations unless otherwise agreed to by the Parties. If no agreement can be reached within a three-month period from the date of the request for consultations, the Parties shall cease the cooperation under the project in question.

3. Rights to background intellectual property may be transferred by the Parties and their participants through license agreements between individuals and/or legal entities. Such license agreements may reflect the following:

   a) definitions,

   b) identification of intellectual property being licensed and the scope of the license,

   c) royalty rates and other compensation,

   d) requirements for protection of business-confidential information,

   e) requirements to comply with the relevant intellectual property and export control laws of the United States of America and the Russian Federation,

   f) procedures for record keeping and reporting,

   g) procedures for dispute resolution and termination of each agreement, and

   h) other appropriate terms and conditions.

Section IV -- Business-Confidential Information

In the event that information identified in a timely fashion as business-confidential is furnished or created under the Agreement, each Party and its participants shall protect such information in accordance with applicable laws, regulations, and administrative practices. Information may be identified as "business-confidential" if a person having the information may derive an economic benefit from it or may obtain a competitive advantage over those who do not have it, if the information is not generally known or publicly available from other sources, and if the owner has not previously made the information available without imposing in a timely manner an obligation to keep it confidential. Neither Party nor its participants shall publish or transfer to third parties business-confidential information furnished or created under the Agreement without the prior written consent of the other Party or its participants.

JOINT STATEMENT
CONCERNING NON-SEPARATION OF WEAPON-GRADE PLUTONIUM
IN CONNECTION WITH
THE AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND
THE GOVERNMENT OF THE RUSSIAN FEDERATION
CONCERNING THE MANAGEMENT AND DISPOSITION OF PLUTONIUM DESIGNATED AS NO LONGER REQUIRED FOR DEFENSE PURPOSES AND RELATED COOPERATION

The Government of the United States of America and the Government of the Russian Federation, hereinafter referred to as the Parties, have already taken significant steps toward ending the production of fissile material for use in nuclear weapons. These steps include the signing of the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation Regarding Plutonium Production Reactors (PPRA) of September 23, 1997, concerning the cessation of the generation of weapon-grade plutonium at United States and Russian plutonium production reactors.

One of the key objectives of the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, hereinafter referred to as the Agreement, is to reduce irreversibly stockpiles of weapon-grade plutonium from each side's nuclear weapons programs. Both Parties recognize that this disposition will require significant resources. Both Parties also recognize that it would make little sense for either side to commit significant financial and other resources to dispose of such plutonium if either side were planning to continue to separate and accumulate new weapon-grade plutonium.

In this light:

- The Parties reaffirm their intentions not to produce any new weapon-grade plutonium, including by reprocessing of spent fuel or by any other technological process, for nuclear weapons or other nuclear explosive devices or for any military purposes.

- The Government of the United States of America also reaffirms its intention not to separate any new weapon-grade plutonium by any means for any other purposes.

- The Government of the Russian Federation also reaffirms its intention not to build up any stockpile of newly separated weapon-grade plutonium for civil purposes and not to produce any newly separated weapon-grade plutonium unless and until justified for civil power production purposes. In the event that spent fuel containing weapon-grade plutonium were to be reprocessed in the future, the Government of the Russian Federation will take all necessary measures to ensure that any such reprocessing and its products are as proliferation-resistant as possible. The Government of the Russian Federation also confirms its intention to ensure that separation of any plutonium through reprocessing or other technological processes will be keyed to the demand in the civil sector, so as to ensure no unnecessary build up of any civil plutonium stockpiles.

- The Parties note that, during the duration of the Agreement, the BN-600 blanket will be removed in stages to achieve its maximum reduction as quickly as possible, consistent with safety considerations, and that all fuel used in that reactor will not be reprocessed during the duration of the Agreement. After termination of the Agreement, any reprocessing of BN-600 spent fuel containing weapon-grade plutonium resulting from irradiation during the duration of the Agreement will be subject to international monitoring under agreed procedures.

- The Parties note their intention to intensify consultations concerning possible cooperation outside the Agreement on immobilization technologies, including immobilization of waste products containing weapon-grade plutonium, to develop alternatives to separation of such plutonium in the Russian Federation.

- The Parties affirm that, if any of these intentions should change in the future, the Parties will consult in advance of such change, for the purpose of reaching new understandings and agreeing on appropriate measures.

The Parties understand the term "reprocessing" to have its internationally agreed definition, that is, the "separation of irradiated nuclear material and fission products," and note that cleaning up existing separated weapon-grade plutonium to remove Am-241, minor alloying elements, or other impurities, does not constitute reprocessing or new production.

The Parties also note that this Joint Statement of intentions does not:

(1) affect the ongoing separation activities related to weapon-grade plutonium for small-scale research and development or clean-up efforts, or efforts to address urgent environmental or safety hazards, involving small numbers of kilograms; or

(2) alter or affect ongoing separation activities related to weapon-grade plutonium generated by the three plutonium production reactors still operating at Seversk and Zheleznogorsk prior to their being converted under the PPRA, provided that all such plutonium is subject to monitoring in accordance with that agreement.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:	FOR THE GOVERNMENT OF THE RUSSIAN FEDERATION:
____________________________	____________________________
________________, 2000	________________, 2000

LA-UR-03-2711

Approved for public release;
distribution is unlimited.

Title: Summary of TA-55/PF-4 Upgrade Evaluation For Long-term Pit Manufacturing Capacity

Author(s): Boertigter, S.T., Kornreich, D. E., Barkmen, W.

Submitted to: General Release

LA-UR-03-2711

Summary of TA-55/PF-4 Upgrade Evaluation For Long-term Pit Manufacturing Capacity

Introduction

The National Nuclear Security Administration (NNSA) is responsible for the stewardship of the United States (U.S.) nuclear weapon stockpile. This accountability includes ensuring the production readiness of the U.S. to maintain that stockpile. The Department of Energy (DOE) has been without the capability to produce war reserve (WR) plutonium pits (the portion of a nuclear weapon that generates the fission energy to drive modern thermonuclear weapons) since the early 1990s. While the Los Alamos National Laboratory (LANL) is in the process of establishing a limited pit production capability (approximately 10 units per year) at the Technical Area 55 plutonium facility (TA-55/PF-4), this manufacturing capacity is insufficient to support the stockpile for the long term. The Departments of Energy and Defense (DoD), as well as Congress, have highlighted the lack of pit production capability as an issue of National Security interest that requires timely resolution. A new facility, known as the Modern Pit Facility (MPF), is proposed to reestablish the Nation's capability to manufacture pits. The key elements of the MPF Mission Need Statement are listed below:

1. A minimum single-shift production rate of 125 pits per year (ppy).
2. The flexibility and agility to produce two pit types simultaneously.
3. The ability to support all pit types in the enduring stockpile.
4. The capability to meet all future pit manufacturing requirements in an environmentally compliant manner.

A process, compliant with the requirements of the National Environmental Policy Act (NEPA), is being followed to make several key decisions related to the MPF. Two of these decisions are whether to build a new pit manufacturing facility and if the first decision is affirmative, where to site it. During this decision process, all reasonable alternatives need to be evaluated. One potential alternative for increasing the nation's pit manufacturing capability is to upgrade the TA-55/PF-4 at LANL to maximize its production capacity in a manner that is compatible with all of this facility's required missions.

A balanced, multi-organizational, multi-disciplinary team was formed in August 2002 to perform a six-month study on whether or not the upgrade of TA-55/PF-4 should be evaluated in the MPF environmental impact statement (MPF-EIS) as a reasonable alternative for meeting the Nation's long-term pit production requirements. This team examined the potential production rates that might be achieved with several upgrade options, estimated the implementation costs, and addressed the advantages and disadvantages of each approach. The outcome of this study was a technical assessment to support a decision on the "reasonableness" of the alternative of relying on an upgraded

TA-55/PF-4 to maintain the security of the nation's nuclear weapon stockpile. The team members included personnel from Kansas City Plant (KCP), LANL, Lawrence Livermore National Laboratory (LLNL), Savannah River Site (SRS), Sandia National Laboratories (SNL), Y-12 National Security Complex (Y-12), and NNSA.

Background

The study team defined three different options, described below, as a means of bounding the assessment. This report covers the underlying assumptions associated with all of the options, their nominal production capacity estimates, estimated implementation costs, and a general discussion of their advantages and disadvantages. It is readily apparent that with the upgrade of an existing facility some reduction in production capacity and agility, as well as infrastructure lifetime, will occur relative to a newly constructed, full-scale Modern Pit Facility. These impacts are discussed for each of the upgrade options.

A TA-55/PF-4 transition approach was developed for each option that incorporated an incremental series of small facility modifications that would be implemented over a period of years. This approach avoided imposing a disruptive, short-term major retrofit operation on the TA-55/PF-4 facility and personnel, and reduced the risk of causing serious disruptions to LANL missions, including the interim production of W88 pits. In addition, the ramping up of the production capability also facilitates the timely incorporation of new equipment and processes as they are demonstrated to be suitable for use in manufacturing plutonium components.

A preliminary analysis was made of the plutonium-related supporting infrastructure that could fit within the available floorspace. Infrastructure requirements, such as waste and residue processing, analytical chemistry resources, and materials characterization operations, were evaluated and addressed to identify differences between the various production options.

Differences between upgrade options and a new baseline facility are discussed with respect to difficult-to-define metrics such as agility. The pit production flowsheet, operation times, expected efficiencies, etc. used in this study are the same as have been used in MPF modeling activities. Additional supporting information was obtained by interviewing nuclear weapons complex (NWC) personnel with experience in special nuclear material (SNM) production operations and facility upgrade projects, as well as by reviewing previous assessments of site reconfiguration options. Manufacturing requirements for non-plutonium components necessary to support pit production, such as metal shell fabrication and mold production operations, were not addressed in this study.

The upgrading of the TA-55/PF-4 facility, as an alternative to the construction of the MPF, implies major strategic tradeoffs. These considerations include issues such as the inherent complications associated with the extended use of an older facility, the possibility of an earlier start-up date of an upgraded TA-55/PF-4 relative to the proposed MPF schedule, and stockpile refurbishment implications associated with a lower production rate than is achievable with the proposed MPF. This report does not directly address these strategic issues, but instead focuses on the reasonable maximum production rate that could be achieved with different TA-55/PF-4 upgrade options.

Objective

The objective of this study was to provide a credible assessment of the costs, issues, impacts, and environmental considerations related to achieving a maximum reasonable pit manufacturing capability at the existing TA-55/PF-4 facility. The specific elements involved in the study are as follows:

1. Provide objective information on upgrade options for LANL plutonium facilities in TA-55 to support an NNSA decision on whether long-term use of an upgraded TA-55/PF-4 is a reasonable alternative to be considered in the MPF NEPA process.

2. If upgrading TA-55/PF-4 is determined not to be a reasonable alternative for detailed evaluation in the MPF NEPA process, document the data used for this determination.

3. If upgrading TA-55/PF-4 is determined to be a reasonable alternative for detailed evaluation in the MPF NEPA process, provide bounding data on the upgrade to support preparation of the MPF EIS.

Study Methodology

The study evaluated several different upgrade options to estimate the maximum number of pits that could be produced within TA-55/PF-4. The manufacturing options range from using only existing floor space available in TA-55/PF-4 for pit production, to shifting non-weapons missions in TA-55/PF-4 to other facilities, and finally, to adding floor space to TA-55/PF-4. The following assumptions were used during the evaluation of each upgrade option.

Assumptions

1. The TA-55/PF-4 manufacturing activities will continue during the upgrade; the facility will not halt pit production operations.

2. All required stockpile certification activities will be preserved.

3. The facility will continue to be operated in compliance with all applicable laws, regulations, DOE Orders, Laboratory requirements and permits, and within the authorization basis.

4. The requisite facility upgrade costs already planned to support existing production commitments at TA-55/PF-4 are presumed to occur as

scheduled. These expenses are not included as a portion of the upgrade costs.

5. Worker radiation exposure guidelines presently in use at TA-55/PF-4 will continue. (The present guideline is a maximum exposure of 2 Rem/yr.)

6. The estimated start date for operations in the upgraded portion of the facility will be as soon as is reasonable, and will be included in the discussion for each of the options.

7. Non-plutonium component fabrication will be supported by other NNSA suppliers and will not be a differentiating factor in the TA-55/PF-4 upgrade options.

8. An adequate supply of non-plutonium parts will be available to support the pit manufacturing operations.

9. Estimates of the "reasonable maximum production rate" will be based upon the production of a single pit type, under nominal 1-shift operating conditions.

10. Sufficient analytical chemistry and materials characterization capability will be available to support activities in the LANL Technical Area-55 complex, and that adequate space will be provided to accommodate this capability.

11. The upgraded facility will not necessarily support production of all weapons systems in the enduring stockpile. Specifically, the B-83 will not be supported in some options.

12. No provision is made to allocate space in TA-55/PF-4 for the present LLNL plutonium activities. This assumption implicitly means that the LLNL Superblock facility would be required to remain open until LLNL no longer requires a plutonium facility capability to support its national security projects.

Table 1 provides a brief summary of the three upgrade cases that were developed for this study. These options incorporate a range of potential scenarios for implementation, schedules, and funding profiles. Option 1 is an upgraded facility that takes advantage of optimized operations and equipment but only produces a minimal impact to the current range of TA-55/PF-4 missions. This option includes the necessary activities required to support all weapons systems within the enduring stockpile except for the B-83. It performs the appropriate equipment and facility upgrades without changing the present TA-55/PF-4 footprint or worker radiation exposure guidelines. Option 2 is based on the same set of conditions except that it allows a limited impact on the currently planned TA-55/PF-4 missions. Specifically, some existing non-weapons missions may be moved elsewhere to provide about 3,000 square feet of additional floor space for pit manufacturing activities. Option 3 describes a case that produces a more significant impact on TA-55/PF-4 beyond what was considered in option 2. This case expands the option 2 criteria to include the construction of a new PF-4 wing and the incorporation of B-83 pit manufacturing activities.

Table 1: Summary of Upgrade Options

Option	Footprint Requirements	Mission Impacts	Weapons Systems
1	No New Floor space	Minimum impact: All existing missions are protected.	Enduring Stockpile less B-83
2	No New Floor space	Limited impact: Stockpile certification mission protected, other missions are shifted, eliminated or reduced.	Enduring Stockpile less B-83
3	Add ~12,000 sq. ft. to TA-55/PF-4	Significant impact: Stockpile certification mission protected, other missions are shifted, eliminated or reduced	Enduring Stockpile

A significant level of detail information on each option was developed and evaluated by the study team. For example, facility layouts, equipment lists, and transition approaches for implementation were developed to establish costs, impacts, projected pit manufacturing capacity, and advantages/disadvantages for each option. Computer models were used to estimate production capacities for various TA-55/PF-4 equipment layouts. Since detailed layout and configuration information on an operating nuclear facility (TA-55/PF-4) is classified as UCNI (unclassified controlled nuclear information) or higher, only summary information of study results is contained in this unclassified document.

Study Results

Table 2 provides summary results associated with an analysis of each option. Option 1 is estimated to be capable of a nominal production capacity of 50 pits per year. As such it falls within the production capacity bounds of the “no action” alternative being evaluated in the MPF EIS and previously evaluated in the Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (SSM PEIS). Option 2 makes use of extra space in PF-4 through non-weapon mission consolidation. With an estimated nominal production capacity of 80 pits per year, it does not meet the minimum pit production capacity (125 ppy) needed for long-term support of a stockpile consistent with requirements of the Nuclear Posture Review. While Option 3 is estimated to meet the minimum capacity target, it has a high execution risk.

Table 3: Top-Level Results of Analysis of Upgrade Options

Option	Nominal Single-shift Production Rate (ppy)	Start Date	Implementation Cost (M$)	Agility	Risk	Process Development (PD)
1	~50	2014	~ 500	Limited	Low	Limited, co-located PD Space
2	~80	2016	~700	Improved	Low	Improved, w/ some dedicated PD Space
3	~150	2020	1200-1600	Good	High	Dedicated PD Space, two pit-type operation

The transition plan for increasing the TA-55/PF-4 pit production capability for each of the three options is based on a strategy of doing a steady upgrade activity over an extended period of time. This minimizes the impact on the facility and enables the existing pit manufacturing operations to continue without serious disruption. The actions required to achieve success with Options 1 and 2 are believed to be manageable and therefore relatively low risk. However, the cost required to achieve Option 2 is higher that the cost of Option 1.

Options 2 and 3 offer the advantages of providing a measured approach to increased capacity. Option 2 has the advantage of being less costly than either Option 3 or a new MPF and being on-line sooner (around 2016). Option 3 has the advantage of providing a production capacity that is equivalent to a small MPF. Option 3 also entails a very significant challenge due to the possibility of an unforeseen event during the construction of new floor space that could disrupt both the upgrade and on-going TA-55/PF-4 manufacturing and certification activities. While Option 3 approaches the cost of a small, new MPF, it is judged to entail a high execution risk without the benefits of a fully newly designed and constructed facility.

The following conclusions are applicable to all of the upgrade options:

1. The TA-55/PF-4 facility will be approximately 40 years old when the planned upgrade capacity is achieved. Although significant facility upgrades are planned for, meeting future nuclear facility safety and operating requirements over an additional 50 years is uncertain without significant and currently unspecified, long-term financial commitments.

2. The TA-55/PF-4 facility was designed for plutonium research and development. For example, pit manufacturing equipment is not on grade in TA-55/PF-4 as would be preferred for a production plant. The additional floor space required for

an increased production mission will reduce the ability of the facility to support potential future plutonium research and stockpile support missions as well as the development of pit manufacturing technology.

3. The physical constraints of the existing facility limit the upgrade options, increase the cost of needed improvements (material handling, storage, ventilation, shielding, and power) and inhibit the introduction of improved manufacturing technologies. These constraints also reduce the opportunities for inclusion of new facility design approaches that can enhance production efficiency, reduce worker radiation exposures, and minimize safety and security risks.

4. Major modifications to an operational nuclear facility increase the risk of significant safety, contamination, or safeguards and security events during the transition period. While manageable, this increased risk is not realized with a new MPF.

5. The analyses for each upgrade option assumed external support for Analytical Chemistry operations (CMR or CMR-R) and the continued operation of existing facilities (Superblock).

Summary

Option 1 provides a nominal 50 pits per year production rate with relatively minimal impact to the current missions in TA-55/PF-4. However, this provides no greater pit manufacturing capacity than the “no action” alternative in the MPF EIS.

Option 2, provides a nominal manufacturing capacity of 80 pits per year. However, this option does not have the potential to reach the minimum production capacity (125 pits per year) or agility required by the current mission need for a long-term pit manufacturing facility. This option may be considered a reasonable EIS alternative to a new MPF since it could support the stockpile should substantial reductions in pit production requirements arise.

Option 3 requires construction of additional floor space in TA-55/PF-4 and has the hypothetical potential to achieve a capacity of approximately 150 pits per year. However, there is a high risk that Option 3 will not meet capacity, cost, or schedule projections. There is uncertainty that significant construction additions might affect the assumptions and regulatory framework for the facility that were originally established at the time of initial construction. In addition, the cost of Option 3 approaches estimates for a new facility that has much greater performance potential and would not be nearly 40 years old at the start of long-term pit production.

As a result of consideration of the summary information developed by the multi-disciplinary team, the NNSA Pit Project Office selected Option 2 as a reasonable alternative to be considered in the MPF-EIS. Option 1 was considered as bounded by the

No Action alternative. Option 3 was not considered reasonable. Subsequent to selection of Option 2 as a reasonable alternative to be considered, study team contributors assembled data on this TA-55/PF-4 upgrade option for inclusion in the MPF-EIS.

LA-UR-03-0259

DRAFT

Plutonium Aging: Implications for Pit Lifetimes

J. Martz, Los Alamos National Laboratory MST-DO, jmartz@lanl.gov
A. Schwartz, Lawrence Livermore National Laboratory, CMS/MSTD,
ajschwartz@llnl.gov)

Executive Summary

Planning for future refurbishment and manufacturing needs in the US nuclear weapons complex critically depends on credible estimates for component lifetimes. One of the key variables in planning both the size and schedule for the proposed Modern Pit Facility (MPF) is the estimated lifetime for stockpile pits, defined as the age at which a pit can no longer be certified to meet the military characteristics. In this report, we will describe the status of our understanding of pit aging, provide our current assessment of pit lifetimes, and describe in some detail the methodology we are using to improve this assessment over the next few years. At a high level, our lifetime assessment methodology is based on an evaluation of all potential aging mechanisms. The test matrix is a series of plutonium alloys ranging in age from newly processed reference alloys to old Pu taken from approximately 40 year old retired pits. Extensive experimental data obtained from these materials over the last three years, derived from microstructural characterization and property measurements, are applied to evaluate any age-related changes. Then, age-dependent, predictive models are developed based on experimental data. The predicted changes in properties are then inserted into design sensitivity calculations in order to quantify the effect of that specific property change on the performance and margin of a specific weapon system.

To date, only minor age induced changes have been observed and there is no direct evidence that these affect pit performance, reliability, and safety. The response of each system to potential changes is specific to each particular design. The current estimate of the minimum age for replacement of pits is between 45 and 60 years. This is based on observations of pit and plutonium aging taken from pits up to 42 years old and conservative extrapolation of this data combined with system-specific design sensitivity analysis. Additional data and analysis coupled with further design sensitivity studies are needed to refine our estimates of minimum lifetimes for each system. It is possible these studies may show that certain systems exhibit lifetimes shorter than the stated 45 years or longer than 60. In the most conservative case that lifetimes are found to be less than 45 years of age, mitigation methods currently exist to extend these lifetimes to a 45-year minimum. At the end of FY03 the Enhanced Surveillance Campaign has a key milestone to provide a pit lifetime assessment based on old pit data. In FY06, we will deliver a pit lifetime estimate based on old pit data and the accelerated aging program. Further experiments, modeling, and design sensitivity calculations on different weapon systems are required to gain greater confidence and reduce uncertainties in our lifetime estimates.

Background

Pits for nuclear weapons have been manufactured by the United States for nearly 60 years. Systematic aging studies on pits were initiated only a few years ago after the loss of the Rocky Flats manufacturing capability. During the past 60 years, designs, materials, and processes have changed dramatically. Throughout this history, refinements have been introduced such that pits of modern design are more robust, safer, and suited for longer storage times. Modern pits consist of hollow, metallic shells containing fissile material at their core. The outer, non-nuclear materials used in pits are selected for properties such as mechanical robustness and integrity as well as corrosion resistance. In practice, these materials remain remarkably pristine over decades. Further, modern designs rely on the boost process – the presence of deuterium/tritium mixtures into the interior – as an essential element of weapon function. Hence, the integrity of pits as gas-pressure vessels is another important element of weapon function. In this respect as well, the surveillance program has proven that pits are demonstrably robust over decades. Given this positive history with the non-nuclear materials in pits, most concerns with pit aging focus on the behavior and possible degradation of the plutonium.

Evaluation of the Aging Process

The approach used to address the aging of pits starts with an identification of the key plutonium properties required to ensure safe and reliable weapon function. These properties (such as density) are selected by knowledgeable design physicists who will ultimately use them in computer simulations as part of the certification process of a given weapon. This process is quite complicated because for years designers relied largely on testing the devices at the Nevada Test Site (NTS) to assess performance. Although a substantial amount of work has been done to relate performance to specific materials properties, our understanding is incomplete. We are in the process of developing a better fundamental understanding as to how key properties influence weapons performance using advanced tools such as improved codes. Once these properties have been identified, diagnostic tools are developed to measure them with sufficient precision as determined by the weapon designer. An important aspect of the aging program is the execution of experiments to measure baseline properties of new (zero-aged) material.[1]

Next, materials scientists and chemists identify the aging mechanisms that could potentially alter these properties over time. The three most important potential aging effects in plutonium are the radioactive decay of the various plutonium isotopes (and the impact of this decay on the chemistry, structure, and properties of the material), the thermodynamic phase stability of the plutonium alloy, and the corrosion of the plutonium during both storage and function. In many cases, these aging effects accumulate slowly over decades, and not necessarily in a linear fashion. Only when key properties have sufficiently changed would we anticipate a measurable impact on weapon safety or performance. Through the process of experiments, model development of the age-related changes, and design sensitivity studies, the weapon designers attempt to specify the limits of acceptable change for each of these properties by evaluation of the margins associated with each system. By combining these limits with the measured or predicted rates of change due to aging effects, we will derive estimates for pit lifetimes.

Each of the three, principal aging mechanisms identified above is under intensive examination within the National Nuclear Security Administration's (NNSA's) Enhanced Surveillance Campaign. This program has four key elements/objectives: 1) measurement of actual properties and trends from the newest to the oldest materials available from the stockpile; 2) acceleration of the aging where possible and subsequent measurement of material properties; 3) modeling of aging effects for insertion into design sensitivity analyses; and 4) the development of new diagnostics to identify the signatures of aging as early as possible in order to provide lead time for refurbishment. In parallel, the Primary Certification Campaign in concert with ASC are developing the computational tools required to address design sensitivity, acquiring the test data (e.g., sub-crits) to quantify key parameters, and the expertise to complete the design sensitivity assessment.

In the following sections, we will describe our current understanding of the three principal aging mechanisms: radiation damage and the application of the accelerated aging methodology, phase stability, and corrosion. Then we will describe our efforts to reduce uncertainties and our current lifetime assessment.

Damage Mechanisms and Applicability to Evaluation of Old Pits

The oldest plutonium made in the United States and available for analysis is approximately 40 years of age. This plutonium was manufactured by processes slightly different from the materials in the enduring stockpile. As a result, a direct comparison of this oldest plutonium to modern alloys may invoke uncertainty, but has provided substantial insight to the aging behavior. Extensive, but incomplete evaluations of this material over the past three years have shown only modest changes in key properties. Nonetheless, these small changes are invaluable in helping to calibrate and refine our aging models. Our experience with this oldest plutonium has been crucial in another respect: we have yet to observe the onset of void-swelling, one of the potentially most troublesome manifestations of self-irradiation damage.

A fundamental aspect in the accumulation of radiation damage in materials is the existence of a threshold beyond which further damage results in rapid swelling and density decrease. Experience from all materials in reactor environments of similar crystal structure to the plutonium alloys in the stockpile shows that the damage results initially in little change in density, but after an “incubation period”, void swelling begins. This void swelling can result in volumetric increases of about 1% per decade. The length of this incubation is unknown for weapon grade plutonium and presently cannot be predicted.

The principal decay mechanism for most plutonium isotopes is alpha-particle decay. The parent atom spontaneously decays into a doubly charged helium nucleus (i.e., alpha particle) and a uranium atom. Both of these particles are highly energetic. This initial decay event is rapid and results in considerable, local disruption of the crystalline lattice. Based on theoretical considerations, this single decay energizes roughly 20,000 other atoms and displaces approximately 2400 atoms from their lattice sites. Within the first 200 nanoseconds, about 90% of these displaced atoms return to a normal lattice position. The remaining 10% of these atoms are retained in the lattice, where an atom now sits between regular positions on the lattice (known as an interstitial) and leaving the regular lattice positions empty (known as a vacancy).[2] The ultimate disposition of these more permanent defects is the principal concern in our evaluation. This accumulation of damage is significant within the time frames of interest: on average, each atom of plutonium has been displaced once every 10 years.

We have developed and deployed a number of advanced diagnostics to obtain data of early evidence of age-related changes. One of these, positron annihilation spectroscopy has recently provided data that indicates the newly formed helium atom immediately fills an unfilled vacancy. These helium filled vacancies have the potential to migrate in the lattice, eventually coalescing as small helium bubbles. This may result in a modest swelling of the material as well as changes in the mechanical properties of the plutonium. These changes can now be estimated with computer simulations supplied with age-dependent experimental data provided by another newly developed diagnostic technique, near atomic resolution transmission electron microscopy. It is found that the helium-induced changes are very small, and if they continue to increase at the predicted rate, will not affect weapons performance for pits in excess of 60 years of age. However, the vacancies also have the potential to migrate and accumulate into voids, the phenomenon of void swelling discussed above. These mechanisms are not necessarily independent: helium likely stabilizes the voids and assists in the accumulation of a critical number of these defects, which defines the incubation period for void swelling. Modeling of these processes requires detailed knowledge of the structure of the lattice and the energy required to nucleate and move these various defects within the crystal structure. These energies are derived from knowledge of the electronic structure of both individual plutonium atoms and the metallic bonds that form between them. The great complexity of interatomic bonding in plutonium has made this a particularly difficult problem to address. Although void swelling models do indeed exist for reactor materials, our best models for plutonium are still incomplete as they lack crucial materials parameters, which cannot easily be measured or computed from fundamental theories for plutonium. Although progress is being made, ultimately, experimental data will be necessary to establish confidence in these models and to reduce the uncertainty in their estimates.

A significant number of macroscopic measurements (such as density), microstructural measurements (optical microscopy, scanning electron microscopy, electron microprobe, transmission electron microscopy, positron annihilation spectroscopy, extended x-ray absorption fine structure, and resonant ultrasound spectroscopy), and dynamic property measurements have shown rather small or nonexistent changes over a period of time of 30 to 40 years. However, additional measurements coupled to model development and design sensitivity calculations are essential to extend these data to longer time frames and to reduce the uncertainty in margin. This estimation requires considerable expertise in the modeling of aging effects in solid-state materials, particularly in the discipline of radiation damage modeling. It is largely the uncertainties in these models that drive uncertainties in the minimum estimates for pit lifetimes.

Accelerated Aging Methodology

The need for fundamental aging data helps to drive the second objective of the Enhanced Surveillance Campaign's technical element on pits: the accelerated aging of plutonium. The process of alpha decay within plutonium can be accelerated by the addition of isotopes with shorter half-lives. An alloy of normal weapon-grade plutonium mixed with 7.5% of the Pu-238 isotope will accumulate radiation damage at a rate 16 times faster than weapon-grade material alone. This is a useful tool to evaluate extended-aged plutonium (up to 60-years equivalent and possibly beyond) within a few years. Critically, acceleration of the input of radiation damage must be matched by acceleration of the subsequent annealing and diffusion of that damage. We accomplish this subsequent acceleration by raising the temperature at which the samples are stored. These processes are thermal in nature, and the activation energy (a term which describes the energy required to activate a process) is different for each specific mechanism. Unfortunately, there is no single temperature at which the thermal diffusion of this damage will be equivalently and perfectly matched to the initial acceleration of the damage input. As a result, the accelerated aging experiments are carried out at three different temperatures.

Thus, the accelerated aging method is only approximate and not a perfect match to the actual aging of materials in the stockpile. Hence, we focus a large portion of the accelerated aging work on comparing the accelerated-aged material with actual-aged plutonium in an effort to calibrate the technique and build confidence that our estimates (for things like storage temperature) are accurate. Nonetheless, findings from the accelerated aging program are essential in order to gather experimental data for key mechanisms such as void swelling and its associated incubation period. Even if the process isn't perfectly replicated, our models are sufficiently sophisticated to use data from the accelerated aging program to refine estimates of the incubation period and rate of void swelling for weapons-grade material.

Thermodynamic Stability of Plutonium Alloys

A secondary concern is the thermodynamic phase stability of the δ-Pu alloy. The δ-phase in unalloyed plutonium is stable between about 310°C and 415°C but can be "stabilized" to room temperature by the addition of small quantities of alloying agents such as aluminum or gallium. The δ-phase alloy is a ductile, copper-like material that is easily fabricated and is thus preferred for weapon use. Plutonium/gallium alloys have been widely studied since the earliest days of the Manhattan Project and have shown that the δ-phase plutonium alloy is metastable, similar to steels in that it will not transform to thermodynamically stable phases in the time frame of thousands of years.[3] However, upon cooling to very low temperatures, the δ-plutonium will partially transform to α-plutonium, a phase that is 20% more dense than the δ-Pu. There has been no evidence of this phase transformation occurring in weapon material, but the severity of the transformation warrants detailed investigation.

A third advanced diagnostic technique has recently been applied to probe the plutonium alloys for early evidence of age-related changes. X-ray absorption spectroscopy is a technique that is ideally suited for determination of the local atomic environment of the major atoms (Pu) and the alloying atoms (Ga). In newly prepared δ-Pu alloys for example, x-ray absorption measurements reveal evidence for a second arrangement of atoms, or a minor amount of a second crystalline structure where there is a deficiency of Ga atoms. This second phase material disappears rapidly with age, and this discovery prompted Jeanloz to observe that the crystallinity of δ-plutonium actually increases with age.[4] More detailed study, using high resolution x-ray absorption and x-ray diffraction reveal that the main δ-phase retains good long-range order for ages exceeding 40 years, but that asymmetry in certain diffraction peaks is also growing in with age, presumably due to accumulated irradiation damage.

The influence of the radiation-damage processes (discussed previously) on phase stability is still unknown and therefore continues to represent an uncertainty in our evaluation of plutonium aging.

Corrosion of Plutonium Alloys

Finally, corrosion of plutonium is potentially the most catastrophic of all aging effects.[5] Fortunately, corrosion is both limited by the availability of corrosive agents and relatively easily studied. Whereas plutonium will readily oxidize given sufficient exposure to air or other oxidizing environments, it is hydrogen-catalyzed corrosion that is of greatest concern. Most importantly from a pit aging perspective is the maintenance of well-sealed pits and the exclusion of foreign contaminants during pit production. The employment and insurance of robust cleaning methods during the final stages of pit manufacture are essential. Experience from stockpile surveillance programs reflects this point: pits have remained remarkably pristine and free of corrosion, especially since the adoption of modern cleaning and sealing methods.

Reducing the Uncertainties

The current program is aimed at quantifying the margins and uncertainties and improving our fundamental understanding in order to increase our confidence in the lifetime assessment. The methodology for this is based on design sensitivity analyses. Extensive experiments are conducted on new and aged material. Age-dependent models are then developed based on the experimental data, science-based computational methods and models, and conservative assumptions. These models are then inserted into the design codes to calculate the change in performance based on the predicted change in properties. The sensitivity calculations to date have indicated no performance impacts of aging under the most pessimistic assumptions. However, it must be noted that these calculations have been conducted on only one system and are not comprehensive. We expect there to be system-by-system variations in sensitivity to aging parameters as a function of design considerations.

To provide crucial data for the design sensitivity analysis and aid in focusing our efforts, extensive measurements of stockpile-aged plutonium are continuing. The assessment presented here will be thoroughly documented and reviewed (by internal and external reviewers), and lifetimes will be updated with data from old pit examinations, at the end of FY03. A series of additional experiments and measurements will occur between now and 2006. These include the conduct of various dynamic experiments (gas guns, laser shock experiments, Kolsky bar measurements, U1a experiments, etc.) to supplement our existing database as well as the careful, in-situ examination of the accelerated aged alloys (via dilatometry, resonant ultrasound spectroscopy, electron microprobe analysis, transmission electron microscopy, positron annihilation spectroscopy, and other techniques). All of this data serve the common goal of trending changes in key properties and understanding the evolution of micro-scale processes (ingrowth of decay product, buildup of radiation damage) that affect macro-properties of the material (density, mechanical properties, etc.).

Assessment of the Minimum Pit Lifetime

On the basis of careful evaluation of the effects described above through extensive characterization of old pits, modeling, and preliminary design sensitivity calculations (as well as a few other, less-prominent concerns), an initial assessment of minimum pit lifetimes has been derived. Evaluation of the oldest samples of plutonium metal, both metal of oldest absolute age (40 years) as well as the oldest samples most directly comparable to the enduring stockpile (25 years) have shown predictably stable behavior. The many properties that have been measured to date, such as density and mechanical properties have shown only small changes and detailed microstructural studies have been correlated to these changes in properties. The response of each system to potential changes is specific to each particular design. Based on this assessment, current estimates of the minimum age for replacement of pits is between 45 and 60 years. Additional data and analysis coupled with further design sensitivity studies are needed to refine our estimates of minimum lifetimes for each system. It is possible these studies may show that certain systems exhibit lifetimes shorter than the stated 45 years or longer than 60. In the most conservative case that lifetimes are found to be less than 45 years of age, mitigation methods currently exist to extend these lifetimes to a 45-year minimum.

The principal uncertainty in this assessment relates to the incubation periods inherent in radiation damage effects. Certain key variables in these models (such as the energy of defects and the nature of plutonium bonds) are still uncertain enough that future estimates will require benchmarking against more extensively aged samples and data. Additional uncertainty arises from the intrinsic scatter in much of the experimental data (necessitating a statistically-based analysis of much of this information) as well as uncertainties on the influence of certain changes on weapon performance. In our design sensitivity studies, we mitigate some of these uncertainties by applying pessimistic assumptions to our models. Thus, our bounding calculations are a valid tool for assessments of this type. In some specific circumstances, pit performance may be found to be extremely sensitive to slight changes in certain properties, more sensitive than current diagnostics can reliably detect. In this case, careful review of data combined with modeling can provide an estimate of change which is useful to designers in establishing acceptable limits. Continuing research is necessary and will strengthen the linkage between the plutonium microstructure and changes resulting from aging, key properties, and weapons performance as determined by prior nuclear tests.

Pit Aging Milestones for the Enhanced Surveillance Campaign

NNSA, through the Enhanced Surveillance Campaign, has a formal program to acquire this data and assess it on a time scale relevant to upcoming decisions such as the Modern Pit Facility. Several key milestones occur from now until 2006. At the end of FY03, we will provide a pit lifetime assessment based on old pit data. For the accelerated aging component of this assessment, we have successfully completed the milestone to produce the accelerated aging alloys at both LANL and LLNL. This material will be validated at both zero-age and against the oldest stockpile samples in the next two years. The comparison of baseline properties of this material to zero-age control samples will be substantially completed as of early 2003. By early 2006, these samples will have reached an equivalent age of 60 years, and measurements of their properties (and comparison to aging models) form a key milestone in our estimate of pit lifetimes.

Summary

We have made substantial progress in the past few years in our fundamental understanding of some of the age-related changes in plutonium. The theoretical, modeling, and experimental components are now in place to make significant progress over the next few years in order to quantify the margins and uncertainties.
We are encouraged that measurements to date have not shown any significant degradation of pits over approximately 40 years. The changes observed to date have been quite small, giving both LANL and LLNL investigators reasonable confidence in the 45 year minimum lifetime estimate based on the data collected to date, though further design sensitivity studies may show a shorter lifetime than 45 years for some systems and longer than 60 years for others. In the case that pit lifetimes are found to be less than 45 years using highly conservative assumptions, mitigation methods are available to extend these

systems back to a 45-year minimum life. Further experiments, modeling, and design sensitivity calculations on different weapon systems are required to gain greater confidence and reduce uncertainties in these estimates.

(For further information on the detailed aging processes in plutonium and the unique nature of this material in general, see "Challenges in Plutonium Science", volume 26 of *Los Alamos Science*, N. Cooper, ed (2000), "Plutonium Aging: from Mystery to Enigma", S.S. Hecker and J.C. Martz, proceedings of the Oxford Conference on Ageing Studies and Lifetime Extension of Materials (1999), or *MRS Bulletin*, "Challenges in Plutonium and Actinide Materials Science," L.J. Terminello, ed Volume 26, No. 9, September, 2001.

---

[1] An example of these important measurements includes the series of subcritical tests at the U1a facility at the Nevada Test Site. These measurements help to describe the equation-of-state and other dynamic properties of plutonium.

[2] An interstitial/vacancy pair is known collectively as a "Frenkel pair". Calculations show that each Pu decay results in the generation of roughly 2200 Frenkel pairs – 2000 from the uranium recoil and 200 from the alpha particle itself. A more extensive account of radiation damage in plutonium is given by W.G. Wolfer, *Los Alamos Science* 26, Vol. 1, p. 274.

[3] S.S. Hecker and L.F. Timofeeva, *Los Alamos Science*, 26, Vol 1., p. 244.

[4] R. Jeanloz, "Science-Based Stockpile Stewardship", *Physics Today*, December 2000.

[5] J.M.Hashcke and J.C.Martz, "Plutonium Storage", in the Encyclopedia of Environmental Analysis and Remediation, John Wiley and Sons, 1999.

APPENDIX H

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE *SUPPLEMENT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT ON STOCKPILE STEWARDSHIP AND MANAGEMENT FOR A MODERN PIT FACILITY*

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 8026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal).

(a) __✓__ Offeror and any proposed subcontractor have no financial or other interest in the outcome of the project.

(b) _____ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests

1.

2.

3.

Certified by:

Thomas

Signature

Thomas E. Magette, Vice President

Printed Name and Title

Tetra Tech, Inc.

Company

5·15·03

Date