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Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, Colorado 80402-0464
Phone: (303) 966-7000

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46469 (Rev. 9/96)

August 28, 1997

S. K. Crowe
Division Manager, Engineering & Integration
Kaiser-Hill Company, L.L.C.
Building 130
Rocky Flats Environmental Technology Site

TRANSMITTAL OF BUILDING 991 COMPLEX FINAL SAFETY ANALYSIS REPORT (FSAR) - TWO-045-97

The purpose of this letter is to provide a copy of the Final Safety Analysis Report (FSAR) for the Building 991 Complex for transmittal to the Department of Energy, Rocky Flats Field Office (DOE, RFFO) for review and approval. Enclosed with this FSAR are (1) the draft Building 991 Complex Fire Hazards Analysis (FHA), (2) the draft FSAR Implementation Plan (IP), and (3) a Criticality Safety Evaluation addressing criticality accident incredibility for the Building 991 Complex.

The Building 991 Complex FSAR, along with the other documents noted above, are being submitted to fulfill the rebaselined FY97 milestone commitment in Work Authorization Document (WAD) #46 for WBS Element 1.1.08.04.07.07.14.02, which commits to issue a Building 991 Basis for Interim Operation (BIO) to DOE, RFFO by August 30, 1997. As an FSAR is a more comprehensive document than a BIO, submittal of the FSAR fully meets the intent of the WAD commitment.

It is recommended the Kaiser-Hill transmittal letter to DOE, RFFO also address the following:

- The Building 991 Complex FSAR was prepared in accordance with DOE Standard DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, using the graded approach.
- A Project Management Plan was provided to Kaiser-Hill in August, 1997 discussing the scope, schedule and technical approach being taken during development of the Building 991 Complex FSAR. This plan also provided a comparison of the Building 991 Complex FSAR to DOE-STD-3009-94 and to the draft Kaiser-Hill BIO template.
- The Building 991 Complex FSAR has adopted an operational controls format consistent with Technical Safety Requirements (TSRs) which are similar to the TSRs for the Building 569 BIO.

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- The FSAR cross-table review with DOE, RFFO should be requested to be conducted during the week of October 6, 1997. This schedule assures full support from RMRS Operations personnel.
- The Criticality Safety Evaluation provides the basis for not analyzing a criticality accident in the Building 991 Complex FSAR, and for not needing a criticality detection system. The justification for not needing a criticality system in Building 991 is similar to the justification provided for Buildings 440 and 664.
- The FHA and FSAR IP are being submitted as draft documents at this time to facilitate DOE, RFFO review of the FSAR. A copy of the final FHA, along with any changes to the FSAR resulting from reconciliation of the accident analysis and TSRs with the final FHA, will be provided to DOE, RFFO prior to the cross-table review. A final version of the FSAR Implementation Plan will be provided to DOE, RFFO after the cross-table review when the final version of the FSAR is resubmitted to DOE, RFFO for approval.

Please formally transmit these documents to DOE, RFFO by no later than Friday, August 29. Any questions or comments should be referred to Don Swanson at extension 7009 or pager 5269.

T. W. Overlid
Vice President, Program Compliance
Rocky Mountain Remediation Services, L.L.C.

DRS:kbb

Enclosures:
As Stated (4)

<u>E2 Consulting Engineers of Colorado</u>
K. B. Baier

<u>MacTec</u>
S. Walker-Lembke

Rocky Mountain
Remediation Services, L.L.C

Revision No: 0
Date: August 28, 1997

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

FINAL SAFETY ANALYSIS REPORT

BUILDING 991 COMPLEX

RMRS ORC Review: Meeting 97-42
August 27, 1997

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REVIEWED FOR CLASSIFICATION/UCNI
By: JdCayer, Reviewing Official
Date: 8/28/97

Reviewed for Classification/UCNI/OUO
By: Janet Nesheim, Derivative Classifier & UCNI RO
DOE, EMCBC
Date: 12-15-08
Confirmed Unclassified, Not UCNI/Not OUO
OK for public release

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REVIEW AND APPROVAL

FOR

BUILDING 991 COMPLEX FINAL SAFETY ANALYSIS REPORT (FSAR)

August 28, 1997

This document was prepared and reviewed by multiple personnel in the RMRS Authorization Basis organization. Team members included M. R. Adler, J. N. Conyers, W. H. Horton, J. S. Kirar, J. L. Morse, M. A. Natzke, and K. B. Baier.

8-28-97

Project Lead: K. B. Baier
E2 Consulting Engineers of Colorado

Reviewed By: S. Walker-Lembke
MacTec

8-28-97

Approved By: D. R. Swanson, RMRS
Team Lead, RMRS Authorization Basis

8-28-97

Approved By: P. M. Sauer, RMRS
Lead, Waste Storage Facility/Operations

8-28-97

Approved By: R. P. Dunn, RMRS
Manager, Solid Waste Operations

8/29/97

Approved By: T. W. Overlid, RMRS
V. P. Program Compliance

Approved By: S. K. Crowe, Kaiser-Hill
Division Manager, Engineering & Integration

EXECUTIVE SUMMARY

This document satisfies the requirement in Department of Energy (DOE) Order 5480.23, *Nuclear Safety Analysis Reports* (Ref. 1), to develop a Final Safety Analysis Report (FSAR). This FSAR is intended to meet a similar requirement in the anticipated Nuclear Safety Rule, 10 CFR 830.110, *Safety Analysis Report* (Ref. 2). This FSAR was prepared in accordance with the DOE-STD-3011-94, *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans* (Ref. 3), DOE-STD-1027-92, *Hazard Characterization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (Ref. 4) and DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Non-reactor Nuclear Facility Safety Analysis Reports* (Ref. 5), as the implementing standards for DOE Order 5480.23.

Per the referenced DOE regulatory documents, the purpose of a FSAR is to provide the authorization basis upon which safe operations of a nuclear facility are based. Annual updates of this FSAR will be prepared per DOE Order 5480.23.

Building 991 is a one-story structure with a partial basement, located in the eastern portion of the Protected Area. The building is situated on the south slope of a hill about 70 feet north of South Walnut Creek. Building 991 is partially buried in the slope and is connected, by tunnels, to Vaults 996, 997, and 999. These four buildings are entirely underground and slightly higher in elevation than Building 991. Tunnel 998 and Room 300 are located to the north of the main building. These are also entirely underground. Building 985 (Filter Plenum) is situated above ground at the northwest corner of Building 991 and above the tunnel to Buildings 996, 997, and 999. Building 989 (Diesel Generator) is located by the southeast corner of Building 991. Building 984 is located south of Building 991. Building 992 is a two story high, normally unoccupied, concrete Guard Post. All of these buildings make up the Building 991 Complex.

Building 991 was the first permanent structure constructed at the Rocky Flats Environmental Technology Site (Site). The facility became operational in 1952. The original facility use included many aspects of weapons production such as administrative support, product assembly, product inspection, shipping and receiving, research and development, and material storage. By the early 1960's, product assembly and the research and development activities were relocated. The current mission of the facility, and its associated underground tunnels and vaults, includes the warehousing functions of receiving, staging, storing, and shipping of Special Nuclear Material (SNM), and Transuranic (TRU) and low-level wastes (LLW). The facility also houses building management personnel, operations involving maintenance and repair of site-wide alarm systems, metallography laboratories, Radiation Control Technicians (RCTs), and the nondestructive testing department.

A Building 991 shipping/receiving dock has the capability to handle shipments via Safe, Secure Transports (SSTs), which are required for all shipments of SNM. Building 991 has continued to store SNM and support shipments to other DOE facilities during the curtailment of plutonium operations at other Site buildings. Continued operation of Building 991 as a TRU waste receipt, storage, transfer and shipping facility is anticipated during the transitional time that Site facilities will be converted to a decontamination and decommissioning (D&D) ready phase, as well as throughout actual D&D and environmental restoration phases for all plutonium buildings at the Site.

The Building 991 Complex was previously classified as a moderate hazard facility per DOE Order 5481.1B (Ref. 6) and a nonreactor nuclear facility per DOE Order 5480.5 (Ref. 7). Based upon the inventory of radionuclides present during the accomplishment of the new mission of the Building 991 Complex, the complex is classified as a Hazard Category 2 nuclear facility in accordance with the inventory thresholds defined in Attachment 1 of DOE-STD-1027-92.

An activity-based hazards analysis of the Building 991 Complex was performed to identify, evaluate, and control hazards associated with waste receipt, storage, transfer and shipping operations. The hazard evaluation identified five accident scenario categories that required evaluation. The four postulated accident categories that could result in a radiological release from the Building 991 Complex are (1) fire, (2) spills, (3) explosion, and (4) natural phenomena (earthquake). Each of the postulated accident categories were evaluated to determine frequency of initiating events, the probable effective Material-At-Risk (MAR) for scenarios, the consequences of releases, and the risk to the maximum off-Site individual (MOI) (also known as public), collocated workers, and immediate workers. The risk classes determined from the evaluations credited the preventive and mitigative features currently present in the Building 991 Complex.

Postulated accident scenarios found to be Risk Class I (major risk) or Risk Class II (serious risk) were evaluated to determine if any preventive or mitigative features exist which, if implemented, could reduce the risk to Risk Class III (marginal risk) or Risk Class IV (negligible risk). These features were noted for inclusion in the control set defined by the Technical Safety Requirements (TSRs). The risk associated with postulated accidents scenarios found to be Risk Class III or Risk Class IV are low enough to not require further evaluation. Seven of the eight accident scenarios evaluated resulted in a Risk Class I or Risk Class II to either the MOI, collocated worker, or immediate worker. The acceptability of these risks are evaluated in Section 4.6. Of the accident scenarios evaluated, none resulted in a MOI dose exceeding 5 rem.

The earthquake scenario is the only scenario resulting in a risk to the collocated and immediate workers of Risk Class I. This risk was deemed acceptable due to the conservatism built into the analysis in respect to the number of waste containers involved in the accident and the quantity of material available for release from the involved drums. Many of the accident scenarios evaluated resulted in a Risk Class II to either the MOI, collocated worker, or immediate worker after further evaluation of the preventive and mitigative features were considered. These accident scenarios were (1) a fire initiated in the Building 991 office area resulting in heating of drum contents in an adjacent room, pyrolization of the contents, and venting of radiological material through failed drum lid seals, (2) a fire in a LLW crate postulated to be stored under the Building 991 west dock area canopy, (3) a hydrogen explosion in the waste containers (55-gallon drums, TRUPACT II Standard Waste Box (SWB), or metal waste box), and (4) a breach of two 55-gallon drums by a forklift. The conservatism built into the analysis of each of these scenarios as it pertains to the number of waste containers involved in each accident, the quantity of material in each of the involved waste containers, the use of conservative meteorology, and the probability of the event occurring makes these acceptable risks.

The safety analysis in Chapter 4 requires that certain preventive and mitigative controls be maintained. These controls have been developed in Appendix A, *Building 991 Facility Technical Safety Requirements*. The Technical Safety Requirements (TSRs) include one Limiting Condition for Operation (LCO) for Safety Systems, Structures, and Components (SSCs) credited in the safety analysis. This LCO addresses the building fire suppression and alarm transmittal system. The key assumptions used in the safety analysis to develop the TSRs are summarized in the *Building 991 Complex FSAR Support Calculation*, 97-RAB-001 (Ref. 8). Any future activities involving fissile or hazardous materials, or any modifications to the Building 991 Complex that fall outside the bounds of the authorized activities, shall have an approved hazard assessment or be shown to be equivalent to the activities analyzed before being authorized for performance.

Operation of the Building 991 Complex in conformance with this authorization basis assures there will be no undue risk to workers and the public.

ACRONYMS

AC	Administrative Control/Alternating Current
ALARA	As Low As Reasonably Achievable
Am	Americium
AOL	Administrative Operating Limit
ARCIE	Alarm Radio Communication Instrumentation and Equipment
BDBE	Beyond Design Basis Earthquake
CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
CAM	Continuous Air Monitor
CAMU	Corrective Action Management Unit
CAPASU	Criticality Alarms and Plant Annunciation System Upgrade
CAS	Criticality Alarm System or Central Alarm Station
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CSOL	Criticality Safety Operating Limit
D&D	Decontamination & Decommissioning
DBE	Design Basis Earthquake
DC	Direct Current
DIA	Denver International Airport
DOE	Department of Energy
DOT	Department of Transportation
DR	Damage Ratio
EE	External Event
ES&H	Environmental Safety & Health
EPST	Emergency Planning Screening Threshold
EPTR	Emergency Planning Technical Report
ERPG	Emergency Response Planning Guidelines
eU	Enriched Uranium
F	Fahrenheit
FCAP	Facility Capability Assurance Program
FHA	Fire Hazards Analysis
FSAR	Final Safety Analysis Report

gpm	gallons per minute
H&S	Health & Safety
HEPA	High Efficiency Particulate Air
HP	Health Physics
HSP	Health and Safety Practices
HVAC	Heating, Ventilation, and Air Conditioning
ICMS	Integrated Chemical Management System
IDC	Item Description Code
ISB	Integrated Site Baseline
IWCP	Integrated Work Control Program
Jeffco	Jefferson County
kg	kilogram
kV	kilovolt
kW	kilowatt
LCO	Limiting Condition for Operation
LLW	Low-Level Waste
LS/DW	Life Safety/Disaster Warning
MAL	Master Activity List
MAR	Material-At-Risk
mJ	millijoule
MOI	Maximum Off-site Individual
MSDS	Material Safety Data Sheet
NA	Not Applicable
NDT	Nondestructive Testing
NFPA	National Fire Protection Association
NMSL	Nuclear Material Safety Limit
NPH	Natural Phenomena Hazard
NRC	Nuclear Regulatory Commission
OSR	Operational Safety Requirement
PA	Protected Area
PAC	Programmatic Administrative Control

PCB	Polychlorinated Biphenyls
PEF	Plenum Exhaust Fan
PFSSR	Plant Fire/Security System Replacement
PHA	Preliminary Hazard Analysis
PIV	Post Indicator Valve
POD	Plan Of the Day
PPG	Plant Procedures Group
psi	pounds per square inch
psig	pounds per square inch gauge
Pu	Plutonium
RCRA	Resource Conservation and Recovery Act
RCT	Radiation Control Technician
RFETS	Rocky Flats Environmental Technology Site
RMRS	Rocky Mountain Remediation Services
SAAM	Selective Alpha Air Monitor
SAR	Safety Analysis Report
SARAH	Safety Analysis and Risk Assessment Handbook
Site	Rocky Flats Environmental Technology Site
SNM	Special Nuclear Material
SR	Surveillance Requirement
SSC	Structure, System, or Component
SST	Safe, Secure Transport
SWB	Standard Waste Box
TPQ	Threshold Planning Quantity
TQ	Threshold Quantity
TRM	TRU-Mixed
TRU	Transuranic
TRUPACT II	Transuranic Package Transporter II
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage and Disposal
TSR	Technical Safety Requirements
TYP	Ten Year Plan
U	Uranium
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination

V	Volt
WAD	Work Authorization Document
WEMS	Waste and Environmental Management System
WFC	Waste Form Code
WG	Weapons Grade
WIPP	Waste Isolation Pilot Plant

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1. INTRODUCTION

1.1 PURPOSE

This FSAR provides an authorization basis for the Building 991 Complex (Building 991 and associated buildings). It identifies TSRs necessary to ensure safe operation of the complex. This FSAR demonstrates understanding and adequate control of the Building 991 Complex potential hazards.

Information discussing the Site characteristics necessary for understanding the facility environment are not presented in this FSAR but instead are addressed in the Site Safety Analysis Report (SAR) (Ref. 9). The Site SAR addresses such items as Site description, environmental description, natural phenomena threats, external man-made threats, nearby facilities, and validity of existing environmental analyses.

The organization of this FSAR satisfies the format requirements of DOE-STD-3009-94 (Ref. 5) and includes the following chapters:

Chapter 1 — Introduction: Discusses the purpose for this FSAR, identifies the complex mission and authorized activities, and discusses the operational and authorization basis history including past Unreviewed Safety Question Determinations (USQDs) applicable to the complex. A comparison to DOE-STD-3009 content requirements is provided in this chapter.

Chapter 2 — Facility and Systems Description: Provides a description of the complex systems and principal equipment housed in the complex facilities.

Chapter 3 — Safety Management Programs: Describes the Site Safety Management System and required Administrative Programs for the complex.

Chapter 4 — Hazard and Accident Analysis: Presents the hazard/risk classification methodology, hazard identification, hazard evaluation, accident scenario development methodologies and safety analysis results. Includes a Facility Hazard Identification Checksheet, Hazard Description Sheet, and accident analysis tables for postulated accident scenarios. Discusses the risk dominant accident scenarios and assesses adequacy of existing controls.

Chapter 5 — Derivation of Technical Safety Requirements: Explains how the TSRs were developed from the hazard identification and accident evaluation processes and discusses the control types used. A discussion of SSCs is provided.

Chapter 6 — References: Provides a list of references cited throughout the FSAR.

Appendix A — Building 991 Facility Technical Safety Requirements: Presents the TSRs based on the results of the safety analyses documented in Chapter 4.

Appendix B Change Summary: (to be added later).

The following table provides a correlation of DOE-STD-3009 chapter requirements to this FSAR for the Building 991 Complex.

Table 1-1 DOE-STD-3009 and Building 991 Complex FSAR Chapter Comparison

DOE-STD-3009 Topic	DOE-STD-3009 Chapter	Building 991 Complex FSAR Chapter and Remarks
Executive Summary	unnumbered	Unnumbered - The organizations responsible for the Building 991 (B991) design and construction are described in Chapter 2, in association with the physical description of the Buildings, instead of in the Executive Summary. B991 FSAR organization is described in Chapter 1 instead of the Executive Summary. All other topics in DOE-STD 3009 are adequately addressed in the B991 Executive Summary in a format that is narrative in style and does not include topic headings.
Site Characteristics	1	Chapter 1 - B991 FSAR addresses the facility specific items and references the Site SAR, which addresses Site specific items.
Facility Description	2	Chapter 2 - Facility and systems descriptions are addressed, though due to the simplicity of the facility, the formatting and topic headings of this chapter vary from DOE-STD 3009 as appropriate.
Hazard and Accident Analyses	3	Chapter 4 - All natural phenomena and external event hazards are addressed, though all are not analyzed due to either B991 Complex physical considerations or beyond-design basis frequency for the facility.
Safety Structures, Systems, and Components	4	Chapter 5 - Relevant information contained in Chapter 4 of the DOE-STD-3009 are included in Chapter 5 as part of the Derivation of Technical Safety Requirements.
Derivation of Technical Safety Requirements	5	Chapter 5 and Appendix A - For the B991 FSAR, LCOs, Administrative Operating Limits (AOLs), Programmatic Administrative Controls (PACs), and Design Features are used, as in the Building 569 Basis for Interim Operation (BIO), and cross-referenced back to the accident scenarios for which they are credited. The B991 facility TSRs are provided in a single stand alone appendix (with its own table of contents). This appendix is designed to be pulled out by operations personnel to facilitate use.
Prevention of Inadvertent Criticality	6	Chapter 3 - DOE-STD 3009 uses Chapters 6 - 17 for individual program descriptions. Instead of describing each program individually, the B991 FSAR refers the reader to the Site SAR in Chapter 3, Safety Management Programs. By referring readers to the Site SAR for descriptions of Site programs, a more consistent understanding and application of the programs is achieved. This approach of referencing back to the Site SAR is used in the Building 569 BIO, the Building 559 FSAR Update, and is expected to be used in future authorization basis documents.

DOE-STD-3009 Topic	DOE-STD-3009 Chapter	Building 991 Complex FSAR Chapter and Remarks
Radiation Protection	7	See above comment.
Hazardous Material Protection	8	See above comment.
Radioactive and Hazardous Waste Management	9	See above comment.
Initial Testing, In-Service Surveillance, and Maintenance	10	See above comment.
Operational Safety	11	See above comment.
Procedures and Training	12	See above comment.
Human Factors	13	See above comment.
Quality Assurance	14	See above comment.
Emergency Preparedness Program	15	See above comment.
Provisions for Decontamination and Decommissioning	16	See above comment.
Management, Organization, and Institutional Safety Provisions	17	See above comment.

1.2 COMPLEX MISSION AND ACTIVITIES OVERVIEW

The complex mission and activity descriptions provided below are for information only. They provide the reader with information helpful to understanding the scope of the safety analysis and derivation of the TSRs presented in this FSAR. They should not be interpreted as the necessary operational configuration of the equipment utilized for waste receipt, storage, transfer and shipment. Credited preventive and mitigative features are described in Appendix A, *Building 991 Facility Technical Safety Requirements*.

The Building 991 Complex supports the receipt, storage, transfer and shipment of nuclear materials, TRU waste, low-level waste (LLW) and Toxic Substances Control Act (TSCA) waste. The complex is also operated as a tenant facility for the Building Manager, Rocky Mountain Remediation Services (RMRS) RCTs, and the Alarm Radio Communication Instrumentation and Equipment (ARCIE) group and includes a metallography laboratory and nondestructive testing (NDT) activities. A description of each activity is provided in the following sections.

The future use of the Building 991 Complex and the schedule for its eventual demolition can only be stated in generic terms due to the uncertainties and the range of possibilities for future actions at the Site. It is expected the complex will continue to perform a landlord function and to serve as a waste storage facility without Resource Conservation and Recovery Act (RCRA) units (i.e., no mixed waste storage). The use of the Building 991 Complex as a waste storage facility is consistent with the Ten Year Plan (TYP) and the Integrated Site Baseline (ISB). The Building 991 Complex storage mission supports the general vision of waste storage outside of the main plutonium production buildings and management of waste from building decontamination and decommissioning. Regardless of the rate of execution or funding, the planned use for the

Building 991 Complex, for at least the next four years, is for interim TRU and LLW storage. The actual usage of the complex for storage is dependent on the opening date/rate of disposal at the Waste Isolation Pilot Plant (WIPP) and the rate of generation from residue stabilization and D&D activities. The Building 991 Complex will likely be in service as waste storage facilities until the last "plutonium" building is demolished and recovered, a new TRU/TRU-Mixed (TRM) facility is constructed, or the volume of TRU waste at the Site is less than the TRU capacity of more advantageous locations (such as Building 664, Building 440, or Building 906). Also, siting of a Correction Action Management Unit (CAMU) at a future date may involve the removal of the Building 991 Complex (Ref. 10).

A RCRA satellite storage area in Room 106 of Building 991 is used to accumulate spent nickel-cadmium batteries. Controls mandated by RCRA regulations are credited as preventive and mitigative measures before the batteries are transferred to a permanent RCRA storage area outside of the Building 991 facility. Existing controls for the chemical hazards associated with the temporary storage of batteries in this area are sufficient.

Administrative Controls established in the Building 991 Complex assure that only activities authorized for performance under this FSAR are placed on the Plan of the Day (POD). Authorized Core Activities are identified in Section 1.2.6, Mission Program Activities are identified in Section 1.2.7, and the primary activities are discussed below.

1.2.1 Shipping, Receiving, Transfer and Storage Operations

The Building 991 Complex is approved to accept and store LLW and TRU waste in support of various projects to stabilize residue materials and to decontaminate, dismantle or demolish various facilities or portions of facilities that are planned for evacuation or the installation of new equipment or treatment processes. Relocation of waste containers from existing facilities will support ongoing projects and maximize the existing use of limited storage space. The Building 991 Complex is also authorized to receive, stage, and ship SNM packaged in Department of Transportation (DOT) approved Type B off-Site shipping containers.

All waste containers accepted into the complex are vented and verified by means of the Waste and Environmental Management System (WEMS) to meet complex criteria for authorized Item Description Codes (IDCs). Upon verification by complex personnel of acceptability, containers are scheduled for shipment to the Building 991 Complex. Operations personnel receive containers, verify container numbers and IDCs from the Nuclear Material Drum Transfer Report, accept the containers, and move them to storage areas. The containers are stored and entered administratively into the locator system. Radiation Operations will perform surveys to determine exposure rates prior to and after the containers are stored.

1.2.2 Alarm Radio Communication Instrumentation and Equipment Group

The ARCIE group provides on-site maintenance, testing, and surveillance support for various electronic systems across the Site. There are five areas covered by the service: (1) fire alarms, (2) security alarms, (3) communications, (4) maintenance control systems, and (5) radiation instrumentation. This support includes assisting technicians in troubleshooting and repair, interfacing with other support groups at the Site, and developing and tracking maintenance programs and special projects. The group is housed in Building 991 but many of the services provided requires the group to work in all facilities throughout the Site.

Activities conducted inside the Building 991 Complex by the ARCIE group include: (1) providing maintenance and testing of Building 991 and Building 985 fire alarm systems, (2) providing corrective maintenance, system upgrades, and calibration of effluent Selective Alpha Air Monitors (SAAMs) in Building 991, and (3) maintaining and repairing out-of-commission SAAMs and Continuous Air Monitors (CAMs).

Activities performed by the group outside the Building 991 Complex include: (1) ensuring fire alarm systems comply with National Fire Protection Association (NFPA) requirements and DOE orders, (2) rectifying security system outages protecting Category I and II SNM, (3) providing corrective maintenance, minor installation, and system upgrades for the site wide utility control systems that monitor and record building status, and (4) maintaining, providing surveillance, and calibrating radiation instrumentation.

1.2.3 Metallography

Metal specimens are received by the Metallography Laboratory from various locations at the Site and from off-site vendors. The evaluations are used for quality assurance. These samples are analyzed for hardness, weld penetration, and grain structure.

Metal samples received for determination of physical properties such as hardness and grain structure are processed in Rooms 109, 110, and 110A & B. In Room 109, there are two chemical hoods, a cutoff saw, grinding and polishing equipment. The indentor used for hardness testing is positioned so that it rests on top of the metal sample. Calibrated weights are then added to the analyzer in increasing amounts. The force of these weights is transferred to the indentor, which in turn deforms the metal sample. The specimen hardness is determined by measuring the metal deformation.

Samples received by this laboratory to investigate weld penetration grain structure are first cut to size then mounted in a thermosetting plastic. The mounted metal sample is ground and polished before undergoing a final etching process. The etching process is carried out in chemical hoods using different acid solutions depending upon the metal, metal alloy, or features to be developed.

1.2.4 Nondestructive Testing

The NDT area, which encompasses rooms 160-165, performs radiography inspection in Room 164 of Building 991. Room 160 has an automatic film processor, and there is a dark room for processing the film, and a film interpretation room. Room 165 is used to house supplies for dye penetrant, ultrasonics, and field radiography equipment utilized by the tank/field NDT group. Radiography is used to non-intrusively inspect materials to meet customer requirements. The materials inspected by the NDT group in Building 991 are all non-radioactive.

The radiography operation in Room 164 utilizes two separate methods. A portable x-ray generating device is set up in the room. A portable gamma Iridium-192 source can be used in the room to radiograph, or can be used throughout the Site to perform radiographic operations. All film generated by either radiography operation is developed in Building 991, using an automated, closed system.

Ultrasonics utilize sound waves to determine things such as material integrity, material thickness, and liquid presence in piping. This testing technique is portable and can be accomplished throughout locations on Site. The ultrasonic transducer is coupled to the surface of the test piece by a glycerin gel, and interpreted on a CRT or readout.

The dye penetrant operation inspects the surface condition of a material for surface defects. The test sequence involves cleaning the test part, applying dye penetrant, removing the excess penetrant, and applying a developer to aid in interpretation. All chemicals used in the dye penetrant operation are non-hazardous.

1.2.5 Administrative Area

The office area of Building 991 provides office space for the Building Manager, operations personnel, and the RMRS RCTs. Administrative activities are conducted by these personnel in the performance of their responsibilities.

1.2.6 Core Activities

The engineered and administrative controls included in this FSAR are based on knowledge of the hazards existing in the Building 991 Complex and those activities necessary to maintain safe facility occupancy, provide for hazards management, or ensure regulatory compliance. These activities are defined as Core Activities. Core Activities are characterized by the following attributes:

- Routinely performed,
- Demonstrated record of safe performance,
- Proceduralized in approved work control documents (Plant Procedure Group (PPG) procedures, Integrated Work Control Program (IWCP) packages, or Operations Orders),

- Completed by trained individuals.

The FSAR controls adequately protect the public, workers, and the environment from identified hazards associated with authorized Core Activities and these activities are, therefore, approved for placement on the POD. Core activities authorized for the Building 991 Complex are listed below. Each Core Activity is cross referenced in Table 1-2 to the Site Master Activity List (MAL) (Ref. 11).

Table 1-2 Core Activity Cross Reference

Core Activity #	MAL Cross-Ref.	Activity Title
991-C-3	RFETS-B-3	Monitor Configuration of Nuclear Material for Safety
991-C-4	RFETS-B-4	Maintain Functional Ventilation and Filtration Capability
991-C-5	RFETS-B-5	Maintain Functional Utilities Capability
991-C-6	RFETS-B-6	Maintain Functional Fire Detection and Prevention Capability
991-C-7	RFETS-B-7	Maintain Functional Fire Suppression Capability
991-C-8	RFETS-B-8	Provide Functional Occupational Safety and Health/Occupational Medicine Capability
991-C-9	RFETS-B-9	Provide Functional Environmental Compliance Capability
991-C-10	RFETS-B-10	Maintain Functional Records Management/Document Control Capability
991-C-11	RFETS-B-11	Provide Functional Waste Management Capability
991-C-12	RFETS-B-12	Provide Functional Radiation Protection Capability
991-C-13	RFETS-B-13	Provide Functional Emergency Response Capability
991-C-14	RFETS-B-14	Maintain Functional Confinement Capability
991-C-15	RFETS-B-15	Conduct Site, Facility, and Equipment Maintenance and Support
991-C-16	RFETS-B-16	Provide a Safety Infrastructure
991-C-17	RFETS-B-17	Maintain Physical Control of Special Nuclear Material
991-C-18	RFETS-B-18	Provide Functional Laboratory Capability

Work scopes falling within the Site MAL descriptions of these Core Activities, and meeting the criteria described above, may be placed on the POD at the discretion of the Building 991 Operations Manager. The receipt, storage, transfer and shipment of LLW and TRU waste is associated with Core Activity 991-C-11.

1.2.7 Mission Program Activities

Mission Program Activities fall outside the bounds of the Core Activity descriptions. Mission Program Activities are hazard uncertainty or hazard level reduction activities not routinely performed. They must have a well defined and understood scope, have a manageable level of process and regulatory uncertainty, be supported by approved work control documents, and be performed by trained individuals. Mission Program Activities authorized for the Building 991 Complex include those identified in Table 1-3 (Ref. 12):

Table 1-3 Mission Program Activity Cross Reference

Mission Program Activity #	Mission Program Activity Title
MP-SMM-013 (A)	Identification, Characterization and Disposition of Excess Chemicals
MP-SMM-036 (A)	Air Monitoring Improvements
MP-SMM-041.991 (A)	Transfer SNM in Off-Site Shipping Containers from Buildings within PA to B991 for Off-Site Shipping Preparation
MP-SMM-044.991 (A)	SNM Consolidation and Transfer of HSP 31.11 Compliant Nuclear Material
MP-SMM-068 (A)	Sampling/Packaging/Shipping of 4.5% enriched Uranium (eU) Oxide
MP-SMM-069	Treatment and Disposal of Reactive Chemicals
MP-SOI-001 (A)	Facility Capability Assurance Program (FCAP)
MP-SOI-003 (A)	Electrical Distribution Upgrade
MP-SOI-004 (A)	Criticality Alarms and Plant Annunciation System Upgrade (CAPASU)
MP-SOI-005 (A)	Plant Fire/Security System Replacement (PFSSR)
MP-SOI-013 (A)	On-Site Transportation in Support of Mission Program Activities
MP-SOI-014 (A)	Off-Site Transportation in Support of Mission Program Activities
MP-SOI-016 (A)	Modification of Site Security Systems

Any additional activities planned for the future, meeting the definition of Mission Program Activities, will be prohibited from placement on the POD until they have been assessed through the USQD process to assure they can be safely performed within the existing set of controls; or additional controls have been identified, verified to be those necessary and sufficient to conduct the planned work, and have been documented and implemented.

1.3 AUTHORIZATION BASIS HISTORY

Until the approval of this FSAR for the Building 991 Complex, the authorization basis for Building 991 consisted of a draft SAR (Ref. 13) with an approved set of OSRs (Ref. 14) and several USQDs. The current activities in the Building 991 Complex include handling of SNM in approved shipping containers, and handling and storage of TRU waste in approved containers and controlled to a limited number of IDCs not to exceed 37.5 kg of weapons-grade plutonium equivalent.

The OSRs were developed based on the draft SAR last revised in 1981. This document was never approved, but the control set, in the form of OSRs, was approved in 1988 and has been maintained. The mission that the OSRs were developed to control was described as primarily receiving, storage, handling, and shipment of radioactive materials in "Department of Transportation (DOT)-, Department of Energy (DOE)-, or Site intraplant-approved shipping containers." At the time the draft SAR was written, radioactive materials transported to and from the Site were primarily SNM; TRU waste was not stored in the Building 991 Complex. A long-term Termination Shift Order (Ref. 15) was issued to address the operating parameters within the Building 991 Complex. The order prohibits any operation involving the opening of a shipping container or repackaging of fissile material containers.

In January, 1995, the Nuclear Safety organization was asked to evaluate the storage of TRU waste on a temporary basis in the Building 991 Complex. This evaluation (Ref. 16) assessed the safety significance of the proposed storage of twelve TRU waste types identified by IDC, in various areas (including vaults and tunnels) of the complex. In April, 1996, Nuclear Safety was requested to evaluate additional TRU waste types for interim storage in the Building 991 Complex (Ref. 17). Analyses were performed to assess the risk associated with this activity in addition to the risk associated with that of the previously evaluated TRU waste storage activity. This second and most recent evaluation found that an Unreviewed Safety Question (USQ) existed for the proposed storage of TRU waste because it created the possibility of an accident of a different type than any previously evaluated. In addition, this activity reduced the margin of safety of the facility due to the change in mission from production storage or short term shipping/receiving and storage of various low level waste types, to the interim storage of TRU waste. The accident analyses performed for the temporary storage of TRU waste in the Building 991 Complex considered four accident scenarios. The postulated accidents assumed no credit for the operability of the secondary confinement, including the high efficiency particulate air (HEPA) filtration system, and backup power systems to mitigate consequences to the public, the worker, or to the environment. The evaluation and supporting analyses were approved and an associated increase in risk was accepted by the DOE in October, 1996. That documentation, together with the approved OSR, were considered to be the interim approved authorization basis documentation for the facility until being superseded by this Building 991 Complex FSAR. Therefore, all previous USQDs with ongoing compensatory actions crediting these systems are no longer applicable.

USQD-RFP-97.0294-KGH, *RFETS HEPA Filter Bypass Leakage Discovery Conditions* (Ref. 18) involves a condition of HEPA filter bypass at three facilities on the Site, including Building 985. Fan shaft seals in fans 601A and 601B were found to have bypass leakage of 31 cfm. Because of this discovery, no waste is allowed inside Building 985. For Building 985, there is no MAR inventory currently available to become involved in an event that could result in an unfiltered release. A control due to this condition was proposed in the USQD. This control requires that any waste generated as a result of maintenance work or filter changes must be removed from the building to an approved waste storage area within 24 hours of job completion. These controls were implemented by Operations Order 991-11 generated in accordance with procedure 1-C15-COOP-020, *Termination of Operations Process* (Ref. 19).

1.4 OPERATING HISTORY

The Architect-Engineer who designed the original Building 991 and the primary construction contractor was The Austin Company, Cleveland, Ohio. Ground breaking occurred on July 10, 1951 for the first permanent buildings at the Site. Included in the initial construction was a small group of buildings identified as the 991 Complex, with the primary building being Building 991. Building operations started in April of 1952. Building 991's main function was assembly, shipping and receiving of final components produced at the Site, Hanford and Oak Ridge. Building 991 functions also included administrative support (later moved to Building 111), product inspection, research and development, and material storage and accountability.

By the early 1960's, product assembly and most research and development activities were relocated. In 1964, beryllium coating operations began in a Building 991 research laboratory. From 1966 to 1974, Building 991 was occupied by groups conducting welding, coating, ecology and product engineering operations. As part of product engineering, testing was conducted to determine the quality of non-nuclear raw materials and parts fabricated by off-site vendors. The building also inventoried and stored these parts for future use.

During the mid-1970s, research and development operations, including beryllium coating, were relocated from Building 705. Scrap beryllium storage, refurbishment of shipping containers, and procurement, receipt, shipment, and storage of forms used by production operations were added to the operations conducted at Building 991. In 1974, Building 985 was constructed to house the air handling system that supports the underground storage vaults.

During the 1980s, Final Quality Certification, Procurement Quality Engineering, Metallography Laboratory, and Nuclear Materials Control and Accountability were added to Building 991. In 1985, a new receiving dock (Room 170) was added to Building 991 for off-site shipment of SNM via SST. In 1986, Building 984 was constructed for the storage of approved shipping containers.

Several operational changes occurred between 1988 and 1992. Finished machined product receipt, certification, storage, and shipment relocated to Building 460. Limited operations remained in Building 991 until March 1992, when final quality certification relocated to Building 130. Raw material receipt, certification, storage, and shipment relocated to Building 130. Procurement quality engineering relocated to Buildings 460 and 850. Machining relocated to Building 130. Administrative offices increased to include Technical Operations Control and Radiological Engineering, and the Surface Laboratory was assembled in Room 155 to test new cleaning methods to replace the carbon tetrachloride and 1,1,1-trichloroethane used in glovebox operations.

In 1992, the ARCIE group moved their equipment and personnel to Building 991. Also during 1992, a decision was made to evacuate all SNM from the Building 991 Complex based on multiple evaluations which identified several potential and/or confirmed concerns. The concerns were visible cracks and the potential for other structural deficiencies with concrete corridors that connect vaults, water seepage into the corridors and vaults, visual corrosion of containers, marginal vault ventilation systems, questionable adequacy of fire detection and suppression systems, questionable criticality detector coverage of the vaults, and potential danger from the propane tanks located on the hillside west of Building 991 at the 750 Pad. Therefore, containers of SNM were relocated from Vaults 996, 997, and 999 and Corridor C of the Building 991 Complex to Building 371 as interim storage while others were consolidated in Building 991 vaults (Ref. 20).

In 1995, because of a shortage of storage areas on site, Vaults 996, 997, and 999 were determined to be an acceptable storage area for TRU waste (Ref. 16). The mission for the Building 991 Complex changed to that of a TRU Waste Storage Facility in August of 1995 when TRU waste was accepted into the facilities.

Documented occurrences from 1991 to 1996 were reviewed for the Building 991 Complex. There were no occurrences involving a chemical or radiological release of material during this time frame. Of the documented occurrences, over 75% were caused by equipment failure or deficiencies. The aging of the equipment in the Building 991 Complex was the predominant reason for the equipment failure.

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2. FACILITY AND SYSTEMS DESCRIPTION

This chapter provides descriptions of the Building 991 Complex facilities and processes to support assumptions used in the hazard and accident analyses and the derivation of control requirements presented in this FSAR. The facility and systems descriptions provided in this chapter of the FSAR are for informational purposes only. They should not be interpreted as the necessary physical or functional configuration of building SSCs or design features credited in the safety analysis. Credited preventive and mitigative features for portions of the Building 991 Complex are described in Appendix A, *Building 991 Facility Technical Safety Requirements.*

This section provides an overview of the basic Building 991 Complex buildings and structures, including construction details such as basic floor plans, equipment layout, construction materials, controlling dimensions, and dimensions significant to the hazard and accident analysis activity. All facilities considered part of the Building 991 Complex are briefly described in the following divisions of this section.

2.1 COMPLEX DESCRIPTION

The Building 991 Complex is located on the east side of the developed portion of the Site within the PA as shown in Figure 2-1 and Figure 2-2. Building 991 is the main building of the Building 991 Complex. Facilities included in the Building 991 Complex are:

- Building 991 - Waste Operations Facility.
- Vaults 996, 997, 999 and Room 300 - LLW and TRU Waste Storage Vaults.
- Corridor A Tunnel - Provides access to Room 300 and future LLW and TRU Waste Storage Area. Also known as Tunnel 998.
- Tunnel 996 - Provides Access to Vault 996 and Corridor C.
- Corridor C Tunnel - Tunnel between Vaults 996, 999 and 997.
- Building 985 - Filter Plenum Building for Vaults 996, 997 and 999.
- Building 989 - Diesel Generator Building for Building 991
- Building 984 - Shipping Container Storage Facility
- Building 992 - Normally unoccupied Guard Post

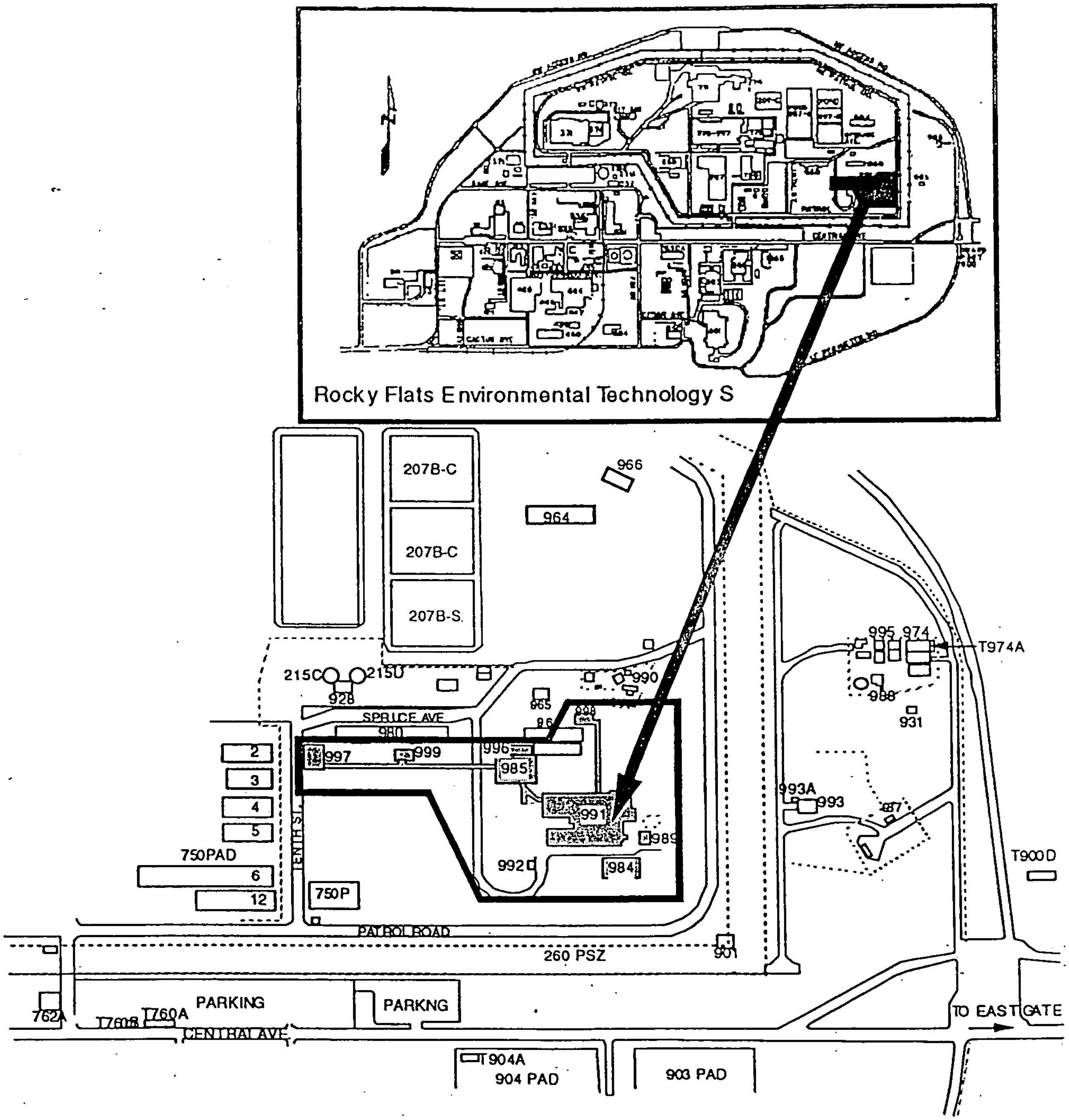

Figure 2-1 Site Location of the Building 991 Complex

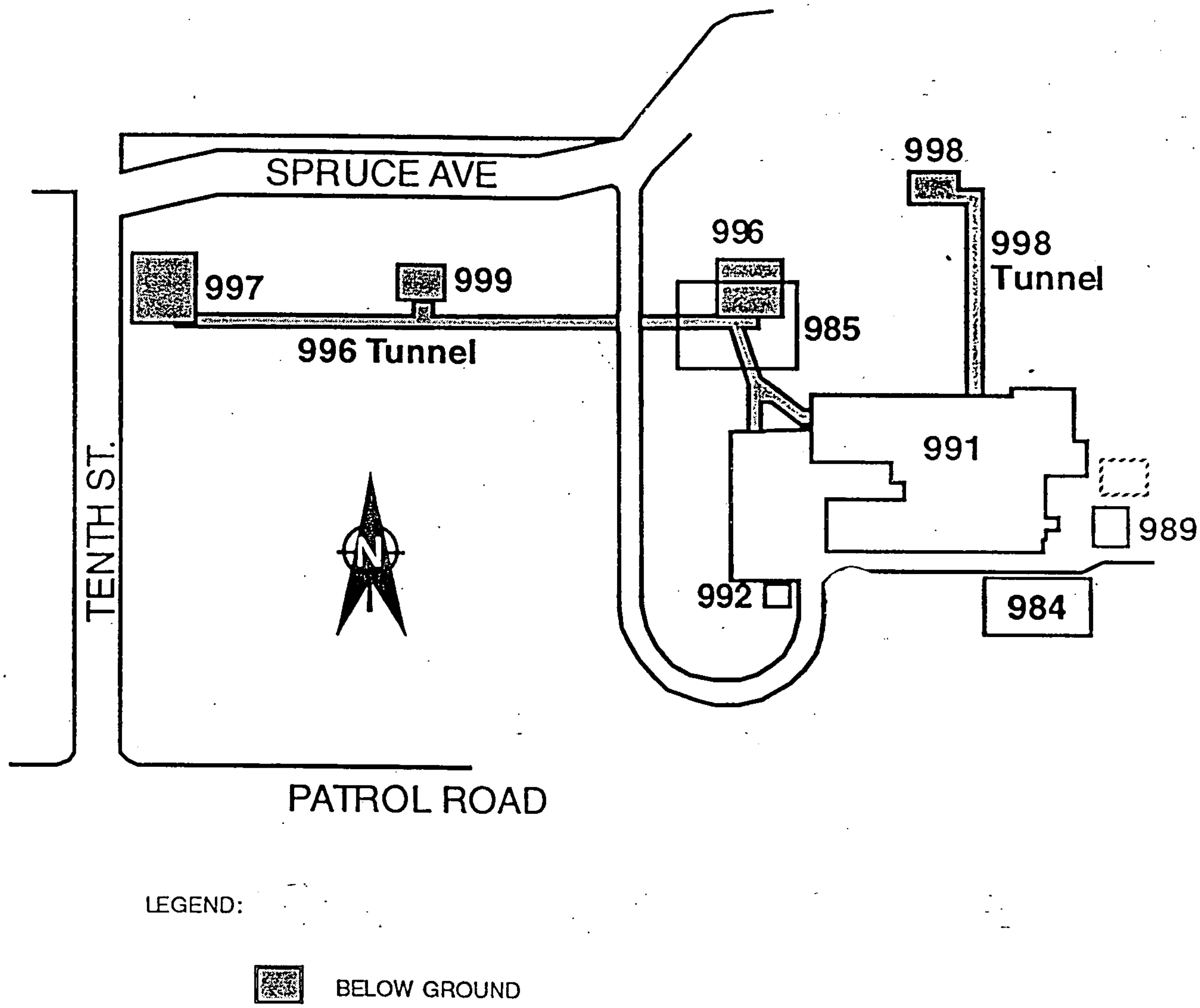

Figure 2-2 Building 991 and Associated Complex Buildings

Building 991, the main structure of the complex, is a one-story structure with a partial basement. The 36,259 square foot building is primarily reinforced concrete and metal on metal framing. Connected to Building 991 by tunnels or corridors are Vaults 996, 997, 999 and Room 300. The vaults and tunnels or corridors leading to them, comprising 20,940 square feet, are all underground and made of reinforced concrete.

There are two support structures for Building 991 which are: (1) Building 985, the Filter Plenum Facility, and (2) Building 989, the Diesel Generator Facility. Building 992 is a former Guard Post located southwest of the Building 991 facility. Empty DOT-approved shipping containers and packaging materials, and ARCIE spare parts are stored in Building 984 which is a metal shed located on the southeast side of Building 991. This building also contains a drum crusher. On the west and south sides of Building 991, are large, fenced storage areas containing steel drums and other materials. Receiving and shipping dock facilities are located on the west and east sides of the building. Also on the west side of the building and in close proximity to the dock area, is an out-of-service paint booth located against the building's west wall.

2.1.1 Building 991

The design for Building 991 was completed in 1951 and followed structural military protection criteria. The original structure, which included Vaults 996 and 997 plus Corridor C and Tunnel 996, was completed in 1952. A subsequent addition, Vault 999, was constructed adjacent to Corridor C in 1956. Three major additions have been built since then: (1) a west side loading dock in 1957, (2) a radiography vault, Rooms 164 and 165, was added in 1959 in the northeast corner, and (3) a covered loading dock and maintenance area on the southeast side was built in 1964. The Building 991 floor plan is as shown in Figure 2-3.

The original design criteria required the structures to support specific dead loads and to withstand the blast pressure of a semi-armor piercing 2,000 pound bomb (1,000 pounds per square foot blast pressure and 18.7 inches diameter, 1,100 feet per second inert penetration). For vault areas, this criteria included a direct-hit penetration resistance. Penetration apparently was not considered for Corridor C. The design criteria for Building 999 is unknown (Ref. 20 and 21).The foundations of Building 991 are composed of footings and foundation walls. There are three basic types of footings: (1) individual spread footings, (2) combined footings, and (3) wall footings. The individual spread footings vary from 3 feet 3 inches square by 1 foot 3 inches thick to 4 feet square by 1 foot 3 inches thick. The combined footings are of two types: (1) 3 feet wide by 15 feet long and either 2 feet or 2 feet 7 inches thick, and (2) 5 feet 2 inches wide by 19 feet long by 2 feet thick. The wall footings vary from 2 feet wide by 10 inches thick to 5 feet wide by 1 foot 6 inches thick (Ref. 22).

Bearing walls and intermediate concrete columns are the structural framing in Building 991. All exterior concrete walls are bearing walls. They are reinforced concrete that vary from 12 inches thick to 18 inches thick on the north side of the building, which is set against a hill. The radiography vaults in the northeast corner of the building have 3 foot thick reinforced concrete walls. The maintenance shop addition has 8 inch thick concrete block bearing walls.

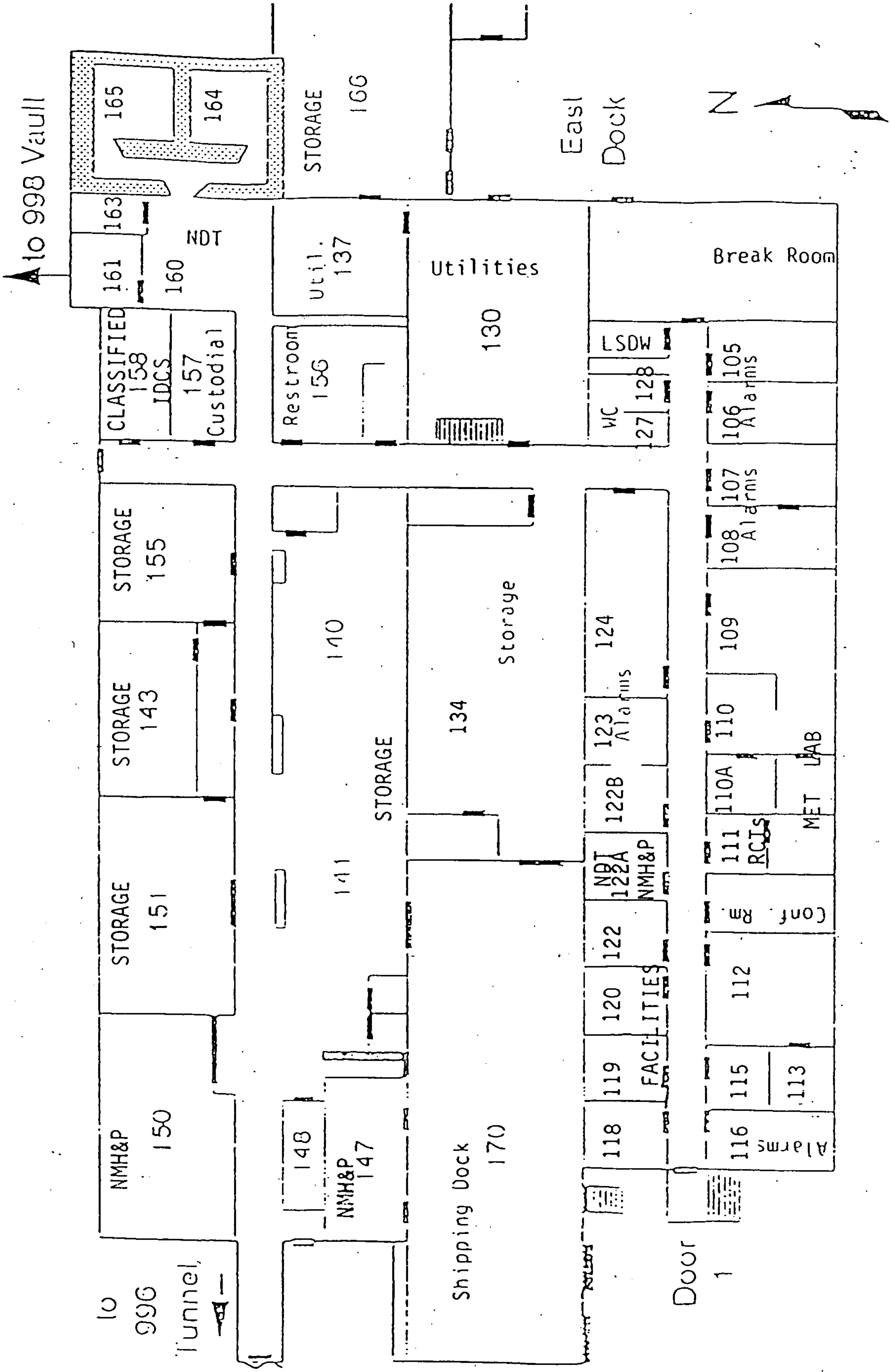

Figure 2-3 Building 991 Floor Plan

The building walls vary in height from 14 feet on the south to 27 feet in the center to 18 feet on the north side (Ref. 22). The covered dock and shop at the east end of the building has reinforced concrete grade walls, 6 feet 5 inches high by 8 inches thick, which rest on footings.

There are two reinforced concrete retaining walls. One runs 50 feet east from the northeast corner of the building. The wall is stepped down from 14 feet 10 inches to 8 feet 10 inches high. The other retaining wall runs 172 feet south from the southwest corner of the entrance to the tunnel leading to the storage vaults. The wall varies in height from 10 feet 6 inches to 9 feet 4 inches (Ref. 22).

The floor of the basement (utility tunnel) under Building 991 is 1 foot above creek elevation at the southwest corner of the building. The utility tunnel has a complete sub-drain system that flows into a 6 foot deep sump. The sump is drained by two 60-gallon per minute (gpm) sump pumps that discharge into the storm drain system (Ref. 22).

The utility tunnel basement is approximately H-shaped, just like the main floor corridors above it. The north leg is 156 feet long, the south leg is about 204 feet long, and the north-south cross leg is over 78 feet long. The north leg is 11 feet 6 inches wide, the south leg is 9 feet 6 inches wide, and the north-south leg is 8 feet wide. The tunnel height is 9 feet (Ref. 22).

There are four different roofs on Building 991. The original building has a reinforced concrete slab supported by concrete beams. The concrete slab varies in thickness from 4 inches to 15 inches. On top of the slab is a 1 inch thick foam insulation and then built-up roofing. The roof of the radiography addition is 6 inch thick reinforced concrete with 1½ inches of insulation and then built-up roofing. The west side loading dock building addition has structural steel roof framing with corrugated asbestos cement roofing. One structural steel column and the existing concrete walls support the roof framing. The southeast side, covered loading dock and maintenance area building addition, has open-web steel roof joists with metal decking covered with insulation and built-up roofing (Ref. 22).

2.1.2 Vaults 996 and 997

Vaults 996 and 997 are underground, reinforced concrete storage vaults with the following dimensions: overall dimensions (exterior) are 60 feet by 68 feet each with walls 14 feet 6 inches thick, roof 12 feet thick, and floor 6 feet thick (Ref. 23). The vaults are partitioned (2 foot walls) into four rooms, each room is 12 feet by 18 feet 6 inches with a 10 foot high ceiling. The earth cover varies from 1 foot to 10 feet.

2.1.3 Vault 999

Vault 999, built in 1956, is an underground, reinforced concrete structure with the following dimensions: overall dimensions (exterior) are 33 feet by 49 feet with walls 1 foot 3 inches thick, roof 1 foot 9 inches thick, and floor 6 inches thick. The vault is partitioned (2 foot walls) into three rooms, each room is 14 feet by 22 feet with a 10 foot high ceiling. The earth cover is approximately 18 inches.

2.1.4 Room 300

Room 300 is an underground, reinforced concrete storage vault with overall dimensions (exterior) of 20 feet by 30 feet. The walls are 2 feet 6 inches thick, the roof is 2 feet 6 inches thick, the floor is 2 feet 6 inches thick, and the earth cover is approximately 13 feet.

2.1.5 Corridor A Tunnel

Corridor A tunnel, also known as Tunnel 998, is an underground, reinforced concrete structure from Building 991 to Room 300 with the following dimensions: overall dimensions (exterior) are 10 feet by approximately 180 feet, with walls, roof and floor being 1 foot 3 inches thick. The earth cover varies from 2 feet to 13 feet.

2.1.6 Tunnel 996

Tunnel 996 is a reinforced concrete structure that connects Building 991 north and west to Vault 996 and the east end of Corridor C. The tunnel is an inverted Y-shaped underground corridor 10 to 12 feet wide and 11 to 13 feet high.

2.1.7 Corridor C Tunnel

Corridor C tunnel from Vault 996 to Vault 997 is an underground, reinforced concrete structure with the following dimensions: overall dimensions (exterior) are 10 feet 6 inches wide and the corridor is greater than 600 feet long, with walls, roof and floor 1 foot 3 inches thick. The earth cover is approximately 12 feet.

Corridor C has a documented history of cracks in its concrete structure and groundwater infiltration associated with many of the cracks since the 1960s. There is significant shear, transverse, and longitudinal cracking in Corridor C. Shear cracks exist in the north and south corridor walls at several locations. Shear cracks appear to be caused by differential settlement along the corridor length or by differential settlement between the corridor and the adjacent vaults. These cracks opened at locations by up to ¼ inch and were the primary source of water infiltration. Transverse cracks exist around the entire section at construction joints. While there is some evidence of water seepage, these transverse cracks are mostly tight. Longitudinal cracks run along the entire length of the roof. There are also cracks spaced at about 7 to 8 inches near the center of the roof slab, likely caused by soil overburden acting on the roof. Additional longitudinal cracks exist as meandering cracks near the center and along the length of the corridor floor. Both the roof and floor cracks are tight cracks, with no water seepage, likely caused by flexure.

Several attempts to seal the cracks from the interior have been marginally successful. In 1988, an internal memorandum on the Corridor C structure estimated the depth of soil overburden to be in excess of that allowed for normal code safety (i.e., Uniform Building Code, American Concrete Institute, etc.).

A new bounding structural analysis was performed in July 1992 (Ref. 24). This analysis was based on confirmed topographical surveys, as-built drawings of record, and comparisons of previous visual inspection documents with current conditions. The second assessment validated the 1988 determination that the depth of soil overburden exceeds that of normally acceptable code safety factors. The bounding analysis was reviewed by established subject matter experts in the fields of concrete design, soils engineering, and seismic response.

The structural assessments confirmed inadequate reinforcing steel was installed in the structure to meet existing design standards for support of the original and current level of soil overburden. The reduced margins of safety in the design were then considered along with other pertinent factors. These factors included the documented forty years of performance, the documented stability of the identified cracks over four years of record, the (minor) nature of the flexural cracks in the region of overstress, and the ductile (slow) and observable progression of the predicted failure mechanism. Significant deformation could be accommodated before collapse would be imminent, and a monitoring system would give sufficient warning time to take remedial action if further distress of the corridor were to occur. These considerations supported a position that catastrophic failure was not imminent from a structural view, and that it was reasonable to continue operations, with compensatory actions, until a safe and orderly restoration of safe material storage conditions could be accomplished (Ref. 24). A crack monitoring system, strain gages, were installed to provide indication of further degradation of the corridor. The conclusion reached was that Corridor C is structurally sound, capable of supporting current loads from the soil which covers the corridor, and not in danger of imminent collapse.

2.1.8 Building 985

Building 985 is a 2,400 square foot filter plenum facility, constructed in 1972. It is a one-story structure adjacent to the northwest corner of Building 991. At the east end of the building is a pit in which there is a tank for collecting water that would result from activation of the plenum fire protection sprays. There are no Raschig rings in the tank.

Building 985 is approximately 60 feet long by 40 feet wide by 15 feet high. The foundation of the building consists of 16 concrete caissons with 2 foot, 2½ foot, and 3 foot diameters and lengths varying from 13 feet to 34 feet. The caissons support reinforced concrete grade beams 12 inches thick and 5 feet deep for interior walls and 5 feet 3 inches deep for exterior walls. The floor slab is reinforced concrete 8 inches thick on ground, nominally 11 inches thick for pads, and an average 12 inches thick for the sloping pit slab.

The pit walls are 12 inch thick reinforced concrete with an average height of 13 feet. The exterior walls of the building are pre-cast concrete, 6 inches thick. Pre-cast concrete walls are over 13 feet high. Cast-in-place straight wall and corner wall connections and continuous perimeter concrete roof beams bond the walls together.

The main roof is precuts concrete, twin tee construction with a 2 inch thick wire mesh reinforced concrete topping, 1½ inch thick insulation, and built-up roofing. The airlock roofs are cast-in-place concrete.

Structural framing is poor due to excessive ground erosion at the west end and south side of the building. The entryway and walkway is sinking and pulling away from the building (Ref. 22).

The drainage system between Buildings 985 and 991 does not have an outlet, causing standing water to collect between the two buildings. The water then seeps into the ventilation control room and into the corridor between Building 991 and Tunnel 996 (Ref. 22).

Building 985 is not heated. Precautions to protect against freezing are taken. A portable heater was installed, in 1991, to prevent fire water lines from freezing. In 1990, fire water lines froze causing approximately 10,000 gallons of water to discharge into the pit. The above conditions were first identified in 1991. All other systems were rated as adequate, and there have been no other changes since then other than normal deterioration or emergency repairs (Ref. 22).

2.1.9 Building 989

Building 989, the Diesel Generator Facility, is a one-story structure located just east of Building 991. It was built in 1973 and has dimensions of 24 feet long by 16 feet wide by 12 feet high. The foundation is a reinforced concrete floor slab on ground reinforced with two layers of welded wire mesh. The walls above grade are 8 inch thick concrete block. The building has a double-sloping, reinforced concrete roof slab, 5 inches thick on one side and 9 inches on the opposite side. The roof slab is covered with 1½ inches of insulation and finished with built-up roofing.

Building 989 houses a 256 kW generator, diesel engine, a 180 gallon diesel fuel oil day tank, starting batteries and associated charger for the diesel engine, generator control panel, and the remainder of the equipment necessary for the operation of the diesel generator. An exhaust fan in the west wall of the building cools the building when the generator is in operation. Building 989 is heated by two 7 kW electric heaters in the north end of the building. The exhaust fan and heaters maintain the diesel generator and the associated equipment within temperature limits required for proper operation. Automatic fire protection for Building 989 and the equipment within is provided by water sprinkler heads in the ceiling above the equipment.

The structural framing is poor due to ground erosion on the east side of the building. Leaks are evident along the upper portion of the walls because of the erosion. The diesel generator is operational. There are several oil leaks around the generator. The above conditions were first identified in 1991. All other systems were rated as adequate, and there have been no other changes since then other than normal deterioration or emergency repairs (Ref. 22).

There is a 3,000 gallon underground diesel fuel storage tank approximately 10 feet east of the generator building. A 1,000 gallon, above-ground fiberglass tank was put into service in May of 1997 to replace the underground tank, which was closed in place using a closed cell polyurethane foam (Ref. 25).

[redacted]

2.1.10 Building 984

Building 984 is located just south of Building 991. This 3,200 square foot building is constructed of concrete floors, metal walls and a metal roof. The building has electric lights but no heat, no alarms, and no plenums. The building is categorized as an Industrial Facility and is further described in the Site SAR, Volumes I and II (Ref. 9).

2.1.11 Building 992

Building 992 is a concrete Guard Post, two-stories high, located south of Building 991. The building is no longer used as a guard post and is normally unoccupied.

2.2 FACILITY SYSTEMS

2.2.1 Heating, Ventilation, and Air Conditioning

All the building heating systems are supplied from a steam-heated heat exchanger located in Room 137 of Building 991. A pneumatic controller located in a cabinet at the north end of the heat exchanger controls two steam regulating valves that modulate to maintain the heating water temperature. The controller is reset by outside air temperature so the water temperature will be 200°F at an outside temperature of 0°F and 80°F at an outside temperature of 60°F. The heating water system can be shut down during the summer months by shutting the steam supply valves and shutting down all the circulating pumps.

On loss of normal power, two pumps in Room 137 can be supplied with backup power from the Building 989 diesel generator. An interruption of power will cause the starters for these pumps to open and the start buttons have to be pressed to restart the pumps. The pumps should provide enough circulation to prevent freezing during a power outage in freezing weather.

There are two primary ventilation supply systems for Building 991 and the associated vaults. One is for Building 991, Tunnel 998, and Room 300 and the other one is for the other tunnels and vaults. Four units are used to supply the air for Building 991, Tunnel 998 and Room 300. Two of the units are only in use during the summer months. The air is cooled with chilled water from cooling coils within two of the units in Room 130 of Building 991. One unit, located in Equipment Room 402 inside the Y of Tunnel 996, supplies the air for Vaults and Tunnels 996, 997, and 999.

The paths of air through the ventilation systems are similar for the two systems. Outside air is drawn through fixed louvers and a bird screen. The air is filtered through replaceable furnace filters and is then directed through a refrigeration unit followed by a reheat unit. The chilled or heated air, depending on the season, enters the building's heating, ventilating and air conditioning (HVAC) distribution system. The supply fans deliver the air, through final temperature control heating coils, to the operation and office area distribution systems. Most of the supply systems are in operation continuously and are only shut down for maintenance.

Building 991 is unique in the design of its exhaust systems as compared to other buildings at the Site. There are numerous smaller exhaust fans each serving an individual operation or room which then discharge into a filter plenum and then to the main building exhaust fans. Special precautions must be taken when any maintenance or filter change operation is to be performed on the system between the individual exhaust fans and the inlet side of the HEPA filter stage due to the possibility that a positive pressure could exist in the system. There are a number of exhaust fans that are not in use at this time and in some cases the hood has been removed but the fan and ductwork are still in place.

All the Building 991 exhaust fans discharge into the main exhaust plenum on the roof where the exhaust air passes through a fire screen and a single stage of HEPA filters. Heat sensors in the inlet ducts will alarm at the Fire Department and sensors in the plenum will operate the fire sprinklers. The decision to stop exhaust fans will be made by the Shift Superintendent, Utility Supervision, or Fire Department Supervision in the event of a plenum fire.

The plenum exhaust fans (PEFs) discharge into a common duct with air flow pitot tubes and air sampling connections. The exhaust air is discharged to the atmosphere through a duct at the northwest corner of the building. All supply and exhaust fans in Building 991 will stop if all the PEFs are stopped.

Exhaust Plenum 601 is located in Building 985 and serves the west tunnel complex. The west tunnel complex consists of Vaults 996, 997, and 999, Tunnel 996 and Corridor C. The inlet ducts to the plenum have overheat sensors that alarm at the Fire Department and sensors in the plenum will initiate the fire sprinklers on the fire screen and HEPA filters. The decision to stop the exhaust fans will be made by the Shift Superintendent, Utility Supervision, or Fire Department Supervision in the event of a plenum fire.

The plenum consists of an inlet fire screen followed by two stages of HEPA filters. Pressure drop indication for each stage is provided on a panel at the west side of the plenum. The exhaust fans are located at the west end of the plenum, one in operation and one in standby. A static pressure controller for each fan is located in Room 402 of Building 991 to modulate the inlet dampers to maintain a set point of 0.8 inches water gauge. The fans discharge through a back draft damper that opens when the fan is started. The discharge duct to atmosphere contains Health Physics air sampling connections. Exhaust Fans 601A and 601B are supplied with backup power from Building 989 in the event of loss of normal power.

There are two, small exhaust systems for operations in the Metallography Laboratory, Room 110 of Building 991. The fans are located on the roof above Room 110 and are user controlled. They discharge directly to the atmosphere and do not go to the building exhaust plenum.

A multiple compressor unit located in Room 130 of Building 991 supplies chilled water to the Unit S-3 air supply system. A cooling water sump and circulating pump in Room 130 provide condensing water. A chilled water pump, located by the unit, circulates chilled water through the chiller and to the Unit S-3 plenum and then to the coil units in the south end of Building 991. A chilled water pump circulates water through a three way valve and the coil in the Unit S-3 plenum for cooling. A pneumatic controller in the Unit S-3 control cabinet modulates the three way valve to maintain the fan discharge at a preset temperature. Chilled water is supplied to fan coil units located in the Office Area (Rooms 101 through 122). Each unit has a multiple speed fan with a control by the unit. By varying the speed of the fan the desired level of cooling for the space is attained. A chilled water controller in the control cabinet will operate the compressors in stages to maintain a preset chilled water temperature. The system is manually operated and is normally started on day shift as required during the spring and fall months and is run continuously during the summer months.

2.2.2 Fire Suppression, Detection and Alarm Transmittal System

The fire suppression, detection and alarm transmittal system in the Building 991 Complex provides protection of life and property against the consequences of fire. The system consists of the following:

- Water Supply
- Detection and Alarm Systems
- Suppression Systems
- Passive Protection Features
- Life Safety Features

The purpose of the fire suppression system is to suppress the fire until the Fire Department responds and the purpose of the detection and alarm transmittal system is to notify emergency response personnel that a fire has occurred. The fire suppression system is designed to reduce the heat release rate of a fire, prevent its re-growth, and hold the fire to the area of origin. This description of the fire suppression and alarm transmittal system in the Building 991 Complex was compiled from information contained in the Building 991 Complex Fire Hazards Analysis (FHA) (Ref. 26). A brief description of each fire suppression, detection and alarm transmittal system feature is provided below.

2.2.2.1 Water Supply

The Site Domestic Cold Water System provides water for the Building 991 Complex sprinkler systems and hose stations. Major components of the fire water supply system consist of:

- Lines from the Site Domestic Cold Water Supply System. The system ties into a 2½ inch external fire department connection. This is a normally closed valve to the outside underground water supply. There is also a normally open 1½ inch cross tie to the Building 991 wet pipe sprinkler system.
- Post Indicator Valves (PIVs)
- Fire Hydrants (2). There are two accessible fire hydrants located within 75 feet of the Building 991 Complex. These fire hydrants provide adequate coverage of the complex and meet the requirements of NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances* (Ref. 27). These hydrants are identified as

Hydrants 9-4 and 9-5. Hydrant 9-4 is positioned near the southwest corner of Building 991 and provides access to pump into the sprinkler system and standpipe Fire Department connection. Hydrant 9-5 is located near the southeast corner of Building 991 and is in a useful position for interior attack.

- Fire Department Connection. Building 991 contains a horizontal standpipe system with eight 1½ inch hose connections for Fire Department use. Hoses, racks, and nozzles have been removed from these locations.
- Distribution Risers. Two distribution risers support the Building 991 Complex. One riser supports the wet pipe sprinkler system in Building 991 and the dry pipe sprinkler system for the east dock and Building 989. The second sprinkler system riser supports the dry pipe sprinkler system for the west dock and canopy.

2.2.2.2 Detection and Alarm System

The Building 991 Complex is protected by multiple detection and alarm systems. These include:

- Manual Fire Phones
- Waterflow Switches
- Smoke Detectors
- Heat Detectors

Fire phones are located in corridors, exits, and other strategic locations within the Building 991 Complex. These emergency telephones lines provide instantaneous communication with the Site Fire Department and with the Central Alarm Station. Each phone line, when lifted, activates a local alarm bell and transmits an alarm signal to the Central Alarm Station.

Waterflow switches installed on sprinkler system risers provide indication of system usage. Upon flow detection, an alarm signal is sent to the Fire Dispatch Center in Building 331 via the Central Alarm Station.

To provide an indication of fire in those areas not covered by sprinklers, Pyrotronics high-voltage DC ionization smoke detectors are installed. These detectors will provide an audible alarm to personnel in the vault storage rooms and tunnel areas not covered by sprinklers.

The fire alarm system also consists of automatic alarms triggered by heat detectors in plenum inlets and by sprinkler water flow.

In the event of loss of electrical power, the Building 991 fire alarm system and plenum deluge have backup supplies from 24 volt batteries, plus additional backup from the diesel generator. The Building 985 plenum deluge system, bell control, and the tunnel smoke detectors are not provided with diesel generator backup capability. The smoke detectors have an 8 hour battery backup capability and the fire alarm panels are provided with a 4 hour battery backup capability. The fire alarm system is periodically tested by the Site Fire Department to ensure they will function in an emergency.

2.2.2.3 Suppression Systems

The Building 991 Complex is protected by three separate types of sprinkler systems. Each system was designed and installed in accordance with NFPA 13, *Installation of Sprinkler Systems* (Ref. 28) according to the Ordinary Hazard pipe schedule method. The only areas not protected by a sprinkler system are Buildings 984 and 992, Tunnel 996, Corridor C, and Vaults 996, 997, and 999.

A wet pipe sprinkler system protects the heated areas of the Building 991 and the Building 985 filter plenum structure. The system is activated by heat rising from a fire and causing the sprinklers to open as they are heated to their design temperature. A dry pipe system is installed to protect the enclosed west dock area (Room 170 of Building 991), the east dock area (Room 166 of Building 991), and the diesel generator building (Building 989). The dry pipe system is fed from the wet pipe system installed in Building 991. A deluge sprinkler system is provided in the exhaust filter plenum in Building 985 and in the Building 991 plenum. The plenum deluge system is actuated by heat detectors located in the inlet duct. Actuation of the heat detector also activates a local alarm and sends an alarm to the Fire Dispatch Center.

Based on the available water supply, the spacing and number of sprinklers on each branch line, and pipe layout, which all meet the NFPA 13 requirements for Ordinary Hazard Group II protection, the existing sprinkler systems are expected to perform satisfactorily. The sprinkler systems are maintained and tested periodically by the Site Fire Systems Services personnel to ensure their continued operability.

In addition to the automatic sprinkler system in the Building 991 Complex, portable fire extinguishers are located throughout the complex and are readily accessible. Extinguisher locations and conditions are in accordance with NFPA 10, *Portable Fire Extinguishers* (Ref. 29).

2.2.2.4 Passive Protection Features

Building 991 is divided by a 2 hour fire resistant rated barrier. This wall runs east and west between the north side of the west dock and the north side of the east dock. The double doors connecting Rooms 141 and 170 are part of the 2 hour fire barrier and are equipped with an automatic closing device. Many of the other interior walls within the building are of adequate construction to function as fire barriers but there is no requirement to designate and maintain these as fire walls.

There is one small unprotected duct penetration in the fire barrier between Rooms 134 and 140. These duct penetrations are required to have fire dampers per NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems* (Ref. 30). Installation of the fire dampers did not occur due to a Site-wide exemption. Based upon the limited fuel loading and fire potential on each side of the fire barrier, the Building 991 Complex FHA concurred with the Site-wide exemption.

2.2.2.5 Life Safety Features

The facilities in the Building 991 Complex are equipped with emergency lighting and illuminated exit signs to enhance emergency egress capabilities. Building wide notification systems are provided and Buildings 991, 985, 989, and Tunnel 998/Room 300 are provided with automatic sprinkler protection.

An evaluation of the Building 991 Complex to the requirements of NFPA 101, *Life Safety Code* (Ref. 31) was performed as part of the Building 991 Complex FHA. Aspects of NFPA 101 considered in performance of the life safety analysis included: (1) capacity and number of means of egress, (2) means of egress components, (3) arrangement of means of egress, (4) travel distance limits, (5) exit discharge, (6) emergency lighting, (7) marking of means of egress, (8) construction and compartmentation, and (9) interior finish. This evaluation identified some deficiencies in the Building 991 Complex. These included:

Exiting distances in the Building 991 basement and in all the vaults/tunnels (Vault/Tunnels 996, 997, 998 and 999) exceed the allowable dead end, common path, and total travel distances. The Building 991 Complex FHA recommended possible solutions to compensate for this hazard. Implementation of compensatory actions to correct the allowable dead end and common path of travel deficiencies will correct the travel distance deficiency.

The other life safety features evaluated were deemed to be adequate and meeting the requirements of NFPA 101.

2.2.3 Confinement Systems

The primary means of confinement in the Building 991 Complex are the shipping package. The secondary means of confinement for the storage vaults and tunnels is provided by the concrete construction of the Building 991 Complex and the ventilation exhaust with HEPA filters.

Currently, material being moved or stored in the Building 991 Complex is in approved on-site or off-site shipping packages. TRU waste, received from the Protected Area (PA), are packaged in 55 gallon drums, DOT-7A Type A Metal Waste Boxes, or Transuranic Package Transporter II (TRUPACT II) Standard Waste Boxes (SWBs). Off-site shipping packages meet DOT requirements for certified Type B packaging (e.g., 30 foot drop test and 30 minute fire barrier). The off-site packages provide double containment (e.g., sealed can inside a drum). Some classified parts are stored in non—Type B containers. These parts have a low level of surface contamination that could not contribute to a radiological release in the event of a loss of power without other concurrent failures (Ref. 32).

A slight negative air pressure (not measured) is maintained between the building and the outside environment. Building 991 air is exhausted through a one-stage HEPA filter plenum located on the roof of the building. A slight negative air pressure (not measured) is also maintained in the storage vault in Building 991, Room 150. Room 300 also has a single-stage HEPA-filtered exhaust system that empties into the Building 991 roof filter plenum.

Vaults 996, 997, and 999, and their access Tunnels 996 and Corridor C, are exhausted through the Filter Plenum FP-601 in Building 985. This plenum has two stages of HEPA filters. The ventilation system has sufficient capacity to maintain a slight negative air pressure in the vaults and their access tunnels, even if the doors to the tunnels and vaults are open. The entryway into Vault 996 also has a single-stage HEPA-filtered exhaust system (not measured) that empties into Filter Plenum FP-601.

2.2.4 Life Safety/Disaster Warning System

The Life Safety/Disaster Warning (LS/DW) System is a multiple-input, Site-wide, public address system. Annunciation of a criticality alarm is provided by the LS/DW System in those facilities requiring Criticality Alarm System coverage. A priority system is used to determine which information is broadcast through the speakers with top priority being given to a criticality alarm. A criticality alarm will override and block out all other alarms or announcements. Besides providing annunciation of a criticality alarm, the LS/DW is used to make other emergency announcements and to alert personnel of hazardous situations. The Building 991 Complex utilizes this latter function of the LS/DW System.

2.2.5 Health Physics Vacuum System

The Health Physics (HP) Vacuum Pumps PID-3A and PID-3B, and 601A and 601B are the vacuum system pumps for the Building 991 and Building 985 SAAMs respectively, and an environmental monitor on the roof. The HP Vacuum Pumps were replaced in 1991. These pumps are located at Vault 150 in Building 991, Tunnel 996, and the Building 985 filter plenum. The HP Vacuum System provides vacuum to the SAAMs and is required for SAAM operability. Therefore, if the HP Vacuum System becomes inoperable the SAAMs also become inoperable.

HP Vacuum Pumps PID-3A and PID-3B do not have automatic transfer capability when switching from normal to backup power and there is no remote alarming system for these pumps. Upon restoration of power after a power failure, these pumps do not automatically restart and must be manually restarted. HP Vacuum Pumps 601A and 601B can automatically switch from normal to backup power(Ref. 22 and 33).

2.2.6 Lightning Protection System

A lightning protection system is installed on the Building 991 Complex, specifically Buildings 991 and 985. The lightning protection systems consist of air terminals uniformly spaced along the periphery of the roofs, across open roof areas, and on equipment on the roofs especially susceptible to lightning strokes. All air terminals are electrically interconnected to the grounding system via connected grounding conductors. The lightning protection systems at the complex are periodically inspected but the systems are not certified. Credit for the lightning protection system cannot be taken unless it can be demonstrated the system is operating as designed. Therefore, the Building 991 Complex lightning protection systems are considered a Performance Category (PC)-1 for accident analysis purposes (Ref. 9).

The surrounding terrain provides some degree of shielding from lightning strokes. This shielding is a result of the roof line of Building 991 being within a few feet of local grade level. Building 989, because of its low profile close to Building 991 and the surrounding structures, is effectively shielded and does not require a lightning protection system. Lightning protection for the vaults and tunnels is not required since these structures are underground.

2.2.7 Compressed Air System

Plant air is supplied to Building 991 and 985 by a compressor in Room 130 of Building 991. The air is provided for the dry pipe suppression systems in the two buildings. The compressor is normally operated in the manual position and the control on the plant air receiver will load the compressor at 80 psi and unload at it at 90 psi. Cooling water to the after cooler and the compressor is from the domestic water system through a backflow preventer located on the south wall under the after cooler. This water flow is adjusted to not use excessive water but supply enough cooling. This cooling water flow must be checked on each tour of the building. A second compressor, located in Building 985, will start if plant air pressure falls to 65 psi and will supply both buildings. This unit will cycle off at 80 psi. Building 985's air compressor capacity is large enough to carry both buildings for short periods of time, but should not be operated for extended periods without cutting back on air usage.

A third compressor is located in the Room 130 of Building 991 and will supply the instrument air system in Building 991. This unit is currently out-of-service.

On loss of normal power the Building 985 compressor will be supplied power from the Building 989 emergency generator. The air system is in operation continuously and operating compressors must be checked daily for proper operation.

2.2.8 Utility Systems

2.2.8.1 Electrical Services

Electrical power is provided to the Site by the Public Service Company of Colorado. Power is received from two transmission lines (Valmont and Boulder), routed through 115 kV ring buses to Substation 679/680, transformed to 13.8 kV for Site distribution, and distributed throughout the Site by a network of overhead and underground conductors.

The Building 991 Complex is served by two transformers that step the voltage down from 13.8 kV to 480 V normal power. Each transformer is sized to carry the load assigned to both. If power to one transformer is lost, the alternate automatically picks up and continuously carries the entire load. Switchgear inside Building 991 receives the 480 V power from the two transformers and distributes the power to power panels, motor control centers (MCCs), bus ducts, and emergency motor control centers (EMCCs). The power panels, MCCs, bus ducts, and EMCCs distribute the 480 V power to the larger normal power loads. Smaller loads and 120 V loads receive their power from lighting panels and standard receptacles.

A panel in Room 130 of Building 991 is used to provide power to other buildings within the protected area. This panel is provided power from the transformers located outside Building 991.

2.2.8.2 Steam and Condensate System

Steam at 125 psi is supplied to the building from an overhead line that enters Room 137 at the east wall and passes through a parallel reducing station. Two pressure reducing valves are sized and pressure settings adjusted to supply steam at 4 psi to 6 psi depending on load. One valve is set to start opening at 6 psi and will be wide open at 5 psi. The other valve will start opening at 5 psi and will be wide open at 4 psi. The low pressure steam is supplied to a heating water heat exchanger and a domestic water heat exchanger in Room 137. See Sections 2.2.8.4 and 2.2.8.5 for description.

Condensate from both heat exchangers drain to a receiver under the heat exchangers. Level probes in the receiver start the two condensate pumps as needed to return the condensate to Building 443. The level controls will alternate the lead pump each pumping cycle. The second, or lag pump, will start if the level in the receiver increases above the lead pump starting level due to high flows or failure of the lead pump.

The steam system operates continuously, providing heating and domestic hot water. Proper operation of the steam traps is checked weekly and all strainers and drip legs are blown down monthly. Steam to the heating water heat exchanger can be shut off during the summer months for energy conservation. During a planned Site steam or condensate outage the Building 991 steam valve is shut down to allow a controlled reactivation of steam into the building.

2.2.8.3 Sanitary Process Waste Systems

All sanitary drains leave the building at the east side and into a manhole located by the northeast corner of Room 166. The basement tunnel floor drains are connected to a lift station at the southeast corner of the basement and two pumps, each controlled by a float switch, discharge into the sanitary drain line leaving the building. The Building 991 sewer line connects to the main sewer line at a manhole northeast of Building 991 just inside the PA.

A fire water holding tank is located in a pit at the east end of Building 985. The tank is designed to collect the drains from the exhaust plenum in the event the plenum fire sprinklers are activated. If water is introduced into this tank, Waste Management is contacted for assistance in the disposal of the water. The system has a recirculating system for sampling the water and a pump that discharges to a hose connection by the east door of the building. By utilizing the pump and hose connection the contents could be transferred to a mobile tank by hose and transported to a disposal site. The fire water holding tank does not contain Raschig rings.

2.2.8.4 Domestic Process Water Systems

Domestic water for the building enters the southeast corner of the basement from a PIV located just west of the security fence. In the basement, domestic waste passes through a pressure reducing valve set at 60 psi and a totalizing meter for recording flow. Fire main water also enters the building at the same location and there are hose connections on both systems. In an emergency, due to a shutdown of either system external to the building, the systems could be cross connected by fire hose.

The domestic water main runs the length of the utility tunnel and all the supplies to the various usage's tap from this main. The domestic hot water system is fed from the main at the bottom of the stairway from Room 130 and is piped to the domestic hot water heat exchanger located in Room 137. The water temperature is controlled by a pneumatic controller located in the cabinet at the north end of the heat exchanger. The controller modulates two steam valves to maintain 120°F water temperature leaving the heat exchanger.

A hot water circulating pump on the south wall of Room 137 maintains circulation from the far end of the system back to the heat exchanger inlet to maintain the whole system at operating temperature.

2.2.8.5 Cooling Water Systems

The S-1 cooling tower is located in Room 130 and provides the cooling for the S-1 air conditioning compressor. A fan located on the top of the tower draws air through a set of dampers controlled by a controller on the refrigerant line to maintain 110 to 120 psi. A spray pump draws water from the tower sump and sprays it into the air stream of the tower and over the condenser coil. The sump level is maintained by a float valve that adds water through a backflow preventer at the south end of Room 130. The cooling system is manually started and is normally operated during day shift as required during the spring and fall months. During the summer months the system operates continuously.

The S-3 cooling tower is located on the roof and the sump is located in Room 130. The cooling water pump draws water from the sump and discharges through the S-3 air conditioning condensers. The outlet from the condensers is then sprayed into the top of the cooling tower. The fan is controlled by a temperature sensor in Room 130 and sump that will start the fan at 70°F and stop it at 60°F. The cooled water drains from the tower back to Room 130 sump. A float valve in the sump adds make-up water through a backflow preventer located on the south wall of Room 130. This system is manually operated and is normally operated for day shift during the spring and fall as required. The system operates continuously during the summer months.

2.2.9 Radiological Monitoring System

The age and technology of the current SAAM systems require high maintenance. The system is in use and tested. The by-pass panel for the SAAM units in Building 991 and 985 is also in need of repair. The SAAMs alarm remotely only in the Building 991 Radiological Operations office which is normally unoccupied (Ref. 22).

3. SAFETY MANAGEMENT PROGRAMS

3.1 INTRODUCTION

This chapter describes the institutional Safety Management Programs (SMPs) that are in place in the Building 991 Complex. The SMPs provide formal, disciplined methods of conducting business and operations. Implementation of these methods minimizes the potential for harm to workers and accidents that impact the collocated workers and the MOI. Inclusion of SMPs in this FSAR represents the contractor's commitment to ensure safe operation of the complex through adequate implementation of the SMPs. Appendix A, *Building 991 Facility Technical Safety Requirements,* identifies elements of the SMPs specifically credited as preventive or mitigative features in the hazard and accident analyses.

The TSRs, as presented in Appendix A, includes LCOs and Administrative Controls consisting of Administrative Operating Limits (AOLs) and Programmatic Administrative Controls (PACs). Development of the TSRs used a graded approach based on the identified hazards and postulated accident scenarios associated with authorized building activities. Conformance with the TSRs assures that the Building 991 Complex core and programmatic activities can be accomplished in a safe manner.

As part of the TSRs, Administrative Controls provide protection to workers and the environment. There may be a need for the Building 991 Complex management to implement other Administrative Controls, not identified in the TSRs, based on regulatory compliance and good management practices. Identification and implementation of such requirements are beyond the scope of this FSAR.

The Administrative Programs important to the Building 991 Complex are listed below:

- Organization and Management
- Configuration Management
- Criticality Safety
- Emergency Response
- Environmental Protection and Waste Management
- Fire Protection
- Industrial Hygiene and Safety
- Maintenance
- Nuclear Safety
- Occurrence Reporting
- Quality Assurance
- Radiation Protection
- Records Management and Document Control
- Training
- Transportation
- Work Control

Applicable attributes, important to safety, are provided as PACs in Table 5-3 of Appendix A, *Building 991 Facility Technical Safety Requirements.* Bases are also provided, discussing the safety significance of each PAC. A complete and detailed description of the PAC Programs and associated attributes are found in the *Site SAR, Volume I, Chapter 6, Safety Management Programs* (Ref. 9), along with references to regulatory drivers and Site implementing documents.

3.1.1 Organization and Management

The Site Integrating Management Contractor (i.e., Kaiser-Hill. L.L.C.) has overall responsibility for the operation of the Site in accordance with the Site Integrating Management contract with DOE. The current contract provides for the Site Integrating Management Contractor to delegate the authority and responsibility to Principal Subcontractors. Rocky Mountain Remediation Services, L.L.C. (RMRS), has overall authority and responsibility for operation of the Building 991 Complex. Operations conducted in the Building 991 Complex by other subcontractors are performed in accordance with the documented authorization basis as maintained by RMRS. RMRS management has assigned authority and responsibility for the operation of the Building 991 Complex to the Building 991 Facility Manager. Others in the chain of operational responsibility include the Waste Management Operations Manager, Solid Waste Operations Manager, and Building Manager.

3.1.2 Configuration Management

The Configuration Management program integrates work control processes with required safety and technical reviews and technical document control to manage changes to safety SSCs. Implementation of Configuration Management protects the operability of engineered safety features and systems credited with prevention and/or mitigation of accidents. This is accomplished by ensuring the proper review, approval, and documentation of changes to safety SSCs. The program stipulates that operation, maintenance, and modification of safety SSCs rely on the development and use of properly authorized work plans, procedures and training. Further, the program ensures that such documents are properly maintained and controlled so that only appropriate revisions are implemented.

The Configuration Management program provides for independent second engineering review for engineering documents, and authorization basis change packages and documentation potentially affecting safety analysis. Management review of authorization basis changes, complex changes and modifications, and other issues affecting the safety analysis is also provided. Management reviews of safety significant issues primarily focus responsible management attention on safety issues, such as unreviewed safety questions, criticality controls, modifications of equipment important to safety, and authorization basis modifications. These reviews ensure adequacy of work authorization and documentation affecting the safe operation of the Building 991 Complex.

Engineering supports configuration management through integration of fire protection, industrial hygiene and safety, nuclear safety and criticality safety, operations, and radiation protection safety requirements into the development of new designs and design modifications, as appropriate. Engineering procedures ensure that changes or modifications within the Building 991 Complex are accomplished according to applicable codes, regulations, and standards. Each change that potentially affects a safety SSC receives review through the USQ process. The program maintains the authorization basis by providing for the control of documentation, review, and approval of proposed Complex modifications and interface with other SMPs.

3.1.3 Criticality Safety

The Criticality Safety program for this building establishes criticality safety controls for building activities involving fissionable material. This program includes the following processes: to develop criticality safety controls (engineered and/or administrative); to monitor compliance status with established controls (including infraction investigation and reporting); and to maintain and control distribution of technical documents. The program ensures that Criticality Safety approves criticality safety controls, either through new evaluations or the Criticality Safety Limit Examination Program. for all activities involving the storage, and relocation. Major features of the program include: engineering design reviews: application of double-contingency principles; establishment of criticality safety controls (e.g., nuclear criticality safety limits, procedures, postings); testing; surveillances; training; and periodic program reviews.

3.1.4 Emergency Response

The Emergency Response program provides the plans, procedures, and resources necessary to respond to emergencies. The program is based on a comprehensive understanding of the hazards and potential radiological and hazardous material release mechanisms present in the Complex. Emergency Response supplements and depends on engineered features and systems as well as the Fire Protection and Radiation Protection programs; collectively, these programs effectively minimizes the occurrence and mitigate accidents.

The program protects Building 991 Complex personnel through management planning; designation of an Emergency Response Organization; training and drills (Site-wide and Complex-specific) for possible abnormal events, including fires and spills; and personnel accountability during complex evacuation. During an abnormal event, the program provides the necessary trained emergency response personnel to ensure the safety of the immediate worker, collocated worker, and the MOI. Program elements of Emergency Response also include pre-planned actions, prompt and accurate emergency classifications, and timely notifications of the Emergency Response Organization.

3.1.5 Environmental Protection and Waste Management

The Environmental Protection and Waste Management programs provide for managing radioactive and waste material inventories, controlling building effluents, and managing waste generation (e.g., waste minimization), storage, treatment, and packaging. Waste management and environmental protection regulations establish the minimum standards for the discharge, generation, storage, or transportation of specified hazardous or toxic materials. These programs, in complying with the standards set by waste management and environmental protection regulations, minimize hazardous and radioactive material spills by ensuring appropriate packaging, inspection, and storage of those materials.

3.1.6 Fire Protection

The Fire Protection program provides fire protection engineering and hazards analysis, fire prevention requirements (control of combustibles, transient fire loads, hot work, and ignition sources, inspections, and training), and fire response. Fire response plans, training, and drills. as well as the inspection, testing, and maintenance of engineered fire protection and notification systems ensure personnel safety, fire fighting capability, and property loss minimization if a fire should occur.

3.1.7 Industrial Hygiene and Safety

The Industrial Hygiene and Safety program contains provisions to implement federal regulations addressing standard industrial hazards. Precedents for controlling standard industrial hazards are well established through institutionalized standards, guidelines, and good practices. Industrial Safety is generally implemented in concert with other SMP requirements.

3.1.8 Maintenance

Testing, surveillance, and maintenance is accomplished predominately within the Maintenance program, which ensures that safety SSCs perform their intended safety functions. Provisions of the Maintenance program specify that maintenance tasks be performed safely and within the Building 991 authorization basis. The program also integrates work control processes, including the identification, request, planning, implementation of maintenance, and testing, with engineering support and required safety and technical reviews. Maintenance of safety SSCs relies on the development and use of work plans that have been properly documented, reviewed, and approved. Testing is usually accomplished via surveillances to return the SSCs to service.

Surveillances consisting of testing, calibration, and inspections are conducted to ensure that the operability of safety SSCs is maintained so that operations are within the specified TSRs. Surveillances are conducted in accordance with the TSRs. The performance of surveillances is typically conducted by the cognizant organization (e.g., Fire Department) for the SSC.

3.1.9 Nuclear Safety

The Nuclear Safety program provides safety evaluations, analyses, and reviews of building activities that potentially affect the health and safety of the public and/or workers or the protection of the environment. The program includes a process (USQ) for conducting safety evaluations of proposed activities, Building 991 Complex modifications, operational tests, and experiments. Additional provisions include the documentation, review, and approval of activity and complex-specific accident analyses. The Nuclear Safety program supports Configuration Management and is integrated with Maintenance; Training; and Work Control programs to identify and analyze the probability and consequences of potential nuclear accidents. Nuclear Safety further supports safe operations by conducting evaluations of the complex safety basis (e.g., USQ process) and ensuring appropriate approval authority and annual updating of the documented authorization basis.

Independent reviews and audits serve as a performance assurance function. By ensuring safety of operations and adequacy of work authorization and documentation affecting operation of the Building 991 Complex, independent reviews and audits provide defense-in-depth. The independent review and audit system is a hierarchical function. The upper most level is the Environmental Safety & Health (ES&H) Council whose members are drawn from senior management of the Site integrating contractor and subcontractors. The RMRS Waste Operations Review Committee, second level in-line independent engineering reviews, and other management reviews and assessments comprise additional tiers. The Committee considers nuclear safety issues, including physical changes to the complex, that could affect the safety envelope of the complex considering all receptors.

3.1.10 Occurrence Reporting

The Occurrence Reporting program provides for the timely reporting of occurrences that could affect the safety of the public, seriously impact the intended purposes of the Site facilities. have an adverse affect on the environment, or endanger the health and safety of the workers. Actual and potential violations or out-of-tolerance conditions are reported to cognizant management and to the DOE. Provisions of the program specify the processes for occurrence categorization, notification, investigation, root cause analysis, development of corrective actions, tracking of corrective actions to completion, and lessons-learned determination.

3.1.11 Quality Assurance

The Quality Assurance (QA) program assures a consistent and appropriate application of quality requirements to the performance of activities using a graded approach. The program ensures that risks to the MOI, collocated workers, and immediate workers are minimized. Safety, reliability, and performance are maximized through the application of effective management systems and graded controls commensurate with the risks posed by Complex activities. Separate Quality Assurance Programs (QAPs) have been prepared that are similar in technical content, but differ in scope and applicability. One QAP is applicable to nuclear facilities activities with radiological risks and is subject to DOE enforcement. The other QAP is applicable to non-nuclear facilities and is a contractual obligation.

QAP requirements are management systems, which are implemented through existing Site procedures and programs. The purpose of these management systems is to assist organizations in the accomplishment of mission objectives; to ensure work is planned and performed in accordance with regulatory and contractual requirements; and to ensure Complex activities are conducted in a safe and cost-effective manner. QA is a shared, interdisciplinary function. It involves management and immediate worker contributions from all organizations responsible for performing activities to independently verify that activities comply with specified standards and requirements. The QAP establishes ten criteria associated with management, performance, and assessment: program, personnel training and qualification, quality improvement, documents and records, work processes, design, procurement, inspection and acceptance testing, management assessment, and independent assessment.

3.1.12 Radiation Protection

The Radiation Protection program implements standards, limits, and program requirements for protecting individuals from exposure to radioactive materials during the conduct of work activities. The program adheres to the fundamental principles of As Low As Reasonably Achievable (ALARA). The protection of personnel from radioactive materials is accomplished through radiological surveillance, contamination control, and minimization of personnel exposure to penetrating radiation. The program provides for personnel dosimetry, the surveillance and maintenance of engineered radiation protection systems, a radiation work permit process, and area surveillance and posting. Radiological protection for planned activities is ensured through reviews of work control documents, pre-job surveys, and the specification of personal protective equipment. Personnel exposures are formally tracked, recorded, and reported back to individuals. Exposure histories undergo periodic review.

3.1.13 Records Management and Document Control

The Records Management and Document Control Program addresses the criteria and processes necessary to control documents and retain records of activities affecting safety at the Site. The systematic approach to records management at the Site includes control, storage, retention, and disposal of records and documents.

3.1.14 Training

The Training program provide for the generation of accurate and consistent training of personnel to ensure the proper conduct of activities in the Building 991 Complex. This program provide the framework to ensure that personnel are knowledgeable of the hazards and capable of appropriate responses to upset conditions. A result of this program is that the appropriate collective knowledge of technical, safety, and operations professionals is transferred to the worker for the performance of activities.

Provisions of the Training program establish applicable training needs based on activities and associated hazards, operational experiences, and lessons learned. The Training program also establishes qualification standards graded to the safety significance of the job function, and establishes the documentation needed to assist complex operations in assigning adequately trained personnel to activities.

3.1.15 Transportation

The Transportation program specifies safe packaging for on-site and off-site transportation of radioactive and hazardous materials to prevent radioactive and hazardous material releases and to minimize accident consequences. Facility management is ultimately responsible for the safe and compliant packaging of material that it releases for transport. The Transportation program describes a process for the incorporation of packaging requirements into work control documents, and defines training requirements for personnel involved in packaging and shipment of hazardous materials. Specific to the safe packaging of hazardous materials for off site shipment, Department of Transportation (DOT) regulations contain the minimum standards for protecting workers, the public, and the environment from the inadvertent handling or impact-related release of containerized hazardous materials.

3.1.16 Work Control

Facility and Building Managers use Work Control to plan and authorize existing and emergent activities for placement on the POD. Thus, Work Control is an integral part of daily operations and maintenance within the complex, and an effective tool for minimizing the occurrence of accidents by ensuring that no unanalyzed or unauthorized work is performed. Work Control provides a disciplined approach to defining and evaluating the hazards prior to the performance of new activities. To ensure safe performance, each emergent activity is defined and a graded hazard assessment is performed, as necessary, to establish appropriate procedure-level controls and to verify the adequacy of the complex-level control set established by this FSAR. To complete this verification, the results of the assessment are compared with the activities and hazard assessment analyzed in the FSAR and with the complex-level control set established by the FSAR. If the activity and its hazards are within the safety envelope as established by the FSAR, conduct of the activity is enveloped. If the activity is not enveloped, the USQ process is invoked.

3.2 INTEGRATED SAFETY MANAGEMENT

The complex implements integrated safety management by the systematic integration of safety considerations into management and work practices at all levels. The SMPs described in this chapter provide the necessary programmatic infrastructure and formalized discipline to meet the primary goal of integrated safety management: to perform work safely. The Site and complex management commitment to these SMPs ensures line management responsibility for safety; clear assignment of roles and responsibilities; competence commensurate with responsibilities; balanced priorities; identification of safety standards and requirements; and hazard controls tailored to work being performed. Complex management requires specific activities to ensure work is performed safely. These activities include definition of work scope; analysis of hazards; development and implementation of operational controls; performance of work or operation; and feedback and improvement.

Definition of any given scope of work is accomplished predominately through the Work Control, and Maintenance programs. Chapter 2 of this FSAR identifies the Core and Mission Program activities authorized for planning or performance in the Building 991 Complex. Engineering documentation defines the technical work scope for any given maintenance activity, and the Integrated Work Control Program (IWCP) work package or operating procedures define the specific planned work scope.

The analysis of hazards involved in a work scope primarily falls within the domain of the Industrial Hygiene and Safety; Radiation Protection; Maintenance; and Work Control programs. The IWCP process defines the hazards analysis approach to be used in planning a maintenance activity, including: hazard identification; walkdowns of area and system; and incorporation of worker safety hazards analysis using appropriately skilled safety professionals.

The development and implementation of operational controls are typically derived from the hazard analysis and transferred into work control documents. The IWCP process governs this function for maintenance activities through the development of specific controls, such as radiological controls defined in a Radiation Work Permit. The IWCP process also specifies post-maintenance testing requirements, based on the technical input from engineering. Lastly, the process requires a formal Safety Evaluation Screen and independent safety review where appropriate. The controls for safe storage and the conduct of routine activities are defined in the TSRs and the SMPs used to support the performance of work. Mission Program hazard reduction work is typically controlled through operating procedures.

The performance of work or an operation is typically controlled through the Work Control; Training; and Configuration Management programs. Specific activities are scheduled on the Plan of the Day (POD), are preceded by a pre-evolution briefing, and are formally approved by the Shift Manager prior to performance. Only appropriately trained personnel are used to perform the activity. Depending on the type of activity, core team members and building support personnel may receive a pre-evolution briefing to include a predefined or practiced set of responses to upset conditions.

Finally, feedback and improvement from performance of work or an operation are elements of the Quality Assurance (including management assessment), and the Organization and Management program. IWCP work packages are formally closed out and reviewed by the Building Manager. Engineering documentation also receives formal close-out. In addition, the Shift Manager reviews all surveillances and logs to provide close oversight and feedback on a day-to-day basis. Occurrence Reports provide feedback (e.g., critiques) on conditions and lessons learned related to routine performance in the complex.

4. HAZARD AND ACCIDENT ANALYSIS

4.1 INTRODUCTION

Various hazards are currently present in the Building 991 Complex. These include fissionable materials contained in various waste forms and TSCA hazardous waste. The waste materials are primarily stored in 55-gallon drums meeting on-site shipping specifications and/or DOT specifications, however, the building may receive and store TRUPACT II SWBs, and DOT-7A Type A Metal Waste Boxes. SNM in DOT approved Type B shipping containers are received and staged in Building 991 prior to being shipped off-site. Wooden LLW crates may be received and stored under the Building 991 west dock area canopy.

This chapter addresses identification and evaluation of the hazards associated with the movement and storage of hazardous materials/waste that could result in a radiological or toxicological (chemical) release. It evaluates the consequences of potential accidents caused by internal, external, and natural phenomena-related events. Potential consequences and risks to workers, both immediate and collocated, and the MOI are evaluated. Preventive and mitigative features credited to lower accident frequencies or to reduce the receptor consequences have also been identified so the appropriate operational controls could be derived. This chapter covers risk classification methodology, hazard identification, hazard evaluation, and final hazard categorization.

The safety analysis presented in this chapter used a Preliminary Hazard Analysis (PHA) technique to identify and evaluate the hazards/accident scenarios in the Building 991 Complex. This technique consists of first identifying the hazardous materials (e.g., radioactive sources, radioactive wastes, chemicals, or non-material hazards (e.g., thermal energy sources, pressure sources, electrical energy sources)) in terms of form, amount, and location of the materials in the complex. The energy sources and mechanisms (accident scenarios) for radiological and chemical releases were then characterized and accident frequencies and consequences associated with such releases were evaluated with consideration given to preventive and mitigative features. Consequence levels were determined based on estimated damage ratios (based on accident analysis), MAR envelopes based on the authorized Mission Program and Core Activities, and release fractions from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94 (Ref. 34). The risks from postulated accident scenarios were then determined using a qualitative binning methodology based on the accident frequency and consequence. The analysis provides sufficient description of the potential significance of the identified hazards to ensure derivation of appropriate operational controls.

Consequences of common industrial accidents are not addressed in this FSAR, unless they: (1) initiate a release of hazardous material, or (2) worsen the consequences of a hazardous material release. Industrial accidents causing only occupational injuries or illnesses are addressed by the Industrial Hygiene and Safety Program, which is a required element identified in the PAC section of Appendix A, *Building 991 Facility Technical Safety Requirements*.

4.2 REGULATORY DRIVERS

The standards, regulations, and DOE Orders reviewed to establish the safety basis for the Building 991 Complex are listed below. Only portions of these documents are relevant to this FSAR, namely those that cover requirements pertinent to safety analysis, hazard classification, and operational controls. A comprehensive listing of the occupational safety and environmental standards is not provided.

- *Facility Safety*, DOE Order 420.1 (Ref. 35):

  This order addresses Natural Phenomena Hazards Mitigation, Fire Protection, General Design Criteria, and Criticality Safety.

- *Nuclear Safety Analysis Reports*, DOE Order 5480.23 (Ref. 36):

  This order requires the preparation of SARs for nuclear facilities. It addresses both nuclear and non-nuclear hazards.

- *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE Standard 1027-92 (Ref. 4):

  The threshold gram limits for nuclear facility Hazard Categories 2 and 3 are given in this standard for various radionuclides.

- *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans*, DOE Standard 3011-94 (Ref. 3):

  This standard provides guidance on performing a PHA.

- *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, DOE Standard 3009-94 (Ref. 5):

  This standard provides guidance on the implementation of DOE Order 5480.23.

- *Nuclear Safety Management Quality Assurance Requirements,* Code of Federal Regulations, 10 CFR 830, Department of Energy, Washington, D. C., 1995 (Ref. 2).

  This Code of Federal Regulation (CFR) subpart prescribes quality assurance requirements that are generally applicable to more than one phase of the life cycle of a DOE nuclear facility.

4.3 RISK CLASSIFICATION METHODOLOGY

The risks identified in the various accident analysis tables (contained in Section 4.5) can be categorized according to a combination of their expected frequencies and consequences, as shown in Table 4-1. For the purpose of this document, Class I risks are considered *major*, Class II are *serious*, Class III are *marginal*, and Class IV are *negligible*. This document evaluates each risk class separately for each of the accident scenarios discussed in Section 4.5. The risk associated with a Risk Class III or IV scenario identifies those controls providing the defense-in-depth necessary to maintain the risk class. Accident scenarios falling into Risk Class I or II are evaluated further, in Section 4.6, to determine if any preventive or mitigative features exist, which if implemented, could reduce the risk to Risk Class III or IV. These features are then noted for development of the control set in Appendix A, *Building 991 Facility Technical Safety Requirements*.

For those accident scenarios that result in Risk Class I or II where no preventive or mitigative features could be identified to reduce the risk class, the risk class is stated as part of a risk communication process to ensure the DOE is cognizant of facility risk.

In accordance with DOE-STD-3011-94, events more frequent than 10^{-2}/ year are classified as *anticipated*, those between 10^{-4} and 10^{-2}/year are classified as *unlikely*, and those less frequent than 10^{-4}/year are classified as *extremely unlikely*. These terms are consistent with the usage in DOE-STD-3009-94. For FSAR purposes, the *extremely unlikely* category also includes non-credible (i.e., less than 10^{-6}/yr) but potentially high-risk scenarios, as discussed in DOE-STD-3011-94. These scenarios are discussed in those instances where the risk potential is judged significant to the assurance of safe building operation. Estimates of frequency are qualitative. Where sufficient qualitative arguments for lower frequencies could not be made, the event was classified as *anticipated*.

Table 4-1 Risk Classes - Frequency vs. Consequences

	FREQUENCY OF OCCURRENCE (per year)		
CONSEQUENCE	**EXTREMELY UNLIKELY** $<10^{-4}$	**UNLIKELY** 10^{-4} - 10^{-2}	**ANTICIPATED** $>10^{-2}$
HIGH	II	I	I
MODERATE	III	II	I
LOW	IV	III	III

4.3.1 Radiological Risk

Consequence levels for radiological accidents are determined using the comparison criteria shown in Table 4-2. For non-lofted plumes, the shortest possible distance from the Building 991 Complex to the Maximum Off-site Individual (MOI) was determined to be 2,367 meters, using the methodology in RFP-4911, *Tools and Methodology for Collocated-Worker Consequence Assessments* (Ref. 37), and 96-SAE-021, *Distances and Azimuths to Selected Points from Site Buildings and Footprint Areas of Those Buildings* (Ref. 38). For lofted plumes, the fire will heat and elevate the plume. The maximum plume concentration for 95th χ/Q occurs at a distance of 4,020 meters, as discussed in RFP-4965, *Reference Computations of Public Dose and Cancer Risk from Airborne Releases of Uranium and Class W Plutonium* (Ref. 39).

Table 4-2 Radiological Accident Consequence Levels

CONSEQUENCE	MOI DOSE (at χ/Q value)	COLLOCATED WORKER DOSE (at χ/Q value)	IMMEDIATE WORKER DOSE
HIGH	> 5 rem	>25 rem	prompt death
MODERATE	> 0.1 rem	> 0.5 rem	serious injury
LOW	$\leq$ 0.1 rem	$\leq$ 0.5 rem	< moderate

The MOI consequences (public dose), for most cases, have been evaluated at 2,367 meters from the Building 991 Complex. If a higher χ/Q value is realized at a distance greater than 2,367 meters, the higher χ/Q value is used. This is the case for lofted plumes with 95th percentile χ/Q which occurs at 4,020 meters as discussed in Reference 39. Using this value provides a more conservative estimate for establishing the necessary controls. For the case with a lofted plume and median χ/Q, the maximum MOI dose occurs at a distance of 1,900 meters per Reference 39 which is still within the Site boundary.

The collocated worker consequences, for most cases, have been evaluated at 100 meters from the complex, in keeping with the SARs for Building 906 and the 750/904 Pads (Ref. 40 and 41), even though DOE-STD-3011-94 suggests (but does not require) using 600 meters. If a higher χ/Q value is realized at a distance greater than 100 meters, the higher χ/Q value is used. This is the case for lofted plumes with median χ/Q values. This approach is more conservative and is appropriate for the following reasons: (1) many collocated workers are closer to the Building 991 Complex than 600 meters due to the compactness of the Site, (2) the minimum distance usable by the Gaussian plume formulation is 100 meters, and (3) distances associated with evaluated maximum χ/Q values are encompassed by the Site boundary.

The term "immediate worker" is used to describe the worker who could be located immediately adjacent to the release location or within the complex. For immediate worker consequences, a qualitative judgment of acute radiological or toxicological effects and scenario related effects is made. It does not include latent cancer effects, per DOE-STD-3009-94.

Radiological doses are calculated using the *Radiological Dose Template* described in calculation 96-SAE-034 (Ref. 42) and are documented, along with the accompanying assumptions, in calculation 97-RAB-001, *Building 991 Complex SAR Support Calculation* (Ref. 8).

4.3.1.1 Radiological Hazard Category Determination

In addition to the risk classification methodology discussed above, DOE-STD-1027-92 allows the use of inventory thresholds to determine the initial facility nuclear Hazard Category. The initial estimate of the Hazard Category of a nuclear facility can be made by simply comparing the amount of the radioactive material in the facility with the isotopic thresholds in DOE-STD-1027-92. For the Building 991 Complex, the radioactive materials of concern are plutonium (Pu) and americium (Am) as contained in Weapons Grade (WG) Pu. The dominant isotope for Hazard Categorization was found to be ^{239}Pu (see Section 4.7). The relative activities and mass fractions for the composition isotopes of WG Pu can be found in the Safety Analysis and Risk Assessment Handbook (SARAH) (Ref. 43). If the amount of material for each isotope present in the facility is less than the Hazard Category 3 thresholds associated with each isotope, a SAR is not needed for the facility to meet the nuclear safety requirements of DOE Order 5480.23 (however, a SAR may still be required if there are significant chemical hazards). If the amount of radioactive material falls between the Hazard Category 3 and Hazard Category 2 thresholds, the nuclear facility is considered Hazard Category 3; if greater than the Hazard Category 2 threshold, it is a Hazard Category 2 nuclear facility.

The Hazard Category 2 and 3 thresholds for the various isotopes (taken from DOE-STD-1027-92) present in the Building 991 Complex are given in Table 4-3. The thresholds designating a facility as Hazard Category 3 are given in the last two columns (which are equivalent) and those for Hazard Category 2 designation are in the second and third columns (which are also equivalent). Note that sealed sources and SNM in certified DOT Type B containers are excluded from the hazard category determinations because of dispersibility of the source and container stoutness.

Table 4-3 Hazard Category 2 and 3 Thresholds for Radionuclides of Interest

	HAZARD CATEGORY 2		HAZARD CATEGORY 3	
ISOTOPE	Activity (Ci)	Amount (g)	Activity (Ci)	Amount (g)
^{233}U (No Crit)	220	2.3×10^{4}	4.2	440
^{233}U (Crit)	4.8	500	NA	NA
^{235}U (No Crit)	240	1.1×10^{8}	4.2	1.9×10^{6}
^{235}U (Crit)	1.5×10^{-3}	700	NA	NA
^{238}U	240	7.1×10^{8}	4.2	1.3×10^{7}
^{239}Pu (No Crit)	56	900	0.52	8.4
^{239}Pu (Crit)	28	450	NA	NA
^{241}Am	55	16	0.52	0.15

NA means not applicable

4.3.2 Chemical Risk

Consequence levels for chemical accidents have been determined using a qualitative evaluation as discussed below. The receptors are the MOI, the collocated worker, and the immediate worker. The definition and location of the receptors are the same as for the radiological risk evaluation.

In order to evaluate the Building 991 Complex chemical risk, the inventory of: (1) chemicals in waste, (2) process chemicals, and (3) bulk (product) chemicals were identified. Chemicals in waste inventory consist of containerized wastes. Product chemical inventory consists of chemicals that are inventoried and tracked using an equivalent system (managed by Building 991 Complex personnel) to the Integrated Chemical Management System (ICMS) database (managed by the Site Chemical Management Services Group).

The other chemicals in the building have been screened against the Threshold Planning Quantity (TPQ) listed in 40 CFR 355 (Ref. 44), the Threshold Quantity (TQ) listed in 29 CFR 1910.119, (Ref. 45) and 40 CFR 68, Subpart C (Ref. 46), and the Emergency Preparedness Screening Threshold (EPST) values listed in the *Development and Maintenance of Emergency Preparedness Hazards Assessment* (Ref. 47). Chemicals assigned TPQs and TQs are listed in Appendix F, Volume I, of the Site SAR (Ref. 9). The consequence level for accidents involving chemicals present in quantities exceeding the TPQ, TQ, or EPST (using the most stringent value) has been determined according to the comparison criteria shown in Table 4-4.

Table 4-4 Chemical Accident Consequence Levels

CONSEQUENCE	MOI EXPOSURE (at χ/Q value)	COLLOCATED WORKER EXPOSURE (at χ/Q value)	IMMEDIATE WORKER EXPOSURE
HIGH	> ERPG-2	> ERPG-3	prompt death
MODERATE	NA	NA	serious injury
LOW	≤ ERPG-2	≤ ERPG-3	< MODERATE

In this table, *NA* means *Not Applicable* and *ERPG* refers to the *Emergency Response Planning Guidelines,* published by the American Industrial Hygiene Association (Ref. 48). These guidelines include a set of three numbers (ERPG-1, ERPG-2, and ERPG-3) that quantify the air concentrations for each chemical, corresponding to *low, moderate,* and *severe* health effects in humans when exposed for greater than one hour. Concentrations of the various chemicals are calculated at the receptor location and compared to assigned ERPG values (or alternative values) in order to determine the consequence in accordance with Table 4-4. The *Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for Use in DOE Facilities* (Ref. 49) discusses alternative standards for cases where no ERPG value has been assigned.

For the Building 991 Complex, the only chemicals included in the evaluation of chemical risk are those present in TSCA hazardous waste. There are no RCRA-permitted wastes stored in the complex and there are no plans to store any in the future. There are no mixed residues stored in the building (Ref. 50) and there are no chemicals contained in idle equipment (Ref. 51). The amount and type (IDC and Waste Form Code designations) of these wastes present in the Building 991 Complex will change on a continuous basis. For these reasons, a method of evaluating chemical risk not requiring precise characterization knowledge was utilized (see Section 4.5.6). The diesel fuel in Building 989 of the complex is the only process chemical identified. The product chemical inventory consists of chemicals screened out because they have no assigned threshold values or are present in quantities less than assigned threshold values. Other hazardous materials beryllium, compressed gases, and lead-acid batteries.

Accident consequence levels for chemical accidents are summarized in Table 4-19.

4.4 HAZARD IDENTIFICATION

This section identifies the radiological and chemical hazards present in the Building 991 Complex as well as other hazards and energy sources that may contribute to a radiological or toxicological release. Initial hazard identification for the complex was accomplished by reviewing radiological and chemical material inventories that will be present during complex activities and by performing facility walkdown inspections. A Facility Hazard Identification Checksheet was used during the walkdown to identify the general hazard categories present in the complex. The hazards specific to the Building 991 Complex are identified in the checksheet shown as Table 4-5.

4.4.1 Building 991 Complex Hazards

Of the 13 hazard categories appearing on the checksheet, 10 are present in the Building 991 Complex. Table 4-6 provides a more detailed discussion of these hazards, describing the hazard in sufficient detail to determine if it is a standard industrial hazard. Standard industrial hazards are sufficiently controlled by the set of PACs listed in Appendix A, *Building 991 Facility Technical Safety Requirements*, or other Site programs, and are not analyzed further in this FSAR. Hazards determined to not be standard industrial hazards are analyzed further in this safety analysis.

4.4.1.1 High Voltage (1)

Two 13.8 kV transformers are located on the outside of Building 991. The transformers are fully enclosed and properly labeled. Minimum working clearances for electrical panels are maintained in accordance with Health and Safety Practice (HSP) 15.00, *Electrical Safety Practices* (Ref. 52). Appropriate postings and signs are provided to inform workers of potential electrical hazards.

4.4.1.2 Direct Radiation Sources (3)

Radiation generating devices present in Building 991 Complex include: (1) the NDT portable X-ray device, and (2) an X-ray source used by the Radiation Control Technicians (RCTs). The radiation generating devices present a potential ionizing radiation hazard to immediate workers. These hazards are controlled by the X-ray unit designs that include engineered safety features. HSP 18.05, *Control of Radiation-Generating Devices* (Ref. 53), provides additional responsibilities, requirements, and instructions (i.e., safety features, inspections and radiological surveys) for the control of radiation-generating devices used at the Site. Additional procedural and training requirements are in place providing worker awareness of the potential hazards associated with operating these units.

The radioactive sources identified in Table 4-7 are sealed sources stored within source lockers and vaults in the complex and are inventoried and inspected semi-annually in accordance with HSP 18.04, *Control of Radioactive Sources* (Ref. 54). These sources are sealed, in a non-dispersible form, are considered a standard industrial hazard, and are not analyzed further.

Table 4-5 Facility Hazard Identification Checksheet

HAZARD	HAZARD DEFINITION	YES/NO
1. High Voltage	Electrical energy sources with more than 600V potential, including AC electrical distribution systems from Site power.	Yes
2. Explosive Substances	Explosives are designated in 49 CFR 173.50-114; category is not for potentially explosive gases or chemicals, but specifically refers to explosive devices or chemicals that are being prepared or used in explosive devices (e.g., blasting caps, squibs, dynamite).	No
3. Direct Radiation Sources	Sources that produce ionizing radiation at a known level and includes X-ray machines, accelerators, and sealed sources.	Yes
4. Radioactive Materials	Radioactive materials that can be dispersible (i.e., require low energy for release); does not include sealed sources of nontransferable contamination.	Yes
5. Thermal Energy	Sources capable of producing burns, starting fires, causing undesired chemical reactions, or producing hazardous vapors; includes hot surface hazards.	Yes
6. Pressure Sources	High-pressure systems (liquid and gas) capable of producing burns, starting fires, causing undesired chemical reactions, or producing hazardous vapors, as well as compressed air used as a facility utility and standard compressed gas bottles.	Yes
7. Kinetic Energy	Includes energy sources, both rotating and linear motion moving masses.	Yes
8. Potential Energy	Includes systems with stored chemicals (large battery banks), mechanical, or electrical systems (large capacitor banks); large masses at heights referred to as mass, gravity, and height hazards are included.	Yes
9. Toxic, Hazardous, or Noxious Materials	Chemicals considered toxic or hazardous (RCRA listed, or has a TQ or TPQ).	Yes
10. Inadequate Ventilation	Areas and rooms susceptible to low or inadequate ventilation where flammable gases, hazardous vapors, or asphyxiants may accumulate.	No
11. Material Handling	Highlight operations that involve continuous handling of materials.	Yes
12. Unknown or Unmarked Materials	Any material or chemical in unmarked containers.	No
13. Other Hazards	Any hazard or concern identified that does not fit into a specific hazard category; examples include documenting areas with high combustible loads, areas with contamination (e.g., hydrogen, shock sensitive chemicals), or areas particularly susceptible to natural phenomena.	Yes

Table 4-6 Building 991 Complex Hazard Description Summary

Energy Source	Quantity on Hand	Form/Description	Packaging	Location	Recognized Controls	Remarks
1. HIGH VOLTAGE:						
13.8 kV Transformers	Two				• Fully enclosed connection • Serviced only by qualified personnel. • Compliance with H&S Practices Manual.	Standard industrial hazard, no further evaluation performed.
2. EXPLOSIVE SUBSTANCES:	None					
3. DIRECT RADIATION SOURCES:						
A Sealed sources	See Table 4-7	Sealed calibration sources.	Standard sealed source packaging.	Vault 996 Room A 150 Vault, Room 170 Dock	• Packaging • Shielding • Training • Procedures • Source inventory & inspection (HSP)	Standard industrial hazard, no further evaluation performed. Used for calibration.
B. X-ray (NDT)	One	Portable iridium-192 source		Room 164	• Packaging • Shielding • Training • Procedures • Source inventory & inspection (HSP)	Used for NDT. Standard industrial hazard, no further evaluation performed
C. X-ray source (RCT)	One			Room 132	• Packaging • Shielding • Training • Procedures • Source inventory & inspection (HSP)	Used for radiation instrument calibration. Standard industrial hazard, no further evaluation performed
4. RADIOACTIVE MATERIALS:						
A. Plutonium, americium, uranium, and other isotopes in LLW and TRU waste containers	Varies	Radioactive contaminated waste	Approved onsite and off-site containers: 55-gal. drums, TRUPACT II SWB, and DOT-7A Type A Metal Waste Boxes. Wooden HEPA filter coffins.	Throughout complex for approved onsite and off-site containers. Under B991 canopy for filter coffins.	• Packaging • NMSLs • Procedures • Dosimetry	Further evaluation provided in Section 4.5.
B. Special Nuclear Material	Varies		Approved DOT Type B shipping container	Room 150	• Packaging • NMSLs • Procedures • Dosimetry	Material contained in approved DOT Type B shipping containers. No further evaluation performed.

Table 4-6 Building 991 Complex Hazard Description Summary

Energy Source	Quantity on Hand	Form/Description	Packaging	Location	Recognized Controls	Remarks
5. THERMAL ENERGY:						
A. Steam	One	Plant steam line supplies facility, 140 psig.	Insulated steel piping.	Enters Building 991 through Room 137	• Standard ASME design and construction • Insulated	Standard industrial hazard, no further evaluation performed. Relief valve leaks.
B. Pyrophoric uranium				Vault 996, Room A	• Packaging • NMSLs • Procedures • Dosimetry	Analyzed in Section 4.5.
C. Electrical Heaters	Two			Room 166		Standard industrial hazard, no further evaluation performed. Considered as initiator of fires.
D. Diesel Generator	One			Building 989		Standard industrial hazard, no further evaluation performed.
6. PRESSURE SOURCES:						
A. Compressed air (standard industrial air compressors)	Two	Compressor receivers and tanks	Steel vessels.	Building 991, Building 985	• Certified vessels, • Pressure relief devices.	Standard industrial hazard, no further evaluation performed.
7. KINETIC ENERGY:						
Vehicles and material handling equipment	Various forklifts, drum handlers.	Standard industrial handling equipment movement in and around building.	NA	Loading dock, forklifts and drum handler wherever containers are located.	• Equipment maintenance • Procedures • Trained operators	Standard industrial hazard, no further evaluation performed. Considered as initiators of spills.
8. POTENTIAL ENERGY:						
A. Overhead Cranes 3 tons ½ ton 750 pounds 2-1 ton 300 pounds	Six total	Mechanical	NA	Room 134 Room 147 Room 164 Room 165 Room 170 Vault 996	• Equipment maintenance • Procedures • Trained operators	All but one crane are no longer in use. Many have lockout/tagout controls on them. Standard industrial hazard, no further evaluation performed.
B. Drum Crusher	One			Building 984	• Equipment maintenance • Procedures • Trained operators	Standard industrial hazard, no further evaluation performed.
C. Stacked Waste Containers	Varies		55-gal. drums, TRUPACT II SWBs, Metal Waste Boxes	Throughout complex	• Procedures • Trained operators	Evaluated in Section 4.5 in earthquake scenario.

Table 4-6 Building 991 Complex Hazard Description Summary

Energy Source	Quantity on Hand	Form/Description	Packaging	Location	Recognized Controls	Remarks
9. TOXIC, HAZARDOUS, OR NOXIOUS MATERIALS:						
A. General Industrial Chemicals (Bulk/Product Chemical Inventory)	Varies - Building Need	Paints, concrete sealer, floor coatings, etc.	Standard containers: plastic drums, cans, bags, etc.	Throughout complex.	• Approved storage • Chemical management • Limited to small quantities	Standard industrial hazard, no further evaluation performed.
B. Lead acid batteries	Twelve	Standard 24-48 volt lead-acid batteries	Plastic cases, vented	Building 989	• Approved battery charging stations • Procedures • Training	Standard industrial hazard, no further evaluation performed.
C. Beryllium	54	Parts	55-gallon drums	Tunnel 998	• Packaging • Procedures • Personnel protective equipment • Training	Previous operations in Building 991 involved beryllium.
D. Asbestos	NA	Throughout complex	Insulation on piping, tiles on floor, etc.	Throughout complex	• Health and Safety Practices	Procedures for working with asbestos minimizes worker exposure to friable asbestos.
E. PCB	Three	NA	Transformers One inside Building 991, two outside.	Room 165, outside Building 991.	• Health and Safety Practices	Standard industrial hazard, no further evaluation performed. Procedures for working with PCBs minimizes worker exposure.
F. Diesel Fuel	1-180 gallon tank, 1-1,000 gallon tank	Liquid	Above ground storage tanks	180 gallon tank - Building 989 1,000 gallon tank - south of Building 989.	• Health and Safety Practices	
G. Corrosives & Flammables	Varies, building need		Standard containers.	Building 991, Rooms 110, 155, 164, 165, docks.	• Approved storage • Chemical management • Limited to small quantities	Standard industrial hazard, no further evaluation performed.
10. INADEQUATE VENTILATION:	None					
11. MATERIAL HANDLING:						
A. Dock	Two	Standard ramp/dock with dock leveler.	NA	Outside 991 along east and west side.	• Dock leveler • Adequate design	Standard industrial hazard, no further evaluation performed.
B. Waste container handling/ movement	NA	Drums and crates moved by forklifts/drum handler and placed into storage location.	55-gal. drums, TRUPACT II SWBs, DOT-7A Type A Metal Waste Boxes. Wooden HEPA filter coffins.	Throughout complex for drums, SWBs and metal waste boxes. B984 and under B991 canopy for wooden HEPA filter coffins.	• Inspections • Procedures • Trained operators	All containers used for storage are approved for onsite transportation. Considered as initiator for spill scenario.

Table 4-6 Building 991 Complex Hazard Description Summary

Energy Source	Quantity on Hand	Form/Description	Packaging	Location	Recognized Controls	Remarks
C. SNM handling	NA	Drums moved by forklift/drum handler and placed into storage location.	DOT Approved Type B shipping containers	Room 150 to Room 170	• Inspections • Procedures • Trained operators	Material contained in approved DOT Type B shipping containers. No further evaluation performed.
12. UNKNOWN OR UNMARKED MATERIALS:	None					
13. OTHER HAZARDS:						
A. Hydrogen generation	NA	Generate hydrogen by radiolysis of water and hydrocarbon	Pu containers	NA	• Drum venting • Aspiration • Inspection	Analyzed as part of explosions
B. Battery Charging Stations				Rooms 134 and 136	• Equipment maintenance • Procedures • Trained operators	Standard industrial hazard, no further evaluation performed.
C. Tunnel Degradation and Leakage	NA	Cracks in tunnel ceiling and walls. Water leakage into tunnel.	NA	Corridor C, Tunnel 998	• Strain Gages • Drainage	Engineering analysis indicated the tunnels are structurally sound.

Table 4-7 Radioactive Sources

NUCLIDE	REGISTRY #	SERIAL # or Mfg #	PRESENT ACTIVITY μCi [1]
^{235}U	RS-518	CSL-400249	2.30E+01
^{133}Ba	RS-553	IR974	5.25E+00
^{133}Ba	RS-554	IR975	5.23+00
^{133}Ba	RS-966	91BA120027	9.62+00
^{133}Ba	RS-967	91BA120028	9.69+00
^{133}Ba	RS-968	91BA120030	1.36+01
^{133}Ba	RS-969	91BA120029	1.41+01
^{133}Ba	RS-970	91BA120032	2.56E+01
^{133}Ba	RS-971	91BA120031	2.58E+01
^{133}Ba	RS-972	91BA120033	2.76E+01
^{133}Ba	RS-973	91BA120034	3.34E+01
^{133}Ba	AS-1687	91BA120021	2.11E+00
^{133}Ba	AS-1688	91BA120023	2.31E+00
^{133}Ba	RS-1689	91BA120026	5.40E+00
^{133}Ba	AS-1690	91BA120022	1.78E+00
^{133}Ba	RS-1691	91BA120024	3.69E+00
^{133}Ba	RS-1692	91BA120025	5.60E+00
^{137}Cs	RS-1694	2S299	9.63E+00
^{137}Cs	RS-839	S901704108	8.52E+01
^{192}Ir	AS-943	1171	1.63E-02
^{238}Pu	RS-5	12535G	7.50E+04
^{238}Pu	RS-14	792	6.00E+06
^{252}Cf	RS-482	2751NC	1.88E+02
^{252}Cf	RS-483	2752NC	1.88E+02
^{252}Cf	RS-603	SR85	2.45E-02
^{252}Cf	RS-629	4003NC	3.45E+00
^{252}Cf	RS-632	4006NC	3.45E+00
^{252}Cf	RS-636	4010NC	3.45E+00
^{241}Am	RS-2850	117241	1.16E+01
^{239}Pu	RS-2904	91PU4703040	1.20E-02
^{137}Cs	RS-551	2S263	8.18E+00
^{239}Pu	RS-3696	CSL-502604	6.65E+04
^{239}Pu	RS-3697	CSL-502605	1.39E+05
^{239}Pu	RS-3698	CSL-502606	3.59E+06
^{239}Pu	RS-3699	CSL-502607	6.49E+05
^{239}Pu	RS-3700	CSL-502608	1.57E+06
^{235}U	RS-3701	4353	8.65E+01
^{192}Ir	3917	RS-7951	2.17E+06

(1) Activity as of April 30, 1997

4.4.1.3 Radioactive Materials (4)

This FSAR addresses the hazards associated with the handling, storage and staging of waste found in a combination of drums and other waste packages. The various container types and their fissile material loading are shown in Table 4-8. This table is presented to support development of accident scenarios (to determine the effective MAR) and should not be interpreted as Nuclear Material Safety Limits (NMSLs) for the complex. The chemical and physical forms of the wastes vary, but are categorized by the IDC or Waste Form Codes (WFC) assigned them. These wastes are contaminated primarily with WG Pu. Some of the wastes are contaminated with slightly higher concentrations of americium than normally found in WG Pu. The hazards associated with these packages are addressed in USQD-RFP-97.0510-TLF, *Americium Quantities Greater Than Analyzed in the FSARs* (Ref. 55). The USQD concluded the Building 991 Complex authorization basis currently applies no administrative controls on americium in the complex. This FSAR addresses the issue of americium in waste containers and applies controls to assure the americium is accounted for.

Personnel performing functions in the Building 991 Complex will also be exposed to penetrating radiation due to their proximity to the waste containers. Exposure to penetrating radiation from waste containers will be controlled through implementation of the As Low As Reasonably Achievable (ALARA) principle of radiation protection.

Table 4-8 Waste Container Material Loading

Container Type	Pu Equivalent Limit	Comments
Crates/Boxes		
DOT-7A Type A Metal Waste Box	320 grams	Two-layer planar array allowed.
TRUPACT II SWB	320 grams	Four-layer planar array allowed.
Wooden LLW Crate	3 grams	May only be stored outside Building 991 under the west dock canopy.
Drums		
55 gallon drum DOT Type A or Approved On-Site drum	≤ 200 grams	Four-layer planar array allowed.

SNM packaged in DOT approved Type B shipping containers also contains radioactive materials. This material is not analyzed further due to the packaging and the controls in affect to package the material in a DOT approved Type B shipping container.

Radioactive material is also present with the sealed sources as discussed in paragraph 4.4.1.2.

One container of pyrophoric uranium fines is in Vault 996 Room A. The consequence of a fire from this container is bounded by those of a plutonium fire because the dose conversion factor is significantly lower for enriched uranium (3.04E+02 rem/gram) as compared to aged WG Pu (3.03E+07 rem/gram) (Ref. 42).

4.4.1.4 Thermal Energy (5)

Plant steam lines are routed throughout the Building 991 Complex. Should a valve or pipe break, escaping steam could injure a person standing nearby. The plant steam lines are cross-connected with steam condensate lines. The steam passes through a reducing station in Room 137 prior to entering the rest of Building 991. Non-radioactive high temperature and pressure systems are considered standard industrial hazards.

4.4.1.5 Pressure Sources (6)

One air compressor unit is present in Building 991 and one in Building 985. These compressors have a normal operating pressure of 110 psig. The compressed air system has the potential for worker injury due to escaping air from damaged lines. The compressors are standard industrial units with proper pressure relief provisions and are not evaluated in this FSAR.

4.4.1.6 Kinetic Energy (7)

During waste container movement, kinetic energy is created in the form of moving vehicles and masses. Waste containers are transported throughout the facility using forklifts, a drum handler, or manual carts. These energy sources can contribute to a breach or spill of one or more waste containers due to puncture or impact and result in a radiological and/or chemical release. Very serious worker injury, and potential fatalities are probable due to kinetic energy sources.

4.4.1.7 Potential Energy (8)

Potential energy sources include six cranes located in various rooms, the drum crusher in Building 984, and the stacked drums/crates in Building 991. The cranes range in capacity from 300 pounds to 3 tons. These cranes, in the past, were used for drum movement but future plans do not include using any of them except the 750 pound crane in Room 164. This crane may be used for non-radioactive NDT operations. The rest of the cranes are locked out. A final potential energy source that could result in a radiological and/or chemical release is the four high stacking of 55-gallon drums and two high stacking of TRUPACT II SWBs and metal waste boxes in the Building 991 Complex storage areas. The drum crusher is used to crush empty non-radioactive contaminated 55-gallon drums but is not located where it could result in a radiological and/or chemical release.

4.4.1.8 Toxic, Hazardous, or Noxious Materials (9)

The product chemical inventory for the Building 991 Complex consists of chemicals that have no assigned threshold values or are present in quantities less than assigned threshold values. Any accidents involving product chemicals would result in *insignificant* consequences to the collocated worker, the MOI, and the environment if released within the building. The hazard to the immediate worker from the product chemical inventory is considered a standard industrial hazard and does not warrant further evaluation.

Other hazardous materials that may be present in the complex include lead-acid batteries and beryllium. Containerized wastes with TSCA regulated Polychlorinated Biphenyls (PCBs) and asbestos may also be generated in the building. Diesel fuel is located in tanks outside and inside Building 989. These materials could result in personnel injury due to improper exposure.

Accident consequence levels for chemical accidents are summarized in Table 4-19, *Building 991 Chemical Evaluation Summary.*

4.4.1.9 Material Handling (11)

Material handling operations include waste container movement to and from the loading dock and storage locations. The primary hazards involved with material handling operations are kinetic and potential energy hazards previously discussed.

4.4.1.10 Other Hazards (13)

Two other hazards have been identified for the Building 991 Complex. The first one is the battery charging stations in Rooms 134 and 136. Generation of hydrogen from this operation could occur. The other hazard is the degradation of the tunnels. Corridor C has multiple cracks in the ceiling and walls. Strain gages have been installed to monitor the cracks. The tunnels also have leaks allowing water inside the tunnels.

4.5 ACCIDENT ANALYSIS

The accident evaluation process includes: (1) developing accident scenarios from potential hazards associated with a specific building activity and (2) identifying applicable preventive and/or mitigative controls for specific accident scenarios. Accident analysis results are documented in the accident analysis tables found in Sections 4.5.2 through 4.5.6. There are five main types of potential accidents at the Site that can result in a radiological release: (1) fire, (2) spill, (3) explosion, (4) nuclear criticality, and (5) natural phenomena/external events. A criticality scenario is not postulated for the Building 991 Complex since a Criticality Safety Evaluation determined that criticalities in the complex are not credible (Ref. 56). For chemicals, only spills are analyzed. Within each main accident type there may be several specific accidents addressed. As a result of scenarios evaluated in the accident analysis tables, calculations were performed to determine consequences and hazard risk class. The accident analysis table format and usage are described in the following section.

4.5.1 Accident Analysis Tables and Scenario Discussions

The purpose of the accident analysis tables (Table 4-10 through Table 4-13 and Table 4-15 through Table 4-18) and accompanying scenario discussions is to determine the controls needed for safe operations and to demonstrate the adequacy of the credited controls. In each of the accident analysis sections (Sections 4.5.2 through 4.5.6), an accident analysis table for each scenario precedes a discussion of the scenario. The accident analysis tables identify the hazards and accident types (scenarios), scenario frequencies, accident consequences to identified receptors, accident risk class, and credited controls necessary to maintain the identified risk class. The accompanying scenario discussions are divided into separate sections addressing accident scenario description, accident frequency, MAR, and accident consequence. The accident analysis table provides a systematic graphical depiction of the safety analysis process used in deriving the credited controls for each accident scenario and for the Building 991 Complex.

***Hazard* Field** - This field describes the hazard being evaluated. Typical entries would be WG Pu, hydrogen, etc.

***Accident Type* Field** - This field defines the accident type being evaluated and will usually be a fire, spill, explosion, criticality, or natural phenomena/external event. The maximum effective MAR is presented in this field. Additional information may also be included to indicate the size and location of the accident.

***Cause or Energy Source* Field** - The initiator(s) of the accident are listed in this field. Sometimes accidents are grouped and there could be several different initiators causing the same basic accident, for example - electrical equipment or machinery failures, maintenance activities, or ignition of combustible material could all be fire initiators. Generally, the more generic an accident is, the more types of initiators will be listed here.

***Applicable Activity(ies)* Field** - This field provides correlation between the hazards by activity, analyzed accident scenarios, and controls necessary to prevent or mitigate accidents involving those hazards. Each postulated accident scenario occurs during performance of at least one specific activity such as waste container handling, storage, or transport.

***Receptor* Column** - This column lists the receptor or the individual analyzed as receiving the dose from the release. Three receptors are analyzed: the public (analyzed as the MOI), the collocated worker, and the immediate worker. A separate row is needed for each of these receptors because they are evaluated separately. Doses to the MOI and the collocated worker may be determined either qualitatively or quantitatively, but doses (or consequences) to the immediate worker are determined qualitatively.

***Scenario Frequency* Column** - Accident scenario frequencies are binned into categories as suggested by DOE-STD-3011-94 (Ref. 3). This column shows the expected frequency bin of the accident as it is developed in the scenario discussion. The frequency bin assignment is generally qualitative. The frequency section in the scenario discussion describes which preventive features were specifically credited to arrive at the assigned frequency bin. Credited preventive features are documented in the *Credited Controls* column of the accident analysis table and included in Appendix A, *Building 991 Facility Technical Safety Requirements*.

In assigning accident scenario frequencies, the following assumptions were used as guidance:

- Proceduralized human action (administrative controls) – An administrative control may be used to reduce the scenario frequency by one order of magnitude (multiply by 10^{-1}). Two or more independent administrative controls can be combined for a maximum frequency reduction of two orders of magnitude (multiply by 10^{-2}) or one frequency bin.

- LCO with surveillance requirement – An LCO may be used to reduce the scenario frequency by two orders of magnitude (multiply by 10^{-2}) or one frequency bin.

***Consequences* Column** - Accident consequences are binned into categories as suggested by DOE-STD-3011-94 (Ref. 3). This column shows the consequence bin of the accident as it is developed in the scenario discussion. The consequence bin assignment is determined by quantitatively determining the expected dose (radiological or chemical) to the collocated worker and MOI and comparing it to the acceptance criteria in Table 4-2 or Table 4-4. The consequence to the immediate worker is determined qualitatively. For all accident scenarios, a 95th percentile χ/Q dose consequence determination is used for comparison purposes with the tables. The consequence section in the scenario discussion describes which mitigative features were specifically credited to arrive at the assigned consequence bin. The section on how the effective MAR was determined also affects the consequence bin assignment (the greater the effective MAR involved, the greater the dose to the receptor). Credited mitigative features are documented in the *Credited Controls* column of the accident analysis table and included in Appendix A, *Building 991 Facility Technical Safety Requirements.*

***Risk Class* Column** - The risk class is determined by combining frequency and consequence for a given scenario and receptor location according to Table 4-1. Risk Class III or Risk Class IV are considered acceptable as described and were not evaluated further. If the risk class for a scenario is a I or II then the scenario is considered a risk dominant accident scenario. Such scenarios are further evaluated to determine if additional preventive and/or mitigative features can be credited to lower the risk to a Risk Class III or IV. Risk Class I or II accident scenarios are discussed in Section 4.6. When additional preventive and/or mitigative features are identified for risk dominant accident scenarios, they are discussed in Section 4.6 and included in Appendix A, *Building 991 Facility Technical Safety Requirements.*

***Credited Controls* Column** - This column presents the preventive and mitigative controls credited in the evaluation of each accident scenario. Credited controls are those controls derived from the individual accident analyses. The column is considered the output of the safety analysis process and defines the required Operational Controls. The scenario discussion explains, in either the *Frequency, Consequence,* or *Material-At-Risk* section, how each credited feature is important to determining the Risk Class.

It should be noted that all scenarios credit an integrated set of Safety Management Programs. The set of integrated Safety Management Programs, referred to as the PACs, is required at all times and described in Chapter 3. If a specific attribute or requirement of a Safety Management Program is important in deriving the risk class, it will be documented in this column and specifically called out in the Administrative Controls.

***Control Type* Column** - This column identifies whether the credited control is considered a primary control or a control that provides defense-in-depth. A primary control is one that limits or reduces accident initiation frequency. It could also limit or reduce accident consequences. Defense-in-depth controls are those additional preventive and mitigative features that provide layers of defense to protect the public or the workers from harm.

***Purpose* Column** - This column identifies whether the credited control provides preventive protection (frequency reduction) or mitigative protection (consequence reduction).

***Reference to Appendix A* Column** - This column provides a cross-reference to where the credited controls are discussed in Appendix A, *Building 991 Facility Technical Safety Requirements*.

Scenario Discussion - The text that follows the hazard analysis table contains a description of the accident scenario, the frequency, the material-at-risk, and the consequences of the scenario. The description section presents each scenario and explains how and where the accident occurs. The material-at-risk section explains the logic behind the material available to be acted on by the forces of the accident. If damage ratios are used, they are explained here. The frequency and consequence sections explain how the scenario frequency and consequence were determined based on the accident scenario description.

The *Scenario Discussion* also discusses the control set adequacy and vulnerability. Although the active credited preventive and mitigative features are assured of high operational reliability by TSRs and safety designation, the active features are still vulnerable to failure which may initiate new scenarios. Therefore, supplementary evaluations of frequency and consequences that assume failure of engineered features or administrative controls are performed. This vulnerability assessment confirms the adequacy of the control set, identifies additional required controls, or identifies additional risk dominant scenarios. For credible cases in which the risk class is higher than Risk Class III, risk reduction is addressed depending on frequency. Additional controls are identified as necessary for *unlikely* scenarios, and the adequacy of available defense-in-depth controls and analysis conservatism's are assessed for *extremely unlikely* scenarios.

Within the control set adequacy/vulnerability assessment, for each accident scenario that credited active features, the risk classes are determined based on failing the credited features, one at a time. Multiple failures are considered under two conditions: (1) failure of the control when qualitatively assessed reduces the frequency by only one order of magnitude, and (2) the scenario frequency with prevention is *anticipated*. If failure of preventive features was included in the analyzed scenario frequency, then such failures need not be further considered. If such failures were not postulated, failure of each credited feature is qualitatively assessed to reduce the scenario frequency one bin (e.g., from *unlikely* to *extremely unlikely*).

4.5.2 Fire Scenarios

The Fire Hazards Analysis for the Building 991 Complex (Ref. 26) was reviewed to characterize fire hazards for the scenarios in this FSAR. Fires were postulated to occur either (1) inside the building involving the material currently being stored, (2) on either the east or west dock and involving the material being loaded or unloaded, and (3) in the wooden LLW boxes stored under the Building 991 canopy.

The predominant fire hazard in the Building 991 Complex is the combustible material located in the Building 991 office areas. The initiators for credible fire scenarios inside the building include combustible material ignited by an electrical equipment failure or by a maintenance activity. LLW wooden boxes of HEPA filters under the canopy are expected to be ignitable by either of the above initiators or by ordinary combustibles ignited by a stray cigarette. Waste drums and metal containers in proximity to combustible materials are expected to be heated either directly or indirectly causing a smoldering fire inside the container resulting in lid seal failure and venting of radiological material through failed lid seals (confined material release). The release of SNM was not evaluated because all SNM delivered to or shipped from Building 991 is contained within certified DOT Type B containers. The integrity of these containers is sufficient to withstand the postulated fire scenarios without releasing any of their contents. The release of LLW, with the exception of the filter coffins, was not evaluated because a release of TRU waste would bound the consequences of LLW releases and LLW scenarios are identical to TRU waste scenarios.

The Building 991 Complex is protected by three sprinkler systems as described in Section 2.2.2. The heated areas of Building 991 are protected by an automatic wet pipe, ordinary hazard sprinkler system. This system also protects Tunnel 998 and Room 300. The Building 985 filter plenum structure is protected by its own wet pipe sprinkler system. A dry pipe system is installed to protect the Room 170 enclosed dock area, the external canopy to the west of Building 991, the east loading dock and the diesel generator building (Building 989). The Building 991 and Building 985 filter plenums are protected by deluge systems. The remaining tunnels, vaults, and ancillary buildings do not have sprinkler protection.

Two fire hydrants are located within 75 feet of the main building. One hydrant is located near the southwest corner of the building. The second one is located near the southeast corner of the building in a useful position for interior attack via the external doors at this end of the building.

Building 991 is divided by a single fire-rated wall, running east and west, from the north side of the west dock to the north side of the east dock. The fire-rated wall divides Building 991 into a north and south fire area. Only the south fire area is postulated to contain sufficient amount of combustible material (office area) to result in a large fire. Door openings for two doors in the fire-rated wall are equipped with fire doors of a comparable rating. Several other interior walls within the building are of adequate construction to function as fire barriers but are not so designated.

The doors that separate Tunnel 998 and Room 300 from Building 991 are of adequate construction but are not fire-rated. The walls and doors that separate Vaults 996/997/999, Tunnel 996 and Corridor C from Building 991 are also of sufficient construction to prevent a fire from spreading from one part of the complex to the other but are not fire-rated (Ref. 26).

Manual fire phones are located in the corridors, large rooms, and other strategic locations. Initiation of the fire alarm systems cause both local and Site alarms to sound. The emergency telephone lines permit instantaneous communication with the Site Fire Department. In the event of loss of electrical power, the fire alarm system has backup supplies from 24-volt batteries, plus additional backup from a diesel generator for the Room 130 panels containing circuits for the Building 991 bell control and fire suppression plenum deluge. Waterflow switches installed on sprinkler system risers provide indication of system usage. Upon flow detection, an alarm signal is sent to the Fire Dispatch Center. The vault storage rooms and tunnel areas (except Tunnel 998 and Room 300 which are sprinklered) are provided with high-voltage direct current ionization smoke detectors. The smoke detectors have an 8-hour back-up battery capability.

Several fire scenarios, summarized in Table 4-9, were assessed in order to determine the bounding scenarios requiring further evaluation for Building 991. A fire in one of the LLW wooden boxes stored under the canopy was considered to be *anticipated*, fires in more than one wooden LLW box and inside Building 991 were considered to be *unlikely*, and the truck fire at the east or west dock scenario was considered to be *extremely unlikely*.

A fire in a waste storage area could be initiated by electrical equipment failure or by maintenance activities igniting combustible materials in close proximity to the waste containers packaged with WG Pu. The postulated scenarios involve either three 55-gallon TRU drums, one TRUPACT II SWB, or one Metal Waste Box. Three 55-gallon TRU drums are postulated to be involved in the fire due to their storage configuration. It is assumed there is a failure of the combustible loading program which allows combustible material to be in the proximity of the TRU waste drums. The combustible material would most likely be stacked in the proximity of two TRU waste drums when the fire starts but, to be conservative, it is assumed three TRU waste drums are involved. It is assumed there is no propagation of fire from one drum to another. Only those drums directly contacted by the fire flame are involved in the fire. Only one TRUPACT II SWB or Metal Waste Box is postulated to be involved in the fire due to the size of these waste containers. Upon failure of the combustible loading program, it is assumed combustible material is only in the proximity of one of the TRUPACT II SWBs or Metal Waste Boxes. Up to 200-grams of WG Pu may be packaged in each drum for a total effective MAR of 600 grams WG Pu (3 x 200 grams/drum) versus 320 grams for the TRUPACT II SWB and Metal Waste Box (1 x 320 grams/SWB or metal waste box). Therefore, the bounding scenario is damage to three drums. A non-lofted plume was assumed in determining the consequences for a fire of this size.

A larger fire is postulated to occur inside Building 991 in the south fire area. It is assumed to be initiated in the office area, rather than the waste storage areas, because of the lack of combustible loading in the waste storage areas. The scenario postulated would affect drums stored in Room 134. Hot gases and combustion products are postulated to spread from the Building 991 office area fire into Room 134, causing heating of the room and drums from the ceiling down, with temperatures expected high enough to pyrolize the drum contents and subsequently venting drum gases containing radioactive material through failed drum lid seals. The scenario assumes that all 560 of the TRU drums in Room 134 could potentially reach temperatures high enough to pyrolize the drum contents and vent. This scenario involves the maximum number of drums that physically may be stored in the room.

Table 4-9 Postulated Fire Scenarios and Effective MAR

Scenario	Packaging	Number of Containers Potentially Involved	Effective MAR (grams)	Frequency	Plume Type
Fire in storage area (confined release)	55-gallon TRU waste drums (up to 200 grams each)	3	600	Unlikely	Non-lofted
	TRUPACT II SWB and/or Metal Waste Box (up to 320 grams each)	1	320	Unlikely	Non-lofted
Fire in office area (hot gases and combustion products spread, heating and venting TRU drums	55-gallon TRU waste drums (up to 200 grams each)	560	112,000	Unlikely	Lofted
Truck fire at dock (confined release)	Two trucks at west dock with 30 55-gallon TRU waste drums on each truck (up to 200 grams in each drum)	36	7,200	Extremely Unlikely	Lofted
	Two trucks at west dock with 10 TRUPACT II SWB and/or Metal Waste Boxes on each truck (up to 320 grams in each container)	20	6,400	Extremely Unlikely	Lofted
Fire in HEPA filter coffin, Building 985	Used HEPA filters (up to 12 HEPA filters in each metal filter coffin)	1	12 (1 gram per filter)	Unlikely (bounded by 3-drum fire in storage area; not analyzed further)	Non-lofted
Fire in wooden LLW crate stored under B991 canopy (unconfined combustible release)	Used HEPA filters	1	3	Anticipated	Non-lofted
Fire in wooden filter coffins stored under Building 991 canopy (unconfined combustible materials)	Used HEPA filters	50	150 (assumed up to 3 grams in each wooden box)	Unlikely	Lofted

Note: Shaded boxes indicate the bounding material packaging configuration for each scenario type: storage area fire, office area fire, truck fire at dock, and plywood filter coffin fire, and identifies the scenarios further evaluated.

A dock fire may occur at either the east or west dock. Up to two trucks/trailers may be present at the west dock at any one time and only one truck/trailer at the east dock. It is assumed an electrical malfunction on a transport vehicle initiates a fuel fire that spreads and involves the fuel tanks on the vehicle and the vehicle load. The maximum load delivered on a truck/trailer is thirty 55-gallon drums of TRU waste containing a maximum of 200 grams of WG Pu each or ten TRUPACT II SWBs and/or Metal Waste Boxes containing 320 grams of WG Pu each (Ref. 9).

The drums are placed in one layer with four rows on the truck/trailer bed within the enclosed cargo compartment. Although the cargo compartment consists of light metal walls it is assumed this structure would be rapidly breached by the flames in the event of a vehicle fire. This would allow up to 18 drums around the outside perimeter or all 10 of the TRUPACT II SWBs and/or Metal Waste Boxes to be exposed to the flames causing heating of containers, pyrolizing container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals. The two drums located inside the first row (behind the truck cab) would be shielded. These vented gases are assumed to be released outside. The fire would be intense enough that a lofted plume release is used for dispersion modeling. The release of contents from the 18 drums represents the bounding scenario because the MAR associated with them is greater than that of the 10 TRUPACT II SWBs and/or Metal Waste Boxes (i.e., 7,200 grams WG Pu (2 trucks/trailers x 18 drums x 200 grams/drum)) versus 6,400 grams WG Pu for the TRUPACT II SWBs and/or Metal Waste Boxes (2 trucks/trailers x 10 boxes x 320 grams/box). The fire at the dock is not postulated to effect drums stored inside Building 991 due to the building design and the sprinkler systems inside the building.

A fire in a HEPA filter coffin in Building 985 resulting from a maintenance activity may occur. In this fire, it is postulated the duration of the fire would be on the order of 30 minutes and may or may not initiate the suppression system before burning itself out. This scenario does not result in a breach of the structural integrity of the building. The fire is postulated to occur during filter changeout activities. During filter changeout, used filters are removed from the filter plenum and placed in coffins for disposal. The coffin is located in Building 985 during filter changeout activities. No waste is allowed inside Building 985, and any waste generated as a result of maintenance work or filter changeout must be removed from the building to an approved waste storage area within 24 hours of job completion (Ref. 57). Based on physical limitations, up to 12 filters may be disposed of in a filter coffin. The MAR for this scenario is 12 grams of WG Pu based on an amount of 1 gram per filter (Ref. 58). This material is not expected to involve americium in quantities above that for "aged" WG Pu. This scenario is bounded by the three-drum fire (991 Fire 1) inside Building 991 and is not evaluated further.

A fire in wooden LLW boxes stored under the Building 991 canopy containing HEPA filters is postulated to occur. The fire is initiated by either maintenance activity, an electrical equipment failure, or a stray cigarette igniting adjacent combustible material. The Building 991 canopy is protected by a dry pipe sprinkler system. Two cases were evaluated. Case A involved only one wooden LLW box due to the assumption there would be enough heat to activate the sprinkler system thereby preventing further spread of the fire. This size of fire is postulated to result in a non-lofted plume. The second case evaluates the effect if the fire suppression system does not actuate and control the fire. All the wooden LLW boxes are assumed involved in the fire. The size of this fire results in a lofted plume. The fire in the wooden LLW boxes is not postulated to effect drums stored inside Building 991 due to the building design and the presence of the fire suppression system inside the building.

The bounding fire scenarios from Table 4-9 are evaluated further below.

991 Fire 1 - Fire Inside Building 991 Waste Storage Area – This is a non-lofted fire that starts in a waste storage area with combustibles located in close proximity to TRU waste drums. Three drums with a maximum of 200 grams of WG Pu each are postulated to be involved in the fire. This amounts to a total MAR of 600 grams of WG Pu.

991 Fire 2 - Fire Inside Building 991 Office Area– This is a fire that starts in the office area and generates enough heat and combustion products to cause heating of containers, pyrolizing container contents, and subsequent venting (through failed lid seals) of 560 TRU drums stored in Room 134 containing radioactive material. The heat of the fire is expected to overcome the Building 991 filter plenum resulting in a lofted plume. A conservative total of 560 drums with a maximum of 200 grams WG Pu each are postulated involved in the fire. This amounts to a total MAR of 112,000 grams of WG Pu.

991 Fire 3 - Truck Fire at Dock – This is a fire that affects the inventory transported to the building in two transport vehicles. The bounding scenario involves thirty-six (18 per transport truck/trailer) 55-gallon TRU drums each containing a maximum of 200 grams of WG Pu. This amounts to a total MAR of 7,200 grams of WG Pu. The intense fire is postulated to result in a lofted plume.

991 Fire 4 - Wooden LLW Crate Fire - This is a fire involving the wooden LLW crates stored under the Building 991 canopy. Two cases are evaluated. In Case A only one of the wooden LLW crate is involved in the fire. Each LLW crate is assumed to contain up to three grams WG Pu, therefore the MAR for Case A is 3 grams (1 LLW crate x 3 grams/crate). This size fire is postulated to result in a non-lofted plume. In Case B, all of the wooden LLW crates are assumed involved in the fire. The dry pipe sprinkler system is assumed to not control the fire. Each LLW crate is assumed to contain up to three grams WG Pu. This amounts to a total MAR of 150 grams of WG Pu (50 LLW crates x 3 grams/crate). The intense fire is postulated to result in a lofted plume.

4.5.2.1 991 Fire 1 - Fire Inside Building 991 Waste Storage Area

This accident scenario is summarized in Table 4-10, with a detailed explanation following the table.

Table 4-10 991 Fire 1 - Fire Inside Building 991 Waste Storage Area

Hazard		Containerized WG Pu					
Accident Type		Small fire involving 3 TRU waste drums. Effective MAR = 600 grams WG Pu					
Cause or Energy Source		Electrical equipment failures, maintenance activities. Fire in combustibles near the waste containers results in pyrolysis of waste inside the containers					
Applicable Activity		Waste Storage					
Receptor	**Scenario Frequency**[1]	**Consequence**[2]	**Risk Class**[3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A,** *TSRs*
MOI	Unlikely (10^{-4} - 10^{-2})	Moderate (0.24 rem)	II	Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				DOT Containers	P	M	AOL 1, 2
				Container Fissile Material Loading	P	M	AOL 4
				Automatic Sprinkler System [4]	D	M	LCO 3.1
				Fire Alarm Transmittal/Fire Department Response	D	M	LCO 3.1, AOL 9
				Fire Phones/Fire Department Response	D	M	AOL 9
				Fire Protection	D	P	PAC 6
				Filtered Exhaust Ventilation	D	M	AOL 10
				Building Structure	P	P	Design Feature
Collocated Worker	Unlikely (10^{-4} - 10^{-2})	High (33 rem)	I	Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				DOT Containers	P	M	AOL 1, 2
				Container Fissile Material Loading	P	M	AOL 4
				Automatic Sprinkler System [4]	D	M	LCO 3.1
				Fire Alarm Transmittal/Fire Department Response	D	M	LCO 3.1, AOL 9
				Fire Phones/Fire Department Response	D	M	AOL 9
				Fire Protection	D	P	PAC 6
				Filtered Exhaust Ventilation	D	M	AOL 10
				Building Structure	P	P	Design Feature
Immediate Worker	Unlikely (10^{-4} - 10^{-2})	Low	III	Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				DOT Containers	P	M	AOL 1, 2
				Container Fissile Material Loading	D	M	AOL 4
				Local Fire Alarms	P	M	LCO 3.1, AOL 9
				Emergency Response	P	M	PAC 4
				Training	D	M	PAC 14

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures, [4] In applicable areas.

Accident Scenario

A fire is postulated to occur in any of the TRU waste storage areas in the Building 991 Complex. The fire is postulated to occur in combustibles in proximity to the waste containers due to administrative control failures allowing combustibles to accumulate and to be placed near the waste containers. The fire could be initiated by either an electrical equipment failure or a maintenance activity. The fire causes heating of the waste containers and their contents, pyrolizing of the container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals. A violent loss of the drum lid from overpressure of the container is not postulated to occur due to the relatively slow heating rate of a solid combustible material fire (versus a flammable liquid pool fire which can cause lid loss) and due to the relatively low heat flux and total heat energy associated with the limited amount of combustibles. Therefore, this fire is analyzed as a confined material release. Due to the limited amount of total heat energy associated with a small fire, a ground-level (non-lofted) release of the radioactive material is conservatively assumed. The fire is conservatively assumed to be of short duration such that a release over 10 minutes is analyzed.

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) fire occurrence is generally considered to be an *anticipated* event although not as frequent as once per year, (2) the amount of combustible material allowed to accumulate in waste storage areas is limited by an administrative control, (3) the placement of combustible materials near waste containers is restricted by an administrative control, and (4) the scenario postulates not only the failure of two attributes of an administrative control program but also the coincident ignition of the combustible material that is non-compliant. The administrative control program attributes restricting amount and location of combustibles in waste storage areas are covered under a credited Fuel and Combustible Loading control. Fires that are exterior to the building (e.g., range fires, vehicle fires, stored/staged combustible material fires near the building) are prevented from propagating into the building and creating a similar scenario by the credited exterior building structure design feature.

Material-at-Risk

Only three 55-gallon TRU waste drums are postulated to be involved in the fire due to: (1) the limited combustible material postulated to be involved in the fire and (2) the low container-to-container heat transmission associated with waste storage containers that are permitted to be received and stored in the Building 991 Complex and the subsequent limited fire propagation potential. It is assumed that there is a failure of a Fuel and Combustible Loading control which results in a limited amount of combustible material being in the proximity of TRU waste drums. Solid combustible material is postulated to be stacked in the proximity of two TRU waste drums but, to be conservative, it is assumed that three TRU waste drums are impacted by the fire. Liquid combustible material (less likely to be used in the facility) is postulated to spill under or around three TRU waste drums. The limited amount of liquid postulated for the scenario is not sufficient to lead to drum lid loss as would be expected in a larger pool fire. The fire is postulated to be of sufficient size to heat the contents of three drums. It is conservatively assumed that the entire inventory of each of the three TRU waste drums is involved in an interior smoldering fire and is subject to release from the drums by venting through failed drum lid seals. An administrative control is credited for limiting the drum contents to a maximum of 200 grams of WG Pu (or equivalent). Therefore, the total effective MAR for the postulated small fire scenario involving three TRU waste drums is 600 grams of WG Pu (or equivalent).

In summary, the Fuel and Combustible Loading control was credited for scenario frequency reduction but also is credited to mitigate the scenario consequences by limiting the amount of combustible material involved in the fire. The resistance of the waste containers to fire propagation and impact is credited to mitigate the scenario consequences by limiting the fire to three TRU waste drums. The credited control dealing with waste container strength and fire resistance restricts waste containers that do not meet on-site shipping specifications and/or DOT specifications from being in the facility (shortened to "DOT Containers" control in the text and tables). This control also restricts SNM from the facility that is not contained in a certified DOT Type B shipping container, which is credited for being resistant to small fires. No analysis of SNM releases for fire scenarios is performed as a result of crediting Type B shipping container resistance to fire. The scenario consequences are also mitigated by a credited Container Fissile Material Loading control limiting the inventory of waste drums to 200 grams of WG Pu (or equivalent). This control further limits waste crates to 320 grams of WG Pu (or equivalent) which results in a three TRU waste drum fire bounding a single waste crate fire.

Accident Consequence

The radiological dose consequences of a fire involving three 55-gallon TRU waste drums are *moderate* (0.24 rem) to the MOI and *high* (33 rem) to the collocated worker. As stated above, the small fire scenario is analyzed as a confined material release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class II for the MOI (*unlikely* frequency, *moderate* consequence) and is Risk Class I for the collocated worker (*unlikely* frequency, *high* consequence).

For immediate workers in the facility at the time of the fire, a fire of this magnitude could hypothetically cause serious injury (*moderate* consequences) to the immediate worker through smoke inhalation or burns if the worker is in the vicinity of the fire. Immediate workers in the facility but not near the fire should have *low* consequences from the fire. The radiological dose consequences for either category of immediate worker are qualitatively judged to be *low* due to: (1) the limited radiological material that is released, (2) the indicators of a fire (e.g., smoke, fire alarms, flames) which informs the immediate worker of the event, and (3) the building emergency plan which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Local Fire Alarms control (from smoke detectors and fire phones resulting in building alarms) and the Emergency Response control (development of a building emergency plan). These two controls tend to lower the fire, non-radiological consequences to *low*, as well. The resulting risk class for the scenario is Risk Class III for the immediate worker (*unlikely* frequency, *low* consequence).

Control Set Adequacy/Vulnerability

The postulated small fire in a waste storage area is considered to be an *unlikely* event with *high* consequences for the collocated worker, *moderate* consequences for the MOI (public), and *low* consequences for the immediate worker. The risk classes for the collocated worker and the MOI are Risk Class I and Risk Class II, respectively. The immediate worker has a Risk Class III scenario result which is considered to be acceptable.

Acceptability of the risk class results for the collocated worker and the MOI is based on the conservatism that is assumed in the analysis. If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the collocated worker and MOI consequences would be *moderate* and *low*, respectively. This would yield a reduction in the corresponding risk class for both the collocated worker and the MOI. If an average MAR (approximately a factor of 3 reduction in MAR) were used in the analysis, the MOI consequences would be reduced to *low* yielding a Risk Class III scenario.

The waste storage areas for the Building 991 Complex have filtered exhaust ventilation. The small fire in a waste storage area is not expected to challenge the ventilation system's ability to maintain a negative building pressure (because of no significant building pressure increase from heating by the small fire) or to filter exhaust air (because of limited particulate to blind/block filters). The Building 991 exhaust goes through one stage of HEPA filtration and the vault and tunnel waste storage areas exhaust through two stages of HEPA filtration. Crediting a filter efficiency of only 0.9 (tested stages credit an efficiency of 0.999) would reduce the risk class for both the MOI and the collocated worker by one level. Crediting a filter efficiency of 0.99 would lower all receptor risks to a Risk Class III level. If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0.1 which yields a result equivalent to crediting a HEPA filter efficiency of 0.9.

Another conservatism deals with the event likelihood. Failure of combustible material controls is not a low probability event and fire occurrences in the facilities are not low probability events. However, this scenario assumes the coincident occurrence of both; i.e., the combustible material control fails **and** a fire starts while the control failure goes unnoticed and uncorrected **and** the fire occurs at the location of the combustible material that is non-compliant. This sequence of events could be argued to yield an accident scenario frequency of *extremely unlikely*. Reducing the frequency bin assignment would lower the risk class for the immediate worker, the collocated worker, and the MOI by one level.

A limited failure of the credited preventive controls (primarily the Fuel and Combustible Loading control) is considered in the determination of the *unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *extremely unlikely* frequency bin assignment for the scenario. This automatically reduces the risk class for the collocated worker to Risk Class II, regardless of increased consequences from the failure of a mitigative control. The MOI risk class for this sequence is reduced to Risk Class III as long as dose consequences do not increase by more than a factor of 20. The immediate worker risk class for the sequence is reduced to Risk Class IV if the qualitative consequence assignment remains *low*, otherwise, the risk class will remain at Risk Class III.

Double batching of the TRU waste drum fissile material inventory (failure of the Container Fissile Material Loading control) would only increase the MOI dose to approximately 0.5 rem (*moderate* consequence), still a factor of 10 lower than that needed for a change to *high* consequences.

Failure of the DOT Container control could lead to more container involvement in the fire or higher release fractions due to container failures. It is not expected that a failure of the DOT Container control would yield containers with a potential for container-to-container fire propagation. Non-compliant container failure due to overpressure is more likely and could yield an increase in release fraction of more than a factor of 20. This type of failure could yield a Risk Class II scenario for the MOI, which is the same risk level as the un-failed mitigation scenario but is a *high* consequence for the MOI. Depending on the magnitude of the container overpressure, an immediate worker in the vicinity of the fire could be seriously injured (*moderate* consequence) or killed (*high* consequence). However, the immediate worker is expected to evacuate which should remove the individuals from the vicinity of the fire long before the container failure occurs. This is more of an issue with emergency response personnel safety.

Failure of the mitigative portion of the Fuel and Combustible Loading control (limiting the amount of combustibles) would imply a gross failure of the control. That is, the amount of combustibles would have to be large enough to impact more than two or three TRU waste drums or the type of combustible material would have to be flammable liquid in significant quantities. In this situation, more drums could be involved and/or a higher release fraction could be realized in the scenario. A failure of the flammable liquid control is judged to be less likely than a larger quantity of solid combustible material, however, the impact of a flammable liquid would be high due to a potential increase of two orders of magnitude in the release fraction associated with the event. This situation is similar to that discussed for the non-compliant container failure due to overpressure in that a MOI Risk Class II scenario could result with a *high* consequence for the MOI. It is expected that the resulting MOI dose consequence would be less than 24 rem as a result of either: (1) more drums being involved with the same release fraction (less than one order of magnitude increase in MOI dose, <2.4 rem) or (2) the same or similar number of drums being involved with a higher release fraction (unconfined material (pool fire) release versus confined material release) for one or two of the drums (less than a two order of magnitude increase in MOI dose, <24 rem).

The failure of the mitigative portion of the Fuel and Combustible Loading control can result in a larger fire which could yield a *moderate* consequence for the immediate worker (see 991 Fire 2). This would yield a Risk Class III scenario for the immediate worker.

The failure of the Local Fire Alarms and Emergency Response controls would tend to keep immediate worker consequences at a *moderate* consequence level (still have smoke detection by the individual or observation of flames). In this case, at worst, the immediate worker risk class would be Risk Class III.

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis:

- Automatic Sprinkler System: If the fire becomes larger due to failures of mitigative controls, the potential for the automatic sprinkler system to actuate and mitigate scenario consequences increases in those areas covered by the system. The small fire analyzed may not actuate the sprinkler system.

- Fire Alarm Transmittal/Fire Department Response: For fires in areas covered by smoke detectors, fire alarm transmittal to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. Smoke detection capability can identify fires in early stages of growth.

- Fire Phones/Fire Department Response: For fires discovered by building personnel, fire phone communication to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. Building personnel can also identify fires in early stages of growth.

- Fire Protection: The Fire Protection program is an additional control which can reduce the likelihood of fires by ignition source controls and building surveillances/tours.

- Filtered Exhaust Ventilation: The filtered exhaust ventilation systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the collocated worker and the MOI.

- Training: The immediate worker Training program is an additional control which can reduce immediate worker consequences as a reinforcement of the emergency response evacuation guidance.

- Container Fissile Material Loading: The Container Fissile Material Loading control is an additional control in the immediate worker control set that tends to lower the immediate worker radiological dose consequences, which are not expected to be of significance.

As noted, two of these defense-in-depth controls can identify early stages of slow growth fires which allows more opportunity for mitigation by the Fire Department. Areas covered by smoke detectors would benefit from these type of controls because most fires smolder before becoming significant enough to impact waste drums. The smoldering fire generates smoke which can activate the alarm and instigate response.

In summary, failures of individual mitigative controls concurrent with the accident do not increase the risk class of the scenario for the MOI, the immediate worker, or the collocated worker. For many cases, there is a risk class reduction for the MOI from Risk Class II to Risk Class III associated with the concurrent failures scenario; the remaining cases have no change in the MOI risk class. It is not expected that failures of mitigative controls will yield MOI doses in excess of 24 rem. Similarly, for many cases, there is a risk class reduction for the immediate worker from Risk Class III to Risk Class IV associated with the concurrent failures scenario; the remaining cases have no change in the immediate worker risk class. In all cases, collocated worker risk class is reduced from Risk Class I to Risk Class II.

4.5.2.2 991 Fire 2 - Fire Inside Building 991 Office Area

This accident scenario is summarized in Table 4-11, with a detailed explanation following the table.

Table 4-11 991 Fire 2 - Fire Inside Building 991 Office Area

Hazard	Containerized WG Pu						
Accident Type	Large fire involving 560 TRU waste drums. Effective MAR = 112,000 grams WG Pu						
Cause or Energy Source	Electrical equipment failures, maintenance activities. Fire in the office area of Building 991 results in pyrolysis of waste inside waste containers from indirect heating.						
Applicable Activity	Waste Storage						
Receptor	**Scenario Frequency**[1]	**Consequence**[2]	**Risk Class**[3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Unlikely (10^{-4} - 10^{-2})	Moderate (4.4 rem)	II	Automatic Sprinkler System	P	P	LCO 3.1
				DOT Containers	P	M	AOL 1, 2
				Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				Container Fissile Material Loading	P	M	AOL 4
				Fire Alarm Transmittal/Fire Department Response	D	M	LCO 3.1
				Fire Phones/Fire Department Response	D	M	AOL 9
				Fire Protection	D	P	PAC 6
				Building Structure	P	P	Design Feature
Collocated Worker	Unlikely (10^{-4} - 10^{-2})	High (150 rem)	I	Automatic Sprinkler System	P	P	LCO 3.1
				DOT Containers	P	M	AOL 1, 2
				Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				Container Fissile Material Loading	P	M	AOL 4
				Fire Alarm Transmittal/Fire Department Response	D	M	LCO 3.1
				Fire Phones/Fire Department Response	D	M	AOL 9
				Fire Protection	D	P	PAC 6
				Building Structure	P	P	Design Feature
Immediate Worker	Unlikely (10^{-4} - 10^{-2})	Moderate	II	Automatic Sprinkler System	P	P	LCO 3.1
				DOT Containers	P	M	AOL 1, 2
				Fuel and Combustible Loading	P	P/M	AOL 8, PAC 6
				Container Fissile Material Loading	D	M	AOL 4
				Local Fire Alarms	P	M	LCO 3.1, AOL 9
				Emergency Response	P	M	PAC 4
				Training	D	M	PAC 14
				Building Structure	P	P	Design Feature

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

<u>Accident Scenario</u>

A large fire is postulated to occur in a non waste-storage area of Building 991 (e.g., office area). The large fire occurs in a non waste-storage area rather than a waste storage area because of the lack of combustible loading in waste storage areas. As an example, the fire is postulated to occur in general office area combustibles (e.g., wooden desks, paper, computer equipment plastics) and does not necessarily involve a failure of an administrative control dealing with combustible material controls. The fire could be initiated by either an electrical equipment failure or a maintenance activity. The fire would create hot gases and combustion products that would flow into contiguous waste storage areas (e.g., Room 134, Room 166); thereby heating the waste containers, pyrolizing the container contents, and subsequently venting container gases containing radioactive material through failed container lid seals. The impacted waste storage area is conservatively postulated to heat from the ceiling to the floor. The room temperatures are postulated to reach levels high enough to pyrolize all container contents. A violent loss of drum lids from overpressure of the containers is not postulated to occur due to the relatively slow heating rate from the hot gases (versus a flammable liquid pool fire which can cause lid loss) and due to the lower temperatures expected in waste storage area versus the non waste-storage area where the fire originated. Therefore, this fire is analyzed as a confined material release. Due to the significant amount of total heat energy associated with a large fire, a lofted release of the radioactive material is assumed via the building ventilation exhaust or building leakage/breach. The fire is assumed to be of long duration such that a release over 60 minutes is analyzed. This internal, large fire can only occur if the Building 991 Automatic Sprinkler System does not operate. Operation of the sprinkler system will preclude the flow of hot gases (of high enough temperature to impact waste container contents) into waste storage areas and will restrict the fire damage to the area of origination.

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) fire occurrence is generally considered to be an *anticipated* event although not as frequent as once per year, (2) the amount of combustible material allowed to accumulate in non waste-storage areas is generally limited by an administrative control but not to the extent to preclude a large fire, and (3) the large fire can only occur if the Automatic Sprinkler System fails. The administrative control program attribute restricting the amount of combustibles in non waste-storage areas is covered under a credited Fuel and Combustible Loading control. This control is not credited with much scenario frequency reduction but is credited to limit the size of the fire to within the capacity of the Automatic Sprinkler System. The Automatic Sprinkler System is credited with suppressing any fire in the non waste-storage areas to a level such that waste containers in the facility are not impacted. The Automatic Sprinkler System is covered under a Limiting Condition for Operation (LCO) with corresponding Surveillance Requirements. The LCO-driven maintenance of the system improves the overall system availability and reliability. The failure of this system is conservatively assumed to only reduce scenario frequency by one frequency bin. Fires that are exterior to the building (e.g., range fires, vehicle fires, stored/staged combustible material fires near the building) are prevented from propagating into the building and creating a similar scenario by the credited exterior building structure design feature.

Material-at-Risk

The Building 991 Fire Hazards Analysis (FHA) conservatively assumes that a maximum possible fire loss for any fire area will involve all the combustible material in the fire area if the suppression system does not operate. The fire area of interest is the south portion of Building 991 and includes the Room 134 and Room 166 waste storage areas. The extreme conservatism of the FHA is not carried over to this safety analysis. It is assumed that the fire in a non waste-storage area of the south portion of Building 991 will only impact a single waste storage area due to: (1) the lack of significant combustible material in waste storage areas which limits the amount of heat generation in the waste storage areas, (2) the relatively low likelihood that hot gases and combustion products from a non waste storage area will flow into multiple waste storage areas that are separated by distance, walls, and doors (not rated fire barriers but still provide some barrier to hot gases, hot gas flow is likely to follow ventilation system flow), (3) the size of the waste storage areas being large enough to limit the impact of hot gas influx, and (4) the expectation that a significant portion of the hot gases will exit the facility via the ventilation system or building leakage and/or breach (windows on the south wall).

The waste storage area with the most waste container storage capacity in the south fire area of Building 991 is conservatively chosen to be the waste storage area that is impacted by the non waste-storage area fire. Room 134 has the highest storage capacity in the south portion of Building 991. Rooms 140 and 141, in the north fire area of Building 991, have a larger combined floor space but have some limitations on stack height due to equipment near the ceiling. The number of waste drums that can be stored in Room 140/141 may exceed the number that can be stored in Room 134, but not by a significant amount. Since the combustible loading of the north fire area of the building is less than that found in the south area (making large fires less likely and/or less impacting in the north fire area) a large fire impacting Room 134 was selected as the bounding case.

It is conservatively assumed that up to 560 55-gallon TRU waste drums, stacked four high, may be stored in Room 134. Assuming that only TRU waste drums are stored in the room, rather than a combination of drums and waste crates, results in a maximum MAR for the room. It is conservatively assumed that the entire inventory of each of the 560 TRU waste drums in the room is involved in an interior smoldering fire and is subject to release from the drums by venting through failed drum lid seals. An administrative control is credited for limiting the drum contents to a maximum of 200 grams of WG Pu (or equivalent). Therefore, the total effective MAR for the postulated large fire scenario involving 560 TRU waste drums is 112,000 grams of WG Pu (or equivalent).

In summary, the Fuel and Combustible Loading control was credited for scenario frequency reduction but also is credited to mitigate the scenario consequences by limiting the amount of combustible material in the waste storage area which maintains the conservatism associated with the drum release fraction. The resistance of the waste containers to hot gas impact is credited to mitigate the scenario consequences by limiting the release fraction from the drums to that associated with a confined material release. The credited control dealing with waste container strength and fire resistance restricts waste containers that do not meet on-site shipping specifications and/or DOT specifications from being in the facility (shortened to "DOT Containers" control in the text and tables). This control also restricts SNM from the facility that is not contained in a certified DOT Type B shipping container, which is credited for being resistant to the effects of hot gases from a large fire (leads to no analysis of SNM releases for fire scenarios). The scenario consequences are also mitigated by a credited Container Fissile Material Loading control limiting the inventory of waste drums to 200 grams of WG Pu (or equivalent). This control further limits waste crates to 320 grams of WG Pu (or equivalent) which results in a 560 TRU waste drum fire bounding a combination of waste drum and waste crate fire.

Accident Consequence

The radiological dose consequences of a fire involving 560 55-gallon TRU waste drums are *moderate* (4.4 rem) to the MOI and *high* (150 rem) to the collocated worker. As stated above, the large fire scenario is analyzed as a confined material release, lofted plume, 60 minute duration accident scenario. The resulting risk class for the scenario is Risk Class II for the MOI (*unlikely* frequency, *moderate* consequence) and is Risk Class I for the collocated worker (*unlikely* frequency, *high* consequence).

For immediate workers in the facility at the time of the fire, a fire of this magnitude could hypothetically cause a fatality (*high* consequences) to the immediate worker through smoke inhalation, burns, or heat if the worker is in the vicinity of the fire. Immediate workers in the facility but not near the fire could suffer serious injury (*moderate* consequences) from smoke inhalation, depending on the smoke migration in the facility. The radiological dose consequences are qualitatively judged to be *low*, for immediate workers that are not incapacitated by the fire, due to: (1) the limited radiological material that is released in areas where the immediate worker could be without suffering significant consequences from the fire (i.e., the radiological source term will follow the hot gas plume; if the immediate worker is located in the hot gas plume, the radiological impact would be minor compared to the physical impact of the hot gases), (2) the indicators of a fire (e.g., smoke, fire alarms, flames) which informs the immediate worker of the event, and (3) the building emergency plan which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Local Fire Alarms control (from smoke detectors and fire phones resulting in building alarms) and the Emergency Response control (development of a building emergency plan). The two controls tend to lower the fire, non-radiological consequences to *moderate*. The resulting risk class for the scenario is Risk Class II for the immediate worker (*unlikely* frequency, *moderate* consequence).

Control Set Adequacy/Vulnerability

The postulated large fire in a non waste-storage area is considered to be an *unlikely* event with *high* consequences for the collocated worker, *moderate* consequences for the MOI (public), and *moderate* consequences for the immediate worker. The risk classes for the collocated worker and the MOI are Risk Class I and Risk Class II, respectively. The immediate worker has a Risk Class II scenario result.

Acceptability of the risk class results for the immediate worker, the collocated worker, and the MOI is based on the conservatism that is assumed in parts of the analysis. Elements of the analysis that were conservative assumptions for the small fire (991 Fire 1) are not necessarily conservative assumptions for the large fire. These elements will be discussed below along with the actual conservatism assumptions for the large fire scenario.

If a median χ/Q value (approximately a factor of 4 reduction in atmospheric dispersion for the MOI and over a two order of magnitude reduction in atmospheric dispersion for the collocated worker) were used in the analysis, the collocated worker consequences would be *moderate* and the MOI consequences would remain *moderate*. This would yield a reduction in the corresponding risk class for the collocated worker. Use of an average MAR (approximately a factor of 3 reduction in MAR) does not have a significant enough effect to reduce collocated worker or MOI consequences but is more representative of the actual situation given the large number of drums involved in the scenario. However, the conservatism in using limiting MAR values for drums and assuming all 560 drums are impacted is a conservatism that may yield an order of magnitude to two orders of magnitude increase over actual consequences. This conservatism, while not quantified, could yield reductions in both the collocated worker and the MOI risk classes.

The waste storage areas for the Building 991 Complex have filtered exhaust ventilation. The large fire in a non waste-storage area is expected to challenge the ventilation system's ability to maintain a negative building pressure (because of significant building pressure increase from heating by the large fire) or to filter exhaust air (because of significant particulate to blind/block filters). No benefit is expected to be gained by consideration of the building ventilation and filtration system. If the Automatic Sprinkler System fails as part of the scenario, it is likely that the Building 991 plenum deluge is also failed (use the same riser) which will challenge the HEPA filters with hot exhaust gases. Similarly, no benefit is expected to be gained under ambient building conditions. An ambient building leakpath factor for the building under large fire conditions may almost be 1.0 due to the pressurization of the building by the hot gases and fire.

Event likelihood is a conservatism in the analysis. Fire occurrences in the facilities are not low probability events. However, this scenario assumes the occurrence of a fire in the office area **and** no personnel are either available or notice the fire and inform the Fire Department (likely on off shifts but less chance of fire initiation when no one is working) **and** the failure of the Automatic Sprinkler System (relatively passive device with high reliability) **and** the fire is large enough to impact waste containers (significant hot gas temperatures) in rooms separated from the fire by distance, walls, and doors. This sequence of events could be argued to yield an accident scenario frequency of *extremely unlikely*. Reducing the frequency bin assignment would lower the risk class for the immediate worker, the collocated worker, and the MOI by one level.

A limited failure of the credited preventive controls (primarily the Automatic Sprinkler System, secondarily the Fuel and Combustible Loading control) is considered in the determination of the *unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *extremely unlikely* frequency bin assignment for the scenario. This automatically reduces the risk class for the collocated worker to Risk Class II, regardless of increased consequences from the failure of a mitigative control. The MOI risk class for this sequence is reduced to Risk Class III as long as dose consequences do not increase by more than 10%. The immediate worker risk class for the sequence is reduced to Risk Class III if the qualitative consequence assignment remains *moderate*, otherwise, the risk class will remain at Risk Class II.

Double batching of the TRU waste drum fissile material inventory (failure of the Container Fissile Material Loading control) would increase the MOI dose to approximately 9 rem (*high* consequence) which would result in a return of the MOI risk class to Risk Class II. However, the likelihood of a double batching of all 560 drums involved in the postulated accident would result in an *incredible* frequency assignment for the scenario. It takes approximately 10% of the drums to be double batched to yield a *high* MOI consequence. This would represent a gross failure of the Container Fissile Material Loading control and still is qualitatively judged to yield an *incredible* scenario. More likely numbers of double batched drums would not impact the MOI consequence sufficiently to raise the original *moderate* consequence assessment.

Failure of the DOT Container control could lead to higher release fractions due to container failures. Non-compliant container failure due to overpressure is possible and could yield an increase in release fraction of up to two orders of magnitude. In the worst case (use of unconfined combustible material release fraction due to complete drum failure and ejection of drum contents from exposure to hot gases), only one drum (0.1% of the containers) has to be non-compliant to increase the MOI consequences to *high*. This type of failure could yield a Risk Class II scenario for the MOI, which is the same risk level as the un-failed mitigation scenario but is a *high* consequence for the MOI. Assuming that 6 drums of the 560 drums are non-compliant (roughly 1%), the MOI dose consequences would be less than 10 rem. Depending on the magnitude of the container overpressure, an immediate worker in the vicinity of the fire could be seriously injured (*moderate* consequence) or killed (*high* consequence). However, the immediate worker is expected to evacuate, which should remove the individuals from the vicinity of the fire long before container failures occur. This is more of an issue with emergency response personnel safety.

Failure of the mitigative portion of the Fuel and Combustible Loading control (limiting the amount of combustibles) would imply a gross failure of the control. That is, the amount of combustibles would have to be large enough to make the Automatic Sprinkler System ineffective in fire mitigation. Since the failure of the Automatic Sprinkler System is included in the scenario frequency bin assignment (original frequency bin assignment of *unlikely* due to sprinkler system reliability), the gross failure of the Fuel and Combustible Loading control in conjunction with an inadequate Automatic Sprinkler System may be of similar frequency, rather than being an *extremely unlikely* event. That is, the likelihood of the initial fire is *anticipated*, and when this is combined with a gross failure of the Fuel and Combustible Loading control, the sequence frequency bin is only *unlikely*. This is a result of the "common cause" failure of the administrative control and the hardware control (the administrative control failure can lead to the hardware control failure). The resulting consequences and risk classes for the collocated worker and the MOI remain the same, in this case. However, it could be argued that such a gross failure of the Fuel and Combustible Loading control (combustible loading overwhelms the sprinkler system) would be an *extremely unlikely* event. In this case, the risk classes for all three receptors would be reduced by one level.

The failure of the Local Fire Alarms and Emergency Response controls would tend to keep immediate worker consequences at a *high* consequence level (still have smoke detection by the individual or observation of flames but delayed egress may be impacted by the size and location of the fire). In this case, at worst, the immediate worker risk class would be Risk Class II.

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis:

- Fire Alarm Transmittal/Fire Department Response: For fires in areas covered by smoke detectors, fire alarm transmittal to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. Smoke detection capability can identify fires in early stages of growth.

- Fire Phones/Fire Department Response: For fires discovered by building personnel, fire phone communication to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. Building personnel can also identify fires in early stages of growth.

- Fire Protection: The Fire Protection program is an additional control which can reduce the likelihood of fires by ignition source controls and building surveillances/tours.

- Training: The immediate worker Training program is an additional control which can reduce immediate worker consequences as a reinforcement of the emergency response evacuation guidance.

- Container Fissile Material Loading: The Container Fissile Material Loading control is an additional control in the immediate worker control set that tends to lower the immediate worker radiological dose consequences, which are not expected to be of significance.

As noted, two of these defense-in-depth controls can identify early stages of slow growth fires which allows more opportunity for mitigation by the Fire Department. Areas covered by smoke detectors would benefit from these type of controls because most fires smolder before becoming significant enough to impact waste drums. The smoldering fire generates smoke which can activate the alarm and instigate response.

In summary, failures of individual mitigative controls concurrent with the accident do not increase the risk class of the scenario for the MOI, the immediate worker, or the collocated worker. For many cases, there is a risk class reduction for the MOI from Risk Class II to Risk Class III associated with the concurrent failures scenario; the remaining cases have no change in the MOI risk class. It is not expected that failures of mitigative controls will yield MOI doses in excess of 10 rem. Similarly, for many cases, there is a risk class reduction for the immediate worker from Risk Class II to Risk Class III associated with the concurrent failures scenario; the remaining cases have no change in the immediate worker risk class. In all cases, collocated worker risk class is reduced from Risk Class I to Risk Class II associated with the concurrent failures scenario (unless a failure of the Fuel and Combustible Loading control leading to a "common cause" sprinkler system failure is an *unlikely* rather than an *extremely unlikely* event).

4.5.2.3 991 Fire 3 - Trailer/Truck Fire at Dock

This accident scenario is summarized in Table 4-12, with a detailed explanation following the table.

Table 4-12 991 Fire 3 - Trailer/Truck Fire at Dock

Hazard		Containerized WG Pu.					
Accident Type		Vehicle fire on west dock involving two trailer/truck loads, 36 TRU waste drums. Effective MAR = 7,200 grams WG Pu					
Cause or Energy Source		Vehicle fire (equipment failure) breaches fuel tanks, fuel spreads beneath both trailers/trucks at the dock. Fire results in pyrolysis of waste inside outer waste containers on truck beds.					
Applicable Activity		Waste Transport					
Receptor	**Scenario Frequency**[1]	**Consequence**[2]	**Risk Class**[3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Extremely Unlikely ($<10^{-4}$)	Moderate (0.40 rem)	III	Container Fissile Material Loading	P	M	AOL 4
				DOT Containers	P	M	AOL 1, 2
				Fire Phones/Fire Department Response	D	M	AOL 9
				Vehicle Inspection Program	P	P	PAC 15
				Automatic Sprinkler System	P	M	LCO 3.1
				Building Structure	P	M	Design Feature
Collocated Worker	Extremely Unlikely ($<10^{-4}$)	Moderate (14 rem)	III	Container Fissile Material Loading	P	M	AOL 4
				DOT Containers	P	M	AOL 1, 2
				Fire Phones/Fire Department Response	D	M	AOL 9
				Vehicle Inspection Program	P	P	PAC 15
				Automatic Sprinkler System	P	M	LCO 3.1
				Building Structure	P	M	Design Feature
Immediate Worker	Extremely Unlikely ($<10^{-4}$)	Low	IV	Container Fissile Material Loading	D	M	AOL 4
				DOT Containers	P	M	AOL 1, 2
				Local Fire Alarms	D	M	LCO 3.1, AOL 9
				Vehicle Inspection Program	P	P	PAC 15
				Emergency Response	P	M	PAC 4
				Training	D	M	PAC 14
				Automatic Sprinkler System	P	M	LCO 3.1
				Building Structure	P	M	Design Feature

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

<u>Accident Scenario</u>

A fire is postulated to occur involving multiple drums on two transport trailers/trucks parked at one of the dock areas. The fire could be initiated by a vehicle engine fire, fuel tank failure, or some other electrical/mechanical failure of a vehicle. The fire either is caused by or results in the failure of the fuel tank of one of the vehicles, allowing the fuel to flow under both trailer cargo beds. The fire causes damage/failure of the sides of the trailers/trucks and heats the waste containers and their contents. The heating pyrolizes the container contents and subsequently vents the container gases containing radioactive material. The trailer/truck bed is assumed to remain intact, shielding the bottoms of the waste containers from direct exposure to the fuel fire. Waste containers (drums) located in the center of the trailer/truck bed are shielded by the outer set of drums from the radiant heat and direct flame impingement of the fire (Ref. 59). A violent loss of the drum lid from overpressure of the container, for the containers impacted by the fire, is not postulated to occur due to the distance that the containers are from the fuel pool (on trailer bed rather than on the ground) and the indirect exposure to the flames of the fire (trailer bed serves to prevent direct flame exposure on most of the drum surface). Therefore, this fire is analyzed as a confined material release. Due to the amount of total heat energy associated with a fuel fire and due to the lack of confinement for a dock fire, a lofted release of the radioactive material is assumed. The fire is expected to be intense (rapid combustion of fuel) and is conservatively assumed to be of short duration such that a release over 10 minutes is analyzed.

Accident Frequency

Vehicle electrical or mechanical failures could act as initiators for vehicle fires. Historically, the Site has observed only one government owned vehicle, a security "sport utility" vehicle, being involved in a fire. Several private vehicle fires, on or near the Site, have also been reported. None of these events involved vehicle gas tank contents (Ref. 60). The likelihood of this postulated accident scenario is judged to be *extremely unlikely* based on the following considerations: (1) vehicle fires are generally considered *anticipated* events although not as frequent as once per year, (2) well maintained vehicles, as required by an administrative control, should be less likely to have a fire, (3) the vehicle fire would have to occur while parked at a dock, (4) the fire would have to be caused by or result in the failure of the vehicle fuel tank, (5) the fuel from the breached fuel tank would have to pool under the trailers of the trucks in a manner to impact waste containers, (6) the cargo beds of the trailers/trucks would have to contain waste containers, and (7) the fire would have to enough fuel and be sufficiently intense to impact waste containers that are shielded by the trailer bed. Maintenance and inspection of vehicles used at the Site is an attribute of the Transportation program and is covered under a credited Vehicle Inspection Program control. This control is credited with ensuring that vehicle fires and fuel tank breaches due to equipment degradation are infrequent events.

Material-at-Risk

Waste container shipments are assumed to contain either 30 waste drums or 10 waste crates. In a waste crate shipment fire, all ten waste crates are conservatively assumed to be impacted by the fire. In a waste drum shipment fire, only eighteen of the thirty waste drums are assumed to be impacted by the fire; all inner drums that are shielded from the flames are not impacted and their contents do not pyrolize. Drums are loaded in rows of four (seven rows of four drums and one row of two drums). The outer drums of each row are assumed to be impacted by the fire (fourteen drums for the seven full rows and each drum of the partial row, sixteen drums). The first row (near the front of the trailer) inner drums are assumed to be shielded from the fire by the cab of the truck or front of the trailer. Depending on the manner of loading the last partial row, the two inner drums of the last full row may be shielded by the last two drums or may be exposed. It is assumed that the inner drums of the last full row are exposed giving a total of 18 drums impacted by the fire.

It is conservatively assumed that the entire inventory of each of the 18 waste drums or the 10 waste crates is involved in an interior smoldering fire and is subject to release from the waste containers by venting through failed container lid seals. An administrative control is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent) and for limiting TRU waste crate contents to a maximum of 320 grams of WG Pu (or equivalent).

Therefore, the total effective MAR for the postulated trailer/truck fire scenario on a single vehicle is 3,200 grams of WG Pu (or equivalent) in the case of a waste crate shipment and 3,600 grams of WG Pu (or equivalent) in the case of a waste drum shipment. The trailer/truck fire involving waste drums bounds the waste crate fire. Since two trailer/truck loads are involved in the postulated trailer/truck fire scenario, the total effective MAR for the analyzed trailer/truck fire scenario involving two trailers/trucks is 7,200 grams of WG Pu (or equivalent).

In summary, the resistance of the waste containers to fire propagation and impact is credited to mitigate the scenario consequences by limiting the fire to only 36 of the 60 waste drums on the two trailers/trucks. The credited control dealing with waste container strength and fire resistance restricts waste containers that do not meet on-site shipping specifications and/or DOT specifications from being received by the facility (shortened to "DOT Containers" control in the text and tables). This control also restricts SNM from being received by the facility that is not contained in a certified DOT Type B shipping container, which is credited for being resistant to this fire scenario (leads to no analysis of SNM releases for fire scenarios). The scenario consequences are also mitigated by a credited Container Fissile Material Loading control limiting the inventory of waste drums to 200 grams of WG Pu (or equivalent). This control further limits waste crates to 320 grams of WG Pu (or equivalent) which results in the TRU waste drum shipment fire bounding the waste crate shipment fire. The trailer/truck fire is prevented from propagating into the building and increasing the MAR for the scenario by the credited exterior building structure design feature. Since dock doors may be open at the time of the fire, the Automatic Sprinkler System is similarly credited for preventing trailer/truck fire propagation into the building through the potentially open dock doors.

Accident Consequence

The radiological dose consequences of a fire involving 36 55-gallon TRU waste drums are *moderate* (0.40 rem) to the MOI and *moderate* (14 rem) to the collocated worker. As stated above, the trailer/truck fire scenario is analyzed as a confined material release, lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class III for the MOI and the collocated worker (*extremely unlikely* frequency, *moderate* consequence).

For immediate workers on the dock at the time of the fire, a fire of this magnitude could hypothetically cause a fatality (*high* consequences) to the immediate worker through smoke inhalation, burns, or heat if the worker is in the vicinity of the fire. Immediate workers on the dock but not near the fire could suffer serious injury (*moderate* consequences) from smoke inhalation. The radiological dose consequences are qualitatively judged to be *low*, for immediate workers that are not incapacitated by the fire, due to: (1) the limited radiological material that is released in the vicinity of the immediate worker (i.e., the radiological source term will follow the lofted plume; if the immediate worker is located in the plume, the radiological impact would be minor compared to the physical impact of the hot gases), (2) the indicators of a fire (e.g., smoke, flames) which informs the immediate worker of the event, and (3) the building emergency plan which directs the immediate worker to evacuate the area. The immediate worker credited controls to mitigate consequences include the Emergency Response control (development of a building emergency plan). Immediate workers egress from the dock area should not be hampered by the fire in its early stages. Immediate workers in the facility are protected by the building structure and the Automatic Sprinkler System. These controls tend to lower the fire, non-radiological consequences to *low*. The resulting risk class for the scenario is Risk Class IV for the immediate worker (*extremely unlikely* frequency, *low* consequence).

Control Set Adequacy/Vulnerability

The postulated large trailer/truck fire at the dock is considered to be an *extremely unlikely* event with *moderate* consequences for the collocated worker and the MOI (public), and *low* consequences for the immediate worker. The risk class for the collocated worker and the MOI is Risk Class III. The immediate worker has a Risk Class IV scenario result. These risk class results are considered to be acceptable.

A failure of the credited preventive control (the Vehicle Inspection Program control) is considered in the determination of the *extremely unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *incredible* frequency bin assignment for the scenario. Therefore, mitigative control failures concurrent with the accident do not need to be considered in assessing the vulnerability of the control set.

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis:

- Fire Phones/Fire Department Response: If building personnel at the dock recognize the fire situation at a very early stage, fire phone communication to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. The rapid growth of this type of fire greatly impacts the ability of the Fire Department to respond in a timely manner.

- Local Fire Alarms: Local facility fire alarms, activated by the Automatic Sprinkler System operation, fire phone use, and smoke detector actuation, provide immediate workers with an indication that a fire is occurring and that evacuation is appropriate, reducing the radiological material uptake of the immediate worker.

- Training: The immediate worker Training program is an additional control which can reduce immediate worker consequences as a reinforcement of the emergency response evacuation guidance.

- Container Fissile Material Loading: The Container Fissile Material Loading control is an additional control in the immediate worker control set that tends to lower the immediate worker radiological dose consequences, which are not expected to be of significance.

In summary, failures of individual mitigative controls concurrent with the accident do not need to be considered due to the frequency of the resulting scenarios. Risk class results for this scenario are acceptable; Risk Class III or Risk Class IV.

4.5.2.4 991 Fire 4 - Wooden LLW Crate Fire

This accident scenario is summarized in Table 4-13, with a detailed explanation following the table.

Table 4-13 991 Fire 4 - Wooden LLW Crate Fire

Hazard	Containerized WG Pu.						
Accident Type	Case A: Fire involving 1 wooden LLW crate stored under Building 991 west dock canopy. Effective MAR = 3 grams WG Pu Case B: Fire involving 50 wooden LLW crates stored under Building 991 west dock canopy Effective MAR = 150 grams WG Pu						
Cause or Energy Source	Electrical equipment failures, maintenance activities, cigarettes. Fire in area consumes wooden LLW crates.						
Applicable Activity	Waste storage.						
Receptor	**Scenario Frequency** [1]	**Consequence** [2]	**Risk Class** [3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Case A Anticipated ($>10^{-2}$) Case B Unlikely (10^{-4} - 10^{-2})	Case A Moderate (0.12 rem) Case B Moderate (0.68 rem)	Case A I Case B II	Automatic Sprinkler System Fuel and Combustible Loading LLW Crate Inventory Fire Alarm Transmittal/Fire Department Response Fire Phones/Fire Department Response Fire Protection Building Structure	P P P D D D P	P/M P/M M M M P M	LCO 3.1 AOL 8, PAC 6 AOL 5 LCO 3.1 AOL 9 PAC 6 Design Feature
Collocated Worker	Case A Anticipated ($>10^{-2}$) Case B Unlikely (10^{-4} - 10^{-2})	Case A Moderate (17 rem) Case B Moderate (24 rem)	Case A I Case B II	Automatic Sprinkler System Fuel and Combustible Loading LLW Crate Inventory Fire Alarm Transmittal/Fire Department Response Fire Phones/Fire Department Response Fire Protection Building Structure	P P P D D D P	P/M P/M M M M P M	LCO 3.1 AOL 8, PAC 6 AOL 5 LCO 3.1 AOL 9 PAC 6 Design Feature
Immediate Worker	Case A Anticipated ($>10^{-2}$) Case B Unlikely (10^{-4} - 10^{-2})	Case A Low Case B Low	Case A III Case B III	Automatic Sprinkler System Fuel and Combustible Loading LLW Crate Inventory Emergency Response Training Local Fire Alarms Fire Protection Building Structure	P P P P D P D P	P/M P/M M M M M P M	LCO 3.1 AOL 8, PAC 6 AOL 5 PAC 4 PAC 14 LCO 3.1, AOL 9 PAC 6 Design Feature

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

Accident Scenario

A fire is postulated to occur in the canopy covered portion of the west dock area. The fire is postulated to occur in combustibles in proximity to wooden LLW crates being stored in the area. The fire could be initiated by an electrical equipment failure, a maintenance activity, or an inadvertent cigarette. The fire ignites the nearby waste crates which are postulated to be fully consumed by the fire. Therefore, this fire is conservatively analyzed as an unconfined combustible material release. Two cases are evaluated:

Case A: The fire starts and begins to consume one or more waste crates. The heat from the fire actuates the Automatic Sprinkler System (dry-pipe) which suppresses the spread of the fire and eventually extinguishes the fire. Due to the limited amount of total heat energy associated with this fire scenario, a ground-level (non-lofted) release of the radioactive material is conservatively assumed. The fire is conservatively assumed to be of short duration such that a release over 10 minutes is analyzed.

Case B: The fire starts and begins to consume one or more waste crates. The heat from the fire does not actuate the Automatic Sprinkler System (dry-pipe) due to system failure. All of the waste crates stored in the area are eventually consumed by the fire. Due to the significant amount of total heat energy associated with this fire scenario, a lofted release of the radioactive material is assumed. The fire is assumed to be of long duration such that a release over 30 minutes is analyzed.

Accident Frequency

The likelihood of Case A of this postulated accident scenario is judged to be *anticipated* based on the following considerations: (1) fire occurrence is generally considered to be an *anticipated* event although not as frequent as once per year, (2) the amount of combustible material allowed to accumulate under the canopy of the west dock area is more likely than in the TRU waste storage areas, and (3) the placement of combustible materials near LLW crates is restricted by an administrative control. The administrative control program attribute restricting the amount of combustibles in waste storage areas is covered under a credited Fuel and Combustible Loading control. This control is not credited with much scenario frequency reduction but is credited to limit the size of the fire to within the capacity of the Automatic Sprinkler System. It is assumed for Case A that the Automatic Sprinkler System (dry-pipe) is actuated and suppresses the fire as a mitigative measure rather than a preventive measure.

The likelihood of Case B of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) fire occurrence is generally considered to be an *anticipated* event although not as frequent as once per year, (2) the amount of combustible material allowed to accumulate under the canopy of the west dock area is more likely than in the TRU waste storage areas, (3) the placement of combustible materials near LLW crates is restricted by an administrative control, and (4) the large fire can only occur if the Automatic Sprinkler System fails. The administrative control program attribute restricting the amount of combustibles in waste storage areas is covered under a credited Fuel and Combustible Loading control. This control is not credited with much scenario frequency reduction but is credited to limit the size of the fire to within the capacity of the Automatic Sprinkler System. The Automatic Sprinkler System is credited with suppressing the fire before multiple wooden LLW crates become involved in the event. The Automatic Sprinkler System is covered under a Limiting Condition for Operation (LCO) with corresponding Surveillance Requirements. The LCO-driven maintenance of the system improves the overall system availability and reliability. The failure of this system is conservatively assumed to only reduce scenario frequency by one frequency bin.

Material-at-Risk

For Case A, the fire is assumed to be suppressed early in the accident progression. It would be difficult to determine how many LLW crates would be involved in the fire at the time of Automatic Sprinkler System actuation. It is conservatively assumed that the equivalent of one LLW crate MAR is totally consumed in the fire prior to suppression. This is believed to be conservative since an unconfined combustible material release fraction is being used in the analysis. Confined combustible material release fractions are used in the case of drum or metal crate releases but are based on bounding values in experiments dealing with combustion of non-metal confined combustible materials (combustibles in plastic bags and cardboard cartons). While a confined combustible material release fraction would appear to be more appropriate in the case of a wooden crate fire, a more conservative (two orders of magnitude) release fraction is used. Based on Site requirements for packaging of LLW in wooden crates, a maximum of 3 grams of WG Pu is assumed to be in a single LLW crate. The total effective MAR for Case A of the LLW crate fire scenario is 3 grams of WG Pu.

For Case B, the fire is conservatively assumed to consume all of the LLW crates that are stored in the west dock canopy area. A LLW Crate Inventory control is credited to limit the number of wooden crates in the area to 50 wooden LLW crates. Based on Site requirements for packaging of LLW in wooden crates, a maximum of 3 grams of WG Pu is assumed to be in a single LLW crate. The total effective MAR for Case B of the LLW crate fire scenario is 150 grams of WG Pu.

The LLW Crate Inventory control also restricts the storage location of wooden LLW crates. No more than one wooden LLW crate may be located within the building structures of the complex. Any additional wooden LLW crates must be located outside of building structures, must be located in areas covered by the Automatic Sprinkler System, and must be compliant with NFPA 231, *Standard for General Storage* (Ref. 61), requirements which define allowable distances between quantities of combustible materials and building structures.

Accident Consequence

For Case A, the radiological dose consequences of a fire involving single LLW crate are *moderate* (0.12 rem) to the MOI and *moderate* (17 rem) to the collocated worker. As stated above, the small, LLW crate fire scenario is analyzed as an unconfined material release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for Case A of the scenario is Risk Class I for both the MOI and the collocated worker (*anticipated* frequency, *moderate* consequence).

For Case A, for immediate workers in the west dock area at the time of the fire, a fire of this magnitude could hypothetically cause serious injury (*moderate* consequences) to the immediate worker through smoke inhalation or burns if the worker is in the vicinity of the fire. Immediate workers in the west dock area but not near the fire should have *low* consequences from the fire. The radiological dose consequences for either category of immediate worker are qualitatively judged to be *low* due to: (1) the limited radiological material that is released, (2) the indicators of a fire (e.g., smoke, fire alarms, flames) which informs the immediate worker of the event, and (3) the building emergency plan which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Local Fire Alarms control (from sprinkler system flow alarms and fire phones resulting in building alarms) and the Emergency Response control (development of a building emergency plan). Immediate worker egress from the dock area should not be hampered by the fire. These controls tend to lower the fire, non-radiological consequences to *low*, as well. The resulting risk class for Case A of the scenario is Risk Class III for the immediate worker (*anticipated* frequency, *low* consequence).

For Case B, the radiological dose consequences of a fire involving 50 wooden LLW crates are *moderate* (0.68 rem) to the MOI and *moderate* (24 rem) to the collocated worker. As stated above, the large, LLW crate fire scenario is analyzed as an unconfined material release, lofted plume, 30 minute duration accident scenario. The resulting risk class for the scenario is Risk Class II for the MOI and the collocated worker (*unlikely* frequency, *moderate* consequence).

For Case B, for immediate workers in the west dock area at the time of the fire, a fire of this magnitude could hypothetically cause a fatality (*high* consequences) to the immediate worker through smoke inhalation, burns, or heat if the worker is in the vicinity of the fire. Immediate workers in the west dock area but not near the fire could suffer serious injury (*moderate* consequences) from smoke inhalation. The radiological dose consequences are qualitatively judged to be *low*, for immediate workers that are not incapacitated by the fire, due to: (1) the limited radiological material that is released in the vicinity of the immediate worker (i.e., the radiological source term will follow the lofted plume; if the immediate worker is located in the plume, the radiological impact would be minor compared to the physical impact of the hot gases), (2) the indicators of a fire (e.g., smoke, flames) which informs the immediate worker of the event, and (3) the building emergency plan which directs the immediate worker to evacuate the area. The immediate worker credited controls to mitigate consequences include the Emergency Response control (development of a building emergency plan). Immediate worker egress from the dock area should not be hampered by the fire in its early stages. Immediate workers in the facility are protected by the building structure and the Automatic Sprinkler System. These controls tend to lower the fire, non-radiological consequences to *low*. The resulting risk class for Case B of the scenario is Risk Class III for the immediate worker (*unlikely* frequency, *low* consequence).

Control Set Adequacy/Vulnerability

For Case A, the postulated small LLW crate fire in west dock area is considered to be an *anticipated* event with *moderate* consequences for the MOI (public) and the collocated worker and *low* consequences for the immediate worker. The risk class for the collocated worker and the MOI is Risk Class I. The immediate worker has a Risk Class III scenario result which is considered to be acceptable.

For Case B, the postulated large LLW crate fire in west dock area is considered to be an *unlikely* event with *moderate* consequences for the MOI (public) and the collocated worker and *low* consequences for the immediate worker. The risk class for the collocated worker and the MOI is Risk Class II. As in Case A, the immediate worker has a Risk Class III scenario result which is considered to be acceptable.

Acceptability of the risk class results for the collocated worker and the MOI, for both Case A and Case B, is based on the conservatism that is assumed in the analysis.

For Case A, if a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the MOI consequences would be *low* and the collocated worker consequences would remain *moderate*. This would yield a reduction in the corresponding risk class for the MOI to Risk Class III. If an average MAR (approximately a factor of 6 reduction in MAR) were used in the analysis, the MOI consequences would also be reduced to *low* yielding a Risk Class III scenario and there would be no change in the consequences and risk class for the collocated worker. The conservatism in using an unconfined combustible material release fraction rather than a modified confined combustible material release fraction is a conservatism that may yield up to two orders of magnitude increase over actual consequences. This conservatism, while not quantified, could yield reductions in both the collocated worker and the MOI risk classes to Risk Class III.

For Case B, if a median χ/Q value (approximately a factor of 4 reduction in atmospheric dispersion for the MOI and over a two order of magnitude reduction in atmospheric dispersion for the collocated worker) were used in the analysis, the collocated worker consequences would be *low* and the MOI consequences would remain *moderate*. This would yield a reduction in the corresponding risk class for the collocated worker. Use of an average MAR (approximately a factor of 6 reduction in MAR) does not have a significant enough effect to reduce collocated worker or MOI consequences but is more representative of the situation given the large number of LLW crates involved in the scenario. The conservatisms in using an unconfined combustible material release fraction rather than a modified confined combustible material release fraction and in assuming all 50 LLW crates are consumed by the fire are conservatisms that may yield over two orders of magnitude increase over actual consequences. These conservatisms, while not quantified, could yield reductions in both the collocated worker and the MOI risk classes to Risk Class III.

Another conservatism deals with the event likelihood. Fire occurrences in the facilities are not low probability events. However, Case A of this scenario assumes the occurrence of a fire in the west dock area **<u>and</u>** no personnel are either available or notice the early stages of the fire and inform the Fire Department (likely on off shifts but less chance of fire initiation when no one is working) **<u>and</u>** the fire happens to occur at the location of the LLW crates. This sequence of events could be argued to yield an accident scenario frequency of *unlikely*. Reducing the frequency bin assignment would lower the risk class for the collocated worker and the MOI by one level. Case B of this scenario assumes the occurrence of a fire in the west dock area **<u>and</u>** no personnel are either available or notice the early stages of the fire and inform the Fire Department (likely on off shifts but less chance of fire initiation when no one is working) **<u>and</u>** the fire happens to occur at the location of the LLW crates **<u>and</u>** the failure of the Automatic Sprinkler System (relatively passive device with high reliability). This sequence of events could be argued to yield an accident scenario frequency of *extremely unlikely*. Reducing the frequency bin assignment would lower the risk class for the immediate worker, the collocated worker, and the MOI by one level.

For Case A, a failure of the credited preventive control (the Automatic Sprinkler System control) is considered in the determination of the *unlikely* scenario frequency bin assignment for the Case B scenario. Concurrent failures of mitigative controls would lead to an *unlikely* frequency bin assignment for Case A of the scenario and to an *extremely unlikely* frequency bin assignment for Case B of the scenario. This automatically reduces the risk class for the collocated worker and the MOI by one level as long as dose consequences remain *moderate* for each receptor. The dose consequences for the MOI cannot increase by more than a factor of 40 for Case A and by more than a factor of 7 for Case B. The dose consequences for the collocated worker cannot increase by more than 45% for Case A and can have no increase for Case B. For Case A, the immediate worker risk class for the sequence will remain at Risk Class III as long as the qualitative consequence assignment remains low. For Case B, the immediate worker risk class for the sequence is reduced to Risk Class IV if the qualitative consequence assignment remains *low*, otherwise, the risk class will remain at Risk Class III.

Failure of the LLW Crate Inventory control has no impact on Case A consequences. Failure of this control for Case B has no impact on the MOI consequences (would need to accumulate more than 350 LLW crates) but does raise the collocated worker dose consequences to *high* and reduces the risk class for the collocated worker from Risk Class III to Risk Class II (original Case B scenario risk class). Failure of this control has no impact on the immediate worker consequences.

Failure of a second aspect of the LLW Crate Inventory control (restrictions on LLW crate storage locations) makes the Case A scenario no longer applicable and raises the likelihood of the Case B scenario to *anticipated*. The results of the failure of this control yields Risk Class I results for both the MOI and the collocated worker. These results are similar to the Case A risk class results but with higher consequences for both receptors.

Failure of the mitigative portion of the Fuel and Combustible Loading control (limiting the amount of combustibles) would imply a gross failure of the control. That is, the amount of combustibles would have to be large enough to make the Automatic Sprinkler System in the west dock area ineffective in fire mitigation. The Case A scenario would no longer be applicable in this situation. The Case B scenario would be the only case and would have an *unlikely* frequency independent of the Automatic Sprinkler System operation or failure. The resulting consequences and risk classes for the collocated worker and the MOI remain the same, in this case. However, it could be argued that such a gross failure of the Fuel and Combustible Loading control (combustible loading overwhelms the sprinkler system in the west dock area) would be an *extremely unlikely* event. In this case, the risk classes for all three receptors would be reduced by one level.

Due to the visibility of a fire in the west dock area (i.e., smoke and flames in open area) and the lack of smoke accumulation (i.e., well ventilated area), the failure of the Local Fire Alarms and Emergency Response controls could keep immediate worker consequences at a *moderate* consequence level associated with a fire but this is not considered to be likely.

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis:

- Fire Alarm Transmittal/Fire Department Response: If the fire impacts the dock and/or building Automatic Sprinkler System, fire alarm transmittal to the Fire Dispatch Center as a result of sprinkler system actuation can lead to scenario mitigation due to Fire Department response. The growth rate of this type of fire impacts the ability of the Fire Department to respond in a timely manner, but some mitigation capability is expected.

- Fire Phones/Fire Department Response: If building personnel at the dock recognize the fire situation at a very early stage, fire phone communication to the Fire Dispatch Center can lead to scenario mitigation due to Fire Department response. The growth rate of this type of fire impacts the ability of the Fire Department to respond in a timely manner, but some mitigation capability is expected.

- Fire Protection: The Fire Protection program is an additional control which can reduce the likelihood of fires by ignition source controls, surveillances/tours, and control of combustible material accumulation in the west dock area.

- Training: The immediate worker Training program is an additional control which can reduce immediate worker consequences as a reinforcement of the emergency response evacuation guidance.

In summary, failures of individual mitigative controls concurrent with the accident do not increase the risk class of the scenario for the MOI, the immediate worker, or the collocated worker. For many cases, there is a risk class reduction for all receptors associated with the concurrent failures scenario; the remaining cases have no change in the receptor risk class. It is not expected that failures of mitigative controls will yield MOI doses in excess of 2 rem.

4.5.3 Spill Scenarios

Table 4-14, *Evaluated Spill Scenarios and Effective MAR*, summarizes the spill scenarios that were evaluated in order to determine the bounding scenario requiring further evaluation. Since all spill accident scenarios are modeled the same and scenario frequencies are all considered to be *unlikely*, the bounding scenario was determined based on the initial respirable source term as a result of the accident. The initial respirable source term is the amount of radioactive material driven airborne at the accident source that is effectively inhalable (Ref. 34). The initial respirable source term is determined by evaluating the total MAR involved in the accident, the damage ratio (DR) estimated for the accident, the airborne release fraction (ARF) used to estimate the amount of radioactive material suspended in the air as an aerosol, and the respirable fraction (RF) which is the fraction of airborne radionuclides that may be transported through the air and inhaled into the human respiratory system. The ambient leakpath factor is assumed to be the same for all potential types of accidents resulting in a spill (i.e., drop/fall, puncture, collision, crush).

Waste container types that may be present in the building and their associated fissile material loading limits are documented in Table 4-8, *Waste Container Material Loading*. Drums, TRUPACT II SWBs and Metal Waste Boxes are Type A packages that satisfy DOT regulations. Plywood crates and other containers not meeting the DOT Type A container specifications are not used for waste storage inside Building 991. Wooden LLW crates may be stored outside Building 991 under the canopy. SNM packaged in certified DOT Type B shipping containers are considered to be highly resistant to spills due to the packaging requirements and are not evaluated.

Line generated TRU drums are supposed to be packaged with rigid interior liners with the waste packaged in plastic bags. Approximately 15% of the TRU drums do not contain the rigid interior liners (Ref. 62). The LLW drums are packaged with a single drum liner, i.e., a plastic bag. It is assumed that not more than 20% of the contents of a properly packaged TRU drum would be released as a result of a drop/fall, crush, or collision. For a TRU drum without a rigid liner, it is conservatively assumed that the entire contents could be released (i.e., DR of 1.0). A material release due to a drop/fall, crush, or collision is evaluated as a confined material release (i.e., ARF of 1.0E-03 and RF of 1.0E-01) (Ref. 42). For a puncture of either a TRU drum, TRUPACT II SWB or Metal Waste Box, the DR is assumed to be the same whether the waste container has proper internal packaging or not. It is assumed a puncture (e.g., from a forklift tine) will result in 10% of the material in the waste container being available for release. A material release from a puncture is evaluated as an unconfined material release (i.e., ARF of 1.0E-03 and RF of 1.0E+00) (Ref. 42). These material release factors are considered conservative assumptions based on the multiple layers of plastic bags that would have to be damaged in order to release any of the contents and the fact that a forklift tine would create a relatively small sized hole through these barriers. The percentage of the contents released from a LLW drum may be greater based on a single drum liner being used, but the effective MAR would be bounded by the TRU drums.

For spill scenarios, the maximum effective MAR is considered to be the amount of WG Pu available for release into the immediate accident area in airborne form. It is not the total quantity of material present, but is only that material the accident scenario postulates to be at risk. For spill scenarios, the maximum effective MAR is determined by multiplying the number of containers postulated to be involved in the scenario, the expected fissile material loading per container, and the percentage of material released from the container (DR as discussed above). The expected fissile material loading is not necessarily the maximum allowable loading based on the building NMSLs, but rather the amount allowable by the operational controls for material handling activities (see Chapter 5). Spills involving LLW containers are bounded by spills involving TRU containers because of the greater WG Pu content of the TRU containers, and therefore, spills involving LLW containers are not discussed.

Table 4-14 Evaluated Spill Scenarios and Effective MAR

Release Mechanism / Container Type	Number of Containers Potentially Involved	Expected MAR[1,2] (g)	Damage Ratio	Airborne Release Fraction	Respirable Fraction	Initial Respirable Source Term (g)
Drop/Fall						
55-gallon drum	1	200	1.0	1.0E-03	1.0E-01	0.02
TRUPACT II SWB/Metal Waste Box	1	320	1.0	1.0E-03	1.0E-01	0.032
Puncture						
55-gallon drum[3]	2	400	0.1	1.0E-03	1.0E+00	0.04
TRUPACT II SWB/Metal Waste Box	1	320	0.1	1.0E-03	1.0E+00	0.032
Crush						
55-gallon drum	1	200	1.0	1.0E-03	1.0E-01	0.02
TRUPACT II SWB/Metal Waste Box	1	320	1.0	1.0E-03	1.0E-01	0.032
Earthquake[4]						
All	3500 Drums	700,000	Developed in Section 4.5.5.1.1.			

1 Container fissile material loading as per Table 4-8, expected loading is based on operational control maximums.

2 Assumes a maximum of 200 g WG Pu equivalent in each drum; a maximum of 320 grams WG Pu equivalent in each TRUPACT II SWB or Metal waste box.

3 The shaded box is the operational spill scenario that is evaluated here, all others (excluding earthquake) are bounded by this scenario.

4 This scenario is developed and evaluated in Section 4.5.5.1.1 as Scenario 991 NPH 1.

A non-pressurized container breach, resulting in a spill of the contents, can occur three ways: drop/fall, puncture, and crushing as described below. Pressurized container releases are covered in explosion scenarios in Section 4.5.4. A drop/fall is assumed to occur during material handling equipment (forklift, drum handler) operations that lift and elevate various containers making them susceptible to dropping/falling due to the load shifting, equipment failure, or acceleration forces exerted by the equipment and/or operator. The quantity of a specific container type that could be dropped is bounded by the maximum number that is normally moved at one time. Movement of a maximum of four TRU drums on a pallet may occur. These drums are postulated to fall a distance greater than four feet and impact the concrete floor. Upon impact, one of the four drums is assumed to be breached and to have all of its contents available for release (intended to bound breaches of multiple drums with limited content release from each). This is considered a confined material release since it is postulated the material is released upon impact and the packaging (drum and polyethylene bag) will contain some of the material from being released to the atmosphere.

A puncture is normally caused by forklift tines inadvertently penetrating a container. For drums, the forklift tines could puncture two containers. For SWBs and metal waste boxes, both forklift tines are assumed to puncture the same container.

Crushing of a container can be caused by a collision by material handling equipment or maintenance equipment, thereby releasing a portion of the container contents. It is assumed that only one container would be crushed during a single handling incident.

The bounding spill scenarios for the Building 991 Complex are described below.

991 Spill 1 - Small Spill: Breach of Two TRU Drums - This spill scenario involves a radiological release from two 55-gallon TRU drums due to forklift puncture. It is postulated to occur either inside Building 991 or outside the building (one of two loading dock areas) during material handling operations. This scenario bounds all other operational spill scenarios and is identified in Table 4-14 as the shaded box. A maximum of 200 grams WG Pu is postulated to be contained in the drums. With the 10% DR, this amounts to an effective MAR of 40 grams of WG Pu.

991 NPH 1 - Earthquake Caused Spill - This spill scenario involves a radiological release from the entire Building 991 Complex inventory involving a TRU waste drums. It is postulated to occur inside the building during a natural phenomena event, specifically an earthquake. Since the initiator of this scenario is a Natural Phenomena Hazard (NPH), it is developed and evaluated as part of Section 4.5.5, *Natural Phenomena and External Event Scenarios*.

4.5.3.1 991 Spill 1 - Small Spill: Breach of Two TRU Drums

This accident scenario is summarized in Table 4-15, with a detailed explanation following the table.

Table 4-15 991 Spill 1 - Small Spill: Breach of Two TRU Drums

Hazard		Containerized WG Pu					
Accident Type		Spill involving 2 TRU waste drums. Effective MAR = 40 grams WG Pu.					
Cause or Energy Source		Waste handling or forklift movement error resulting in forklift tine puncture of two 55-gallon drums. Waste container contents spill from hole caused by puncture.					
Applicable Activity		Waste Handling, Waste Storage					
Receptor	**Scenario Frequency[1] (per year)**	**Consequence[2]**	**Risk Class[3]**	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Unlikely (10^{-4} - 10^{-2})	Low (0.032 rem)	III	DOT Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 1, 2 AOL 4 AOL 10
Collocated Worker	Unlikely (10^{-4} - 10^{-2})	Moderate (4.4 rem)	II	DOT Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 1, 2 AOL 4 AOL 10
Immediate Worker	Unlikely (10^{-4} - 10^{-2})	Low to Moderate	III to II	DOT Containers Container Fissile Material Loading Radiation Protection Emergency Response Training	P P P P D	P M M M P/M	AOL 1, 2 AOL 4 PAC 12 PAC 4 PAC 14

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures, [3] Considers failure of credited preventive measures and considers credited mitigative measures

Accident Scenario

A forklift handling or movement error is postulated to occur at the docks or in any of the TRU waste storage areas in the Building 991 Complex. The forklift error is postulated to occur when handling or when near a pallet of TRU waste containers. The forklift error could be initiated by either an equipment failure or an operator error. The forklift error results in a puncture, by the forklift tines, of either two adjacent waste drums or a single waste crate. A fraction of the contents of the punctured waste container(s) is postulated to "flow" through the breach onto the ground/floor. Therefore, this puncture induced spill is analyzed as an unconfined material release. A ground-level (non-lofted) release of the radioactive material is assumed. The spill is a short duration event and a minimum duration release (10 minutes) is analyzed.

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) material handling accidents have occurred at the Site and are generally considered to be *anticipated* events, (2) the accidents that have occurred dealt with dropping containers, denting containers, or minor surface scraps; actual breaches of containers due to puncture are less likely as a result of container strength, and (3) the forklift tine puncture must breach all waste confinement in the waste container (i.e., plastic liners, bags, bottles, etc.).

The credited control dealing with waste container strength (resistance to container damage from drops/falls, punctures, crushing) and fire resistance restricts waste containers that do not meet on-site shipping specifications and/or DOT specifications from being in the facility (shortened to "DOT Containers" control in the text and tables). This control also restricts SNM from the facility that is not contained in a certified DOT Type B shipping container, which is credited for being resistant to drops or punctures (leads to no analysis of SNM releases for spill scenarios).

Material-at-Risk

It is conservatively assumed that the 10% of the entire inventory of each of the two waste drums or the single waste crates exits the container(s) following the removal of the forklift tines from the container(s). The involvement of 10% of a waste container inventory in the spill is judged to be conservative based on the following considerations: (1) a forklift tine puncture only creates a small breach of the container, (2) few, if any, non-liquid wastes would "flow" out of the container through the breach, (3) any packaging (plastic) in the container will tend to inhibit the "flow" of waste due to recovery from the breach rather than having permanent deformation as might be the case with the metal container wall, and (4) waste material that is capable of "flowing" is most likely to clog at the exit before much material has passed through the container hole. The only types of solid material where the 10% assumption may not be conservative are fine sands (hourglass-like material), and it is not clear if any exists as TRU waste at the Site. An administrative control is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent) and for limiting TRU waste crate contents to a maximum of 320 grams of WG Pu (or equivalent). Therefore, the total effective MAR for the forklift tine puncture of the waste container(s) is 32 grams of WG Pu (or equivalent) in the case of a waste crate and 40 grams of WG Pu (or equivalent) in the case of two TRU waste drums. The two TRU waste drum puncture event is further evaluated and bounds the waste crate puncture.

Accident Consequence

The radiological dose consequences of the puncture of two TRU waste drums are *low* (0.032 rem) to the MOI and *moderate* (4.4 rem) to the collocated worker. As stated above, the spill scenario is analyzed as an unconfined material release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class III for the MOI (*unlikely* frequency, *low* consequence) and is Risk Class II for the collocated worker (*unlikely* frequency, *moderate* consequence).

For immediate workers in the facility at the time of the spill, a forklift accident could hypothetically cause serious injury (*moderate* consequences) to the immediate worker driving the forklift or standing near the waste containers, depending on the actual cause of the accident. Immediate workers in the facility but not near the spill will have *low* consequences from the accident. The radiological dose consequences for either category of immediate worker are qualitatively judged to be *low* due to: (1) the limited radiological material that is released due to container fissile material limits, (2) the indicators of an accident (i.e., toppled drums, noise) which informs the immediate worker of the event, and (3) the building emergency plan and radiation protection guidance which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Container Fissile Material Loading control (limiting the amount of material released), the Radiation Protection control (guidance on response to radioactive material spills), and the Emergency Response control (development of a building emergency plan). The resulting risk class for the scenario is Risk Class III for the immediate worker not directly involved in the accident (*unlikely* frequency, *low* consequence) and Risk Class II for the immediate worker directly involved in the accident (*unlikely* frequency, *moderate* consequence).

Control Set Adequacy/Vulnerability

The postulated forklift puncture induced spill is considered to be an *unlikely* event with *moderate* consequences for the collocated worker, *low* consequences for the MOI (public), *low* consequences for the immediate worker not directly involved in the accident, and *moderate* consequences for the immediate worker involved in the accident. The risk class for the immediate worker not involved in the accident and the MOI is Risk Class III which is considered to be acceptable. The collocated worker and the immediate worker directly involved in the accident have Risk Class II scenario results.

Acceptability of the risk class result for the collocated worker is based on the conservatism that is assumed in the analysis. If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the collocated worker consequence would remain *moderate*, but is almost *low* (approximately 0.55 rem). Use of an average MAR (approximately a factor of 3 reduction in MAR) has no impact on the risk class results.

The waste storage areas for the Building 991 Complex have filtered exhaust ventilation. The forklift puncture induced spill could occur in the facility but could also occur at one of the docks. The Building 991 exhaust goes through one stage of HEPA filtration and the vault and tunnel waste storage areas exhaust through two stages of HEPA filtration. For in-building accidents, crediting a filter efficiency of only 0.9 (tested stages credit an efficiency of 0.999) would reduce the risk class for the collocated worker by one level. If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0.1 which yields a result equivalent to crediting a HEPA filter efficiency of 0.9. As stated before, this conservatism only applies to in-building accidents.

The postulated forklift puncture induced spill scenario has an *unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *extremely unlikely* frequency bin assignment for the scenario. This reduces the risk class for the collocated worker to Risk Class III as long as dose consequences do not increase by more than a factor of 5. The MOI risk class for this sequence is reduced to Risk Class IV as long as dose consequences do not increase by more than a factor of 3, otherwise, the risk class will remain at Risk Class III. The immediate worker (not directly involved in the accident) risk class for the sequence is reduced to Risk Class IV if the qualitative consequence assignment remains *low*, otherwise, the risk class will remain at Risk Class III. This reduces the risk class for the immediate worker directly involved in the accident risk class to Risk Class III.

Double batching of the TRU waste drum fissile material inventory (failure of the Container Fissile Material Loading control) would only increase the MOI dose to approximately 0.064 rem (*low* consequence), still lower than that needed for a change to *moderate* consequences. Similarly, double batching of the TRU waste drum fissile material inventory (failure of the Container Fissile Material Loading control) would only increase the collocated worker dose to approximately 8.8 rem (*moderate* consequence), still a factor of about 3 lower than that needed for a change to *high* consequences. The failure of the Container Fissile Material Loading control would tend to increase immediate worker radioactive material uptake for workers not directly involved in the accident, but it is not clear if the *moderate* consequence level would be reached due to inhalation of radioactive material. At worst, the immediate worker (not directly involved in the accident) risk class would rise to a Risk Class III for a *moderate* consequence event.

The failure of the Radiation Protection and Emergency Response controls would also tend to increase immediate worker radioactive material uptake for workers not directly involved in the accident, but it is not clear if the *moderate* consequence level would be reached due to inhalation of radioactive material. At worst, the immediate worker (not directly involved in the accident) risk class would rise to a Risk Class III for a *moderate* consequence event.

In all situations discussed above, the following defense-in-depth features tend to mitigate the scenario but are not credited in the analysis:

- Filtered Exhaust Ventilation: The filtered exhaust ventilation systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the collocated worker and the MOI.

- Training: The immediate worker Training program is an additional control which can reduce immediate worker consequences as a reinforcement of the emergency response evacuation guidance and as a preventive measure for reducing the frequency of the forklift accidents.

In summary, failures of individual mitigative controls concurrent with the accident do not increase the risk class of the scenario for the MOI, the immediate worker, or the collocated worker. In all cases, there is a risk class reduction for the MOI from Risk Class III to Risk Class IV associated with the concurrent failures scenario. Similarly, in all cases, collocated worker risk class is reduced from Risk Class II to Risk Class III associated with the concurrent failures scenario. For many cases, there is a risk class reduction for the immediate worker not directly involved in the accident from Risk Class III to Risk Class IV associated with the concurrent failures scenario; the remaining cases have no change in the immediate worker risk class. The radiological component of risk for the immediate worker not directly involved in the accident is worse in spill events than in fire events because there is no indication in the remainder of the facility that a spill has occurred, whereas fires are indicated by alarms and smoke. Radioactive material uptake by the immediate worker is a concern for forklift accidents involving waste containers. Immediate worker, forklift induced, serious injuries are also possible dealing with waste movement in the facility.

4.5.4 Explosion Scenarios

The Building 991 Complex stores up to 3,500 drums and some waste crates of TRU waste. The transfer, receiving, and storage activities (Section 1.2.1) provide for the handling and storage of these waste containers. Hydrogen and oxygen generation in drums has led to a concern about potential for hydrogen explosion accidents. The Los Alamos Technology Office report *Plutonium and Uranium Solutions Safety Study* (Ref. 63) documents some early effort to understand radiolytic hydrogen hazard in drums and tanks. USQDs, which have evaluated hydrogen explosion risk relative to handling and storage of drums include: *Movement of Drums Containing Unvented Hydrogen Gas with Building 371,* USQD-371-95.0170-MDT (Ref. 64), and *Movement and Storage of 55 Gallon Drums in Unfiltered Areas Suspected of Having hydrogen Accumulated in Drum space,* USQD-RFP-95.0180-DSR (Ref. 65). Radiolytic hydrogen generation has been evaluated in several technical reports including *Evaluation of Residue Drum Storage Safety Risks* (Ref. 66) and *Safety Analysis of Hydrogen Generation in Drums Containing Plutonium Contaminated Materials* (Ref. 67). Calculations to predict pressure rise in unvented drums due to radiolytic gas generation in drums are contained in Nuclear Safety Calculation *Building 371/374 BIO Support Calculation - Explosions*, 96-SAE-025 (Ref. 68). Radiolytic hydrogen generation in waste crates has not been evaluated. A concurrent fire involving waste container contents is judged not to occur following the overpressurization due to the rapidity and low energy of the excursion (Ref. 69).

The two explosion events analyzed and presented in the Explosions section are:

991 Explosion 1 - Hydrogen Explosion in a 55 Gallon Drum - Storage drums may contain materials which lead to generation of hydrogen and oxygen by alpha radiolysis. In particular, IDCs which contain solid, liquid or emulsified hydrocarbon materials, or contain aqueous materials, will radiolyze to generate hydrogen. Significant oxygen may also be generated in stoichiometric proportions, especially in aqueous residues. Other uncharacterized drum storage also has the propensity for combining hydrogen/oxygen generation with high Pu/Am contents.

991 Explosion 2 - Hydrogen Explosion in a Waste Crate - Waste crates (TRUPACT II SWBs or Metal Waste Boxes) may contain materials which lead to generation of hydrogen and oxygen by alpha radiolysis. In particular, IDCs which contain solid, liquid or emulsified hydrocarbon materials, or contain aqueous materials, will radiolyze to generate hydrogen. Significant oxygen may also be generated in stoichiometric proportions, especially in aqueous residues. Other uncharacterized drum storage also has the propensity for combining hydrogen/oxygen generation with high Pu/Am contents.

4.5.4.1 991 Explosion 1 - Hydrogen Explosion in a 55-Gallon Drum

This accident scenario is summarized in Table 4-16, with a detailed explanation following the table.

Table 4-16 991 Explosion 1 - Hydrogen Explosion in a 55-Gallon Drum

Hazard	Waste container hydrogen, Containerized WG Pu.						
Accident Type	Explosion inside single TRU waste drum Effective MAR = 20 grams WG Pu.						
Cause or Energy Source	Waste container hydrogen gas ignited by static electrical discharge. Waste container contents ejected from opened waste container.						
Applicable Activity(ies)	Waste Handling, Waste Storage						
Receptor	**Scenario Frequency**[1]	**Consequence**[2]	**Risk Class**[3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A,** *TSRs*
MOI	Extremely Unlikely ($<10^{-4}$)	Moderate (1.1 rem)	III	Vented Waste Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 3 AOL 4 AOL 10
Collocated Worker	Extremely Unlikely ($<10^{-4}$)	High (160 rem)	II	Vented Waste Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 3 AOL 4 AOL 10
Immediate Worker	Extremely Unlikely ($<10^{-4}$)	Low to High	IV to II	Vented Waste Containers Container Fissile Material Loading Radiation Protection Emergency Response	P P P P	P M M M	AOL 3 AOL 4 PAC 12 PAC 4

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

Accident Scenario

Waste drum movement is postulated to occur at the docks or in any of the TRU waste storage areas in the Building 991 Complex. The waste drum movement is postulated to generate sufficient electrostatic energy (>0.01 mJ) to ignite a flammable hydrogen/oxygen mixture that may be found in the waste drum gas space. The hydrogen is postulated to accumulate over time due to radiolysis of materials in the drum. Ignition of the flammable hydrogen/oxygen mixture in the confined space of a waste drum will result in a deflagration and rapid pressure rise in the drum. It is postulated that the pressure rise in the drum is sufficient to separate the drum lid from the drum, along with a fraction of the waste drum contents. Tests described in Ref. 70 demonstrate that if ignition of drum free volume gases containing greater than 15% hydrogen and 7.5% oxygen, by volume, occurs, the lid will separate from the drum. This explosion induced release is conservatively analyzed as a venting of pressurized gas through powder. A ground-level (non-lofted) release of the radioactive material is assumed since the explosion is not expected to generate high temperature (potentially lofted) materials in the release. The explosion induced release is a short duration event and a minimum duration release (10 minutes) is analyzed.

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Accident Frequency

The likelihood of this postulated accident scenario is judged to be *extremely unlikely* based on the following considerations: (1) Site data have indicated that some radioactive material containers may contain hydrogen/oxygen mixtures that can lead to this explosion scenario; therefore, the occurrence of potentially explosive drums is generally considered to be an *anticipated* event, (2) an extremely small ignition source is needed under these conditions to initiate the event, (3) the Site has implemented a waste container venting program (installation of filtered vents on drums), (4) hydrogen is an extremely difficult gas to retain in containers (significant propensity to diffuse), (5) filtered vent plugging has occurred at the Site due to vent damage or the presence of foreign material, (6) hydrogen generation rates for TRU waste containers are relatively low, (7) a plugged vent would still have difficulty in retaining hydrogen gas in the container, particularly for low hydrogen generation rates, and (8) waste drums in the Building 991 Complex must be vented. The administrative control restricting unvented waste containers from the Building 991 Complex is covered under a credited Vented Waste Containers control.

Material-at-Risk

Only a single TRU waste drum is postulated to be involved in the drum explosion scenario due to: (1) the accident deals with a hydrogen/oxygen mixture in the gas space of a single waste container, (2) as indicated in the previous accident frequency discussion, the likelihood of vented drums containing sufficient hydrogen to be a concern is *extremely unlikely*, and (3) the likelihood of two contiguous TRU waste drums both containing explosive mixtures of hydrogen and oxygen is considered to be *incredible*.

Not all of the MAR in a drum would be impacted by the explosion. Since the deflagration of the hydrogen and oxygen occurs in the waste drum gas space, most of the effect of the deflagration would occur at the top of the drum. Waste material located at the bottom of the drum would experience a pressure rise in the drum but would not be impacted by the subsequent drum lid loss. Arguments put forth in the supporting calculation (Ref. 68) justify it is conservative to apply a damage ratio (DR) of 0.1 to the drum. This is believed to be conservative since a venting of pressurized gas through a powder release fraction is being used in the analysis (airborne release fraction of 0.1 and respirable fraction of 0.7). An administrative control is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent). Therefore, the total effective MAR for the TRU waste drum hydrogen explosion is 20 grams of WG Pu (or equivalent) when a DR of 0.1 is applied.

Accident Consequence

The radiological dose consequences of a hydrogen explosion in a TRU waste drum are *moderate* (1.1 rem) to the MOI and *high* (160 rem) to the collocated worker. As stated above, the explosion scenario is analyzed as a venting of a pressurized gas through powder release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class III for the MOI (*extremely unlikely* frequency, *moderate* consequence) and is Risk Class II for the collocated worker (*extremely unlikely* frequency, *high* consequence).

For immediate workers in the facility at the time of the explosion, a drum lid ejection could hypothetically cause a fatality (*high* consequences) to the immediate worker moving or standing near the waste container. Immediate workers in the facility but not near the explosion will have *low* consequences from the accident. The radiological dose consequences are qualitatively judged to be *low*, for immediate workers that are not incapacitated by the explosion, due to: (1) the limited radiological material that is released due to container fissile material limits, (2) the indicators of an accident (i.e., toppled drum, noise) which informs the immediate worker of the event, and (3) the building emergency plan and radiation protection guidance which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Container Fissile Material Loading control (limiting the amount of material released), the Radiation Protection control (guidance on response to radioactive material spills), and the Emergency Response control (development of a building emergency plan). The resulting risk class for the scenario is Risk Class IV for the immediate worker not directly involved in the accident (*extremely unlikely* frequency, *low* consequence) and Risk Class II for the immediate worker directly involved in the accident (*extremely unlikely* frequency, *high* consequence).

Control Set Adequacy/Vulnerability

The postulated waste drum hydrogen explosion is considered to be an *extremely unlikely* event with *high* consequences for the collocated worker, *moderate* consequences for the MOI (public), *low* consequences for the immediate worker not directly involved in the accident, and *high* consequences for the immediate worker involved in the accident. The risk classes for the immediate worker not involved in the accident and the MOI are Risk Class IV and Risk Class III, respectively, which are considered to be acceptable. The collocated worker and the immediate worker directly involved in the accident have Risk Class II scenario results.

Acceptability of the risk class result for the collocated worker is based on the conservatism that is assumed in the analysis. If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the collocated worker consequence would be *moderate*. This would yield a reduction in the corresponding risk class for the collocated worker. Use of an average MAR (approximately a factor of 3 reduction in MAR) has no impact on the risk class results. The conservatism in using a venting of pressurized gas through powder release fraction may yield between one and two orders of magnitude increase over actual consequences. This conservatism, while not quantified, could yield a reduction in the collocated worker risk class to Risk Class III.

The waste storage areas for the Building 991 Complex have filtered exhaust ventilation. The waste drum hydrogen explosion could occur in the facility but could also occur at one of the docks. The Building 991 exhaust goes through one stage of HEPA filtration and the vault and tunnel waste storage areas exhaust through two stages of HEPA filtration. For in-building accidents, crediting a filter efficiency of only 0.9 (tested stages credit an efficiency of 0.999) would reduce the risk class for the collocated worker by one level. If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0.1 which yields a result equivalent to crediting a HEPA filter efficiency of 0.9. As stated before, this conservatism only applies to in-building accidents.

A failure of the credited preventive control (the Vented Waste Container control) is considered in the determination of the *extremely unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *incredible* frequency bin assignment for the scenario. Therefore, mitigative control failures concurrent with the accident do not need to be considered in assessing the vulnerability of the control set.

In all situations discussed above, the following defense-in-depth feature tends to mitigate the scenario but is not credited in the analysis:

- Filtered Exhaust Ventilation: The filtered exhaust ventilation systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the collocated worker and the MOI.

In summary, failures of individual mitigative controls concurrent with the accident do not need to be considered due to the frequency of the resulting scenarios. The radiological component of risk for the immediate worker not directly involved in the accident is worse in explosion events than in fire events because there is no indication in the remainder of the facility that a release has occurred, whereas fires are indicated by alarms and smoke. Radioactive material uptake by the immediate worker is a concern for hydrogen explosion accidents involving waste containers. Immediate worker, explosion induced, fatalities are also possible dealing with waste container movement in the facility.

4.5.4.2 991 Explosion 2 - Hydrogen Explosion in a Waste Crate

This accident scenario is summarized in Table 4-17, with a detailed explanation following the table.

Table 4-17 991 Explosion 2 - Hydrogen Explosion in a Waste Crate

Hazard	Waste container hydrogen, Containerized WG Pu.						
Accident Type	Explosion inside single TRU waste crate Effective MAR = 32 grams WG Pu.						
Cause or Energy Source	Waste container hydrogen gas ignited by static electrical discharge. Waste container contents ejected from opened waste container.						
Applicable Activity(ies)	Waste Handling, Waste Storage						
Receptor	**Scenario Frequency** [1]	**Consequence** [2]	**Risk Class** [3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Extremely Unlikely ($<10^{-4}$)	Moderate (1.8 rem)	III	Vented Waste Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 3 AOL 4 AOL 10
Collocated Worker	Extremely Unlikely ($<10^{-4}$)	High (250 rem)	II	Vented Waste Containers Container Fissile Material Loading Filtered Exhaust Ventilation	P P D	P M M	AOL 3 AOL 4 AOL 10
Immediate Worker	Extremely Unlikely ($<10^{-4}$)	Low to High	IV to II	Vented Waste Containers Container Fissile Material Loading Radiation Protection Emergency Response	P P P P	P M M M	AOL 3 AOL 4 PAC 12 PAC 4

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

Accident Scenario

Waste crate movement is postulated to occur at the docks or in any of the TRU waste storage areas in the Building 991 Complex. The waste crate movement is postulated to generate sufficient electrostatic energy (>0.01 mJ) to ignite a flammable hydrogen/oxygen mixture that may be found in the waste crate gas space. The hydrogen is postulated to accumulate over time due to radiolysis of materials in the crate. Ignition of the flammable hydrogen/oxygen mixture in the confined space of a waste crate will result in a deflagration and rapid pressure rise in the crate. It is postulated that the pressure rise in the crate is sufficient to separate the crate lid from the crate, along with a fraction of the waste crate contents. Tests described in Ref. 70 demonstrate that if ignition of drum free volume gases containing greater than 15% hydrogen and 7.5% oxygen, by volume, occurs, the lid will separate from a drum. The waste crate is assumed to behave in a similar manner. Therefore, this explosion induced release is conservatively analyzed as a venting of pressurized gas through powder. A ground-level (non-lofted) release of the radioactive material is assumed since the explosion is not expected to generate high temperature (potentially lofted) materials in the release. The explosion induced release is a short duration event and a minimum duration release (10 minutes) is analyzed.

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *extremely unlikely* based on the following considerations: (1) Site data have indicated that some radioactive material containers may contain hydrogen/oxygen mixtures that can lead to this explosion scenario; therefore, the occurrence of potentially explosive waste crates is assumed to be an *anticipated* event, (2) an extremely small ignition source is needed under these conditions to initiate the event, (3) the Site has implemented a waste container venting program (installation of filtered vents on waste crates), (4) hydrogen is an extremely difficult gas to retain in containers (significant propensity to diffuse), (5) filtered vent plugging has occurred at the Site due to vent damage or the presence of foreign material, (6) hydrogen generation rates for TRU waste containers are relatively low, (7) a plugged vent would still have difficulty in retaining hydrogen gas in the container, particularly for low hydrogen generation rates, and (8) waste crates in the Building 991 Complex must be vented. The administrative control restricting unvented waste containers from the Building 991 Complex is covered under a credited Vented Waste Containers control.

Material-at-Risk

Only a single TRU waste crate is postulated to be involved in the crate explosion scenario due to: (1) the accident deals with a hydrogen/oxygen mixture in the gas space of a single waste container, (2) as indicated in the previous accident frequency discussion, the likelihood of vented crates containing sufficient hydrogen to be a concern is *extremely unlikely*, and (3) the likelihood of two contiguous TRU waste crates both containing explosive mixtures of hydrogen and oxygen is considered to be *incredible*.

Not all of the MAR in a crate would be impacted by the explosion. Since the deflagration of the hydrogen and oxygen occurs in the waste crate gas space, most of the effect of the deflagration would occur at the top of the crate. Waste material located at the bottom of the crate would experience a pressure rise in the crate but would not be impacted by the subsequent crate lid loss. Arguments put forth in the supporting calculation (Ref. 68) justify it is conservative to apply a damage ratio (DR) of 0.1 to a container. This is believed to be conservative since a venting of pressurized gas through a powder release fraction is being used in the analysis (airborne release fraction of 0.1 and respirable fraction of 0.7). An administrative control is credited for limiting TRU waste crate contents to a maximum of 320 grams of WG Pu (or equivalent). Therefore, the total effective MAR for the TRU waste crate hydrogen explosion is 32 grams of WG Pu (or equivalent) when a DR of 0.1 is applied.

Accident Consequence

The radiological dose consequences of a hydrogen explosion in a TRU waste crate are *moderate* (1.8 rem) to the MOI and *high* (250 rem) to the collocated worker. As stated above, the explosion scenario is analyzed as a venting of a pressurized gas through powder release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class III for the MOI (*extremely unlikely* frequency, *moderate* consequence) and is Risk Class II for the collocated worker (*extremely unlikely* frequency, *high* consequence).

For immediate workers in the facility at the time of the explosion, a crate lid ejection could hypothetically cause a fatality (*high* consequences) to the immediate worker moving or standing near the waste container. Immediate workers in the facility but not near the explosion will have *low* consequences from the accident. The radiological dose consequences are qualitatively judged to be *low*, for immediate workers that are not incapacitated by the explosion, due to: (1) the limited radiological material that is released due to container fissile material limits, (2) the indicators of an accident (i.e., toppled drum, noise) which informs the immediate worker of the event, and (3) the building emergency plan and radiation protection guidance which directs the immediate worker to evacuate. The immediate worker credited controls to mitigate consequences include the Container Fissile Material Loading control (limiting the amount of material released), the Radiation Protection control (guidance on response to radioactive material spills), and the Emergency Response control (development of a building emergency plan). The resulting risk class for the scenario is Risk Class IV for the immediate worker not directly involved in the accident (*extremely unlikely* frequency, *low* consequence) and Risk Class II for the immediate worker directly involved in the accident (*extremely unlikely* frequency, *high* consequence).

Control Set Adequacy/Vulnerability

The postulated waste crate hydrogen explosion is considered to be an *extremely unlikely* event with *high* consequences for the collocated worker, *moderate* consequences for the MOI (public), *low* consequences for the immediate worker not directly involved in the accident, and *high* consequences for the immediate worker involved in the accident. The risk classes for the immediate worker not involved in the accident and the MOI are Risk Class IV and Risk Class III, respectively, which are considered to be acceptable. The collocated worker and the immediate worker directly involved in the accident have Risk Class II scenario results.

Acceptability of the risk class result for the collocated worker is based on the conservatism that is assumed in the analysis. If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the collocated worker consequence would remain *high*, but is closer to *moderate* (approximately 31 rem). Use of an average MAR (approximately a factor of 3 reduction in MAR) has no impact on the risk class results. The conservatism in using a venting of pressurized gas through powder release fraction may yield between one and two orders of magnitude increase over actual consequences. This conservatism, while not quantified, could yield a reduction in the collocated worker risk class to Risk Class III.

The waste storage areas for the Building 991 Complex have filtered exhaust ventilation. The waste crate hydrogen explosion could occur in the facility but could also occur at one of the docks. The Building 991 exhaust goes through one stage of HEPA filtration and the vault and tunnel waste storage areas exhaust through two stages of HEPA filtration. For in-building accidents, crediting a filter efficiency of only 0.9 (tested stages credit an efficiency of 0.999) would potentially reduce the risk class for the collocated worker by one level (dose consequence is at the 25 rem threshold). If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0.1 which yields a result equivalent to crediting a HEPA filter efficiency of 0.9. As stated before, this conservatism only applies to in-building accidents.

A failure of the credited preventive control (the Vented Waste Container control) is considered in the determination of the *extremely unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *incredible* frequency bin assignment for the scenario. Therefore, mitigative control failures concurrent with the accident do not need to be considered in assessing the vulnerability of the control set.

In all situations discussed above, the following defense-in-depth feature tends to mitigate the scenario but is not credited in the analysis:

- Filtered Exhaust Ventilation: The filtered exhaust ventilation systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the collocated worker and the MOI.

In summary, failures of individual mitigative controls concurrent with the accident do not need to be considered due to the frequency of the resulting scenarios. The radiological component of risk for the immediate worker not directly involved in the accident is worse in explosion events than in fire events because there is no indication in the remainder of the facility that a release has occurred, whereas fires are indicated by alarms and smoke. Radioactive material uptake by the immediate worker is a concern for hydrogen explosion accidents involving waste containers. Immediate worker, explosion induced, fatalities are also possible dealing with waste container movement in the facility.

4.5.5 Natural Phenomena and External Event Scenarios

This section addresses natural phenomena and external events that may challenge the Building 991 Complex. The discussion below includes scenarios driven by events considered in the *Site SAR, Volume I, Site Description and Characteristics* (Ref. 9) events mandated by standards, and seismic events determined by recent Site studies.

4.5.5.1 Natural Phenomena Hazards (NPHs)

The NPHs of concern at the Site and to the Building 991 Complex are: (1) seismic (earthquakes), (2) high winds and tornadoes, (3) heavy rain and flooding, (4) heavy snow, and (5) lightning. DOE Order 5480.28, *Natural Phenomena Hazards Mitigation* (Ref. 71) establishes the policy and requirements for NPH mitigation for DOE sites and facilities. Guidance addressing NPHs is provided in several DOE standards: DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (Ref. 72); DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Criteria for Structures, Systems, and Components* (Ref. 73); DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria* (Ref. 74); DOE-STD-1023-94, *Natural Phenomena Hazards Assessment Criteria* (Ref. 75); DOE-STD-1024-92, *Guidelines for Use of Probabilistic Seismic Hazard Curves at DOE Sites* (Ref. 76); and draft standard entitled *Lightning Hazard Management Guide for DOE Facilities* (Ref. 77).

<u>Earthquake Hazards</u>

An earthquake is credible and considered to result in the spill scenario evaluated in this section. The design basis earthquake (DBE) for the Site has an occurrence frequency of 1.2×10^{-3}/yr with a horizontal bedrock acceleration of 0.14g. Thus, a DBE is considered an *unlikely* event.

Vault 999 was added to the Building 991 Complex in 1956. Its structural capability was evaluated in 1992 and was found not to meet American Concrete Institute code requirements of reserve capacity for the roof slab shear strength for the vault and vestibule (Ref. 78). However, it was also found that these structures were not in imminent danger of collapse. Seismic evaluations performed by Agbabian (Ref. 79) and Los Alamos Technical Associates (Ref. 80) determined that the vault and tunnel portions of the Building 991 Complex would be able to withstand all seismic events up to the DBE without significant damage or collapse. However, in more recent evaluations, the validity of Corridor C analyses have been questioned and the survivability of the structure following the DBE is not assured. Seismic evaluations of Building 991 performed by Agbabian (Ref. 81) determined that Building 991 is adequate for the DBE.

Based on the *FSAR Review Team Report on Rocky Flats Plant Building 707*, (Ref. 82) it is not expected that stacks of boxes or drums will fall under ground accelerations below 0.3 g, unless the earthquake collapses the structure. The minimum peak velocity imparted by an earthquake needed to topple the stack is approximately 51 inches per second or about 0.33 g (Ref. 82). The peak velocities listed for earthquakes of 0.08 g to 0.21 g range from 0.5 inches per second to 4.4 inches per second, much less than that required to topple a stack. Since the DBE for the Site (and for the Building 991 Complex) is 0.14 g, no waste container damage is expected to occur during the DBE or lesser earthquakes unless the earthquake collapses the structure.

Beyond Design Basis Earthquake (BDBE) events, with intensities greater than 0.14 g, are assumed to cause structural damage and partial collapse of the building structure. The number of waste containers estimated to be damaged by a BDBE is based on the number of containers that would be exposed to absorb the impact of falling objects. Additionally, damage to containers may result from a BDBE with an intensity greater than 0.33 g causing drums to tip over.

Should an earthquake occur, it is postulated that Corridor C collapses. Currently no drums are stored there, but in the future, up to 300 drums of TRU waste could be physically accommodated in a single planar array. The corridor is covered with soil of a depth between 6 to 20 feet. If Corridor C survives the earthquake, no drum damage is postulated due to the limited overhead equipment that could cause drum damage and due to the fact that drums are not stacked in the corridor. If Corridor C does not survive the earthquake, collapse would allow the earth above the corridor to enter and bury any drums damaged by the collapse, yielding a negligible release of radioactive material relative to other analyzed sources.

High Winds/Tornadoes

Destructive tornadoes are considered *extremely unlikely* for the Site and do not require any consideration for The Building 991 Complex. The location of the Site near the Front Range of the Rocky Mountain places the complex in a "special wind area" as defined by building codes. The reason for this is that certain weather conditions lead to extremely high winds of fairly frequent occurrence. However, the location is westerly enough so tornado occurrence has a lower probability. When the hazard curves for wind and tornado were updated in 1995 (Ref. 83) it was shown that for exceedance probabilities greater than 10^{-7}, straight wind clearly dominates the Site hazard.

High wind scenarios (penetrations from wind generated missiles or building structural damage) are considered to result in spills. The original Building 991 Complex design criteria for high winds was 116 mph for sustained wind capability. The occurrence frequency for 100 mph straight wind is *anticipated* and for 150 mph winds it is considered *unlikely*. For wind events up to the design basis winds no damage to the building structure or the roof-mounted HVAC equipment would occur. It is assumed that, for winds greater than 116 mph, partial damage to the southward facing walls of the building is possible as is damage to the eastward wall and part of the north wall of Room 166. The rest of the structure is underground and not subject to wind damage. Since drums may be stored along the above ground exterior walls of Room 166, damage from wind generated missiles could cause a release of material. The damage to waste containers within the building would occur, similar to the earthquake initiated spill, due to impact by falling structural components of the building. The frequency and consequence of the earthquake initiated spill scenario, 991 NPH 1, *Earthquake Caused Spill,* bounds high wind initiated spills because the earthquake has a greater potential to involve more material and has a lower capability to disperse the release than a high wind scenario. Spill scenarios involving wind generated missiles are also bounded by the earthquake initiated spill scenario for the same reasons. If a wind generated missile impacting the Building 991 Complex were to result in a fire it is considered bounded by scenario 991 Fire 2, *Large Fire in Storage Area.* Tornado and high wind events are not further analyzed.

Heavy Rain/Flooding

A load can be applied to a building roof due to the amount of rainfall and/or ponding. Ponding of water on the Building 991 roof is not a concern since the roof is sloped. Heavy rain events are not further analyzed.

Flooding of the Building 991 Complex is considered possible from several events: storm runoff, infiltration of water through the roof, and because Building 991 is below the water table. Although the watershed is small, the Site is protected from excessive runoff and floods by good drainage characteristics and a diversion canal west of the Plutonium Recovery and Waste Treatment Facility. Plastic sheets are hung in various locations in the tunnels of the Building 991 Complex to collect rainfall infiltration through leaks in the roof. As a result of the first floor being fairly level it is not expected that any leakage through the roof would accumulate to a significant depth, but would disperse throughout the first floor and then flow into the basement or outside onto the ground.

Heavy Snow

Since the heavy snow design load for Building 991 is not known, it is assumed to be able to withstand a 30 psf roof snow load per Reference 43. This translates to a snow depth of 22 inches and an exceedance probability of less than 2×10^{-2} per year. Thus this is an *anticipated* event. A scenario involving structural damage to the roof due to snow loads exceeding the design capability would result in a spill scenario and is considered bounded by the earthquake initiated spill scenario. Heavy snow scenarios are not further analyzed.

Lightning

Lightning is considered a potential ignition source for fire scenarios. The building is equipped with a perimeter lightning protection system that includes a lightning protection loop with air terminals mounted on the perimeter of the roof. The lightning protection system is intended to reduce the probability that lightning strikes will result in damage to building systems or initiate a fire. However, the condition of the lightning protection system is not known and therefore cannot be relied upon to provide protection against lightning strikes. The frequency of a lightning occurrence is estimated at 8×10^{-3} based on information in Ref. 43 making this an *unlikely* event. If a lightning strike occurs initiating a building fire, the scenario is considered bounded by scenario 991 Fire 1, *Small Fire Inside Building.*

The selected NPH event scenario evaluated for the Building 991 Complex is:

991 NPH 1 - Earthquake Caused Spill - This scenario involves a beyond DBE resulting in structural damage and collapse of the building and toppling of stacked containers. This scenario bounds all other NPH events that are considered credible for the Building 991 Complex.

4.5.5.1.1 991 NPH 1 - Earthquake Caused Spill

This accident scenario is summarized in Table 4-18, with a detailed explanation following the table.

Table 4-18 991 NPH 1 - Earthquake Caused Spill

Hazard		Containerized WG Pu.					
Accident Type		Spill and breach of multiple containers of TRU waste. Effective MAR = 10,865 grams WG Pu.					
Cause or Energy Source		Beyond Design Basis Earthquake: Horizontal Bedrock Acceleration > 0.14 g. Partial collapse of Building 991 causing damage to exposed drums and some stacked drums fall					
Applicable Activity(ies)		All					
Receptor	**Scenario Frequency**[1]	**Consequence**[2]	**Risk Class**[3]	**Credited Control**	**Control Type** P = Primary D = Defense-in-Depth	**Purpose** P = Prevention M = Mitigation	**Reference to Appendix A, *TSRs***
MOI	Unlikely (10^{-4} - 10^{-2})	Moderate (0.87 rem)	II	Fuel and Combustible Loading DOT Containers Container Fissile Material Loading Banded Drums Building Structure	P P P P D	P M M M P/M	AOL 8, PAC 6 AOL 1, 2 AOL 4 AOL 7 Design Feature
Collocated Worker	Unlikely (10^{-4} - 10^{-2})	High (120 rem)	I	Fuel and Combustible Loading DOT Containers Container Fissile Material Loading Banded Drums Building Structure	P P P P D	P M M M P/M	AOL 8, PAC 6 AOL 1, 2 AOL 4 AOL 7 Design Feature
Immediate Worker	Unlikely (10^{-4} - 10^{-2})	High	I	Fuel and Combustible Loading DOT Containers Container Fissile Material Loading Banded Drums Emergency Response Building Structure	D D D D D D	P M M M M P/M	AOL 8, PAC 6 AOL 1, 2 AOL 4 AOL 7 PAC 4 Design Feature

[1] Considers failure of credited preventive measures, [2] Considers credited mitigative measures; [3] Considers failure of credited preventive measures and considers credited mitigative measures.

Accident Scenario

A BDBE is postulated to occur impacting the TRU waste storage areas in the Building 991 Complex. TRU waste stored in Building 991 is considered to be susceptible to earthquake impacts. TRU waste drums that are impacted may be breached by falling debris from the partial collapse of the facility or may be subject to falling from upper tiers (third or fourth tiers) of drum stacks. The breached drums from falling debris do not spill drum contents from the breach since the breach is at the top or upper portion of the drum. Since the breaches do not result in radioactive material "flowing" from the breach, as is the case in the forklift tine puncture of waste containers (see Section 4.5.3.1), these drum breaches are analyzed as a confined material releases as are the drum breaches due to falling. A ground-level (non-lofted) release of the radioactive material is assumed. The spill is a short duration event and a minimum duration release (10 minutes) is analyzed.

TRU waste stored in tunnels and vaults is assumed to either survive the BDBE (no ceiling collapse due to wall thickness and no falling debris due to minimal overhead material) or collapse and bury the waste (Corridor C may be susceptible to this failure mode, significant earth cover above susceptible tunnels or vaults) with minimal radioactive material release relative to the Building 991 release. A concurrent fire, caused by the earthquake, is not considered due to the low combustible loading in the waste storage areas (the Fuel and Combustible Loading control).

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) the occurrence frequency of a Design Basis Earthquake (DBE) is 1.2×10^{-3} per year and is considered to be an *unlikely* event and (2) the occurrence frequency of a BDBE would be less than 1.2×10^{-3} per year but could still be in the *unlikely* frequency bin. As stated above, a concurrent fire with the BDBE is considered *incredible* due to the credited Fuel and Combustible Loading control which limits the amount of combustibles in waste storage areas. Fires in non waste-storage areas may occur but building partial collapse and breach would be expected to vent hot gases from the fires away from waste storage areas, unlike the fire scenario discussed in 991 Fire 2. The DOT Containers control restricts SNM from the facility that is not contained in a certified DOT Type B shipping container, which is credited for being resistant to drops or punctures (leads to no analysis of SNM releases for the BDBE scenario).

Material-at-Risk

The TRU waste stored in Building 991 is impacted by the earthquake in two ways: (1) partial collapse of the facility creates significant debris which can fall onto exposed waste drums and lead to a breach of a fraction of the drums and (2) third or fourth tier drums may topple from the upper tier (drop more than four feet) and result in a breach of a fraction of the drums.

It is assumed that 50% of the exposed drums (drum lids exposed to the ceiling) in the facility will be subject to debris from the partial collapse of Building 991. The 50% value is based on engineering judgment and is believed to be conservative since the entire facility is not collapsing and overhead materials that may fall onto drums do not cover every part of the facility ceiling area. Of the drums subjected to falling debris, it is assumed that 10% of the drums are breached to the point of losing confinement of radioactive material contents (penetration of drum and internal packaging). The 10% value is also based on engineering judgment and takes into account the strength of the drums (the DOT Containers control) and the types of overhead materials that may fall (limited amount of heavy, penetrating overhead materials).

It is assumed that third and fourth tier drums may topple during the BDBE. It is conservatively assumed that 25% of the drums on the third or fourth tiers of stacks are subject to falling from the top of the stack. The 25% value is based on engineering judgment and is believed to be conservative since: (1) stacked drums are not susceptible to falling except for very large earthquakes (see Section 4.5.5 discussion) and (2) the credited Banded Drums control reduces the likelihood of drums falling from upper tiers of stacks. Of the drums subjected to falling from upper tiers, it is assumed that 25% of the drums are breached to the point of losing confinement of radioactive material contents (failure of drum and internal packaging). The 25% value is also based on engineering judgment and takes into account the strength of the drums (the DOT

Containers control), the Banded Drums control (a single drum in the four banded set is subject to damage from the crushing weight of the other three drums in the banded set), and the limited amount of room available for upper tier drums to fall onto the floor (other drums in the way or limited aisle space). Additional strength or resistance to internal package breaching as a result of falling is provided by rigid liners and at least one polyurethane bag. Drums that are compliant with internal packaging requirements have these barriers. Non-compliant drums do not have both of the barriers and are more susceptible to internal package breach as a result of drum falling. It is assumed that 20% of the compliant breached drums as a result of falling will have breaches of the internal packaging. It is conservatively assumed that 100% of the non-compliant breached drums will have internal package failure. No control has been specified to restrict internal packaging non-compliant TRU waste drums from the Building 991 Complex so the Site statistics for non-compliant drums are used in the analysis. It is conservatively assumed that 85% of drums on the Site are compliant with internal packaging requirements (based on Real Time Radiography, RTR, statistics that over 86% were compliant (Ref. 62)) leaving 15% that are not compliant.

A conservative estimate of the number of TRU waste drums that can be stored in Building 991 is 2,173 drums. This estimate is based on the following assumed room inventories and stacking arrangements:

Room 132	14 drums total	14 exposed drums	no drums on upper tiers
Room 134	560 drums total	200 exposed drums	120 drums on upper tier
Room 135	24 drums total	24 exposed drums	no drums on upper tiers
Room 140/141	652 drums total	190 exposed drums	136 drums on upper tier
Room 142	60 drums total	30 exposed drums	no drums on upper tiers
Room 143	35 drums total	35 exposed drums	no drums on upper tiers
Room 147	60 drums total	60 exposed drums	no drums on upper tiers
Room 151	420 drums total	140 exposed drums	140 drums on upper tier
Room 157	60 drums total	60 exposed drums	no drums on upper tiers
Room 166	288 drums total	72 exposed drums	72 drums on upper tier

The above room loading assumptions are not intended to be restrictions on room inventories or stacking arrangements but are used only as estimates of the building inventory for the purposes of determining approximate BDBE consequences. Conservative assumptions dealing with damage factors, inventories, and container contents that go into the MAR estimate for the BDBE accident scenario are expected to cover all variations of the drum totals and stacking arrangements except for significant departures (more than 25% increases) from the above assumptions.

The total number of exposed drums in Building 991, based on the above assumptions, is 825 drums. Taking 50% as being subjected to debris and the 10% of those subjected to debris that are penetrated yields approximately 41 drums that are breached by falling debris. The total number of upper tier drums (top layer of third or fourth tier drums, does not count third tier drums that are under fourth tier drums) is 468 drums. Taking 25% of the upper tier drums as falling and 25% of the falling drums having the drum fail yields approximately 29 drums that fail due to falling from upper tiers. Of the falling drums, 85% are assumed to have compliant internal packaging of which 20% are assumed to experience internal package breach as a result of the fall.

The remain 15% non-compliant drums are assumed to experience internal package breach as well yielding approximately 9 drums that are completely breached due to falling. The resulting overall equivalent damage ratio (approximately 50 drums out of 2,173 drums are breached) is approximately 2.3%. As added conservatism, the analysis assumes that the overall equivalent damage ratio is 2.5%.

An administrative control is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent). The total inventory for the Building 991 is estimated to be 434.6 kilograms of WG Pu (or equivalent). This is not a restriction on the Building 991 inventory. Using the conservative overall equivalent damage ratio of 2.5%, the total effective MAR for the BDBE resulting in the breach of the waste container(s) is 10.865 kilograms of WG Pu (or equivalent).

Accident Consequence

The radiological dose consequences of the BDBE are *moderate* (0.87 rem) to the MOI and *high* (120 rem) to the collocated worker. As stated above, the BDBE scenario is analyzed as a confined material release, non-lofted plume, 10 minute duration accident scenario. The resulting risk class for the scenario is Risk Class II for the MOI (*unlikely* frequency, *moderate* consequence) and is Risk Class I for the collocated worker (*unlikely* frequency, *high* consequence).

For immediate workers in the facility at the time of the earthquake, partial facility collapse could hypothetically cause a fatality (*high* consequences). No controls are credited for protecting the immediate worker in this scenario since the impacts of the initiating event are so severe that radiological impacts are of little consequence. For lesser earthquakes, the same controls that protect the MOI and the collocated worker provide protection for the immediate worker. In addition, the Emergency Response control would be credited for the development of a facility emergency plan directing the immediate worker to evacuate following spills of radioactive materials. However, the resulting risk class for the BDBE scenario is Risk Class I for the immediate worker (*unlikely* frequency, *high* consequence).

Control Set Adequacy/Vulnerability

The postulated BDBE scenario is considered to be an *unlikely* event with *high* consequences for the collocated worker, *moderate* consequences for the MOI (public), and *high* consequences for the immediate worker. The MOI risk class for the scenario is Risk Class II. The collocated worker and the immediate worker have Risk Class I scenario results.

Acceptability of the risk class results for the collocated worker and the MOI is based on the conservatism that is assumed in the analysis. If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the collocated worker and MOI consequences would be *moderate* and *low*, respectively. This would yield a reduction in the corresponding risk class for both the collocated worker and the MOI. Use of an average MAR (approximately a factor of 3 reduction in MAR) has no impact on the risk class results.

The BDBE scenario does not take any credit for deposition and building retention of radioactive material that is released during the event, except in the case of the tunnel and vault inventories. If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0.1 for an intact facility. The type of damage that the facility will incur from the BDBE is not known. However, if significant collapse occurs, the facility may end up buried partially buried due to the movement of earth above the facility. Conversely, if the building main structure remains intact but wall breaching occurs, the ambient leakpath factor may be negligible. Leakpath factors of an order of magnitude or more lead to a reduction in dose consequences and a corresponding reduction in collocated worker and MOI risk classes.

The damage ratios used in the analysis and the drum loading of the facility that is assumed are both conservative. However, an order of magnitude conservatism from each of these analysis assumptions is not likely. The combined effect of the two assumptions could result in an order of magnitude conservatism which, if removed, would yield lower risk classes for both the collocated worker and the MOI.

The immediate worker analysis is insensitive to analysis assumptions or credited controls due to the impact of the earthquake on the facility and the corresponding *high* consequences to the immediate worker as a result of building partial collapse. The level of earthquake that is postulated would have similar effects to workers in most other buildings, on or off the Site.

The postulated BDBE has an *unlikely* scenario frequency bin assignment. Concurrent failures of mitigative controls would lead to an *extremely unlikely* frequency bin assignment for the scenario. This automatically reduces the risk class for the collocated worker to Risk Class II regardless of increased consequences from the failure of a mitigative control. The MOI risk class for this sequence is reduced to Risk Class III as long as dose consequences do not increase by more than a factor of 5, otherwise, the risk class will remain at Risk Class II. Failures of mitigative controls concurrent with the earthquake are not investigated for the immediate worker. Slight increases in MAR due to administrative control failures would have no impact on the direct earthquake consequences and would contribute little in increasing any radiological consequences associated with the event due to the amount of material released.

Failure of the Fuel and Combustible Loading control could result in a fire concurrent with the BDBE. If the fire were of significant size, the release fraction assumed in the analysis would significantly increase (breached drums could have a combined airborne release fraction and respirable fraction of up to 0.05 rather than the 0.0001 used in the analysis, drums that were not breached could have their inventory added to the effective MAR with a release fraction of 0.0005). While the lofted plume associated with a large fire would have some benefit (about one order of magnitude in atmospheric dispersion), the increased effective MAR and potential release fraction increase could overwhelm the benefit. At worst, the MOI risk class would return to Risk Class II, but the resulting dose potential is not quantified. Failure of this control could yield significant consequences. However, the likelihood of failing the Fuel and Combustible Loading control, having a BDBE, and having an ignition source in the area of the excess combustible materials may be an *incredible* event.

Double batching of the TRU waste drum fissile material inventory (failure of the Container Fissile Material Loading control) would only increase the MOI dose to approximately 1.7 rem (*moderate* consequence), still lower than that needed for a change to *high* consequences. However, the likelihood of a double batching of the approximately 50 random drums involved in the postulated accident would result in an *incredible* frequency assignment for the scenario.

Failure of either of the DOT Containers control or the Banded Drums control could lead to more drums being breached. The number of drums breached would have to increase by a factor of 5 (from 50 drums to 250 drums) to result in a change in the MOI dose consequences from *moderate* to *high*. This would mean that approximately 10% of the drums that were supposed to remain intact would have to be non-compliant with these controls. Such a gross failure of the administrative control programs associated with these credited controls would be associated with an *incredible* event.

In all situations discussed above, the following defense-in-depth feature tends to mitigate the scenario but is not credited in the analysis:

- Building Structure: The Building Structure design feature can lead to the preventing (reducing the likelihood of building partial collapse) and mitigating (remaining intact yielding a ambient leakpath factor and reducing the number of drums impacted by falling debris, allowing the immediate worker to survive the event and evacuate the facility) the effects of the BDBE.

- Fuel and Combustible Loading, DOT Containers, Container Fissile Material Loading, and Banded Drums: The Fuel and Combustible Loading control, the DOT Containers control, the Container Fissile Material Loading control, and the Banded Drums control all reduce the radiological source term that the immediate worker could be exposed to following the BDBE.

- Emergency Response: The Emergency Response control directs the immediate worker to evacuate the facility in the event of spills of radioactive material which lessens the worker exposure to radiological material releases.

As discussed above, the defense-in-depth controls for protecting the immediate worker are of limited value if the earthquake is large enough to collapse the facility. These controls have more importance for lesser earthquakes.

In summary, credible failures of individual mitigative controls concurrent with the accident do not increase the risk class of the scenario for the MOI, the immediate worker, or the collocated worker. In all cases, there is a risk class reduction for the MOI from Risk Class II to Risk Class III associated with the concurrent failures scenario. Similarly, in all cases, collocated worker risk class is reduced from Risk Class I to Risk Class II associated with the concurrent failures scenario. Immediate worker, earthquake induced, fatalities are possible due to occupation of the building during the event and are not impacted by the TRU waste storage mission of the facility.

4.5.5.2 External Events

Range Fires

Range fires were considered but not evaluated further because of insignificant radiological consequences. Range fires have occurred on and near the Site, but are not expected to challenge the Building 991 Complex. This is because the protected area boundary, roadways, and parking lots provide a substantial fire break and the Site Fire Department has adequate procedures and training to suppress a range fire on the Site.

Aircraft Crashes

The frequency of occurrence for a small aircraft crash as a function of target area has been analyzed in Emergency Planning Technical Report, 97-EPTR-004, *Analysis of Aircraft Crash Accidents at the Rocky Flats Environmental Technology Site* (Ref. 84). In terms of frequency, the greatest numbers of aircraft are represented by the small plane category associated with the Jefferson County (Jeffco) Airport due to its operational volume and the closeness to the Site. The crash of a large aircraft at the Site is screened out as a possibility in 97-EPTR-004. Denver International Airport (DIA) and the J-60 Jet Route are also screened out from the analysis using the methodology of the DOE Standard on analysis of aircraft accidents (Ref. 85), because the airport is more than 12 miles from the Site and the center of the jet route is more than six miles from the Site. The technical report concluded the accident frequency involving Site facilities has been determined to be 7.7×10^{-4} accidents/square mile-year. Multiplying this frequency by the footprint area of Building 991, 1.3×10^{-3} square miles (36,259 square feet), results in a frequency of occurrence of 1.0×10^{-6} aircraft crashes per year. This frequency is right at the *extremely unlikely* frequency bin - *incredible* frequency bin threshold. Due to the closeness of the estimated annual frequency of aircraft crash to the incredible frequency range, further analysis was performed.

Building 991 is partially set back into a hillside which removes most aircraft crash vulnerability from the north and the west. The front of the building faces south and one side of the facility faces east. The TRU waste containers are stored away from the south facing portion of the building which is composed primarily of offices and laboratories. Small aircraft penetration through the south face of the facility into a TRU waste storage area is unlikely due to the number of walls that must be penetrated to reach the storage area. Room 166, along the east facing wall of the facility, is intended to store TRU waste (roughly 288 drums) and has no buffer areas and walls as protection against aircraft crashes. However, this vulnerable room area is approximately 5.74×10^{-5} square miles (1,600 square feet). Doubling the area for conservatism and multiplying by 7.7×10^{-4} accidents/square mile-year yields an annual aircraft crash frequency into the vulnerable waste storage areas of Building 991 of approximately 9.0×10^{-8} aircraft crashes per year. Therefore, aircraft crashes into the vulnerable TRU waste storage areas of Building 991 are considered to be *incredible*.

Therefore, there are no external event scenarios evaluated for the Building 991 Complex.

4.5.6 Chemicals and Hazardous Materials

The accident consequence levels for accidents involving identified chemicals and hazardous materials are summarized in Table 4-19.

Hazardous Chemicals in Waste

A qualitative determination was made of the consequence levels for accidents involving the building waste inventory. This was necessary because complete and accurate characterization data is not available for all of the waste types potentially present in the building and the fact the waste inventory will continuously change.

There were containers of TSCA waste identified as being stored in the building and there will be TSCA waste stored in the future. Site PCB wastes include liquid and solid PCB waste forms. Liquid PCB waste forms include IDC 533 (PCB liquids with hazardous constituents), IDC 970 (PCB liquids without hazardous constituents), IDC 971 (PCB fluorescent light ballasts), and IDC 973 (PCB transformers/capacitors). Solid PCB waste forms include IDC 972 (miscellaneous PCB debris such as rags, drained PCB equipment, and soils). A *low* accident consequence has been assigned to accident scenarios involving containerized wastes with PCB liquids based on the number of containers of these IDCs present at the Site. The ERPG-2 and ERPG-3 fractions for IDC 533 have not been determined to date but should be comparable to those calculated for IDC 970 which range from 1E-08 to 1E-05 for various accidents (e.g., fire or spill) and container types per Nuclear Safety Calculation 96-SAE-006 (Ref. 86). With ERPG fractions in this range, it would require a release from thousands of containers to exceed the *low* accident consequence level criteria in Table 4-4. The storage of TSCA-regulated waste meets all applicable requirements of the *TSCA Management Plan* (Ref. 87). A *low* consequence level has been qualitatively assigned for these types of accidents involving TSCA wastes.

Table 4-19 Building 991 Chemical Evaluation Summary

CHEMICAL OR CHEMICAL SOURCE	ACCIDENT CONSEQUENCE LEVEL		
	MOI	Collocated Worker	Immediate Worker
TSCA Polychlorinated Biphenyl (PCB) Containerized Waste	low	low	low
Fixer/Replenisher in Room 160	insignificant	insignificant	low
Product Chemicals	insignificant	insignificant	low

There are three polyethylene 55-gallon drums of fixer/replenisher waste stored in Room 160, and each drum is overpacked in another polyethylene 85-gallon drum to prevent leakage or spills. This chemical is recycled as part of the Waste Minimization Program at the Site and is exempted from the RCRA program requirements (Ref. 88). Any spill or leak of this chemical is assumed to be effectively mitigated by overpacked containers and existing spill response procedures. Potential accident consequences have been qualitatively assigned as *low* for the immediate worker and *insignificant* for collocated workers and the MOI.

Product Chemicals

After review of the product chemical inventory, it has been determined that none of the identified chemicals are present in quantities that exceed the evaluation threshold quantities discussed in Section 4.3.2. Material Safety Data Sheets (MSDSs) are on file in the building. Proper labeling and use of these chemicals are as defined in the HSP 9.07, *Hazard Communication Program* (Ref. 89). Potential accident consequences are considered *insignificant* for the small quantity of product chemicals present. Future process or product chemicals brought into Building 991 would require comparison to guideline thresholds in accordance with the Environmental Compliance Administrative Program.

Process Chemicals

An above ground 1,000 gallon tank, Tank 33, is located outside Building 989 and is closed in place using a closed cell polyurethane foam. A day tank inside Building 989 holds up to 180 gallons of diesel fuel oil. This is a standard industrial hazard and is not analyzed further.

Other Hazardous Materials

A transformer containing PCBs is located in Room 165. Two transformers containing PCBs are also located in a fenced area outside north of Building 989. The PCBs are completely contained inside the transformers and caution signs are posted to notify workers that PCBs are present. Potential worker exposure to the toxic effects of the PCBs is *unlikely* because of the non-dispersible form of the material. This is a standard industrial hazard and is not analyzed further.

There are fifty-four steel 55-gallon drums containing beryllium stored in the Tunnel 998. While beryllium fines and shavings can be toxic if inhaled or ingested, these materials are large metallic parts and are packaged within plastic bags or liners, and then sealed within the 55-gallon drums. Potential worker exposure to the toxic effects of the beryllium is *unlikely* because of the non-dispersible form of the material. There are no plans to store beryllium fines in the building. Therefore, the beryllium inventory does not present a health hazard and is not analyzed further.

Standard 24- to 48-volt lead-acid batteries power seven electric forklifts used during material handling operations. Lead-acid batteries have a potential for hydrogen offgassing during charging and possible rupture if they are overcharged. Hydrogen gas can create an explosive atmosphere if adequate ventilation is not provided. Hazards associated with battery charging are controlled procedurally by HSP 15.01, *Batteries* (Ref. 90). This is a standard industrial hazard and is not analyzed further.

4.6 RISK DOMINANT ACCIDENT SCENARIOS

This section discusses the dominant risk contributors to the MOI, collocated workers, and immediate workers. These accident scenarios have significant risk even after crediting preventive and mitigative features, and are categorized as Risk Class I or II. Table 4-20 summarizes the risk dominant accident scenarios, lists the assumed effective MAR used in the accident scenario, lists the realistic effective MAR for those scenarios applicable, shows the 95th percentile χ/Q consequences determined for the accident scenario, provides the median χ/Q when combined with the more realistic effective MAR determined in the risk dominant accident scenario discussion, shows the Before Risk Class as determined in the accident scenario evaluation in Section 4.5, and provides the estimated After Risk Class based upon the risk dominant accident scenario discussion below on reduced frequency and consequences. In the text that follows a brief discussion of each risk dominant scenario, its primary characteristics, analysis outcomes, and suggestions for risk minimization are provided.

Dominant Accident Scenario 1: 991 NPH 1 - Earthquake Caused Spill. The earthquake is postulated to potentially involve the total inventory of waste containers inside the main part of Building 991. Waste containers stored in the tunnels and vaults are not assumed to contribute to the airborne release of material. It is assumed waste containers stored in the tunnels and vaults would be buried if the tunnels collapsed. There are no third or fourth tier drums in the tunnels and vaults. Potentially 2,173 drums loaded with TRU waste up to 200 grams WG Pu are postulated involved in the earthquake. The drums could either be breached by falling material from the ceiling or by falling from either the third or fourth tier and impacting the floor of Building 991. This results in *moderate* (0.87 rem) consequences to the MOI and *high* (120 rem) consequences to the collocated worker. The earthquake at the Site is considered an *unlikely* event which results in a Risk Class II to the MOI and Risk Class I to the collocated and immediate workers.

For the TRU waste drums stored in the complex, it was assumed that each drum was loaded with a maximum of 200 grams WG Pu. A more realistic estimate is to use the 95th percentile upper control limit (UCL) gram loading for TRU waste 55-gallon drums. Per SARAH (Ref. 43) this value is approximately 75 grams WG Pu. Applying this loading to the involved drums results in a realistic effective MAR of approximately 4,074 grams WG Pu. Use of the realistic effective MAR reduces the consequences to the MOI and collocated worker by greater than two times. This does not change consequence bins for either the MOI or the collocated worker.

Use of median versus 95th percentile χ/Q, along with the realistic effective MAR, would reduce the MOI dose to *low* (0.034 rem) and the collocated worker dose to *moderate* (5.6 rem). This would reduce the MOI risk to Risk Class III and the collocated worker risk to Risk Class II.

Table 4-20 Risk Dominant Accident Scenarios

Risk Dominant Accident Scenarios	Assumed Effective MAR (grams WG Pu)	Realistic Effective MAR (grams WG Pu)	χ/Q				Risk Class					
			95th Percentile		Median		MOI		Collocated Worker		Immediate Worker	
			MOI Dose (rem)	CW Dose (rem)	MOI Dose (rem)	CW Dose (rem)	Before[1]	After[2]	Before[1]	After[2]	Before[1]	After[2]
1. *991 NPH 1 - Earthquake Caused Spill* Spill of multiple containers of TRU waste.	10,865	4,074	0.87	120	0.034	5.6	II	II	I	I	I	I
2. *991 Fire 2 - Large Fire Inside Building* Fire involving 560 TRU waste drums.	112,000	42,000	4.4	150	0.39	0.39	II	III	I	II	II	II
3. *991 Fire 1 - Fire Inside Building 991 Waste Storage Area* Fire involving 3 TRU waste drums.	600	No Change	0.24	33	0.025	4.2	II	III	I	II	III	NA
4. *991 Fire 4 - LLW Wooden Crate Fire* Case A: Fire involving 1 LLW crate under canopy.	3	No Change	0.12	17	0.012	2.1	I	II	I	II	III	NA
Case B: Fire involving 50 wooden waste crates under canopy.	150	31.5	0.68	24	0.034	0.034	II	III	II	III	III	NA
5. *991 Explosion 2 - Hydrogen Explosion in a Waste Crate* Explosion of one TRUPACT II SWB or Metal Waste Box due to hydrogen build up.	32	No Change	1.8	250	0.18	31	III	NA	II	II	II	II
6. *991 Explosion 1 - Hydrogen Explosion in a 55-gal. Drum* Explosion of one TRU waste drum due to hydrogen build up.	20	No Change	1.1	160	0.12	19	III	NA	II	III	II	II
7. *991 Spill 1 - Small Spill: Breach of Two TRU Drums* Spill of two 55-gal. waste drums.	400	No Change	0.032	4.4	3.3E-03	0.55	III	NA	II	II	III	NA

[1] Risk class as determined in Section 4.5 discussion of accident scenarios with conservative assumptions for accident scenario frequency and consequences.
[2] Risk class based upon use of realistic assumptions for accident scenario frequency and consequences.

In summary, none of the actions taken would result in reducing the risk to the MOI, collocated worker, and immediate worker short of providing a WG Pu gram loading limit in Building 991. The evaluated risk to the collocated and immediate workers is considered an acceptable risk to incur due to the conservatism on estimated number of drums involved in the accident and the amount of material available for release from the involved drums.

Risk Dominant Accident Scenario 2: 991 Fire 2 - Fire Inside Building 991 Office Area. A fire is postulated to start in the Building 991 office area along with failure of the fire suppression system in the area. The uncontrolled fire is expected to spew hot gases and combustion products into Room 134, a waste storage area. The heat in Room 134 is postulated to increase in the room such that all the drums experience lid seal failure, pyrolization of inner contents, and venting of contents through the failed lid seal resulting in a radiological release. The consequences of such a fire are *moderate* (4.4 rem) to the MOI and *high* (150 rem) to the collocated worker. With an *unlikely* frequency of the event occurring the resulting risk to the MOI is Risk Class II, to the collocated worker is Risk Class I, and to the immediate worker is Risk Class II.

Total failure of the fire suppression system is postulated for this accident scenario. Since the fire suppression system is an LCO, this is a very conservative assumption. Even partial operation of the fire suppression system would reduce the heat of the fire thereby resulting in reduced heating of Room 134 and most likely a reduced number of TRU waste drums with lid seal failure and venting of contents through the failed lid seal. Assuming all 560 drums in Room 134 are heated to a temperature high enough to damage the lid seal and pyrolize the inner contents is also extremely conservative. Another conservative assumption is that each drum is loaded with a maximum 200 grams WG Pu. Applying the 95^{th} percentile UCL gram loading, as discussed in Risk Dominant Accident Scenario 1, a more realistic effective MAR would be 42,000 grams WG Pu versus 112,000 grams WG Pu.

The frequency of this fire evolving into the size of fire postulated could be argued to be *extremely unlikely*. The frequency is based on a fire starting in the office area, no personnel are either available or notice the fire, complete failure of the fire suppression system, the Fire Department is not notified in time to assist in controlling the fire, and the fire is large enough to impact waste containers in rooms separated by distance, walls and doors.

Use of median versus 95^{th} percentile χ/Q, along with the realistic effective MAR, would reduce the MOI dose to *moderate* (0.39 rem) and the collocated worker dose to *low* (0.39 rem). This would reduce the MOI risk to Risk Class II and the collocated worker risk to Risk Class III with an assumed event frequency of *extremely unlikely*. Since the intensity of this size fire results in a lofted plume, the maximum dose occurs at 1,900 meters. This distance is still on the Site therefore the maximum collocated worker dose occurs at this distance. Assuming the MOI dose at a distance of 1,900 meters is conservative. The actual dose to the MOI (2,367 meters) would be less than 0.39 rem.

In summary, the most realistic estimate of this fire occurring is probably closer to *extremely unlikely* than *unlikely* as assumed in the accident analysis discussion. This estimate is based on the number of failures that must occur for the fire to evolve into a large fire. Using the realistic MAR reduces the consequences to the MOI and collocated worker but not to a lower consequence bin. With an *extremely unlikely* frequency and *moderate* consequences to the MOI, the MOI risk reduces to Risk Class III. *High* consequences are still postulated for the collocated worker, therefore the risk reduces to Risk Class II with the reduction in frequency. The risk to the immediate worker remains at Risk Class II due to the potential for inhalation of combustion products and burns from the fire.

Risk Dominant Accident Scenario 3: 991 Fire 1: Fire Inside Building 991 Waste Storage Area. A fire is postulated to occur in any of the Building 991 waste storage areas due to a failure of the combustible loading program in conjunction with an ignition source. Three TRU waste drums are assumed to be involved in the fire. The consequences of this fire are *moderate* (0.24 rem) to the MOI and *high* (33 rem) to the collocated worker. With an *unlikely* frequency estimated for fire, the MOI risk is Risk Class II and the collocated worker risk is Risk Class I.

To reduce the consequences of this accident scenario the effective MAR or the dose needs to be reduced. Even though the number of drums estimated to be involved in this fire is considered conservative, it can probably not be further reduced. No credit is taken for the exhaust filtration system in Building 991 since it is an untested system. An untested HEPA filtration system would still provide some benefit in reducing the dose consequences to the MOI and collocated worker. Taking credit for this system would conservatively reduce the consequences one bin. The drums involved in the fire are assumed to be loaded with a maximum of 200 grams WG Pu per drum. Using the 95^{th} percentile UCL would reduce the effective MAR to 225 grams WG Pu. This would reduce the consequences of the fire to *low* for the MOI and *moderate* for the collocated worker. The respective risk to the MOI and collocated worker would then be Risk Class III and II.

The frequency of this event could also be lowered to reduce the risk to the MOI, collocated and immediate workers. The *unlikely* frequency established in the accident analysis is based on the probability of a fire occurring in conjunction with a failure of the combustible material control program. This sequence of events could be argued to yield an accident scenario frequency of *extremely unlikely*. This reduction in frequency bin would result in a reduction of risk class to the MOI, collocated worker and immediate worker by one level.

Use of median versus 95^{th} percentile χ/Q, along with the assumed effective MAR, would reduce the MOI dose to *low* (0.025 rem) and the collocated worker dose to *moderate* (4.2 rem). This would reduce the MOI risk to Risk Class III and the collocated worker risk to Risk Class II.

The risk class as determined in the accident analysis is conservatively estimated. A more realistic determination of either the consequence or the frequency, as stated above, would have the effect of reducing the risk class to the MOI, collocated and immediate workers by one level. The risk class for the MOI and collocated worker is more realistically Risk Class III and Risk Class II respectively.

Risk Dominant Accident Scenario 4: 991 Fire 4 - LLW Wooden Crate Fire. Two sizes of fires are postulated for the LLW crates stored under the Building 991 west dock area canopy. The first case involves one LLW crate and the second case assumes the total inventory of LLW crates is involved in the fire. For the first case, the MOI and collocated worker risk is a Risk Class I since this fire is an *anticipated* event with *moderate* consequences. In the second case, both the MOI and collocated worker are Risk Class II since this is an *unlikely* event with *moderate* consequences.

A reduction in the consequence for Case A could be postulated based on the conservative assumptions used in the accident analysis. A fire in a wooden waste crate is modeled assuming an unconfined material release fraction. The packaging is expected to provide some confinement of the material even though it is a combustible package. A release fraction somewhere between confined and unconfined combustible material is probably more appropriate. Using a more realistic release fraction could qualitatively reduce the consequences to the MOI and collocated worker by up to two orders of magnitude. A reduction in the consequence for Case B could be argued based on the conservatism discussed above for the release fraction or by reducing the effective MAR. The accident analysis assumes the LLW crates are loaded with a maximum of 3 grams WG Pu. Due to the number of LLW crates postulated to be involved in the fire, a 95th percentile UCL gram loading for the waste crates can be conservatively estimated. This assumption reduces the consequences but not to a lower consequence bin.

For Case A, the frequency of the fire occurring and involving one wooden LLW crate could be argued to be *unlikely*. The accident analysis assumes the occurrence of a fire in the west dock area is initiated, no personnel are either available or notice the early stages of the fire, and the fire occurs at the location of the LLW crates. For Case B, complete failure of the fire suppression system is assumed. Since the fire suppression system is an LCO system and surveilled and maintained, this is a very conservative assumption. Partial operation of the fire suppression system would reduce the number of wooden LLW crates involved in the fire which would also have the effect of reducing the effective MAR.

Use of median versus 95th percentile χ/Q, along with the assumed effective MAR for Case A, would reduce the MOI dose to *low* (0.012 rem) and the collocated worker dose to *moderate* (2.1 rem). This would reduce the MOI risk to Risk Class III and the collocated worker risk to Risk Class II maintaining the assumed accident analysis frequencies. For Case B, using the realistic effective MAR, the MOI and collocated worker doses are reduced to *low* (0.034 rem). This would reduce the MOI and collocated worker risk to Risk Class III.

Based upon the discussion above on consequence and frequency reduction it is reasonable to assume a reduction in frequency bin for Case A. This will reduce the MOI and collocated worker risk to Risk Class II. For Case B, an *extremely unlikely* frequency can be argued assuming there will be a coincident fire and total failure of the fire suppression system. This frequency, in conjunction with the more realistic effective MAR which results in *moderate* consequences to the MOI and collocated worker, results in a risk reduction to the MOI and collocated worker to Risk Class III.

Risk Dominant Accident Scenario 5: 991 Explosion 2 - Hydrogen Explosion in Waste Crate. Waste crates (TRUPACT II SWBs or Metal Waste Boxes) are postulated to generate sufficient electrostatic energy to ignite a flammable hydrogen/oxygen mixture resulting in a deflagration and rapid pressure rise in the crate. The pressure rise is enough to separate the crate lid from the crate along with a fraction of the waste crate contents. The accident analysis determined the likelihood of this event occurring as *extremely unlikely* with *moderate* consequences to the MOI, *high* consequences to the collocated worker, and *low* to *high* consequences for the immediate worker. This resulted in an unacceptable risk to the collocated worker of Risk Class II and potential unacceptable risk to the immediate worker of Risk Class II.

The consequences of this accident can be reduced by reducing the effective MAR involved in the accident. A factor of 10 decrease in MAR would be required to reduce the consequences to *moderate* for the collocated worker. The frequency of this accident is greatly reduced by the use of vented waste containers. A program to periodically inspect and aspirate the drums further reduces the frequency of this event occurring.

Use of median versus 95^{th} percentile χ/Q, along with the assumed effective MAR, results in no decrease in consequence bin for the collocated worker. The dose is decreased from 250 rem to 31 rem. Therefore, assuming the frequency remains the same as analyzed in the accident scenario, the collocated worker risk would remain at Risk Class II.

The frequency of this event could be further reduced by a labor intensive program of periodically aspirating the waste crates. This additional control is not considered necessary due to the *extremely unlikely* probability of this event occurring without aspiration. The consequences to the collocated worker cannot be effectively reduced through a reduction in MAR allowed in the waste crates. The MAR would have to be reduced to less than 20 grams WG Pu per crate to reduce the consequences one bin. If the explosion were to occur inside the building the consequences could be further reduced by accounting for the untested HEPA filtration system. There is no basis to assume the accident could only occur inside the building though. Therefore, the risk to the collocated worker cannot be further reduced (Risk Class II). The risk to immediate workers in the vicinity of the explosion is adequately analyzed as Risk Class II since there are no indications (such as smoke from a fire that can be seen or smelled) that a release has occurred. A radiological material uptake by the immediate worker is a concern with potential fatalities.

Risk Dominant Accident Scenario 6: 991 Explosion 1 - Hydrogen Explosion in a 55-gal. Drum. Waste drums (55-gallon TRU waste drums) are postulated to generate sufficient electrostatic energy to ignite a flammable hydrogen/oxygen mixture resulting in a deflagration and rapid pressure rise in the drum. The pressure rise is enough to separate the drum lid from the drum along with a fraction of the waste drum contents. The accident analysis determined the likelihood of this event occurring as *extremely unlikely* with *moderate* consequences to the MOI, *high* consequences to the collocated worker, and *low* to *high* consequences for the immediate worker. This resulted in an unacceptable risk to the collocated worker of Risk Class II and potential unacceptable risk to the immediate worker of Risk Class II.

The consequences of this accident can be reduced by reducing the effective MAR involved in the accident. A factor of 7 decrease in MAR would be required to reduce the consequences to *moderate* for the collocated worker. The frequency of this accident is greatly reduced by the use of vented waste containers. A program to periodically inspect and aspirate the drums further reduces the frequency of this event occurring.

Use of median versus 95th percentile χ/Q, along with the assumed effective MAR, results in a reduction in consequence bin for the collocated worker. The dose is decreased from 160 rem to 19 rem. Therefore, assuming the frequency remains the same as analyzed in the accident scenario, the collocated worker risk would be reduced to Risk Class III if median χ/Q is assumed.

The frequency of this event could be further reduced by a labor intensive program of periodically aspirating the waste drums. This additional control is not considered necessary due to the *extremely unlikely* probability of this event occurring without aspiration. The consequences to the collocated worker cannot be effectively reduced through a reduction in MAR allowed in the waste drums. The MAR would have to be reduced to less than 29 grams WG Pu per drum to reduce the consequences one bin. If the explosion were to occur inside the building the consequences could be further reduced by accounting for the untested HEPA filtration system. There is no basis to assume the accident could only occur inside the building though. Therefore, the risk to the collocated worker cannot be further reduced (Risk Class II). The risk to immediate workers in the vicinity of the explosion is adequately analyzed as Risk Class II since there are no indications (such as smoke from a fire that can be seen or smelled) that a release has occurred. A radiological material uptake by the immediate worker is a concern with potential fatalities.

Risk Dominant Accident Scenario 7: 991 Spill 1 - Small Spill: Breach of Two TRU Drums. A forklift handling or movement error is postulated to occur at the docks or in any of the TRU waste storage areas. A forklift error results in a puncture of two TRU drums. The likelihood of this event occurring is considered *unlikely*. The consequences to the MOI is *low* (0.032 rem) which results in an acceptable risk of Risk Class III. The consequences to the collocated worker are *moderate* (4.4 rem) which results in a Risk Class II. The consequences to the immediate worker were evaluated to be from *low* to *moderate* which results in a Risk Class III or II respectively.

The consequences of this event could be reduced if the accident occurs inside Building 991 by accounting for the untested HEPA filtration system. Even untested, the HEPA filtration system will provide some protection and reduce the amount of material released from the building. The consequences to the collocated worker would be reduced one consequence bin by accounting for the untested HEPA filtration system. There is no basis to assume the accident would only occur inside the building though.

The frequency of this event occurring is not expected to be reduced further than currently analyzed in the accident scenario. Material handling accidents do occur and would probably not be significantly reduced through implementation of additional training or other controls.

Use of median versus 95th percentile χ/Q, along with the assumed effective MAR, results in no decrease in consequence bin for the collocated worker. The dose is decreased from 4.4 rem to 0.55 rem. Therefore, assuming the same frequency as analyzed in the accident scenario, the collocated worker risk would remain at Risk Class II.

4.7 FINAL HAZARD CATEGORIZATION

The safety analysis performed for the Building 991 Complex concludes the identified radiological hazards have the potential for significant on-site consequences that would require on-site emergency planning activities. In addition, the inventory of WG Pu that will continue to be present in the complex throughout the defined mission authorized by this FSAR exceeds the nuclear Hazard Category 2 threshold as defined in DOE-STD-1027-92 for the combination of isotopes in WG Pu. Therefore, the Building 991 Complex is classified as a DOE Hazard Category 2 Nuclear Facility.

5. DERIVATION OF TECHNICAL SAFETY REQUIREMENTS (TSRs)

5.1 INTRODUCTION

The TSRs for Building 991, provided as Appendix A to the FSAR, establish those requirements that define the conditions, safe boundaries, and Administrative Controls necessary to ensure safe operation of the building and reduce the risk to immediate workers, collocated workers, the MOI, and the environment from uncontrolled release of hazardous materials. There are four types of controls used to provide this assurance: LCOs, Surveillance Requirements (SRs), Administrative Controls (ACs), and Design Features. Each of these controls are defined below:

Limiting Conditions for Operation - LCOs are imposed on SSCs credited in the FSAR to reduce the frequency of postulated accidents or mitigate the consequences of postulated accidents to the MOI and/or collocated worker. The Building 991 Complex LCO addresses the following system:

- Building 991 Facility Fire Water Systems and Flow Alarms

Surveillance Requirements - SRs are requirements relating to testing, calibration, or inspection to ensure the necessary operability of Safety SSCs and their support systems. This section of the TSRs contains the requirements necessary to maintain operation of the Building 991 Complex within the LCOs. In the event that SRs are not successfully completed or accomplished within their specified frequency, the systems or components involved are assumed to be not operable and required actions defined by the LCOs are taken until the system or components can be shown to be operable.

SRs for each system or component identified in a specific LCO are provided subsequent to the LCO itself. These SRs add assurance that those systems and components that the safety analysis credits for prevention of postulated accidents or mitigation of postulated accident consequences will perform their intended functions.

Administrative Controls - ACs are provisions relating to organization and management, conduct of operations, procedures, record-keeping, assessment, and reporting necessary to ensure safe operation of the building. The ACs for the Building 991 Complex are divided into two types; AOLs and PACs.

AOLs are discrete administrative controls/limits that have been credited in the safety analysis. AOLs are credited as providing a reduction in postulated accident scenario initiation frequency and/or a reduction in postulated accident consequences. Such controls are more precise and discrete than those defined by a safety management program or the key attributes of a safety management program. The AOLs are an administrative equivalent to hardware requirements specified in LCOs and, as such, have requirements for surveillance of and requirements for actions following discovery of non compliance with the AOL. Examples of AOLs include: waste container specifications, limits on fissile material (similar to Criticality Safety Operating Limits

(CSOLs)/NMSLs), and restriction of selected items (e.g., fossil-fueled vehicles, flammable gases).

PACs reflect facility-specific implementation of specific attributes of safety management programs that are necessary to maintain the safety envelope described in the safety analysis and TSRs. The PACs cover the programmatic functions credited for reduction in accident frequency or consequences. PACs include a programmatic requirement statement and a list of key program elements/attributes.

Design Features - Design Features are the building passive features that reduce the frequency and/or mitigate the consequences of uncontrolled releases of radioactive or other hazardous materials from the building for postulated accident scenarios analyzed in the FSAR. These design feature descriptions are provided in the TSRs to assure that evaluations of proposed changes or modifications to these design features are properly performed and documented, consistent with requirements specified in the TSRs. The only design feature credited in the FSAR is the building external structure that protects the building contents from fires exterior to the building and lightning strikes. Maintenance of this design feature is addressed in the TSRs, Section 5.2, PACs under *Configuration Management* and *Maintenance*.

5.2 DEVELOPMENT OF TECHNICAL SAFETY REQUIREMENTS

The TSRs were developed as a result of the hazards identification (Section 4.4) and accident evaluation (Sections 4.5 and 4.6) processes presented in Chapter 4. The process used to develop the TSRs is depicted in Figure 5-1. There are four inputs to the TSRs: (1) Recognized Controls, (2) Credited Controls, (3) Derived Controls, and (4) Site Management Controls. ***Recognized Controls*** were identified during the hazard identification step of the safety analysis. Recognized controls helped to determine whether identified hazards could be characterized as *standard industrial hazards,* requiring no further evaluation, or as hazards requiring further evaluation. Recognized Controls are typically PACs that enhance defense-in-depth and worker safety and are not usually driven by the individual accident scenario evaluations. Examples of Recognized Controls include drum handling equipment design and health and safety practices addressing control of such equipment. ***Credited Controls*** are those controls specifically identified and credited during evaluation of postulated accident scenarios in Section 4.5. Credited Controls include LCOs (and associated SRs), Design Features, AOLs, and PACs that support the accident scenario frequency and consequence assumptions presented in the accident analysis tables. Examples of Credited Controls include the Fire Suppression and Alarm Transmittal System and waste container fissile material load limits. ***Derived Controls*** are any additional controls that were identified during evaluation of the risk dominant accident scenarios. Derived Controls further reduce the risk of the postulated accident scenarios from what is presented in the accident evaluation section. Derived Controls are similar to Credited Controls; the distinction between these types of controls deals with the point in the analysis where the control is defined. Finally, ***Site Management Controls*** help assure the continued implementation and maintenance of the TSRs. Examples of Site Management Controls include quality assurance, records management, configuration control, training, and nuclear safety.

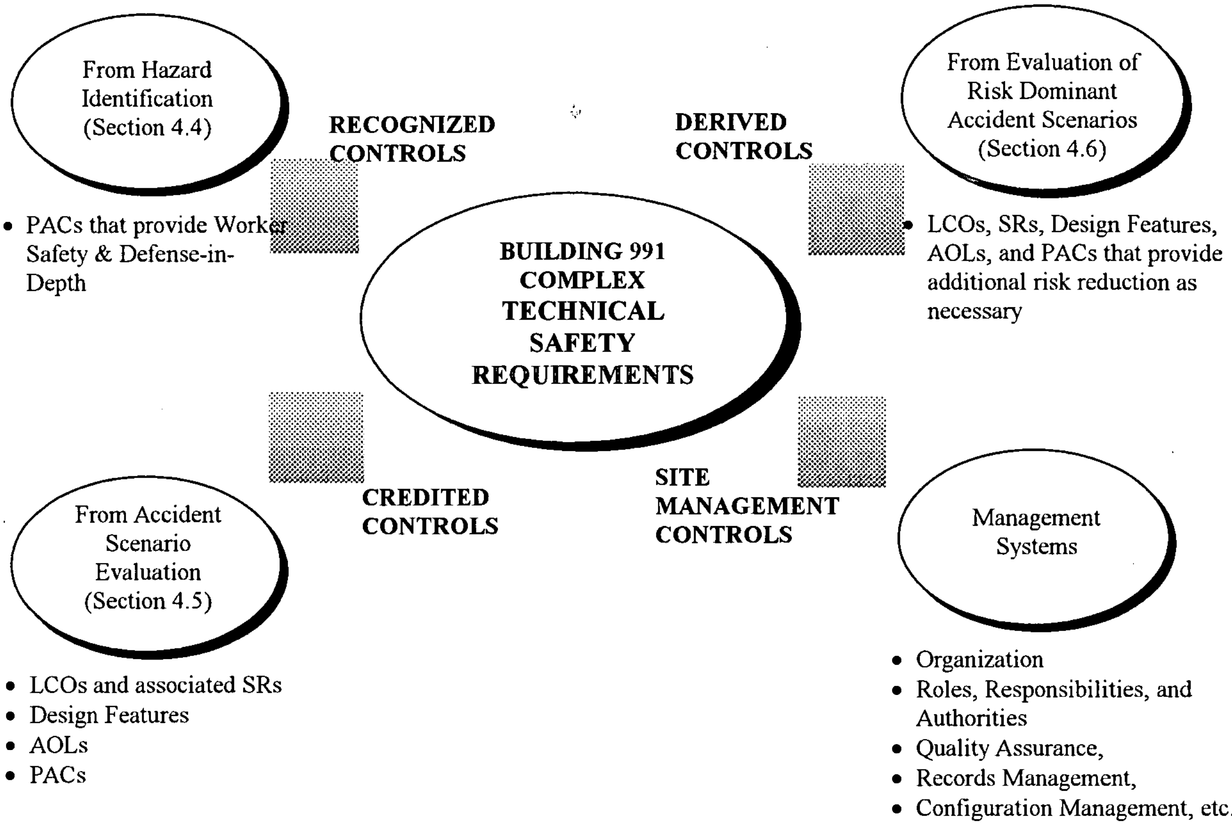

Figure 5-1 Development of Building 991 Complex Technical Safety Requirements

5.3 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS (SSCs)

5.3.1 Introduction

This section identifies the safety SSCs that ensure safety functions necessary for safe facility operations. The hazard and accident analyses identify the preventive and mitigative safety features necessary to protect the MOI, collocated worker, immediate worker, and the environment, or to provide significant elements of defense in depth. The analyses also identify safety features that may be generally applicable to many or all scenarios (e.g., assumed initial condition). This section correlates those safety features to the SSCs capable of providing the necessary safety functions. Once identified, safety SSCs are categorized according to their importance to safety and their operability requirements to perform their safety function. The extent and detail of SSC descriptions in Chapter 2 suffice, and descriptions in this section are minimized.

Safety SSCs are categorized into one of the following levels, based on the definitions in DOE-STD-3009-94:

- Safety-Class: SSCs whose failure could adversely affect the environment, or safety and health of the MOI as identified by safety analyses.

- Safety-Significant: SSCs not designated as safety-class SSCs, but whose preventive or mitigative function is a major contributor to defense in depth (i.e., prevention of uncontrolled material releases) and/or worker safety as determined from hazard analysis. As a general rule of thumb, Safety-Significant SSC designations based on worker safety are limited to those SSCs whose failure is estimated to result in an acute worker fatality or serious injuries to workers. Serious injuries refers to medical treatment for immediately life-threatening or permanently disabling injuries from other than standard industrial hazards. Potential latent effects (e.g., potential carcinogenic effects of radiological exposure or uptake) are specifically excluded.

Section 5.3.2 provides a matrix of safety features identified in the hazard and accident analyses to safety SSCs, and provides the safety category of the safety SSCs. Sections 5.3.3 and 5.3.3.2 identify safety functions and provide brief system descriptions sufficient to understand the performance of these functions for the applicable Safety SSC.

5.3.2 Identification and Classification of Safety SSCs

The accident analysis tables (Chapter 4, Table 4-10 through Table 4-13 and Table 4-15 through Table 4-18) identify the safety features considered significant for each of the accident scenarios analyzed. Those tables list these features in the 'Credited Control' column. These features represent the broad set of controls considered for accident prevention and/or mitigation, and from which the safety features specifically credited for reducing the risk of an accident to acceptable levels are derived. The primary credited safety features are indicated in the 'Control Type' column with a 'P', while those providing defense in depth are indicated with a 'D'.

5.3.2.1 Identification of Safety SSCs

Table 5-1 correlates safety features identified in the hazard and accident analyses to safety SSCs performing the safety functions. The first column of the table, ' Credited Control,' lists the preventive and mitigative safety features from the Chapter 4 accident analysis tables for the postulated accident scenarios. The second column identifies the safety SSC providing the safety feature listed in the first column.

The middle series of columns provides the accident scenario-specific identification of Safety-Class and Safety-Significant SSCs. The target population for the SSC safety function is indicated for the MOI (m), collocated worker (c), and immediate worker (i). SSCs providing primarily credited safety functions are indicated in capitals (e.g., M, C, I).

The 'Safety Category' column indicates the system categorization of the SSC, either Safety-Class or Safety-Significant. The SSCs that provide specifically credited safety features for the MOI are categorized as Safety-Class. The SSCs that provide specifically credited safety feature for the collocated or immediate worker are categorized as Safety-Significant. All SSCs listed in the accident analysis tables as providing defense in depth are categorized as Safety-Significant.

The level indicated in the 'Safety Category' column reflects the highest level of safety significance achieved by an SSC (i.e., indicated levels are independent of safety significance to any one particular accident scenario). For example, the fire suppression system is Safety-Class because the system performs a specifically credited safety function for the MOI in at least one accident scenario analyzed. In contrast, the fire detection system is Safety-Significant because although it provides defense in depth for MOI, collocated workers, and immediate workers, it is never specifically credited in the hazard and accident analyses for protection of the MOI.

Table 5-1 Matrix of Safety Features to Safety SSCs

Credited Control	**Safety SSC**	**Fire 1**	**Fire 2**	**Fire 3**	**Fire 4**	**Spill 1**	**Hyd Expl 1**	**Hyd Expl 2**	**NPH Spill 1**	**Safety Category**
Fire Alarm Transmittal/Fire Department Response	Fire detection system	m/c	m/c		m/c					Safety-Significant
Fire Phones/Fire Department Response	Fire detection system	m/c	m/c	m/c/	m/c					Safety-Significant
Building Structure	Building structure	M/C	M/C/I	M/C/I	M/C/I				m/c/i	Safety-Class
Automatic sprinkler system	Fire suppression system	m/c	M/C	M/C/I	M/C/I					Safety-Class
Local Fire Alarms	Fire detection system	I	I	i	I					Safety-Significant
Filtered exhaust ventilation	Ventilation	m/c				m/c	m/c	m/c		Safety-Significant

Note: Capital letters (M, C, I) indicate that the type of control credited is primary. Lowercase letters (m, c, i) indicate that the type of control credited is defense in depth.

5.3.2.2 Functional Compliance and Operational Reliability of Safety SSCs

The system categorization of safety SSCs recognizes the more significant safety role performed by Safety-Class SSCs versus Safety-Significant SSCs. This difference in priority also applies to ensuring operational reliability. Safety-Class SSCs typically require more stringent levels of surveillance requirements and maintenance to ensure the highest level of operational reliability. Safety-Class SSCs are surveyed, tested, and maintained to the standards defined in the Limiting Conditions for Operation (LCOs) in the TSRs.

The Safety-Significant SSCs are typically engineered and maintained in accordance with safety management programs. Standards for the functionality of Safety-Significant SSCs generally derive from good industry practices and existing site procedures. Absence of high reliability does not materially affect the risk profile of the building, given that it operates in accordance with the building TSRs. Designation of an SSC as Safety-Significant in the FSAR ensures that system functionality will be maintained commensurate with the system importance to safety, current configuration, and the barrier it poses to accident occurrence and/or consequence.

5.3.3 Safety-Class SSCs

This section summarizes the safety function and system description for those SSCs specifically credited in the accident analysis as providing necessary safety functions to protect the MOI. These SSCs are designated Safety-Class. The following system is addressed:

- Fire suppression system including the automatic wet-pipe sprinkler system
- Building structure.

Specific Safety-Class components are address under Section 5.3.3.1. The balance of the SSCs are Safety-Significant and are addressed in Section 5.3.3.2.

5.3.3.1 Fire Suppression System

The features of the Fire Suppression System specifically credited in the accident analysis are the automatic wet-pipe sprinkler suppression system and the automatic dry pipe sprinkler system for the west dock. Other complex suppression components (e.g., dry pipe systems in other areas) are Safety-Significant and are discussed in Section 5.3.4.1. Additional information on the Fire Suppression System is available in Section 2.2.2.3 Suppression Systems.

5.3.3.1.1 Safety Function

The safety function of the automatic sprinkler suppression systems are to reduce the frequency of occurrence of large fires and to mitigate the radiological consequences from significant size fires. The fire severity is reduced by preventing growth and flashover and by decreasing the energy release rate from direct combustion.

5.3.3.1.2 System Description

A detailed description of the Fire Suppression System is provided in Section 2.2.2, Fire Suppression, Detection and Alarm Transmittal System.

5.3.3.2 Building Structure

The Safety-Class feature identified in the accident analysis is the building structure.

5.3.3.2.1 Safety Function

Safety functions provided by the building structure include passive design safety features. The safety function of the structure is prevention of external fires from propagating inside the structure.

5.3.3.2.2 System Description

A detailed description of the building structure is provided in Section 2.1.1, Building 991.

5.3.4 Safety-Significant SSCs

This section summarizes the safety function and system description for those SSCs identified in the accident analysis as providing significant safety functions to protect the MOI, collocated worker, and/or immediate worker. These SSCs are designated Safety-Significant. Three systems and one structure are addressed:

- Fire Suppression System
- Fire Detection System
- Building 991 building structure
- Ventilation.

Specific Safety-Significant components are addressed under the appropriate system heading. Any Safety-Class components are addressed in Section 5.3.3.

5.3.4.1 Fire Suppression System

The Safety-Significant safety features identified in the accident analysis for the Fire Suppression System are the dry pipe system in Room 166, and the exhaust filter plenum deluge system. Portions of the Fire Suppression System that are Safety-Class are discussed in Section 5.3.3.1.

5.3.4.1.1 Safety Function

The safety function of manual, portable fire suppression equipment, the dry pipe system, and the exhaust filter plenum deluge system is to reduce frequency of occurrence of fires and to help mitigate the consequences from fires.

5.3.4.1.2 System Description

A detailed description of the Fire Suppression System is provided in Section 2.2.2, Fire Suppression, Detection and Alarm Transmittal System.

5.3.4.2 Fire Detection System

The Safety-Significant features identified in the accident analysis for the Fire Detection System include the automatic wet pipe sprinkler flow alarm, manual fire phones, local fire alarms, smoke detectors, and heat detectors.

5.3.4.2.1 Safety Function

The safety function of the Fire Detection System is to provide an alarm indicating a fire to the CAS and FDC, or to the site Fire Department.

5.3.4.2.2 System Description

A detailed description of the Fire Detection System is provided in Section 2.2.2, Fire Suppression, Detection and Alarm Transmittal System.

5.3.4.3 Building Structure

The Safety-Significant features identified in the accident analysis for the building structure include elements of secondary containment, worker egress routes, fire barriers, and security barriers.

5.3.4.3.1 Safety Function

Safety functions provided by the building structure predominately include passive design safety features. The safety function of the building is to provide secondary containment to facilitate control of radiological and hazardous materials; building egress routes for safe exit of building occupants; fire barriers that provide defense in depth to prevent the spread and growth of fires; and security barriers.

5.3.4.3.2 System Description

A detailed description of the building structure is provided in Section 2.1.1, Building 991.

5.3.4.4 Ventilation

The Safety-Significant safety feature identified in the accident analysis for the Heating, Ventilation, and Air Conditioning System is filtered exhaust ventilation.

5.3.4.4.1 Safety Function

The safety function of the heating, ventilation, and air conditioning system is to mitigate the consequences from small fires, spills, and explosions.

5.3.4.4.2 System Description

A detailed description of the Heating, Ventilation, and Air Conditioning System is provided in Section 2.2.1.

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APPENDIX A

BUILDING 991 FACILITY
TECHNICAL SAFETY REQUIREMENTS

[redacted]

APPENDIX A
BUILDING 991 FACILITY TECHNICAL SAFETY REQUIREMENTS

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LIST OF TABLES

1. USE AND APPLICATION

The TECHNICAL SAFETY REQUIREMENTS (TSRs) for the BUILDING 991 FACILITY establish those requirements that define the conditions, safe boundaries, and ADMINISTRATIVE CONTROLS necessary to ensure safe operation of the facility and reduce the risk to immediate workers, collocated workers, the public, and the environment from uncontrolled releases of hazardous materials. There are four types of controls used to provide this assurance: LIMITING CONDITIONS FOR OPERATION (LCOs), SURVEILLANCE REQUIREMENTS (SRs), ADMINISTRATIVE CONTROLS (divided into ADMINISTRATIVE OPERATING LIMITS (AOLs) and PROGRAMMATIC ADMINISTRATIVE CONTROLS (PACs)), and DESIGN FEATURES. A separate "Use and Application" section proceeds each of the LCO, AOL, and PAC sections providing information and instructions for using and applying each type of control. Compliance with all TSRs as written is mandatory.

BASES for each of the TSR controls immediately follow the stated controls rather than being included as an annex to the TSRs. This facilitates a better understanding of the need for the control and avoids forcing the reader to search the document for such information.

1.1 DEFINITIONS

NOTE

The defined terms of this section appear in capitalized type throughout the TSRs.

TERM	**DEFINITION**
ADMINISTRATIVE CONTROLS (ACs)	Provisions relating to organization and management, conduct of operations, procedures, record-keeping, assessment, and reporting necessary to ensure the safe operation of a facility.
ADMINISTRATIVE OPERATING LIMITS (AOLs)	Administrative controls/limits that have been credited in the safety analysis as providing a reduction in postulated accident scenario initiation frequency and/or a reduction in postulated accident consequences.
AFFECTED AREA	That portion of the BUILDING 991 FACILITY in which the credited safety function provided by a single system, subsystem, train, component or device is compromised by an OUT-OF-TOLERANCE.
BASIS/BASES	Summary statement(s) of the rationale for the LCOs and associated SRs, AOLs, and PACs. The BASES explain how the numeric value, the specified function, or the surveillance fulfills the credited safety function assumed in the safety analysis.

TERM	**DEFINITION**
BUILDING 991 FACILITY	The portion of the Building 991 Complex that is covered by the TSRs. This includes Building 991, Tunnel/Vault 996, Tunnel/Vault 997, Tunnel 998/Room 300, and Vault 999. NOTE: Building 984, Building 985, Building 989, and Building 992 are not considered as part of the BUILDING 991 FACILITY.
COMPLETION TIME	The amount of time allowed to complete a REQUIRED ACTION. The COMPLETION TIME starts whenever a situation (e.g., not OPERABLE equipment or variable not within limits) is DISCOVERED that requires entering the REQUIRED ACTION for a given CONDITION. REQUIRED ACTIONS shall be performed before the specified COMPLETION TIME expires, except as defined for SUSPEND OPERATIONS.
CONDITION	Configuration and status of the facility related to compliance with the TSRs for which REQUIRED ACTIONS are performed within specified COMPLETION TIMES, including; (1) discrete degradations of SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS (SAFETY-CLASS SSCs), (2) non-compliance with AOLs, and (3) noncompliance with PACs.
DESIGN FEATURES	Those passive features which, if altered or modified, could have a significant effect on safety.
DISCOVERY/ DISCOVERED	The point in time when it is realized that a CONDITION has been entered, not to exceed the point in time when the facility management has reviewed, confirmed, and acknowledged information showing that a CONDITION was entered.
EMERGENCY EVACUATION	Any evacuation resulting from a significant deviation from planned or expected behavior or course of events which could result in significant consequences to people, property, the environment, or security. It includes unusual events, alerts, Site emergencies, and general emergencies.
LIMITING CONDITION FOR OPERATION (LCO)	The lowest functional capability or performance level of SAFETY-CLASS SSCs and their support systems required for safe operations of the facility.
OPERABLE/ OPERABILITY	A SAFETY-CLASS SSC shall be OPERABLE when it is capable of performing its specified function(s) for compliance with the TSR.

TERM	DEFINITION

OUT-OF-SERVICE

Equipment not available or credited for operation. Equipment may be declared OUT-OF-SERVICE due to actual or anticipated equipment failure or for administrative convenience. Removing equipment from service implies a temporary condition. For the purposes of this document, equipment or systems will only be considered OUT-OF-SERVICE when all of the following conditions have been satisfied:

- The equipment or system boundary has been established and has been administratively isolated from the rest of the facility.
- The isolation boundary and the affected equipment is properly tagged and/or labeled as OUT-OF-SERVICE.
- An evaluation of the removal of the affected equipment on facility safety has been performed.

OUT-OF-TOLERANCE

A CONDITION that exists upon failure to meet LCOs or SRs.

PROGRAMMATIC ADMINISTRATIVE CONTROLS (PACs)

PACs reflect facility-specific implementation of specific attributes of safety management programs that are necessary to maintain the safety envelope described in the safety analysis and TSRs. PACs include the programmatic control of specific limits credited for reduction in accident frequency or consequences.

PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY

A deficiency of a PAC shall be identified when <u>any</u> of the following conditions are being met:

- Facility management cannot demonstrate that an adequate administrative and physical infrastructure exists to implement each administrative program requirement.
- Facility management cannot demonstrate that the infrastructure has been reasonably implemented to meet each administrative program requirement.
- Facility management cannot demonstrate that appropriate measures have been taken to address individual failures to meet administrative program requirements.

REQUIRED ACTIONS

The mandatory response when an LCO or AOL cannot be met. REQUIRED ACTIONS include the maximum durations (COMPLETION TIMES) for facility operation in an OUT-OF-TOLERANCE before it is required to change operating configuration, except as defined for SUSPEND OPERATIONS.

SAFETY SIGNIFICANCE

A determination of how an identified PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY impacts the continued safe operation of the BUILDING 991 FACILITY.

TERM	DEFINITION
SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS (SAFETY-CLASS SSCs)	Those SAFETY SSCs that have been credited in the accident evaluation section of the Final Safety Analysis Report (FSAR) to provide protection for the health and safety of the collocated worker or the public.
SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS (SAFETY-SIGNIFICANT SSCs)	Those SAFETY SSCs that have been credited in the accident evaluation section of the Final Safety Analysis Report (FSAR) to provide protection for the health and safety of the immediate worker or to provide defense-in-depth protection for the health and safety of the immediate worker, the collocated worker, or the public.
SAFETY SSCs	Those structures, systems, and components that are important to safety: *i.e.*, those SSCs that have been credited in the accident evaluation section of the Final Safety Analysis Report (FSAR). SAFETY SSCs consist of SAFETY-CLASS and SAFETY-SIGNIFICANT SSCs.
SURVEILLANCE REQUIREMENTS (SRs)	Requirements relating to testing, calibration, or inspection to ensure that the OPERABILITY of SAFETY SSCs is maintained or that operations are within the specified LCOs.

TERM	DEFINITION

SUSPEND OPERATIONS

A formal termination of all activities involving the handling of radioactive and hazardous materials, performing spark/heat/flame producing work, performing laboratory analyses, and performing maintenance/test/repair except for those directly involved in:

- placing and maintaining the BUILDING 991 FACILITY in a safe configuration,
- restoring the safety function associated with the suspension,
- restoring the safety function associated with other LCO OUT-OF-TOLERANCES,
- remediating AOL non-compliance CONDITIONS, or
- restoring the safety function associated with other AC VIOLATION CONDITIONS.

It is expected that any activity that can be placed in a safe configuration within the specified COMPLETION TIME for the SUSPEND OPERATION REQUIRED ACTION will be terminated within the COMPLETION TIME. Processes or other activities that require more time than specified in the COMPLETION TIME to be placed in a safe configuration will have had a termination sequence formally initiated within the COMPLETION TIME. In any case, each activity, underway at the time a SUSPEND OPERATIONS REQUIRED ACTION is entered, should be terminated as soon as a safe configuration is reached and no additional time should be used for operational convenience. Facility management shall determine activities to be continued for the purpose of maintaining a safe facility configuration; weighing worker and public safety risk that may arise from the suspension or other OUT-OF-TOLERANCE.

TECHNICAL SAFETY REQUIREMENTS (TSRs)

TSRs define the operating limits, SRs, ACs, and BASES thereof necessary to protect the health and safety of the public and to minimize the potential risk to workers from the uncontrolled release of radioactive or other hazardous materials and from radiation exposure due to inadvertent criticality.

TERM	**DEFINITION**
VIOLATION	A VIOLATION of a TSR can occur as a result of any of the following circumstances:

a) failure to take the REQUIRED ACTIONS within the specified COMPLETION TIME following:

   (1) failure to meet an LCO,

   <u>OR</u>

   (2) failure to successfully meet an LCO SR;

b) failure to perform an LCO SR within the specified frequency;

c) failure of an AOL identified in Section 5.1.2 defined as follows:

   A VIOLATION of a AOL shall be declared whenever the AOL is not being met and corresponding REQUIRED ACTIONS are not performed within specified COMPLETION TIMES;

d) failure of a PAC, identified in Table 6 defined as follows:

   A VIOLATION of a PAC shall be declared when a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is identified and the necessary REQUIRED ACTIONS, based on the SAFETY SIGNIFICANCE of the deficiency, are not performed within the specified COMPLETION TIMES.

1.2 ACRONYMS

AC	ADMINISTRATIVE CONTROL
AOL	ADMINISTRATIVE OPERATING LIMIT
CSE	Criticality Safety Evaluation
CSOL	Criticality Safety Operating Limit
DOE	Department of Energy
DOT	Department of Transportation
FHA	Fire Hazards Analysis
FSAR	Final Safety Analysis Report
HEPA	High Efficiency Particulate Air (filters)
IDC	Item Description Code
LCO	LIMITING CONDITION FOR OPERATION
LLW	Low Level Waste
MAR	Material-at-Risk
NFPA	National Fire Protection Association
NMSL	Nuclear Material Safety Limit
PAC	PROGRAMMATIC ADMINISTRATIVE CONTROL
PCB	Polychlorinated Biphenyl
POD	Plan of the Day
RCRA	Resource Conservation and Recovery Act
RFFO	Rocky Flats Field Office
Site	Rocky Flats Environmental Technology Site
SNM	Special Nuclear Material
SR	SURVEILLANCE REQUIREMENT
SSC	Structure, System, and Component
TRU	Transuranic (waste)
TRUPACT	Transuranic Package Transporter
TSCA	Toxic Substances Control Act
TSR	TECHNICAL SAFETY REQUIREMENTS
USQ	Unreviewed Safety Question
WG Pu	Weapons Grade Plutonium

1.3 SAFETY LIMITS/LIMITING CONTROL SETTINGS

There are no Safety Limits or Limiting Control Settings for the BUILDING 991 FACILITY.

1.4 LIMITING CONDITIONS FOR OPERATIONS/SURVEILLANCE REQUIREMENTS

LIMITING CONDITIONS FOR OPERATION (LCOs), presented in Section 3, are imposed on SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS (SSCs) credited in the Final Safety Analysis Report (FSAR) to reduce the frequency of postulated accidents or mitigate the consequences of postulated accidents to the public and/or collocated worker. The BUILDING 991 FACILITY LCO addresses the following system:

- BUILDING 991 FACILITY Fire Water Systems and Flow Alarms

SURVEILLANCE REQUIREMENTS (SRs) are requirements relating to testing, calibration, or inspection to ensure that the OPERABILITY of SAFETY-CLASS SSCs and their support systems is maintained or that operations are within the specified LCOs. This section of the TSRs contains the requirements necessary to maintain operation of the BUILDING 991 FACILITY within the LCOs. In the event that SRs are not successfully completed or accomplished within their specified frequency, the systems or components involved are assumed to be not OPERABLE and REQUIRED ACTIONS defined by the LCOs are taken until the system or components can be shown to be OPERABLE.

1.5 ADMINISTRATIVE CONTROLS

ADMINISTRATIVE CONTROLS (ACs), presented in Section 5, are provisions relating to organization and management, conduct of operations, procedures, record-keeping, assessment, and reporting necessary to ensure safe operation of the facility. The ACs for the BUILDING 991 FACILITY are divided into two types: ADMINISTRATIVE OPERATING LIMITS (AOLs) and PROGRAMMATIC ADMINISTRATIVE CONTROLS (PACs).

AOLs are specific administrative controls/limits that have been credited in the safety analysis as providing a reduction in postulated accident scenario initiation frequency and/or a reduction in postulated accident consequences. Such controls are more precise and discrete than those defined by a safety management program or the key attributes of a safety management program. The AOLs are an administrative equivalent to hardware requirements specified in LCOs and, as such, have requirements for surveillance of and requirements for actions following DISCOVERY of non compliance with the AOL. Examples of AOLs include: waste container specifications, limits on fissile material (similar to Criticality Safety Operating Limits (CSOLs)/Nuclear Material Safety Limits (NMSLs)), and restriction of selected items (e.g., fossil-fueled vehicles, flammable gases).

PACs reflect facility-specific implementation of specific attributes of safety management programs that are necessary to maintain the safety envelope described in the safety analysis and TSRs. The PACs cover the programmatic functions credited for reduction in accident frequency or consequences. PACs include a programmatic requirement statement and a list of key program elements/attributes.

1.6 DESIGN FEATURES

DESIGN FEATURES are the facility passive features that reduce the frequency and/or mitigate the consequences of uncontrolled releases of radioactive or other hazardous materials from the facility for postulated accident scenarios analyzed in the FSAR. These DESIGN FEATURE descriptions are provided in the TSRs to assure that evaluations of proposed changes or modifications to these DESIGN FEATURES are properly performed and documented, consistent with requirements specified in the TSRs. The only DESIGN FEATURE credited in the FSAR is the gross facility external structure integrity that protects the facility contents from fires exterior to the facility and lightning strikes. Maintenance of this DESIGN FEATURE is addressed in the TSRs, Section 5.2 Programmatic Administrative Controls, under *Configuration Management* and *Maintenance*.

1.7 TECHNICAL SAFETY REQUIREMENTS BASES CONTROL

The contractor may make changes to the TSR BASES without prior Department of Energy Rocky Flats Field Office (DOE-RFFO) approval provided the changes do not involve any of the following:

a) A change in the TSR

b) A change to the FSAR that involves an Unreviewed Safety Question (USQ).

Proposed changes that meet the criteria of a) or b) above shall be reviewed and approved by the DOE-RFFO prior to implementation. Changes to the BASES that may be implemented without prior DOE-RFFO approval will be provided to the DOE-RFFO during annual updates to this FSAR.

2. SAFETY LIMITS AND LIMITING CONTROL SETTINGS

There are no Safety Limits or Limiting Control Settings for the BUILDING 991 FACILITY.

3./4. LIMITING CONDITIONS FOR OPERATIONS/SURVEILLANCE REQUIREMENTS

A LIMITING CONDITION FOR OPERATION (LCO) and associated SURVEILLANCE REQUIREMENTS (SRs) have been identified for the BUILDING 991 FACILITY Fire Water Systems and Flow Alarms. This system is credited in the FSAR, Chapter 4 safety analysis to reduce the frequency of large fires in the facility that have the potential to impact waste storage areas. As a result, the system indirectly reduces the consequences of analyzed accidents to the collocated workers and the public.

3.0/4.0 USE AND APPLICATION

LCO 3.0.1 through LCO 3.0.9 and SR 4.0.1 through SR 4.0.4 establish the general requirements applicable to LCO 3.1, BUILDING 991 FACILITY Fire Water Systems and Flow Alarms, at all times. A summary table of the general requirements or topics is presented below and is followed by a more detailed discussion of each general requirement and their BASES.

Table 1 SUMMARY OF LCO/SR GENERAL REQUIREMENTS

LCO/SR	GENERAL REQUIREMENT/TOPIC	REMARKS
LCO 3.0.1	LCOs shall be met.	LCO Applicability Statements define when LCO must be met. Refer to LCO 3.0.2 when LCO cannot be met.
LCO 3.0.2	LCO REQUIRED ACTIONS shall be met.	REQUIRED ACTIONS must be completed for specified CONDITIONS. If LCO CONDITION is remedied before REQUIRED ACTION COMPLETION TIME, REQUIRED ACTION does not have to be performed. Refer to LCO 3.0.3 when REQUIRED ACTION is not defined or cannot be met.
LCO 3.0.3	LCO REQUIRED ACTIONS cannot be met or are not provided.	When an LCO REQUIRED ACTION cannot be taken or is not defined, the facility must SUSPEND OPERATIONS in the AFFECTED AREA within 4 hours.
LCO 3.0.4	Return to service.	OPERABILITY tests of SAFETY-CLASS SSCs or other equipment may be performed under administrative control without meeting applicable LCO REQUIRED ACTIONS. This is an exception to LCO 3.0.2.
LCO 3.0.5	Calibration.	Devices used to demonstrate compliance with LCOs must be calibrated. Entering LCO REQUIRED ACTIONS may be delayed for the lesser of 24 hours or the next SR inspection for installed devices found to be past due for calibration between SR inspections under certain conditions.

Table 1 SUMMARY OF LCO/SR GENERAL REQUIREMENTS

LCO/SR	GENERAL REQUIREMENT/TOPIC	REMARKS
LCO 3.0.6	Performing SURVEILLANCE REQUIREMENTS.	If an SR inspection or test would result in temporarily entering an LCO CONDITION, the applicable REQUIRED ACTIONS may not have to be entered. This is an exception to LCO 3.0.2.
LCO 3.0.7	Planned OUT-OF-TOLERANCES.	If an activity would result in entering an LCO CONDITION, the applicable REQUIRED ACTIONS must be entered before performing the activity. This also applies to significant risk SR inspections or tests covered by LCO 3.0.6.
LCO 3.0.8	Response to an LCO VIOLATION.	LCO VIOLATIONS must be reported, corrective actions taken, and, if the LCO CONDITION still exists, operations must be suspended.
LCO 3.0.9	Response to an EMERGENCY EVACUATION.	LCO specified times for SRs or REQUIRED ACTIONS can be extended for the duration of an EMERGENCY EVACUATION from a facility. This is an exception to LCO 3.0.2 and SR 4.0.1.
SR 4.0.1	SRs shall be met.	LCO Applicability Statements or SRs define when SRs must be met. LCO REQUIRED ACTIONS must be entered upon failure to meet a SR. SAFETY-CLASS SSCs must meet applicable SRs before being declared OPERABLE.
SR 4.0.2	Frequencies.	SRs define inspection/test frequencies that must be met. Refer to SR 4.0.3 when SR frequencies are not met.
SR 4.0.3	Response to an SR VIOLATION (SR frequencies shall be met).	Entering LCO REQUIRED ACTIONS may be delayed for the lesser of 24 hours or the next SR inspection for missed SR inspections or tests. If the SR is met within the delay time, LCO REQUIRED ACTIONS do not need to be entered but a VIOLATION must be declared and LCO 3.0.8 should be entered.
SR 4.0.4	SR documentation.	SR inspections and tests must be documented to demonstrate SR compliance.

LCO 3.0.1 LCOs Shall Be Met.

LCOs shall be met during the specified operating configurations in the Applicability Statements. Upon DISCOVERY of a failure to meet an applicable LCO, refer to LCO 3.0.2 for the appropriate action.

<u>BASIS</u>: LCO 3.0.1 establishes the applicability statements with each LCO as the requirement for conformance to the LCO. This ensures safe operation of the facility during the specified operating configurations. Upon DISCOVERY of a failure to meet an applicable LCO, LCO 3.0.1

directs the operator of the facility to LCO 3.0.2 for guidance on the appropriate actions to take to maintain the safe operation of the facility during an OUT-OF-TOLERANCE.

LCO 3.0.2 LCO REQUIRED ACTIONS Shall Be Met.

Upon DISCOVERY of a failure to meet an LCO, the REQUIRED ACTION for the associated CONDITION shall be taken. If the LCO is restored before the specified COMPLETION TIME expires, completion of the REQUIRED ACTION is not required, unless otherwise stated. If the LCO REQUIRED ACTION cannot be met or the CONDITION defined by the DISCOVERED facility configuration does not have a corresponding REQUIRED ACTION, refer to LCO 3.0.3 for the appropriate action.

<u>BASIS</u>: LCO 3.0.2 establishes that, upon DISCOVERY of a failure to meet an LCO, the associated REQUIRED ACTIONS shall be taken. DISCOVERY that LCO requirements are not met may be the result of failures of SAFETY-CLASS SSCs or supporting equipment, failures of SRs, changes in the facility configuration, or finding a previously unknown facility configuration that is non-compliant with the LCO. The COMPLETION TIME of each REQUIRED ACTION is applicable from the time that a CONDITION is DISCOVERED. The REQUIRED ACTIONS establish the appropriate actions to take within specified COMPLETION TIMES to maintain the safe operation of the facility during an OUT-OF-TOLERANCE. This LCO establishes that:

1. Completion of the REQUIRED ACTIONS within the specified COMPLETION TIMES constitutes compliance with an LCO. By completing REQUIRED ACTIONS within the specified COMPLETION TIMES, the safe operation of the facility is maintained even though an OUT-OF-TOLERANCE exists.
2. Completion of the REQUIRED ACTIONS is not required when an LCO is met within the specified COMPLETION TIME, unless otherwise stated. The COMPLETION TIMES for REQUIRED ACTIONS define the amount of time that the facility can be in a specific CONDITION without undue risk to the public or the workers. If the CONDITION is corrected within the corresponding specified COMPLETION TIME, the risk associated with the original facility configuration prior to the DISCOVERY of the OUT-OF-TOLERANCE is re-established and the corresponding REQUIRED ACTIONS associated with the CONDITION are no longer necessary.

Some LCO REQUIRED ACTIONS specify a COMPLETION TIME to initiate action to place the facility in a safe configuration or to

SUSPEND OPERATIONS. This wording allows the operator of the facility a reasonable amount of time:

1. to determine what actions are necessary,
2. to determine the correct course of action to perform the necessary actions safely, and
3. to perform any necessary administrative functions associated with the actions.

The intent is not to delay placing the facility in a safe configuration or to delay SUSPEND OPERATIONS. Necessary actions should be completed in a minimum time frame and not extended for operational convenience.

A second type of REQUIRED ACTION specifies the appropriate actions that can be taken to permit continued operation of the facility not further restricted by a COMPLETION TIME. In this case, conformance to the REQUIRED ACTION with no additional degradation of the corresponding SAFETY-CLASS SSC provides an acceptable level of safety for continued operation.

LCO 3.0.3 LCO REQUIRED ACTIONS Cannot Be Met Or Are Not Provided.

The facility shall SUSPEND OPERATIONS in the AFFECTED AREA when LCO REQUIRED ACTIONS cannot be taken or when LCO REQUIRED ACTIONS are not defined for the DISCOVERED CONDITION. When an LCO is not met, the associated REQUIRED ACTION cannot be taken, and no other LCO CONDITION applies to the inability to take the REQUIRED ACTION, the facility shall SUSPEND OPERATIONS in the AFFECTED AREA within four (4) hours. Also, when an LCO is not met and a corresponding REQUIRED ACTION is not defined for the DISCOVERED CONDITION, the facility shall SUSPEND OPERATIONS in the AFFECTED AREA within four (4) hours. Actions taken to SUSPEND OPERATIONS shall be initiated upon the determination that the specified REQUIRED ACTION(S) cannot be taken or upon the determination that the DISCOVERED CONDITION has no corresponding REQUIRED ACTIONS.

BASIS: LCO 3.0.3 establishes the REQUIRED ACTIONS that shall be taken:

1. when specified LCO CONDITION REQUIRED ACTIONS cannot be taken and no other CONDITION applies,
2. when REQUIRED ACTION COMPLETION TIMES cannot be met and no other CONDITION applies, or
3. when the LCO CONDITION does not fit into any of the specified CONDITIONS which have corresponding REQUIRED ACTIONS.

The listed situations are not explicitly addressed in the FSAR safety analysis and represent potentially unanalyzed facility operating configurations. The conduct of any activity, other than those necessary to place or maintain the facility in a safe configuration, is not permitted since the combination of the facility configuration and conduct of the activity may not be covered by the safety analysis. The operator of the facility is permitted to identify those activities necessary to place or maintain the facility in a safe configuration and to determine the scope of the AFFECTED AREA(s). In the AFFECTED AREA, no activities may be conducted other than those permitted in the definition of SUSPEND OPERATIONS.

This LCO delineates a COMPLETION TIME for SUSPEND OPERATIONS when the facility cannot be maintained within the limits for safe operation, as defined by the LCO and its REQUIRED ACTIONS. The duration of the COMPLETION TIME associated with LCO 3.0.3 is not to be used as an operational convenience that permits the extension of REQUIRED ACTION COMPLETION TIMES in lieu of completing the REQUIRED ACTION within the corresponding specified COMPLETION TIME.

Upon entry into LCO 3.0.3, four (4) hours are specified to SUSPEND OPERATIONS in the AFFECTED AREA. The specified time limit is intended to permit the required terminations to proceed in a controlled and orderly manner that is within the capabilities of the facility and operations personnel. This reduces the potential for a facility upset that could challenge safety systems under operating configurations to which this LCO applies. The specified time limit is not intended to be used to delay the termination of unnecessary activities (those activities that are not associated with placing or maintaining the facility in a safe configuration). The selection of 4 hours to SUSPEND OPERATIONS is based on consideration of the time needed to perform an orderly termination of activities and, to a lesser extent, on risk considerations.

Terminations of facility operations required in accordance with LCO 3.0.3 may be ceased and LCO 3.0.3 exited if any of the following occurs:

1. the LCO is met,
2. a CONDITION exists in the LCO for which the REQUIRED ACTION has been performed, or
3. REQUIRED ACTIONS exist that do not have expired COMPLETION TIMES. The LCO REQUIRED ACTION COMPLETION TIMES are applicable from the point in time that

the CONDITION was DISCOVERED and not from the time LCO 3.0.3 is entered or exited.

LCO 3.0.4 Return To Service.

LCO REQUIRED ACTIONS do not necessarily have to be taken to return SAFETY-CLASS SSCs or supporting system SSCs to service. SAFETY-CLASS SSCs or supporting system SSCs removed from service or declared not OPERABLE may be returned to service under administrative control without meeting the corresponding REQUIRED ACTIONS of the LCO. This exemption from the REQUIRED ACTION statements of an LCO is permitted solely to perform the testing required to demonstrate OPERABILITY of the SAFETY-CLASS SSC or the OPERABILITY of other equipment. This is an exception to the requirements of LCO 3.0.2 for the SSC being returned to service.

BASIS: LCO 3.0.4 allows the restoration of OUT-OF-SERVICE or not OPERABLE SAFETY-CLASS SSCs or supporting equipment to service under administrative or procedural controls that may be in conflict with the REQUIRED ACTIONS of the corresponding LCO. The sole purpose of LCO 3.0.4 is to provide an exception to LCO 3.0.2 to allow the performance of SR tests on the OUT-OF-SERVICE or not OPERABLE equipment to demonstrate the following:

1. OPERABILITY of the equipment being returned to service; or
2. OPERABILITY of other equipment.

Administrative or procedural controls must ensure that the time associated with returning the equipment to service, which may be conflict with the requirements of LCO REQUIRED ACTIONS, is limited to the time absolutely necessary to perform the necessary SR test. LCO 3.0.4 is not to be used to provide time to perform any preventive or corrective maintenance outside of the activities directly associated with performing the SR test.

LCO 3.0.5 Calibration.

Measurement devices used to demonstrate compliance with LCOs shall be calibrated to plant design, manufacturer's specification and/or industry standards, as applicable.

If an installed measurement device is found to be past due for calibration between SR inspections/tests, declaring the LCO not met and entering the corresponding REQUIRED ACTIONS may be delayed. The delay time begins at the time of finding that the device is past due for calibration and extends for up to the lesser of

24 hours or the actual time for performing the next SR inspection/test. The delay time can only be used if all of the following conditions are met:

1. the measurement device is reading as expected, **AND**
2. the measurement device is reading within the parameters of the LCO, **AND**
3. the measurement device is found to be past due for calibration during the interval between inspections/tests defined by the SR frequency, **AND**
4. redundant indication is not available for the measured parameters.

This delay period for entering the LCO REQUIRED ACTIONS is permitted to allow the installation of a calibrated measurement device or to calibrate the installed measurement device, allowing validation of the actual operating parameter.

If the in-calibration measurement device reading is not taken within the delay period, the LCO shall immediately be declared not met and the applicable REQUIRED ACTIONS shall be entered. The COMPLETION TIMES of the REQUIRED ACTIONS begin at the end of the above delay period.

If the in-calibration measurement device reading is taken within the delay period and the parameter is outside of LCO requirements, the LCO shall immediately be declared not met and the applicable REQUIRED ACTIONS shall be entered. The COMPLETION TIMES of the REQUIRED ACTIONS begin immediately upon observing that the parameter is outside of LCO requirements.

Regardless of the outcome of the measurement device calibration process, the past due calibration shall be recorded as an individual programmatic failure, potentially contributing to a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY under the Quality Assurance PAC.

BASIS: LCO 3.0.5 establishes the requirements for performing SR inspections/tests using measurement devices that are calibrated in accordance with plant design, manufacturer's specifications, and/or industry standard practices. By meeting appropriate calibration requirements, all measurement devices used in determining LCO compliance will be capable of readings within designated tolerances. The use of calibrated measurement devices supports the determination of LCO compliance, assuring that facility operations are conducted within the bounds of the safety analysis.

Measurement device readings must be taken using a calibrated instrument when performing a SR inspection/test. Use of an uncalibrated instrument to perform an inspection/test would not provide sufficient assurance that the LCO is still being met.

For installed measurement devices that are used to perform a SR inspection/test, readings of the device could be performed more frequently than required by the specified SR frequency. Calibration of the measurement device at all times, rather than at actual SR inspection/test performance, is not required to demonstrate compliance with the LCO. However, the PAC dealing with Quality Assurance has a programmatic requirement associated with control of items covered by LCOs which generally applies to the calibration of measurement devices used to determine LCO compliance.

For the above reasons, a delay period is defined by LCO 3.0.5 to allow for installation of a calibrated measurement device upon finding that the device is past due for calibration without having to enter the corresponding LCO REQUIRED ACTIONS. A programmatic requirement to record the out of calibration measurement device still remains, but the requirement to enter the LCO REQUIRED ACTIONS is delayed.

Under the applicability of the delay period, the measurement device is apparently still functioning properly and there is no indication that the LCO is not being met. The LCO parameter reading following installation of a calibrated measurement device, at that point, is expected to be within the requirements of the LCO. The only degradation that has occurred deals with exceeding the calibration interval for the measurement device. This generally does not lead to an immediate degradation of the ability of the device to measure the LCO parameter.

Also, given that the event occurs between required surveillances, the risk associated with the LCO parameter yielding an OUT-OF-TOLERANCE, at that point, is covered by the specification of the frequency associated with the SR. That is, SR frequency intervals are set with some consideration of the likelihood of the parameter OUT-OF-TOLERANCE. Longer SR frequency intervals would indicate that the measured parameter is not expected to yield an OUT-OF-TOLERANCE in a short time frame.

The selection of the lesser of 24 hours and the actual time for performing the next SR inspection/test attempts to provide sufficient time for the facility operator to replace or calibrate the measurement device without adding to the already specified risk associated with the parameter. There is no relaxation of a calibration requirement associated with a parameter that is required to be inspected/tested, per SRs, within 24 hours of finding that the measurement device is past due for calibration. The selection of a maximum of 24 hours to replace or calibrate the measurement device is based solely on engineering judgment and is not based on risk considerations.

LCO 3.0.6 Performing SURVEILLANCE REQUIREMENTS.

LCO REQUIRED ACTIONS do not necessarily have to be taken to perform SRs requiring the removal of equipment from service or resulting in LCO requirements not being met. An SR inspection or test that requires removal of equipment from service or that results in a temporary failure to meet LCO requirements does not constitute failure to meet an LCO. The SAFETY-CLASS SSCs or supporting equipment may be removed from service or may be tested under administrative control without meeting the corresponding REQUIRED ACTIONS of the LCO. This exemption from the REQUIRED ACTION statements of an LCO is permitted solely to perform the inspection or testing required by the SR. Individual inspection/test procedures shall describe appropriate limitations beyond which an OUT-OF-TOLERANCE would exist.

Failing an SR requires the SAFETY-CLASS SSC be deemed not OPERABLE and the appropriate LCO REQUIRED ACTIONS be taken.

<u>BASIS</u>: LCO 3.0.6 allows the testing of LCO SAFETY-CLASS SSCs and supporting equipment under administrative or procedural controls without declaring an OUT-OF-TOLERANCE and entering the REQUIRED ACTIONS of an LCO. The sole purpose of LCO 3.0.6 is to provide an exception to LCO 3.0.2 to allow the performance of SR inspections/tests that require removing equipment from service or temporarily failing to meet LCO requirements as part of the required inspection or testing. This exception is not intended to place the facility at risk as an operational convenience. The removal of SAFETY-CLASS SSCs or supporting equipment from service and the inspection or testing of SAFETY-CLASS SSCs or supporting equipment that results in not meeting LCO requirements without entering the REQUIRED ACTIONS of the LCO as a planned OUT-OF-TOLERANCE should be evaluated to determine the level of risk associated with the performance of the SR inspection or test. If the impact of the SR inspection/test on facility risk is significant (as determined by facility management), the inspection/testing associated with the SR should be performed as a planned OUT-OF-TOLERANCE under LCO 3.0.7. If the impact of the SR inspection/test on facility risk is low, the inspection/testing associated with the SR may be performed without entering the LCO REQUIRED ACTIONS corresponding to the loss of the equipment.

Administrative or procedural controls must ensure that the time associated with removing the equipment from service to perform the inspection/test, which may be conflict with the requirements of LCO

REQUIRED ACTIONS, is limited to the time absolutely necessary to perform the SR inspection or test. Also, the administrative or procedural controls must restrict the activity to performance of the SR inspection/test. LCO 3.0.6 is not to be used to perform any inspections or testing outside of the activities directly associated with performing the SR inspection or test. Individual SR procedures are required to provide appropriate limitations to ensure that the safety of the facility is maintained while testing any attributes of SAFETY-CLASS SSCs.

The failure of a SR requires that the affected SAFETY-CLASS SSC is deemed not OPERABLE, that a OUT-OF-TOLERANCE is declared, and that the corresponding LCO REQUIRED ACTIONS are taken. Failure of a SR indicates that the minimum requirements to demonstrate compliance with the LCO are not being met. Reporting of the failed SR is required in accordance with contractor procedures.

LCO 3.0.7 Planned OUT-OF-TOLERANCES.

If the performance of a planned activity will result in noncompliance with the requirements of an LCO or if the risk associated with performing a SR inspection or test is considered to be significant (see LCO 3.0.6), then the applicable LCO REQUIRED ACTIONS shall be implemented prior to performing the activity or the SR inspection/test. Prior to entering this planned OUT-OF-TOLERANCE, the DOE-RFFO shall be notified in accordance with approved procedures.

Planned OUT-OF-TOLERANCES do not require the reporting of the OUT-OF-TOLERANCE as an occurrence per contractor occurrence reporting procedures.

BASIS: LCO 3.0.7 establishes the requirements to enter the applicable LCO REQUIRED ACTIONS for any planned activity in which work being performed places the facility in an OUT-OF-TOLERANCE. The same requirement applies to the performance of SR inspection or testing which is considered to result in significant risk if REQUIRED ACTIONS are not entered, as discussed in LCO 3.0.6. Both of these situations deal with planned facility configurations that do not meet the requirements of an LCO. Rather than waiting until the LCO requirements are not met during the performance of the activity, the risk associated with the activity performance can be reduced by entering the appropriate REQUIRED ACTIONS prior to performing the activity.

Notification to the DOE-RFFO shall be made prior to the performance of the activity to ensure that any identified compensatory actions are understood for the planned OUT-OF-TOLERANCE. This requirement to notify the DOE-RFFO avoids potential confrontation between the facility and the DOE-RFFO as a result of DOE-RFFO oversight activities.

Because the work is planned and applicable REQUIRED ACTIONS are entered prior to the work being performed, the planned OUT-OF-TOLERANCE is not considered a facility occurrence or event and does not have to be reported as an OUT-OF-TOLERANCE per contractor occurrence reporting procedures.

LCO 3.0.8 Response To An LCO VIOLATION.

LCO VIOLATIONS may result from either of two situations. The first situation occurs when a CONDITION currently exists, and the second situation occurs when a CONDITION no longer exists.

A. Upon DISCOVERY that an LCO VIOLATION exists, the following REQUIRED ACTIONS shall be performed:

1. SUSPEND OPERATIONS in the AFFECTED AREA within four (4) hours, **AND**
2. perform any applicable LCO REQUIRED ACTIONS that are in addition to the SUSPEND OPERATIONS action, **AND**
3. declare an LCO VIOLATION, **AND**
4. notify the DOE-RFFO in accordance with contractor occurrence reporting procedures, **AND**
5. develop a restart plan for DOE-RFFO approval that defines corrective measures to address the LCO VIOLATION.

B. Upon DISCOVERY that an LCO had not been met, the LCO REQUIRED ACTIONS had not been taken resulting in an LCO VIOLATION, and the DISCOVERED failure to meet the LCO no longer exists, the following REQUIRED ACTIONS shall be performed:

1. declare an LCO VIOLATION, **AND**
2. notify the DOE-RFFO in accordance with contractor occurrence reporting procedures, **AND**
3. provide the DOE-RFFO a report, within sixteen (16) calendar days, identifying the root causes for the VIOLATION, any corrective actions currently taken, and the corrective actions to be taken to prevent recurrence of the event.

Note that LCO REQUIRED ACTIONS do not need to be entered if the failure to meet the LCO no longer exists.

BASIS: LCO 3.0.8 establishes the REQUIRED ACTIONS to be taken upon DISCOVERY of an LCO VIOLATION. Two situations are addressed by the LCO.

In the first situation, the facility is currently in an unacknowledged OUT-OF-TOLERANCE and thus is in an unsafe configuration. A REQUIRED ACTION to SUSPEND OPERATIONS in the AFFECTED AREA is specified because facility operations are occurring outside of the approved safety bases. The action to SUSPEND OPERATIONS puts the facility in as safe a condition as can be achieved. The applicable LCO REQUIRED ACTIONS may contain other actions dealing directly with the OUT-OF-TOLERANCE that should be performed in addition to the SUSPEND OPERATIONS action. These may include fire watches, startup of standby equipment, or other reconfigurations of equipment.

Following the termination of operations in the facility, a restart plan must be developed and approved before any operations included in the termination can be conducted. The restart plan requires DOE-RFFO approval. Since LCO VIOLATIONS are significant occurrences, it is required that some effort is applied to assure that the VIOLATION does not recur. The restart plan is a vehicle to document the corrective measures that are and will be taken by the facility to prevent a recurrence of the VIOLATION. A restart plan will address the root cause of the LCO VIOLATION to assure that the selected corrective measures cover the root cause and are appropriate for prevention of a recurrence.

In the second situation, the facility was in an unacknowledged OUT-OF-TOLERANCE but is currently in a safe configuration. Actions to SUSPEND OPERATIONS and enter the applicable LCO REQUIRED ACTIONS are not necessary due to the currently compliant configuration of the facility.

Since a restart plan will not be developed in the second situation, a report is provided to the DOE-RFFO within the specified time frame. A period of sixteen (16) calendar days was selected to focus attention on the event and its significance. Since LCO VIOLATIONS are significant occurrences, there must be some effort applied to assure that the VIOLATION does not recur. The report will document the corrective measures that are and will be taken by the facility to prevent a recurrence of the VIOLATION. Part of the report will address the root cause of the LCO VIOLATION to assure that the selected corrective measures cover the root cause and are appropriate for prevention of a recurrence.

In both of the situations, declaration of the LCO VIOLATION and notification of the DOE-RFFO are performed to alert the DOE-RFFO of the situation. Notification of the DOE-RFFO is performed using contractor occurrence reporting procedures.

LCO 3.0.9 Response To An EMERGENCY EVACUATION

SR frequencies and REQUIRED ACTION COMPLETION TIMES do not have to be met during an EMERGENCY EVACUATION. Failure to initiate or complete a SR inspection/test within the specified frequency or a REQUIRED ACTION within the specified COMPLETION TIME, due to an EMERGENCY EVACUATION of the facility, does not constitute a VIOLATION of the TSRs. However, upon authorized resumption of operations, the SR inspection/test or REQUIRED ACTION must be initiated or completed as soon as practicable, not exceeding corresponding specified frequencies or COMPLETION TIMES, based on the requirements of LCO 3.0.2 and SR 4.0.1. LCO 3.0.9 is a temporary exception to the requirements of LCO 3.0.2 and SR 4.0.1 during an EMERGENCY EVACUATION.

<u>BASIS:</u> LCO 3.0.9 allows flexibility for responding to priority emergency situations in the facility that could preempt the initiation or completion of REQUIRED ACTIONS or SR inspections/tests. EMERGENCY EVACUATIONS could restrict the ability of the facility personnel to respond to LCO CONDITIONS or other situations for which the TSRs specify REQUIRED ACTIONS. An EMERGENCY EVACUATION could also interfere with the performance of inspections or tests associated with SRs. LCO 3.0.9 allows the appropriate TSR requirements to be satisfied after the authorized resumption of operations in the facility without incurring a VIOLATION due to exceeding a REQUIRED ACTION COMPLETION TIME or a SR inspection/test specified frequency.

LCO 3.0.9 indicates that the deferred REQUIRED ACTIONS or SR inspections/tests should be initiated or completed as soon as practicable. The times allowed for completion of any deferred REQUIRED ACTIONS cannot exceed the COMPLETION TIMES specified in the TSRs. The times allowed for completion of any deferred inspections or testing associated with SRs cannot exceed the specified SR inspection/test frequencies. However, these statements are not intended to restart COMPLETION TIME or SR inspection/test frequency clocks. Every effort should be made to expedite the completion of the REQUIRED ACTIONS or SR inspections/testing.

The impact of the EMERGENCY EVACUATION on COMPLETION TIMES and SR inspection/test frequencies should be related to the duration of the EMERGENCY EVACUATION relative to the duration of the COMPLETION TIME or SR inspection/test frequency. If the EMERGENCY EVACUATION is significantly shorter than the COMPLETION TIME or SR inspection/test frequency, the impact (i.e., extension of the actual duration) of the EMERGENCY EVACUATION on the REQUIRED ACTIONS or SR inspections/testing is expected to be minimal. EMERGENCY EVACUATION durations of similar length to COMPLETION TIMES or SR inspection/test frequencies could require a restart of the corresponding clock time associated with the COMPLETION TIME or SR inspection/test frequency, depending on the length of time to perform the REQUIRED ACTION or SR inspection/test. Effort to immediately initiate and/or complete the REQUIRED ACTIONS and SR inspections/tests that were deferred due to the EMERGENCY EVACUATION should be made in this latter situation.

SR 4.0.1 **SRs Shall Be Met.**

SRs shall be met during the specified operating configurations in the Applicability Statements for the corresponding LCOs unless otherwise stated in the SR. Failure to meet a SR (whether such failure is experienced during performance of the SR inspection/test or between performances of the SR inspection/test) shall constitute failure to meet the LCO, shall require entry into the LCO REQUIRED ACTIONS, and shall result in the SAFETY-CLASS SSC being declared not OPERABLE. Similarly, failure to perform a SR inspection/test within the specified frequency shall constitute failure to meet the LCO, shall require entry into the LCO REQUIRED ACTIONS, and shall result in the SAFETY-CLASS SSC being declared not OPERABLE, except as provided in LCO 3.0.9 and SR 4.0.3. Prior to changing the status of a not OPERABLE SAFETY-CLASS SSC to an OPERABLE SAFETY-CLASS SSC, applicable SRs must be met.

Exceptions to these requirements are as follows: SR inspections or tests do not have to be performed on not OPERABLE SAFETY-CLASS SSCs, support systems for not OPERABLE SAFETY-CLASS SSCs (unless the support system is required to support other OPERABLE SAFETY-CLASS SSCs), or SAFETY-CLASS SSCs with LCO parameters outside specified limits.

BASIS: SR 4.0.1 establishes the requirement that SRs must be met during the specified operating configurations in the Applicability Statements for LCOs unless otherwise stated in the SRs. SR 4.0.1 ensures safe operation of the facility during the specified operating configurations by requiring that SR inspections and tests are performed to verify the OPERABILITY of SAFETY-CLASS SSCs and to verify that LCO parameters are within specified limits. Failure to meet a SR indicates that the LCO required configuration is no longer in place. Failure to perform a SR inspection/test within the specified frequency, in accordance with SR 4.0.2, exceeds the time frame required for verification that the LCO required configuration is in place, resulting in an unverified and potentially non-compliant configuration. Either of these situations constitutes a failure to meet an LCO, requires entry into the appropriate REQUIRED ACTIONS of the LCO, and results in declaring the SAFETY-CLASS SSC not OPERABLE.

Exceptions to the requirements associated with the performance of SR inspections or tests within the specified frequency are identified in LCO 3.0.9 dealing with EMERGENCY EVACUATION impact on SR inspection/test specified frequencies and SR 4.0.3 dealing with missed SR inspections and tests.

SAFETY-CLASS SSCs are considered to be OPERABLE when the associated SRs have been met unless:

1. the SAFETY-CLASS SSCs are known to be not OPERABLE, although still meeting the SRs; or
2. the SRs are known not to be met between performance of the required SR inspections/tests.

SR inspections/tests do not have to be performed when facility is in an operating configuration for which the requirements of the associated LCO are not applicable, unless otherwise specified. If the LCO requirements are not applicable to an operating configuration, verification of the OPERABILITY of the corresponding SAFETY-CLASS SSCs is not necessary to assure safe operation of the facility under the configuration.

SAFETY-CLASS SSCs that have been declared not OPERABLE are required to have their OPERABILITY verified prior to declaring them OPERABLE. This requires that the SAFETY-CLASS SSCs meet all of the applicable SRs prior to a return to OPERABLE status.

SR 4.0.1 also lists exceptions to SR 4.0.1 requirements primarily dealing with previously acknowledged OUT-OF-TOLERANCES. SR inspections/tests, including inspections or tests invoked by REQUIRED ACTIONS, do not have to be performed on not OPERABLE SAFETY-CLASS SSCs, on corresponding support systems (unless the support system is required by an OPERABLE SAFETY-CLASS SSC), or on SAFETY-CLASS SSCs with LCO parameters outside of the LCO specified limits. In each of these situations, the REQUIRED ACTIONS associated with the CONDITION resulting from the declaration of the SAFETY-CLASS SSC being not OPERABLE or resulting from the LCO parameters being outside of specified limits would have been entered. The appropriate actions (as defined by the REQUIRED ACTIONS) to maintain facility safety would have been performed for the not OPERABLE SAFETY-CLASS SSC configuration. Verification of the OPERABILITY of the SAFETY-CLASS SSC under this configuration is no longer necessary since it is already acknowledged that the SAFETY-CLASS SSC cannot perform its function.

SR 4.0.2 Frequencies.

Each SR inspection or test shall be performed with the frequency specified for the SR. Upon realization that a SR inspection or test was not performed within the interval defined by the specified frequency, refer to SR 4.0.3 for the appropriate action.

BASIS: SR 4.0.2 establishes the requirements for performing SR inspections or tests with the specified SR frequency. The specified frequencies associated with SR inspections or tests were developed based on a number of factors including; consideration of the failure rate of the inspected/tested SAFETY-CLASS SSC, consideration of the impact of SAFETY-CLASS SSC failure on the facility risk, industry standard inspection and test intervals for equipment similar to the SAFETY-CLASS SSC, Site precedent for inspection and test intervals associated with the SAFETY-CLASS SSC, and engineering judgment. Inherent in the selection of a SR inspection/test frequency is the acceptance of some risk that the SAFETY-CLASS SSC will have failed without operator knowledge of the failure and operations will continue in the non-compliant facility configuration. By performing SR inspections or tests with the specified frequency, the facility controls the risk associated with the SAFETY-CLASS SSC failure at an acceptable level based on the factors included in the SR inspection/test frequency.

SR 4.0.3 Response To An SR VIOLATION (SR Frequencies Shall Be Met).

Upon realization that a SR inspection/test was not performed within the time interval associated with its specified frequency, declaring the LCO not met and entering the corresponding REQUIRED ACTIONS may be delayed. The delay time begins at the time of finding that the SR inspection/test was not performed and extends for up to the lesser of 24 hours or the actual time for performing the next SR inspection/test. This delay period for entering the LCO REQUIRED ACTIONS is permitted to allow performance of the SR inspection/test to verify the OPERABILITY of the corresponding SAFETY-CLASS SSC and/or compliance with the LCO. Satisfactory performance of the SR inspection/test within the delay time shall indicate that the LCO was met and that any applicable SAFETY-CLASS SSC is OPERABLE (refer to SR 4.0.1). Even though the LCO was not in an OUT-OF-TOLERANCE, the VIOLATION of SR 4.0.2 shall be reported to DOE-RFFO in accordance with Site procedures.

If the SR inspection/test is not performed within the delay period, the LCO shall immediately be declared not met and the applicable REQUIRED ACTIONS shall be entered. The COMPLETION TIMES of the REQUIRED ACTIONS begin immediately on expiration of the delay period. If the SR inspection/test is performed within the delay period and the SR is not met, the LCO shall immediately be declared not met and the applicable REQUIRED ACTIONS shall be entered. The COMPLETION TIMES of the REQUIRED ACTIONS begin immediately on failure to meet the SR.

BASIS: SR 4.0.3 establishes the flexibility to defer declaring affected SAFETY-CLASS SSCs not OPERABLE or an affected LCO parameter outside specified limits when a SR inspection or test has not been completed within the time interval associated with the SR specified frequency. Because it is expected that the result of performance of the SR inspection/test would be a confirmation of the OPERABILITY of the SAFETY-CLASS SSC and/or compliance with the LCO, entering REQUIRED ACTIONS due to a perceived CONDITION rather than a DISCOVERED CONDITION is delayed for a limited time. It is assumed that the facility has no other indication that the inspected/tested parameter or SAFETY-CLASS SSC is outside of specified limits or is not OPERABLE. This temporary exemption from the requirements of SR 4.0.2 is not intended to be used to avoid entering LCO REQUIRED ACTIONS if there is any indication that the LCO is not met. Also, the delay period is not intended to be used as an operational convenience to extend SR inspection/test intervals. The missing of a SR inspection/test is still a VIOLATION of the TSRs and is required to be reported.

The delay period applies from the time it is realized that the SR inspection/test has not been performed, and not from the time the SR inspection/test should have been performed. This provides the facility with adequate time to perform most missed SR inspections/tests, but still restricts the time that the facility is potentially in an OUT-OF-TOLERANCE without entering the corresponding REQUIRED ACTIONS. The selection of a maximum of 24 hours to perform the missed SR inspection/test is based solely on engineering judgment and is not based on risk considerations.

If the indication of a need to perform a SR inspection/test is not based on time intervals but is based on specified facility configurations or operational situations, the full 24 hour delay time is applied for performance of the SR inspection/test, regardless of the facility configuration or operational situation.

The SR VIOLATION associated with the not performing a SR inspection/test within the time interval associated with the SR specified frequency is to be reported to the DOE-RFFO in accordance with Site procedures. Even though the facility may have been in a safe configuration during the event, the missing of a SR inspection/test is still a VIOLATION of the TSRs.

Successful completion of the SR inspection/test within the delay period allowed by SR 4.0.3 restores compliance with SR 4.0.1.

SR 4.0.4 SR Documentation.

The performance of SR inspections/tests and the SR inspection/tests results shall be documented in an auditable and traceable manner and the records shall be maintained.

BASIS: SR 4.0.4 establishes a requirement that records for completed SR inspections/tests must be maintained for audit purposes to provide proof that SR inspections/tests were completed within the time interval corresponding to the SR frequency and that SRs were met. Records for completed SR inspections/tests will be maintained and stored in accordance with contractor procedures.

3./4. LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

3.1 LIMITING CONDITION FOR OPERATION: BUILDING 991 FACILITY FIRE WATER SYSTEMS AND FLOW ALARMS

LCO: **The BUILDING 991 FACILITY Automatic Sprinkler and Flow Alarm Transmittal System and Fire Service Main System Shall Be OPERABLE.**

APPLICABILITY: At all times in the BUILDING 991 FACILITY except in Tunnel/Vault 996, Tunnel/Vault 997, and Vault 999.

REQUIRED ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Automatic Sprinkler System not OPERABLE.	A.1 Establish a fire watch in AFFECTED AREAS.	4 hours.
	AND	
	A.2 Terminate all spark/heat/flame producing work in AFFECTED AREAS.	2 hours.
B. Loss of fire suppression system flow alarm transmittal capability to the Fire Department.	B.1 Establish a fire watch in AFFECTED AREAS.	4 hours.
C. Loss of fire water supplies to the BUILDING 991 FACILITY.	C.1 Establish a fire watch for BUILDING 991 FACILITY.	4 hours.
	AND	
	C.2 SUSPEND OPERATIONS.	2 hours.
D. Notification that the Fire Department does not have a minimum staff or response capability.	D.1 Terminate all spark/heat/flame producing work.	2 hours.
	AND	
	D.2 Verify compliance of manual fire extinguishers.	8 hours.

3./4. LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

4.1 SURVEILLANCE REQUIREMENTS: BUILDING 991 FACILITY FIRE WATER SYSTEMS AND FLOW ALARMS

SURVEILLANCE REQUIREMENT		FREQUENCY
SR 4.1.1	Verify correct positioning of post indicating valves, sprinkler control valves, and fire service main valves.	Once per calendar month (not to exceed 37 days between inspections).
SR 4.1.2	Verify adequate static pressure in Sprinkler System Risers A and B.	Once per calendar month (not to exceed 37 days between inspections).
SR 4.1.3	Verify adequate air pressure in dry pipe Sprinkler System B and in the dry pipe portion of Sprinkler System A.	Once per calendar month (not to exceed 37 days between inspections).
SR 4.1.4	Perform a main drain flow test at Sprinkler System Risers A and B.	Once per calendar quarter (not to exceed 120 days between tests).
SR 4.1.5	Perform a water flow alarm test at an inspector's test connection and verify Sprinkler System Riser A and B alarm transmittal to Fire Department.	Once per calendar quarter (not to exceed 120 days between tests).
SR 4.1.6	Perform visual inspection of the Sprinkler Systems A and B.	Once per calendar year (not to exceed 13 months between inspections).
SR 4.1.7	Perform operational test of dry pipe Sprinkler System B and the dry pipe portion of Sprinkler System A.	Once per calendar year (not to exceed 13 months between inspections).
SR 4.1.8	Perform operational test of fire service main hydrants and valves.	Once per calendar year (not to exceed 13 months between inspections).

3./4. LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

3.1/4.1 BUILDING 991 FACILITY FIRE WATER SYSTEMS AND FLOW ALARMS BASES

BACKGROUND

The BUILDING 991 FACILITY handles and stores Low-Level Waste (LLW) and Transuranic (TRU) waste containers of various types. Containers that are received by the facility are fully characterized (contents of the containers are generally known) and meet on-site transportation specifications and/or meet or formerly met Department of Transportation (DOT) specifications. Packaging internal to the container may or may not be compliant with Site requirements. The waste containers are never opened in the facility. All of the waste containers inside the buildings are metal drums or metal crates with the exception of a single, allowed wooden crate used to collect waste (not exceeding LLW quantities of radioactive material) generated during the stripout of unused equipment from Building 991. Wooden LLW crates are permitted to be stored outside of the buildings in areas covered by an automatic sprinkler system. All Special Nuclear Material (SNM) in the facility, awaiting off-site shipment, is packaged in accordance with off-site transportation requirements in robust metal containers that are not susceptible to fire damage or droppage.

The combustible loading in the TRU waste storage areas of the BUILDING 991 FACILITY is minimal, consisting of drum-protecting plywood sheets between drum tops and metal pallets in stacked drum configurations, crate-protecting plastic covers between stacked metal crates, and limited transient combustible materials. Wooden pallets are not permitted to be used for drum storage in the BUILDING 991 FACILITY. Storage of waste containers in the tunnel/vault areas of the BUILDING 991 FACILITY involves minimal combustible materials. Storage of waste containers in the storage areas inside Building 991 involves more, but limited, combustible materials and proximity to areas with less combustible material control (offices, laboratories, utilities, etc.).

Fires starting in TRU waste container storage areas involving more than a small number of waste containers are not significant risk contributors due to accident likelihood, as long as the combustible material controls for storage areas are in place and maintained. However, fires starting in the non-storage areas of Building 991 that become large fires, impacting a significant number of waste containers stored in Building 991, and fires starting outside the buildings in dock areas are a concern. Fires large enough to impact a significant number of waste containers in the tunnel/vault areas of the BUILDING 991 FACILITY are not significant risk contributors due to accident likelihood, as long as the combustible material controls for storage areas are in place and maintained.

The Automatic Sprinkler System provides the credited safety function to minimize the involvement of waste containers from a postulated fire occurring in the non-storage areas of Building 991 or at the docks. The Automatic Sprinkler System is expected to actuate automatically and mitigate the fire and/or to prevent fire propagation into TRU waste storage areas. It also provides a defense-in-depth safety function to potentially mitigate the effects of any small fires that may occur in storage areas. An additional defense-in-depth and immediate worker protection safety function is the notification and response of the Fire Department to assure mitigation of any fire. The Flow Alarm Transmittal System to notify the Fire Department (sprinkler system flow alarms transmitted via the Central Alarm Station to the Fire Department) and the Fire Service Main System to support Fire Department response provide the defense-in-depth safety function. The Automatic Sprinkler System, the Flow Alarm Transmittal System, and the Fire Service Main System, in combination with Fire Department response capability, assure that fires in non-storage areas of Building 991 and at the docks are mitigated prior to becoming large enough to impact a significant number of waste containers stored in Building 991 and/or are prevented from propagating into waste storage areas in Building 991. These controls also assure that small fires in storage areas of Building 991 are extinguished.

The BUILDING 991 FACILITY (except for Tunnel/Vault 996, Tunnel/Vault 997, and Vault 999) is provided with automatic sprinkler systems. One part of Sprinkler System A is a wet pipe system which covers the heated areas of Building 991 and Tunnel 998/Room 300. The remainder of Sprinkler System A is a dry pipe system branching off of the wet pipe portion of Sprinkler System A and covers the east dock as well as Building 989 (diesel generator building, not part of the BUILDING 991 FACILITY). Sprinkler System B is a dry pipe system and covers Room 170 (enclosed west dock) and the external canopy that is west of Room 170. Sprinkler System Riser A supports the wet pipe and dry pipe portions of Sprinkler System A. Sprinkler System Riser B supports the dry pipe Sprinkler System B. The remainder of the BUILDING 991 FACILITY (Tunnel/Vault 996, Tunnel/Vault 997, and Vault 999) is provided with a smoke detection system but is not covered by any automatic sprinkler systems.

The BUILDING 991 FACILITY contains manual fire alarms (e.g., fire phones) distributed throughout the facility. The Flow Alarm Transmittal System discussed above consists of water-flow switches to detect sprinkler system usage and to send an alarm signal to the Fire Dispatch Center (Fire Department) via the Central Alarm Station. The smoke detector system, located in some tunnels and vaults, sends an alarm signal to the Fire Department in the same manner as the sprinkler system flow alarm. Alarm functions have battery backup capacities of from 4 to 8 hours for loss of power situations.

Functional performance and maintenance expectations are established for these system in Site procedures, which are based on accepted industry standards such as NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems* (Ref. A-1), NFPA 72, *National Fire Alarm Code* (Ref. A-2); and NFPA 13, *Standard for the Installation of Sprinkler Systems* (Ref. A-3).

APPLICATION TO SAFETY ANALYSIS

The Automatic Sprinkler System is a recognized control credited in the analysis of postulated fire accident scenarios in Section 4.5.2 of the FSAR. The Flow Alarm Transmittal System and the Fire Service Main System are recognized controls providing immediate worker or defense-in-depth protection against postulated fire accident scenarios.

While fires initiated in TRU waste storage areas involving more than a few waste containers are not significant contributors to risk due to the lack of combustible material in the areas, large fires in other portions of Building 991 or at the docks can impact waste storage areas in Building 991 due to heating of the waste containers by hot gases and combustion products generated by the fire. The combination of the above controls serves to mitigate fires initiated in non-storage areas prior to the fires becoming large enough to impact waste containers in other parts of the facility and to prevent propagation of dock fires into the facility. Without these controls, there is a possibility of a fire, initiated in a non-storage area or at the docks, of sufficient size to impact a significant number of waste containers stored in the facility.

The ventilation system for Building 991 is located on the roof of the facility and was designed primarily for air circulation. The Building 985 ventilation system, containing two stages of uncredited (assumed to be untested) High Efficiency Particulate Air (HEPA) filtration and an automatic plenum deluge system, supports the portion of the BUILDING 991 FACILITY that is least likely to have large fires due to the combustible material controls associated with the tunnels and vaults. Tunnel/Vault 996, Tunnel/Vault 997, and Vault 999 are ventilated through Building 985. All other areas of the BUILDING 991 FACILITY are ventilated through the Building 991 roof plenum which has a single stage of uncredited (assumed to be untested) HEPA filtration and an automatic plenum deluge system which comes off of wet pipe Sprinkler System A. A large, unmitigated fire in Building 991 would likely damage the HEPA filter associated with the roof filter plenum if the plenum deluge system fails to function, but is unlikely to impact the Building 985 ventilation system.

Because of the design of the ventilation system and the mission change of the facility to waste storage in Building 991, fires impacting a significant number of waste containers yield unacceptable dose consequence results to the collocated worker and the public. Basically, any releases from waste containers are analyzed as unmitigated by HEPA filtration, due to the single stage of uncredited (assumed to be untested) HEPA filters in the Building 991 exhaust. But even if the HEPA filters were credited, the automatic plenum deluge system is not credited for protecting the single stage of HEPA filtration from the effects of a large fire. Finally, if both the HEPA filtration and plenum deluge system were credited, the overpressure associated with a large fire in the facility may lead to significant ventilation system bypass from Building 991 due to the limited capacity of the system and potential blockage of the HEPA filters from fire generated smoke and particulate. Therefore, large fires in the BUILDING 991 FACILITY could lead to significant unfiltered releases from the facility and are unacceptable.

LCO

This LCO assures that portions of the BUILDING 991 FACILITY are protected from large fires by requiring the Automatic Sprinkler System capability. The LCO also assures the immediate worker protection and defense-in-depth Flow Alarm Transmittal and Fire Service Main Systems capabilities which support Fire Department response to any Building 991 fire. The water-flow switch on an Automatic Sprinkler System riser automatically activates an alarm that is transmitted to the Fire Department so that the Fire Department can provide response and additional fire suppression capability using the Fire Service Main System.

APPLICABILITY

This LCO is applicable at all times in those portions of the BUILDING 991 FACILITY that are covered by the Automatic Sprinkler System. This excludes Tunnel/Vault 996, Tunnel/Vault 997, and Vault 999 from the applicability of portions of the LCO dealing with fire suppression and alarm transmittal. The immediate worker protection and defense-in-depth portions of the LCO dealing with Fire Department response are applicable to all of the BUILDING 991 FACILITY.

REQUIRED ACTIONS

A.1 If the Automatic Sprinkler System (fire suppression) is not OPERABLE in the BUILDING 991 FACILITY (as defined in the Applicability Statement), an undetected small fire may occur in areas of Building 991 which has the potential to propagate into a large fire. Two functions provided by the Automatic Sprinkler System (and integral Flow Alarm Transmittal System) are fire suppression (which reduces the likelihood that small fires become large fires) and fire detection and alarm (which identifies fires prior to their becoming large fires, allowing the Fire Department to participate in their mitigation). Without the fire suppression function, the dependence on the Fire Department to mitigate fires is increased. The facility is still protected if there is a capability to notify the Fire Department of small fires prior to their becoming large fires.

The fire watch in AFFECTED AREAS partly replaces the fire detection and alarm functions of the Automatic Sprinkler System with a fire watch individual capable of providing the functions during watch tours. The fire watch individual is expected to notify the Fire Department in the event of a fire, either via manual fire alarms or an alternative method if the manual fire alarms are unavailable. The Fire Department then provides a fire suppression function in lieu of the Automatic Sprinkler System in the AFFECTED AREAS. Non-waste storage areas and dock areas included in the AFFECTED AREA in Building 991 are considered to be the most important areas for the purpose of establishing the fire watch due to less restrictive combustible material controls and the corresponding increased likelihood of small fires becoming large fires.

The establishing of a fire watch in the AFFECTED AREAS does not provide full-time fire detection capability. A fire could initiate and propagate between tours of the fire watch. Because the fire watch does not monitor all areas continuously and, therefore, does not completely replace the fire detection and alarm capability of the Automatic Sprinkler System, a reduction in fire initiating event frequency is warranted. REQUIRED ACTION A.2 is identified to reduce the likelihood of fires while the Automatic Sprinkler System is not OPERABLE. Operations outside of the REQUIRED ACTION A.2 restrictions can continue since they do not significantly impact fire initiation frequency and do not contribute significantly to fire-related facility risk. The fire-related facility risk is dominated by the storage of waste containers in the facility rather than activities dealing with waste container movements.

While the fire watch does not provide the full-time fire detection capability afforded by an OPERABLE Automatic Sprinkler System and integral Flow Alarm Transmittal System, the fire watch individual has the capability to detect fires well in advance of the actuation of the Automatic Sprinkler System. This earlier fire detection capability partially offsets the reduced time coverage of the fire watch versus the Automatic Sprinkler System.

The four-hour COMPLETION TIME for establishing a fire watch provides adequate time for facility management to assign the appropriate personnel, particularly on back shifts and weekends. Occupants of the facility can perform the fire watch function. The four-hour COMPLETION TIME does not result in undue risk due to the low initiation frequency of a fire. However, the REQUIRED ACTION to establish a fire watch is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The four-hour COMPLETION TIME should not be used for operational convenience.

A.2 If the Automatic Sprinkler System (fire suppression) is not OPERABLE in the BUILDING 991 FACILITY (as defined in the Applicability Statement), an undetected small fire may occur in areas of Building 991 which has the potential to propagate into a large fire. Two functions provided by the Automatic Sprinkler System (and integral Flow Alarm Transmittal System) are fire suppression (which reduces the likelihood that small fires become large fires) and fire detection and alarm (which identifies fires prior to their becoming large fires, allowing the Fire Department to participate in their mitigation). Without the fire suppression function, the dependence on the Fire Department to mitigate fires is increased. The facility is still protected if there is a capability to notify the Fire Department of fires prior to their becoming large.

The termination of spark/heat/flame producing work in the AFFECTED AREAS is a measure to reduce the likelihood of fires during the time that the Automatic Sprinkler System is not OPERABLE. Areas that are not impacted by the OUT-OF-TOLERANCE can continue to perform work with no additional restrictions associated with the Automatic Sprinkler System OPERABILITY. The termination of spark/heat/flame producing work does not preclude fire initiation. Energized electrical systems in the facility always have the potential to initiate fires. Therefore, REQUIRED ACTION A.1 is identified to provide some fire detection and alarm capability while the Automatic Sprinkler System is not OPERABLE.

The two-hour COMPLETION TIME for terminating all spark/heat/flame producing work provides adequate time for facility management to suspend these types of operations. The termination of these activities does not negate any fire watch requirements associated with the original activity. That is, if the hot work permit stipulated a continuous fire watch for eight hours to monitor equipment while it is cooling, the termination of the activity would not relax the requirement for a continuous fire watch.

The two-hour COMPLETION TIME associated with the termination of spark/heat/flame producing work provides adequate time for facility management to inform the workers of the required termination and for the workers to safely terminate the work. The two-hour COMPLETION TIME does not result in undue risk due to the already continuous monitoring of the activities by the workers involved in the activities. However, the REQUIRED ACTION to terminate all spark/heat/flame producing work in the AFFECTED AREAS is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The two-hour COMPLETION TIME should not be used for operational convenience.

B.1 If the flow alarm portion of the Automatic Sprinkler System capability is lost in the BUILDING 991 FACILITY (as defined in the Applicability Statement), the Fire Department may not be automatically notified that a fire and/or actuation of the Automatic Sprinkler System has occurred. The Fire Department serves a defense-in-depth protection function in mitigating fires in the facility. The Fire Department also serves to mitigate facility flooding and water damage due to actuation of the Automatic Sprinkler System.

The fire watch in AFFECTED AREAS partly replaces the fire detection and alarm functions of the Automatic Sprinkler System with a fire watch individual capable of providing the functions during watch tours. The fire watch individual is expected to notify the Fire Department in the event of a fire, either via manual fire alarms or an alternative method if the manual fire alarms are unavailable. The Fire Department can then serve to fully suppress a fire, if needed, and to terminate the Automatic Sprinkler System water flow in the facility.

The establishing of a fire watch in the AFFECTED AREAS does not provide full-time fire detection and/or sprinkler actuation detection capability. A fire could initiate and propagate and/or the Automatic Sprinkler System could actuate between tours of the fire watch. While the fire watch does not provide the full-time fire detection capability afforded by the Flow Alarm Transmittal System, the fire watch individual has the capability to detect fires well in advance of the actuation of the Automatic Sprinkler System. This earlier fire detection capability partially offsets the reduced time coverage of the fire watch versus the Automatic Sprinkler System. As a result of the above considerations, the fire watch allows operations in the BUILDING 991 FACILITY to continue during the loss of the Flow Alarm Transmittal System.

The four-hour COMPLETION TIME for establishing a fire watch provides adequate time for facility management to assign the appropriate personnel, particularly on back shifts and weekends. Occupants of the facility can perform the fire watch function. The four-hour COMPLETION TIME does not result in undue risk due to the low initiation frequency of a fire. However, the REQUIRED ACTION to establish a fire watch is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The four-hour COMPLETION TIME should not be used for operational convenience.

C.1 If the fire water supplies to the BUILDING 991 FACILITY (as defined in the Applicability Statement) are lost, an undetected small fire may occur in areas of Building 991 which has the potential to propagate into a large fire. Loss of the fire water supplies disables the Automatic Sprinkler System and integral Flow Alarm Transmittal System. Two functions provided by the Automatic Sprinkler System (and integral Flow Alarm Transmittal System) are fire suppression (which reduces the likelihood that small fires become large fires) and fire detection and alarm (which identifies fires prior to their becoming large fires, allowing the Fire Department to participate in their mitigation). Without the fire suppression function, the dependence on the Fire Department to mitigate fires is increased. However, the loss of fire water supplies also degrades the Fire Department response capability by restricting the amount of water available to mitigate a fire. The facility is still protected, to some extent, if there is a capability to notify the Fire Department of fires prior to their becoming large.

The fire watch for the BUILDING 991 FACILITY partly replaces the fire detection and alarm functions of the Automatic Sprinkler System with a fire watch individual capable of providing the functions during watch tours. The fire watch individual is expected to notify the Fire Department in the event of a fire, either via manual fire alarms or an alternative method if the manual fire alarms are unavailable. The Fire Department then provides a fire suppression function in lieu of the Automatic Sprinkler System, for those areas provided with fire suppression capability. Non-waste storage areas included in Building 991 and dock areas are considered to be the most important areas for the purpose of establishing the fire watch due to less restrictive combustible material controls and the corresponding increased likelihood of small fires becoming large fires.

The establishing of a fire watch does not provide full-time fire detection capability. A fire could initiate and propagate between tours of the fire watch. Because the fire watch does not monitor all areas continuously and, therefore, does not completely replace the fire detection and alarm capability of the Automatic Sprinkler System, a reduction in fire initiating event frequency is warranted. REQUIRED ACTION C.2 is identified to reduce the likelihood of fires while fire water supplies to the BUILDING 991 FACILITY are lost. The only operations that are permitted are those associated with placing and maintaining the BUILDING 991 FACILITY in a safe configuration or those associated with restoring a required safety function.

While the fire watch does not provide the full-time fire detection capability afforded by the Automatic Sprinkler System and integral Flow Alarm Transmittal System, the fire watch individual has the capability to detect fires well in advance of the actuation of the Automatic Sprinkler System. This earlier fire detection capability partially offsets the reduced time coverage of the fire watch versus the Automatic Sprinkler System.

The four-hour COMPLETION TIME for establishing a fire watch provides adequate time for facility management to assign the appropriate personnel, particularly on back shifts and weekends. Occupants of the facility can perform the fire watch function. The four-hour COMPLETION TIME does not result in undue risk due to the low initiation frequency of a fire. However, the REQUIRED ACTION to establish a fire watch is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The four-hour COMPLETION TIME should not be used for operational convenience.

C.2 If the fire water supplies to the BUILDING 991 FACILITY (as defined in the Applicability Statement) are lost, an undetected small fire may occur in areas of Building 991 which has the potential to propagate into a large fire. Loss of the fire water supplies disables the Automatic Sprinkler System and integral Flow Alarm Transmittal System. Two functions provided by the Automatic Sprinkler System (and integral Flow Alarm Transmittal System) are fire suppression (which reduces the likelihood that small fires become large fires) and fire detection and alarm (which identifies fires prior to their becoming large fires, allowing the Fire Department to participate in their mitigation). Without the fire suppression function, the dependence on the Fire Department to mitigate fires is increased. However, the loss of fire water supplies also degrades the Fire Department response capability by restricting the amount of water available to mitigate a fire. The facility is still protected, to some extent, if there is a capability to notify the Fire Department of fires prior to their becoming large.

The REQUIRED ACTION to SUSPEND OPERATION in the BUILDING 991 FACILITY is a measure to reduce the likelihood of fires during the time that the fire water supplies to the BUILDING 991 FACILITY are lost. The REQUIRED ACTION to SUSPEND OPERATIONS does not preclude fire initiation. Energized electrical systems in the facility always have the potential to initiate fires. Therefore, REQUIRED ACTION C.1 is identified to provide some fire detection and alarm capability while the fire water supplies are lost.

The two-hour COMPLETION TIME for SUSPENDING OPERATIONS provides adequate time for facility management to terminate all work in an orderly and safe manner. The two-hour COMPLETION TIME does not result in undue risk due to the continuous monitoring of current activities by the workers involved in the activities. However, the REQUIRED ACTION to SUSPEND OPERATIONS is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The two-hour COMPLETION TIME should not be used for operational convenience.

D.1 If the Fire Department is not capable of responding to a BUILDING 991 FACILITY fire, an alternate means of fire mitigation is lost. The Fire Department serves as a defense-in-depth mitigative function to limit the growth of fires in the facility and to respond to fires in areas without Automatic Sprinkler System coverage. The Automatic Sprinkler System still serves as the primary line of defense in assuring that small fires in non-waste storage areas do not propagate into large fires and that fires in dock areas do not propagate into the facility.

Combustible material controls in TRU waste storage areas still serve as the primary line of defense in assuring that only small fires can occur in TRU waste storage areas. The Fire Department was an alternate means of assuring these functions.

The termination of spark/heat/flame producing work in the BUILDING 991 FACILITY is a measure to reduce the likelihood of fires during the time that the Fire Department is not available. The termination of spark/heat/flame producing work does not preclude fire initiation. Energized electrical systems in the facility always have the potential to initiate fires. The Automatic Sprinkler System is still OPERABLE which provides protection against fires in those areas covered by the system. REQUIRED ACTION D.2 is identified to verify that an alternate fire suppression capability is available in the BUILDING 991 FACILITY for response to small fires. Operations outside of the REQUIRED ACTION D.1 restrictions can continue since they do not significantly impact fire initiation frequency and do not contribute significantly to fire-related facility risk. The fire-related facility risk is dominated by the storage of waste containers in the facility rather than activities dealing with waste container movements.

The two-hour COMPLETION TIME for terminating all spark/heat/flame producing work provides adequate time for facility management to suspend these types of operations. The termination of these activities does not negate any fire watch requirements associated with the original activity. That is, if the hot work permit stipulated a continuous fire watch for eight hours to monitor equipment while it is cooling, the termination of the activity would not relax the requirement for a continuous fire watch.

The two-hour COMPLETION TIME associated with the termination of spark/heat/flame producing work provides adequate time for facility management to inform the workers of the required termination and for the workers to safely terminate the work. The two-hour COMPLETION TIME does not result in undue risk due to the already continuous monitoring of these activities by the workers involved in the activities. However, the REQUIRED ACTION to terminate all spark/heat/flame producing work is expected to be implemented as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The two-hour COMPLETION TIME should not be used for operational convenience.

D.2 If the Fire Department is not capable of responding to a BUILDING 991 FACILITY fire, an alternate means of fire mitigation is lost. The Fire Department serves as a defense-in-depth mitigative function to limit the growth of fires in the facility and to respond to fires in areas without Automatic Sprinkler System coverage. The Automatic Sprinkler System still serves as the primary line of defense in assuring that small fires in non-waste storage areas do not propagate into large fires and that fires in dock areas do not propagate into the facility. Combustible material controls in TRU waste storage areas still serve as the primary line of defense in assuring that only small fires can occur in TRU waste storage areas. The Fire Department was an alternate means of assuring these functions.

The verification that the manual fire extinguishers are compliant with their surveillances and tests (certification date has not expired) provides some assurance that an alternate means of fire suppression is available in the facility. The Automatic Sprinkler System is still OPERABLE which provides protection against fires in those areas covered by the system. In these areas, the manual fire extinguishers serve as defense-in-depth protection for fire suppression. The manual fire extinguishers serve as the primary mitigation for fires occurring in waste storage areas not covered by the Automatic Sprinkler System when Fire Department response is not available. While these fires have analyzed consequences limited to the inventories of up to three drums, use of manual fire extinguishers on these fires would further reduce the consequences and provide defense-in-depth protection. The safety analysis is not taking any credit for facility personnel response to fires using the manual fire extinguishers. Only emergency response personnel or facility personnel that are trained in the use of fire extinguishers and trained in fire response should use the fire extinguishers in response to small fires.

The fire detection and alarm capability is not impaired by the loss of Fire Department response capability. Facility alarms, if available, or Central Alarm Station notification will inform the facility management that a fire is potentially occurring in the facility. It is expected that only personnel in the facility or emergency response personnel who are trained in fire extinguisher use and in fire fighting will respond to this notification with fire extinguishers or other fire suppression devices/systems, particularly in those areas not covered by the Automatic Sprinkler System. It is also expected that facility management attempt to obtain the capability to terminate sprinkler operation following suppression of a fire to avoid flooding and water damage in the facility.

The eight-hour COMPLETION TIME for verifying the compliance of manual fire extinguishers provides adequate time for facility management to perform the determination of certification. The eight-hour COMPLETION TIME does not result in undue risk due to the low initiation frequency of a fire. However, the REQUIRED ACTION to verify extinguisher compliance is expected to be performed as soon as reasonably achievable, even if this is significantly less than the assigned COMPLETION TIME. The eight-hour COMPLETION TIME should not be used for operational convenience.

SURVEILLANCE REQUIREMENTS

SR 4.1.1 The verification of the correct positioning of control valves in the fire water supply to the BUILDING 991 FACILITY assures, in part, the OPERABILITY of the Automatic Sprinkler System, including the Dry Pipe Systems which are sub-components of the entire system. The SR to verify valve positioning on a monthly interval satisfies several of the requirements found in NFPA 25. The SR inspection frequency of once per calendar month (not to exceed 37 days between inspections) is intended to be compliant with the NFPA requirements and restricts the interval between inspections to an increase of less than 25% of the intended monthly inspection interval. If SR 4.1.1 is not met, entry into LCO CONDITION A or LCO CONDITION C is expected, depending on the finding.

SR 4.1.2 The verification of adequate static pressure in the Automatic Sprinkler System risers assures, in part, the OPERABILITY of the Automatic Sprinkler System. The SR to verify riser static pressure on a monthly interval satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar month (not to exceed 37 days between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 25% of the intended monthly inspection interval. If SR 4.1.2 is not met, entry into LCO CONDITION A is expected.

SR 4.1.3 The verification of adequate air pressure in the dry pipe portions of the Automatic Sprinkler System assures, in part, the OPERABILITY of the Dry Pipe Systems. The SR to verify dry pipe air pressure on a monthly interval satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar month (not to exceed 37 days between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 25% of the intended monthly inspection interval. If SR 4.1.3 is not met, entry into LCO CONDITION A is expected.

SR 4.1.4 The performance of a main drain flow test on the Automatic Sprinkler System risers assures, in part, the OPERABILITY of the Automatic Sprinkler System. The SR to test main drain flow on a quarterly interval satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar quarter (not to exceed 120 days between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 34% of the intended quarterly inspection interval. If SR 4.1.4 is not met, entry into LCO CONDITION A is expected.

SR 4.1.5 The performance of a water flow alarm test at an inspector's test connection and verification of the Automatic Sprinkler System riser flow alarm transmittal assures that the fire suppression system flow alarm is functioning. The SR to test the water flow alarm on a quarterly interval satisfies a requirement found in NFPA 25 and NFPA 72. The SR inspection frequency of once per calendar quarter (not to exceed 120 days between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 34% of the intended quarterly inspection interval. If SR 4.1.5 is not met, entry into LCO CONDITION B is expected.

SR 4.1.6 The performance of a visual inspection of the Automatic Sprinkler Systems assures, in part, the OPERABILITY of the Automatic Sprinkler Systems. The SR to visually inspect the systems annually satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar year (not to exceed 13 months between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 10% of the intended annual inspection interval. If SR 4.1.6 is not met, entry into LCO CONDITION A is expected.

SR 4.1.7 The performance of an operational test of the dry pipe portions of the Automatic Sprinkler Systems assures, in part, the OPERABILITY of the Dry Pipe Systems. The SR to test the dry pipe systems annually satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar year (not to exceed 13 months between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 10% of the intended annual inspection interval. If SR 4.1.7 is not met, entry into LCO CONDITION A is expected.

SR 4.1.8 The performance of an operational test of the fire service main hydrants of the Fire Service Main System assures, in part, the OPERABILITY of the Fire Service Main System. The SR to test the fire hydrants annually satisfies a requirement found in NFPA 25. The SR inspection frequency of once per calendar year (not to exceed 13 months between inspections) is intended to be compliant with the NFPA requirement and restricts the interval between inspections to an increase of less than 10% of the intended annual inspection interval. If SR 4.1.8 is not met, entry into LCO CONDITION C is possible.

5. ADMINISTRATIVE CONTROLS

ADMINISTRATIVE CONTROLS (ACs) are provisions relating to organization and management, conduct of operations, procedures, record-keeping, assessment, and reporting necessary to ensure safe operation of the facility. The ACs for the BUILDING 991 FACILITY are divided into two types; ADMINISTRATIVE OPERATING LIMITS (AOLs) and PROGRAMMATIC ADMINISTRATIVE CONTROLS (PACs).

5.1 ADMINISTRATIVE OPERATING LIMITS

AOLs are specific administrative controls/limits that have been credited in the safety analysis as providing a reduction in accident scenario initiation frequency and/or a reduction in accident consequences. Such controls are more precise and discrete than those defined by a safety management program or the key attributes of a safety management program. The AOLs are the administrative equivalent to hardware requirements in LCOs. Section 5.1.1 lists a set of general guidelines applicable to the BUILDING 991 FACILITY AOLs. Section 5.1.2 lists the BUILDING 991 FACILITY AOLs and their BASES.

5.1.1 Use And Application Of AOLs

The following AOL guidelines establish the general requirements applicable to the specific AOLs listed in Section 5.1.2 at all times. A summary table of the guidelines or topics is presented below and is followed by a more detailed discussion of AOL guidelines and their BASES.

Table 2 SUMMARY OF AOL GUIDELINES

GUIDELINE/TOPIC	REMARKS
AOLs shall be met at all times	This guideline defines when AOLs must be met. Refer to the next guideline when AOLs cannot be met.
A VIOLATION of an AOL shall be declared whenever the AOL is not being met and a failure to implement specified REQUIRED ACTIONS has occurred.	This guideline indicates that any non-compliance with an AOL and corresponding REQUIRED ACTIONS is considered an AOL VIOLATION. Refer to the next guideline for response to an AOL VIOLATION.
Response to an AOL VIOLATION.	AOL VIOLATIONS must be reported, corrective actions taken, and, if the AOL VIOLATION still exists, operations must be suspended.
AOL SRs shall be met, where specified.	This guideline defines when AOL SRs must be met. Failure to meet an AOL SR could place the facility in an AOL VIOLATION CONDITION.

<u>**AOLs Shall Be Met At All Times**</u>

<u>BASIS:</u> This guideline ensures safe operation of the facility. Each of the AOLs in Section 5.1.2 are credited as either preventive or mitigative controls for the postulated

accident scenarios evaluated in FSAR Sections 4.5.2 through 4.5.6. Failure to meet the AOLs in Section 5.1.2 may result in increased risk to the worker and the public.

<u>A VIOLATION Of An AOL Shall Be Declared Whenever The AOL Is Not Being Met And A Failure To Implement Specified REQUIRED ACTIONS Has Occurred</u>

<u>BASIS:</u> This guideline establishes when AOL VIOLATIONS occur. The AOLs are defined in a manner such that failure to met an AOL is associated with a facility configuration that either is not analyzed in the safety analysis or has yielded unacceptable consequences when evaluated. Opportunity to correct the situation is included as REQUIRED ACTIONS in the AOL and VIOLATION of the AOL only occurs if the facility configuration is not corrected per the REQUIRED ACTIONS.

<u>Response To An AOL VIOLATION</u>

AOL VIOLATIONS may result from either of two situations. The first situation occurs when an AOL is currently not being met and the second situation occurs when an AOL was not met but is currently being met.

A. Upon identification that an AOL VIOLATION exists, the following REQUIRED ACTIONS shall be performed:

   1. SUSPEND OPERATIONS in the AFFECTED AREA within two (2) hours, **<u>AND</u>**
   2. perform any applicable AOL REQUIRED ACTIONS that are in addition to the SUSPEND OPERATIONS action, **<u>AND</u>**
   3. declare an AOL VIOLATION, **<u>AND</u>**
   4. notify the DOE-RFFO in accordance with contractor occurrence reporting procedures, **<u>AND</u>**
   5. develop a restart plan for DOE-RFFO approval that defines corrective measures to address the AOL VIOLATION.

B. Upon identification that an AOL had not been met resulting in an AOL VIOLATION, and the identified failure to meet the AOL no longer exists, the following REQUIRED ACTIONS shall be performed:

   1. declare an AOL VIOLATION, **<u>AND</u>**
   2. notify the DOE-RFFO in accordance with contractor occurrence reporting procedures, **<u>AND</u>**
   3. provide the DOE-RFFO a report, within sixteen (16) calendar days, identifying the root causes for the VIOLATION, any corrective actions currently taken, and the corrective actions to be taken to prevent recurrence of the event.

Note that AOL REQUIRED ACTIONS do not need to be entered if the failure to meet the AOL no longer exists.

BASIS: This guideline establishes the REQUIRED ACTIONS to be taken upon identification of an AOL VIOLATION. Two situations are addressed by the guideline.

In the first situation, the facility is currently in an unacknowledged unsafe configuration. A REQUIRED ACTION to SUSPEND OPERATIONS in the AFFECTED AREA is specified because facility operations are occurring outside of the approved safety bases. The action to SUSPEND OPERATIONS puts the facility in as safe a condition as can be achieved.

Following the termination of operations in the facility, a restart plan must be developed and approved before any operations included in the termination can be conducted. The restart plan requires DOE-RFFO approval. Since AOL VIOLATIONS are significant occurrences, it is required that some effort is applied to assure that the VIOLATION does not recur. The restart plan is a vehicle to document the corrective measures that are and will be taken by the facility to prevent a recurrence of the VIOLATION. A restart plan will address the root cause of the AOL VIOLATION to assure that the selected corrective measures cover the root cause and are appropriate for prevention of a recurrence.

In the second situation, the facility was in an unacknowledged unsafe configuration but is currently in a safe configuration. Actions to SUSPEND OPERATIONS and enter the applicable AOL REQUIRED ACTIONS are not necessary due to the currently compliant configuration of the facility.

Since a restart plan will not be developed in the second situation, a report is provided to the DOE-RFFO within the specified time frame. A period of sixteen (16) calendar days was selected to focus attention on the event and its significance. Since AOL VIOLATIONS are significant occurrences, there must be some effort applied to assure that the VIOLATION does not recur. The report will document the corrective measures that are and will be taken by the facility to prevent a recurrence of the VIOLATION. Part of the report will address the root cause of the AOL VIOLATION to assure that the selected corrective measures cover the root cause and are appropriate for prevention of a recurrence.

In both situations, declaration of the AOL VIOLATION and notification of the DOE-RFFO are performed to alert the DOE-RFFO of the situation. Notification of the DOE-RFFO is performed using contractor occurrence reporting procedures.

AOL SRs Shall Be Met, Where Specified

BASIS: This guideline establishes that any specified SRs for AOLs shall be met. In general, AOL compliance is verified during various facility tours rather than at specific times and frequencies. The AOLs often deal with unacceptable facility configurations that can be found at any time by any of the facility occupants. In those cases where an SR is specified, the SR is expected to be met to assure that an unacceptable facility configuration is not entered.

5.1.2 AOLs For The BUILDING 991 FACILITY

The following AOLs establish administrative controls/limits that have been credited in the safety analysis. A summary table of the AOLs is presented below and is followed by a more detailed discussion of each AOL and their BASES. The AOL requirements presented in the summary table are shortened forms of the AOL specific requirements. The summary table should only be used as a general reminder of the actual AOLs. The requirements shown in the summary table do not exempt the facility from the more detailed or specific requirements found in the detailed discussions that follow the summary table.

Table 3 SUMMARY OF AOLS FOR THE BUILDING 991 FACILITY

AOL	REQUIREMENT	REQUIRED ACTIONS	SURVEILLANCE/REMARKS
AOL 1	Received and stored metal waste containers shall be compliant with transportation requirements.	If not at receipt: segregate in 1 hour; and remove by next work day end. If not during operations: segregate in 8 hours; and remove by third work day end.	Surveilled upon receipt and surveilled during facility tours and operations. Container integrity is part of transportation requirement compliance.
AOL 2	Staged SNM shall be in certified Type B shipping containers.	If not: remove in 4 hours.	Surveilled upon receipt.
AOL 3	Received and stored metal waste containers shall be vented.	If not at receipt: segregate in 1 hour; and remove by next work day end. If not during operations: segregate in 8 hours; and remove by third work day end.	Surveilled upon receipt and surveilled during facility tours and operations.
AOL 4	Received and stored waste containers shall not contain more than an equivalent of 200 g of WG Pu per drum or 320 g of WG Pu per crate.	If so at receipt: remove by next work day end. If so during operations: remove by next work day end after receiving facility is identified.	Surveilled upon receipt and surveilled during facility tours and operations. Criticality Safety Program requirements take precedence. Exception for existing drum number 84291.
AOL 5	Wooden LLW crates shall be stored outside, under sprinklers, and shall be limited to 50 crates.	If not: properly locate in 8 hours; or remove by third work day end.	Surveilled during facility tours and operations. Storage must meet NFPA 231 requirements.
AOL 6	Received and stored waste containers shall be compliant with the controls specified in the Criticality Safety Evaluation indicating that a criticality event is incredible.	If so at receipt: segregate in 1 hour; and remove by next work day end. If so during operations: segregate in 8 hours; and remove by third work day end.	Surveilled upon receipt and surveilled during facility tours and operations. Criticality Safety Program requirements take precedence.
AOL 7	Fourth tier waste drums shall be banded.	If not: remove from 4th tier or band in 8 hours.	Surveilled during facility tours and operations.

Table 3 SUMMARY OF AOLS FOR THE BUILDING 991 FACILITY

AOL	REQUIREMENT	REQUIRED ACTIONS	SURVEILLANCE/REMARKS
AOL 8	Wooden pallets shall not be used for waste container storage.	If so: remove in 4 hours.	Surveilled during facility tours and operations.
	Flammable/combustible liquids shall not be stored outside NFPA approved cabinets.	If so: remedy in 4 hours; or remove in 4 hours.	Surveilled during facility tours and operations.
	Bulk flammable/combustible liquids shall not be located in waste storage areas without proper diking.	If so: remedy in 24 hours; or remove in 24 hours.	Surveilled during facility tours and operations.
	Significant quantities of plastics shall not be located in waste storage areas without proper diking.	If so: remedy in 24 hours; or remove in 24 hours.	Surveilled during facility tours and operations.
	Combustibles shall be separated from stored waste containers by at least 5 feet.	If not: remedy in 4 hours; or remove in 4 hours.	Surveilled during facility tours and operations.
	Fossil-fueled vehicles shall not be used in waste storage areas.	If so: remove in 1 hour.	Surveilled during facility tours and operations.
	Flammable gas cylinders shall not be located in the BUILDING 991 FACILITY	If so: remove in 1 hour.	Surveilled during facility tours and operations.
	No more than 1 wooden waste crate shall be located inside a building in the BUILDING 991 FACILITY.	If so: remove additional crates in 24 hours.	Surveilled during facility tours and operations.
	Combustible loading in the BUILDING 991 FACILITY shall be maintained as low as reasonably achievable.	If not: remove excess combustibles as soon as reasonable achievable.	Surveilled during facility tours and operations.
AOL 9	BUILDING 991 FACILITY fire phones, fire extinguishers, smoke detectors, and local fire alarms shall be maintained.	If not: inform personnel in 8 hours & periodically thereafter; and remedy or compensate for in 48 hours.	Surveilled per NFPA standards.
AOL 10	The BUILDING 991 FACILITY filtered exhaust ventilation function shall be maintained.	If not: remedy or compensate for in 48 hours.	Surveilled per facility procedures.

AOL 1 Metal waste containers received at and stored in the BUILDING 991 FACILITY shall meet on-site shipping specifications and/or shall meet or formerly have met DOT specifications. Metal waste container integrity is a part of meeting the specifications. All metal waste containers received at the BUILDING 991 FACILITY docks shall be inspected for compliance with this requirement either before shipment or at receipt. Upon failure to meet this requirement at the BUILDING 991 FACILITY docks, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Segregate the non-compliant waste container within one (1) hour.**
- **Develop and begin implementation of an action plan defining necessary short-term compensatory measures and final disposition of the non-compliant waste container within twenty-four (24) hours.**
- **Bring the non-compliant waste container into compliance or remove from the BUILDING 991 FACILITY within one (1) week.**

Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Segregate the non-compliant waste container within eight (8) hours.**
- **Develop and begin implementation of an action plan defining necessary short-term compensatory measures and final disposition of the non-compliant waste container within twenty-four (24) hours.**
- **Bring the non-compliant waste container into compliance or remove from the BUILDING 991 FACILITY within one (1) week.**

AOL 1 BASIS

The term DOT waste container or DOT container will be used in the following discussion to signify containers that meet on-site shipping specifications and/or meet or formerly have met DOT specifications. The term also signifies waste container integrity. That is, waste containers that have lost integrity (e.g., punctured, rusted, significantly damaged) do not meet the intent of the AOL. This AOL applies to metal waste containers that are to be stored in the BUILDING 991 FACILITY and does not apply to wooden LLW crates that can be stored outside.

Postulated accident scenarios dealing with spills and fires, both internally and externally initiated, credit the capabilities of the waste containers to withstand drops and to provide some confinement in response to fires. Specifically, postulated spill scenario assumptions dealing with the waste containers credit the resistance of the containers to droppage in determining that a fork lift tine breach scenario bounds a pallet or container drop scenario (see forklift breach scenario 991 Spill 1). Earthquake scenario 991 NPH 1 credits the package in the scenario MAR determination. Small internal fire scenario 991 Fire 1 credits the DOT container in venting rather than explosively ejecting contents due to involvement in the fire. Similarly, large internal fire scenario 991 Fire 2 and truck dock fire scenario 991 Fire 3 credit the containers in venting rather than ejecting material.

In order to restrict waste containers that either do not comply with on-site shipping and/or DOT specifications or have lost integrity from the BUILDING 991 FACILITY, the SR to inspect every container brought into the facility for compliance with the requirement is specified. The compliance surveillance can occur at time of receipt of at the container originating facility prior to shipment. In addition, a general surveillance is specified to cover identification of non-compliant waste containers during facility operations and tours.

If a waste container that is not on-site shipping or DOT specification compliant or has lost integrity is brought to a BUILDING 991 FACILITY dock, the waste container is to be segregated within one hour to prevent interaction of the non-compliant container with other waste containers. One hour is sufficient time to perform the segregation given that the non-compliant container will be identified during truck unloading and personnel to perform the segregation are available during the unload activity. If a waste container integrity loss results in an emergency situation, segregation of the container is subject to the requirements imposed by the emergency response personnel.

If a waste container that is not on-site shipping or DOT specification compliant is found in the BUILDING 991 FACILITY, the waste container is to be segregated within eight hours to prevent interaction of the non-compliant container with other waste containers. Eight hours provides sufficient time for facility management to recruit the personnel to perform the segregation. If a waste container integrity loss results in an emergency situation, segregation of the container is subject to the requirements imposed by the emergency response personnel.

In either case, upon identification of a non-compliant waste container, the BUILDING 991 FACILITY is required to develop and begin implementation of an action plan dealing with the waste container. A minimum of 24 hours is provided for the development of the action plan. The action plan should address any short-term compensatory measures for placing the container into a safe or safer configuration. The action plan should also address a longer-term disposition of the waste container. That is, how the container will be brought back into compliance and/or removed from the facility. The 24 hour COMPLETION TIME for the development of an action plan focuses significant attention on the non-compliant container and the safety of the facility.

Within a week, if the BUILDING 991 FACILITY wishes to retain the container, the facility must bring the non-compliant container back into compliance with the intent of the AOL requirement. That is, the container must be strong enough to survive drops of approximately four feet and must be resistant to the effects of a fire such that a violent lid loss will not occur for the types of fires analyzed in the safety analysis. If the facility does not wish to retain the container or re-compliance with the requirements of the AOL cannot be achieved, the container must be removed from the facility within the week. Note, for example, that a patched container may meet on-site shipping requirements but not meet the intent of the AOL.

If identified during operations or tours, the segregation of the non-compliant container may introduce risk from a spill due to droppage if the container is on an upper tier of a stack of waste containers. This risk is independent of the time the facility is at risk due to a delay in removal or remediation. There is a tradeoff associated with moving the container (which must be done eventually, regardless) versus leaving the container and being outside the safety analysis for a single container. The risk from container movement probably dominates the tradeoff but is a risk that would also be realized when the container is removed from the facility for final disposition. Therefore, the overall risk associated with leaving the non-compliant container in the facility is higher than removing the container from the facility or bringing the container back into compliance.

Since the non-compliant container is segregated from other containers, it will not be re-stacked and, therefore, the container is not susceptible to droppage events during the removal or remediation delay. The occurrence of a significant earthquake during the one week interval is extremely unlikely, and a small number of non-compliant containers would have minor impacts on the risk associated with this event. Segregation of the container also reduces the likelihood of container involvement in fire scenarios, thus reducing the risk associated with fire related releases from the container during the one week wait. Therefore, the risk impact of having the container at the facility for a one week is small as long as the container integrity is not in question. In the case of a non-compliant and breached container, it is assumed that emergency response measures would minimize the in-facility release from the failed container.

AOL 2 Special Nuclear Material (SNM) containers staged in the BUILDING 991 FACILITY shall meet DOT Type B shipping container certification. All SNM containers received at the BUILDING 991 FACILITY docks shall be verified to be compliant with this requirement. Upon failure to meet this requirement at the BUILDING 991 FACILITY docks, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:

- **Remove the non-compliant SNM container from the BUILDING 991 FACILITY within four (4) hours.**

AOL 2 BASIS

No postulated accident scenarios for the BUILDING 991 FACILITY involve releases from SNM containers. The accident analyses credit the certified DOT Type B shipping containers for preventing the release of the SNM contents in postulated fire, spill, and earthquake scenarios. The certified Type B shipping container is also credited to reduce accidental criticality likelihood to the incredible frequency range. Allowing SNM to enter the facility that is not packaged in a container the does not meet DOT Type B shipping container certification would invalidate a key assumption of the safety analysis and would introduce additional MAR into earthquake scenario 991 NPH 1. A non-compliant SNM container would be more susceptible to fire and spill accidents, potentially creating additional accident scenarios in the safety analysis. In addition, criticalities may become credible if SNM is introduced in the facility in packages that are not certified DOT Type B shipping containers. In order to maintain the assumptions of the safety analysis, all SNM in the BUILDING 991 FACILITY must be packaged in certified DOT Type B shipping containers.

In order to restrict SNM containers that do not comply with DOT Type B shipping container certification from the BUILDING 991 FACILITY, the SR to verify that every container brought into the facility is compliant with the requirement is specified. If a SNM container that is not DOT Type B certification compliant is brought to a BUILDING 991 FACILITY dock, the removal of the SNM container from the BUILDING 991 FACILITY is required to re-establish the assumptions of the safety analysis. Four hours is provided for removal of the SNM container to allow Building 991 facility management, security forces, and originating facility management time to arrange shipment of the SNM container back to the originating facility.

It is expected that, at a minimum, security personnel will remain with the non-compliant SNM container for the entire time that the container remains at the BUILDING 991 FACILITY. The container certification verification surveillance may be performed before the container leaves the transport vehicle or may be performed as the container is being removed from the vehicle. In either case, the amount of handling of the non-compliant container is expected to be minimal and should not require lifting the container significantly (container should remain close to the floor at all times). Therefore, the container is not considered to be susceptible to droppage events that could challenge the container integrity during the removal delay. The occurrence of a significant earthquake during the 4 hour interval is extremely unlikely, and a single non-compliant SNM container would have limited impact on the risk associated with this event due to the low likelihood of the accident. Constant personnel attendance with the container also reduces the likelihood of container involvement in fire scenarios, thus reducing the risk associated with fire related releases from the container during the 4 hour wait. Therefore, the risk impact of having the container at the facility for 4 hours is small.

AOL 3 **Metal waste containers received at and stored in the BUILDING 991 FACILITY shall be vented. All waste containers received at the BUILDING 991 FACILITY docks shall be inspected for compliance with this requirement. Upon failure to meet this requirement at the BUILDING 991 FACILITY docks, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:**

- **Segregate the unvented waste container within one (1) hour.**
- **Remove the unvented waste container from the BUILDING 991 FACILITY by the end of the day shift of the next regular work day.**

Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Segregate the unvented waste container within eight (8) hours.**
- **Remove the unvented waste container from the BUILDING 991 FACILITY by the end of the day shift of the third regular work day.**

AOL 3 BASIS

Postulated accident scenarios dealing with hydrogen explosions credit the venting of waste containers to reduce the hydrogen gas buildup in the container to safe levels. Waste containers include 55-gallon drums, Transuranic Package Transporter (TRUPACT II) Standard Waste Boxes, and DOT-7A Type A Metal Waste Crates. Hydrogen explosion scenario 991 Explosion 1 credits the venting of a 55-gallon TRU waste drum to reduce the accident scenario frequency from anticipated to extremely unlikely. Similarly, hydrogen explosion scenario 991 Explosion 2 credits the venting of a waste crate to reduce the accident scenario frequency from anticipated to extremely unlikely. Although not explicitly credited, the venting of waste containers aids in the venting of gases from the containers in response to postulated fires, further reducing the likelihood of material explosive ejection from the container due to external heating.

In order to restrict unvented waste containers from the BUILDING 991 FACILITY, the SR to inspect every container brought into the facility for compliance with the requirement is specified. In addition, a general surveillance is specified to cover identification of non-compliant waste containers during facility operations and tours.

If a waste container that is not vented is brought to a BUILDING 991 FACILITY dock, the waste container is to be segregated within one hour to prevent interaction of the non-compliant container with other waste containers. One hour is sufficient time to perform the segregation given that the non-compliant container will be identified during truck unloading and personnel to perform the segregation are available during the unload activity. The removal of the waste container from the BUILDING 991 FACILITY is required to re-establish the assumptions of the safety analysis. A minimum of 8 hours (received at end of night shift) and a maximum of 4 days (received at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least one day shift) to arrange shipment of the waste container back to the originating facility. A day shift of a working day is needed to assure that facility management can communicate with the waste container originating facility.

If a waste container that is not vented is found in the BUILDING 991 FACILITY, the waste container is to be segregated within eight hours to prevent interaction of the non-compliant container with other waste containers. Eight hours provides sufficient time for facility management to recruit the personnel to perform the segregation. The removal of the waste container from the BUILDING 991 FACILITY is required to re-establish the assumptions of the safety analysis. A minimum of 80 hours (identified at end of night shift) and a maximum of 6 days (identified at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least three day shifts) to arrange shipment of the waste container to another facility, which is not necessarily the container originating facility. Three day shifts are needed to assure that facility management can identify, communicate with, and coordinate shipment with a receiving facility.

Once the container is segregated from other containers, it will not be subjected to much movement during the removal delay. Movement of the unvented container could initiate the hydrogen explosion in the container, therefore any movement of the container increases the risk of a hydrogen explosion (given that the container is susceptible). Movement of the container to initially segregate the container from other containers is the most vulnerable movement with respect to hydrogen explosions. In the case of a non-compliant container being identified in the facility, the length of time that the unvented container was in the facility may not be readily determined, so the container susceptibility to hydrogen explosion cannot be determined. If the waste container contained an explosive concentration of hydrogen, it is possible that an explosion could occur if the container were susceptible to movement induced ignition of the hydrogen. Additional moves (placement on the truck) should not challenge the container any more than it was already challenged by the segregation move.

The segregation movement of the unvented waste container at the time of identification is less of a risk than leaving the container in place until final disposition of the container. Since the time until final disposition of the container is not known, the delay, if significant, may increase the hydrogen concentration into the explosive range. The longer the delay until final disposition, the greater the potential for container to become susceptible to hydrogen explosions, if the container can become susceptible at all.

Waiting an additional 4 to 6 days beyond the segregation movement for removal is not expected to alter the hydrogen concentration significantly in an unvented TRU or LLW container, thus the susceptibility of the container to movement is not expected to change. Therefore, immediate removal of the container from the facility versus waiting for 4 to 6 days to remove the container have similar risks associated with hydrogen explosions.

AOL 4 The quantities of radioactive material in waste drums and waste crates received at and stored in the BUILDING 991 FACILITY shall not exceed 200 grams Weapons Grade Plutonium equivalent and 320 grams Weapons Grade Plutonium equivalent, respectively. All waste containers received at the BUILDING 991 FACILITY docks shall be verified to be compliant with this requirement. Upon failure to meet this requirement at the BUILDING 991 FACILITY docks, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:

- **Remove the excessive radioactive material waste container from the BUILDING 991 FACILITY by the end of the day shift of the next regular**

work day if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.

Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:

- **Remove the excessive radioactive material waste container from the BUILDING 991 FACILITY by the end of the day shift of the next regular work day after a receiving facility is identified if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.**

AOL 4 EXCEPTIONS

The BUILDING 991 FACILITY is assumed to initially contain one 55-gallon waste drum with a quantity of americium that is higher than that expected from the decay of ^{241}Pu in WG Pu. This waste drum, identification number 84291, contains 208 grams WG Pu equivalent. It is assumed that no other waste drums containing more than 200 grams WG Pu equivalent are introduced into the BUILDING 991 FACILITY prior to implementation of these TSRs.

AOL 4 BASIS

All postulated accident scenarios in the safety analysis make MAR assumptions associated with the accident scenarios. These MAR assumptions are generally tied to assumed waste container radioactive material limits. The safety analyses for new waste containers that are received at the BUILDING 991 FACILITY are performed assuming that 55-gallon waste drums contain no more than 200 grams of Weapons Grade Plutonium (WG Pu) equivalent radioactive material and that waste crates contain no more than 320 grams of WG Pu equivalent radioactive material. Under these assumptions, all postulated accident scenarios, except waste container internal hydrogen explosions, are bounded by assuming that the accidents involve 55-gallon drums rather than waste crates. WG Pu equivalent radioactive material considers the higher dose consequences associated with accidents involving americium in concentrations greater than that expected from ingrowth due to the decay of ^{241}Pu. The formula for calculating WG Pu equivalency is:

$$\text{WG Pu equivalency (in grams)} = \text{WG Pu (in grams)} + 66 * \text{Am (in grams)}$$

This formula should only be used for waste containers containing more than approximately 0.3% americium in the radioactive material content. If the radioactive material contains less than 0.3% americium, the americium content is consistent with the natural ingrowth of americium in WG Pu.

In order to restrict high radioactive material content waste containers from the BUILDING 991 FACILITY, the SR to inspect every container brought into the facility for compliance with the requirement is specified. In addition, a general surveillance is specified to cover identification of non-compliant waste containers during facility operations and tours.

If a waste container containing more than the specified radioactive material limit is brought to a BUILDING 991 FACILITY dock, the waste container is to be removed from the BUILDING 991 FACILITY to re-establish the assumptions of the safety analysis. Movement of the waste container is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, removal of the container is subject to the requirements of that program. Otherwise, a minimum of 8 hours (received at end of night shift) and a maximum of 4 days (received at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least one day shift) to arrange shipment of the waste container back to the originating facility. A day shift of a working day is needed to assure that facility management can communicate with the waste container originating facility.

If an excessive radioactive material waste container is found in the BUILDING 991 FACILITY, the waste container is to be removed from the BUILDING 991 FACILITY to re-establish the assumptions of the safety analysis. Movement of the waste container for removal is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, removal of the container is subject to the requirements of that program. Otherwise, following identification of a receiving facility (which should be performed as soon as possible), a minimum of 8 hours (receiving facility identified at end of night shift) and a maximum of 4 days (receiving facility identified at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least one day shift) to arrange shipment of the waste container to the receiving facility. A day shift of a working day is needed to assure that facility management can coordinate waste container shipment with the receiving facility.

An increase in a specific waste container MAR does not have any impact on contiguous waste containers, other than for issues dealing with criticality. Therefore, for all accidents not involving a criticality, high MAR containers do not require container segregation. The Criticality Safety Program is credited for handling any criticality issues related to high MAR containers and their movement.

If identified at receipt, the likelihood of an occurrence of an accident involving the identified high MAR waste container is small during the maximum 4 day interval for removal. This interval equates to roughly a one-hundredth of a year and reduces all accident initiating frequencies by a frequency bin. The MAR increase is not expected to exceed a factor of 10 (2 kilogram residue drum rather than a TRU waste drum). Therefore, in the worst case situation of an accident only involving a single container, the risk is a factor of 10 lower than the safety analysis evaluation of the accident (frequency went down two orders of magnitude and MAR went up an order of magnitude). Multiple container accidents would have even less relative consequences associated with the high MAR container. The maximum 4 day residence time of the high MAR waste container does not impact risk significantly.

As stated above, an increase in a specific waste container MAR does not have any impact on contiguous waste containers, other than for issues dealing with criticality, and high MAR containers are not required to be segregated if identified during facility operation or tours. Since the length of time before facility management can identify a facility to receive the container is unknown, segregation of the container is prudent, but not required, to both highlight the container and potentially reduce the likelihood of container involvement in accidents. A segregated container may not be as susceptible to impacts from equipment in storage areas or to small fires resulting from transient combustibles. If the container is truly segregated, activities around the container should be minimal. This marginal reduction is risk from the segregation is not as important as the emphasis placed on the segregated container due to its isolation within the facility.

The likelihood of an occurrence of an accident involving the identified high MAR waste container is expected to be small during the delay interval for removal. However, the longer the delay, the more likely that the container will be involved in an accident. Therefore, there is significant emphasis placed on finding a receiving facility and expediting the removal of the high MAR waste container. By segregating the container, the facility awareness of the container is enhanced and the segregation may lead to impacts on other facility activities. Delay in removal is not desired or expected. The MAR increase is not expected to exceed a factor of 10 (2 kilogram residue drum rather than a TRU waste drum). Residence time in the facility would have to be on the order of a month to double the risk associated with single or few container accidents (spills, small fires, explosions). Much longer residence times would be required before a risk increase would be noticed in the multiple container accidents (large fires, earthquakes).

AOL 5	**Wooden LLW crates stored at the BUILDING 991 FACILITY shall be located outside of buildings, shall be located in areas covered by the Automatic Sprinkler System, and shall be located in compliance with NFPA requirements. No more than fifty (50) wooden LLW crates may be stored at the BUILDING 991 FACILITY. Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:** • **Relocate any misplaced wooden LLW crates to compliant locations with eight (8) hours.** • **Remove any excess wooden LLW crates from the BUILDING 991 FACILITY by the end of the day shift of the third regular work day.**

AOL 5 BASIS

A postulated accident scenario dealing with a dock fire credits a limit on wooden LLW crates and credits fire suppression capability. Specifically, wooden LLW crate fire scenario 991 Fire 4 credits a maximum inventory of 50 wooden LLW crates and credits Automatic Sprinkler System coverage of the LLW crate storage area. In addition, the accident analysis credits the Building 991 structure to prevent the crate fire from propagating into the building and impacting TRU waste storage areas. It is assumed that the wooden crates will be compliant with NFPA 231 (Ref. A-4) requirements dealing with the placement of combustible materials near facility walls.

In order to assure that wooden LLW crates are properly located and are within inventory limits assumed in the safety analysis, a general surveillance is specified to cover identification of non-compliant configurations during facility operations and tours.

If a wooden LLW crate is found in the BUILDING 991 FACILITY in a non-compliant location, the waste container is to be relocated to an appropriate storage location within eight hours to re-establish the assumptions of the safety analysis. Eight hours provides sufficient time for facility management to recruit the personnel to perform the crate movement. If an excess wooden LLW crate is found in the BUILDING 991 FACILITY, the waste container is to be removed to re-establish the assumptions of the safety analysis. A minimum of 80 hours (identified at end of night shift) and a maximum of 6 days (identified at end of a day shift before a three day weekend) is provided for removal of the waste crate to allow facility management time (at least three day shifts) to arrange shipment of the waste container to another facility, which is not necessarily the container originating facility. Three day shifts are needed to assure that facility management can identify, communicate with, and coordinate shipment with a receiving facility.

The risks of waiting 8 hours to come back into compliance or to wait 6 days for removal of excess LLW crates is not expected to significantly impact the risks identified in the safety analysis due to the low likelihood of fires. Although fires are considered to be anticipated events, their frequency is not expected to be as high as once per year. Assuming that the frequency is once per year, an 8 hour wait for re-compliance is adding a scenario risk that is three orders of magnitude lower in frequency than the analyzed scenario. The 6 day wait is a little less than a two order of magnitude lower frequency. Locating LLW crates in areas not covered by sprinklers for 8 hours would yield an unlikely scenario for combustion of the entire inventory. This is the same scenario that is analyzed in the safety analysis as Case B, only the sprinkler system failure is not needed due to the location of the crates in an unprotected location. Locating LLW crates inside a building is covered by AOL 8 requirements which are more stringent. Locating crates too close to a building exterior wall for 8 hours adds little risk due to the building structure DESIGN FEATURE and the Automatic Sprinkler System LCO which will reduce the likelihood of the fire propagating into the facility. Excess LLW crate inventory for 6 days has a limited increase in risk due to the fissile material content of LLW crates.

AOL 6 Waste containers received at and stored in the BUILDING 991 FACILITY shall be compliant with all requirements specified in the Criticality Safety Evaluation justifying that criticality accidents are incredible. All waste containers received at the BUILDING 991 FACILITY docks shall be inspected for compliance with this requirement. Upon failure to meet this requirement at the BUILDING 991 FACILITY docks, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Segregate the non-compliant waste container within one (1) hour if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.**

- **Remove the non-compliant waste container from the BUILDING 991 FACILITY by the end of the day shift of the next regular work day if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.**

Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Segregate the non-compliant waste container within eight (8) hours if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.**

- **Remove the non-compliant waste container from the BUILDING 991 FACILITY by the end of the day shift of the third regular work day if the movement is permitted by Criticality Safety, or within the requirements of**

the Criticality Safety Program if the movement is restricted by Criticality Safety.

AOL 6 BASIS

Criticality accident scenarios are not addressed in the FSAR safety analysis due to a determination that criticalities are incredible as long as specified controls are in place. This AOL elevates the requirements specified in the Criticality Safety Evaluation (CSE) that make criticality scenarios incredible to TSR and AOL requirements. Non-compliance with the CSE requirements significantly impacts the assumptions made in the safety analysis for excluding criticality accidents from consideration.

In order to restrict waste containers that do not comply with IDC restrictions from the BUILDING 991 FACILITY, the SR to inspect every container brought into the facility for compliance with the requirement is specified. In addition, a general surveillance is specified to cover identification of non-compliant waste containers during facility operations and tours.

If a waste container that is not compliant with the CSE requirements is brought to a BUILDING 991 FACILITY dock, the waste container is to be segregated within one hour to prevent interaction of the non-compliant container with other waste containers. Movement of the waste container for segregation is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, segregation of the container is subject to the requirements of that program. Otherwise, one hour is sufficient time to perform the segregation given that the non-compliant container will be identified during truck unloading and personnel to perform the segregation are available during the unload activity. The removal of the waste container from the BUILDING 991 FACILITY is required to re-establish the assumptions of the safety analysis. Again, movement of the waste container for removal is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, removal of the container is subject to the requirements of that program. Otherwise, a minimum of 8 hours (received at end of night shift) and a maximum of 4 days (received at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least one day shift) to arrange shipment of the waste container back to the originating facility. A day shift of a working day is needed to assure that facility management can communicate with the waste container originating facility.

If a waste container that is not compliant with the CSE requirements is found in the BUILDING 991 FACILITY during facility operations or tours, the waste container is to be segregated within eight hours to prevent interaction of the non-compliant container with other waste containers. Movement of the waste container for segregation is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, segregation of the container is subject to the requirements of that program. Otherwise, eight hours provides sufficient time for facility management to recruit the personnel to perform the segregation. The removal of the waste container from the BUILDING 991 FACILITY is required to re-establish the assumptions of the safety analysis. Movement of the waste container for removal is not exempted from any requirements that may be placed on the container by Criticality Safety. If the container is infracted under the Criticality Safety Program, removal of the container is subject to the requirements of that program. Otherwise, a minimum of 80 hours (identified at end of night shift) and a maximum of 6 days (identified at end of a day shift before a three day weekend) is provided for removal of the waste container to allow facility management time (at least three day shifts) to arrange shipment of the waste container to another facility, which is not necessarily the container originating facility. Three day shifts are needed to assure that facility management can identify, communicate with, and coordinate shipment with a receiving facility.

If the container is permitted to be segregated from other containers, there is a very limited possibility for it to serve as a moderator or reflector for the other containers. The criticality concern is primarily associated with large storage arrays involving multiple non-compliant containers, both in fissile material loading and moderation/reflection potential. Segregation greatly reduces any criticality concern. If waste containers with excess fissile material loading are included in the storage array, AOL 4 will be invoked and Criticality Safety will become involved. The risk impact of having the container remain at the facility, segregated from other containers, for a period of 4 to 6 days is minimal due to the container not being located in a large storage array following segregation. The Criticality Safety Program is credited for handling any criticality issues related to high moderation/reflection potential containers and their movement.

AOL 7 **The fourth tier of 55-gallon waste drums shall be banded. All stacked drum storage areas shall be surveilled during normal facility tours for verification of compliance with this requirement. Upon identification of a failure to meet this requirement during operations or facility tours in the BUILDING 991 FACILITY, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:**

- **Remove non-banded drums from the fourth tier or band the non-compliant drums within eight (8) hours.**

AOL 7 BASIS

Postulated accident scenarios dealing with spills, both internally and externally initiated, credit the capabilities of the waste containers to withstand drops. Specifically, postulated spill scenario assumptions dealing with the waste drums credit the banding of drums on pallets dropped from the fourth tier in determining that a fork lift tine breach scenario bounds a pallet drop scenario. Earthquake scenario 991 NPH 1 credits the banding of drums on the fourth tier in the scenario MAR determination.

In order to verify that fourth tier waste containers are banded in the BUILDING 991 FACILITY, the SR to inspect, during normal facility tours, fourth tier stacks in the facility for compliance with the requirement is specified. If a fourth tier pallet of waste drums is found to be unbanded in the BUILDING 991 FACILITY, the waste drums on the pallet are to be removed from the pallet. This re-establishes the assumptions of the safety analysis. Eight hours provides sufficient time for facility management to recruit the personnel to perform the unbanded drum removal.

The removal of the unbanded waste drums from the fourth tier may introduce risk from a spill due to droppage. This risk is independent of the time the facility is at risk due to a delay in removal. There is a tradeoff associated with moving the containers (which must be done eventually, regardless) versus leaving the containers in a non-compliant configuration and being outside the safety analysis. The risk from container movement probably dominates the tradeoff but is a risk that would also be realized when the containers are removed from the facility for final disposition. Therefore, the overall risk associated with leaving the containers in the non-compliant configuration is higher than not having the containers compliant.

AOL 8 Fuel and combustible loading in the BUILDING 991 FACILITY in the following manner:

1. **Wooden pallets shall not be used for waste container storage;**

2. **Flammable/combustible liquids shall not be stored outside of a NFPA-approved cabinet or container;**

3. **Bulk flammable/combustible liquids shall not be located in the same room or area with stored waste containers without adequate diking to contain the liquids at least 1.5 meters (5 feet) from the waste containers;**

4. **Significant quantities of plastics subject to melting that are located in the same room or area with stored waste containers shall be properly containerized or diked to assure that pooling following a fire remains at least 1.5 meters (5 feet) from the waste containers;**

5. **Transient/stored combustible materials in the same room or area with stored waste containers shall be separated from the waste containers by at least 1.5 meters (5 feet);**

6. **No fossil-fueled vehicles shall be used in waste container storage rooms or areas;**

7. **No flammable gas cylinders or containers shall be located in the BUILDING 991 FACILITY;**

8. **Wooden waste crates inside buildings in the BUILDING 991 FACILITY shall be limited to a single wooden waste crate; and**

9. **Combustible loading in all areas of the BUILDING 991 FACILITY shall be maintained as low as reasonably achievable.**

Compliance with the above requirements shall be surveilled during normal facility tours. Upon failure to meet the above requirements in the BUILDING 991 FACILITY, the following corresponding REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

1. **Remove the wooden pallet from the waste container storage area within four (4) hours;**

2. **Store the flammable/combustible liquid in an approved container within four (4) hours OR remove the flammable/combustible liquid from the BUILDING 991 FACILITY within four (4) hours;**

3. **Remove the bulk flammable/combustible liquid from the waste container storage area within twenty-four (24) hours OR come into compliance within twenty-four (24) hours;**

4. **Remove the plastic from the waste container storage area within twenty-four (24) hours OR come into compliance within twenty-four (24) hours;**

5. **Remove the transient/stored combustible materials from the waste container storage area within four (4) hours OR come into compliance within four (4) hours;**

6. **Remove the fossil-fueled vehicle from the waste container storage area within one (1) hour;**

7. **Remove the flammable gas cylinder or container from the BUILDING 991 FACILITY within one (1) hour;**

8. **Remove any additional wooden waste crates from within the BUILDING 991 FACILITY within twenty-four (24) hours; and**

9. **Remove excessive combustible materials from the BUILDING 991 FACILITY as soon as reasonably achievable.**

AOL 8 BASIS

A major premise of the safety analysis is that only small fires will occur in the waste container storage areas and that only small fires will occur in the entire BUILDING 991 FACILITY as long as the Automatic Sprinkler System functions. In order to support this premise, the facility must implement a stringent combustible material control program. This is necessary in the waste container storage areas, particularly those storage areas that are not covered by the Automatic Sprinkler System. The only combustibles, other than waste container contents, that are assumed to be located in waste container storage areas are drum-protecting plywood sheets between drum tops and metal pallets in stacked drum configurations, crate-protecting plastic covers between stacked metal crates, and limited transient combustible materials. In addition, the earthquake scenario 991 NPH 1 assumes that a fire does not occur following the earthquake due to a stringent combustible material control program.

In order to verify that combustible materials are controlled in the BUILDING 991 FACILITY, the SR to inspect, during normal facility tours, the facility for compliance with the requirement is specified.

To support limited combustibles in the waste container storage areas, wooden pallets are not permitted to be used in storage configurations. This is an assumption in the Fire Hazards Analysis (FHA) for the Building 991 Complex. If a wooden pallet is found to be used in a waste container storage area of the BUILDING 991 FACILITY, the wooden pallet is to be removed to re-establish the assumptions of the safety analysis. Four hours provides sufficient time for facility management to recruit the personnel to perform the wooden pallet removal.

To support limited combustibles in the BUILDING 991 FACILITY and to prevent fire propagation due to flammable/combustible liquids, flammable/combustible liquids are not permitted to be stored in the facility except in NFPA-approved storage cabinets or containers. This is a recommendation of the FHA for preventing undue fire exposure of waste containers. If flammable/combustible liquids are found to be stored outside of approved containers in the BUILDING 991 FACILITY, the liquid is to be stored properly or removed from the facility to re-establish the assumptions of the safety analysis. Four hours provides sufficient time for facility management to recruit the personnel to perform the flammable/combustible liquid relocation and to arrange for proper disposition.

To support limited combustibles in the BUILDING 991 FACILITY and to prevent fire propagation due to flammable/combustible liquids, flammable/combustible liquids are not permitted to be stored or used in waste container storage areas without providing adequate diking to contain the liquids at least 5 feet from the waste containers following a spill. This is a recommendation of the FHA for preventing undue fire exposure of waste containers. If flammable/combustible liquids are found to be used or stored in waste container storage areas without proper diking, the liquid is to be properly diked or removed from the waste container storage area to re-establish the assumptions of the safety analysis. Twenty-four hours provides sufficient time for facility management to recruit the personnel to remove the flammable/combustible liquid from the storage area and to arrange for proper disposition. It is not expected that a dike could be constructed in the twenty-four hour period.

To support limited combustibles in the BUILDING 991 FACILITY and to prevent fire propagation due to melting plastics forming pools, significant quantities of plastic that are susceptible to melting are not permitted to be located in waste container storage areas without providing adequate containerization of diking to contain the melted plastic pool resulting from a fire at least 5 feet from the waste containers. This is a recommendation of the FHA for preventing undue fire exposure of waste containers. If flammable/ combustible liquids are found to be used or stored in waste container storage areas without proper diking, the liquid is to be properly diked or removed from the waste container storage area to re-establish the assumptions of the safety analysis. Twenty-four hours provides sufficient time for facility management to recruit the personnel to remove the flammable/combustible liquid from the storage area and to arrange for proper disposition. It is not expected that a dike could be constructed in the twenty-four hour period.

To support limited combustible material impact on waste containers in the waste container storage areas, transient/stored combustible materials are not permitted to be located within 5 feet of waste containers. Transient or stored combustible materials do not include the plywood sheets used to protect drum lids in stacking configurations, the plastic covers used to protect metal waste crates in stacking configurations, or fixed combustible loads associated with the facility. This is a recommendation of the FHA for preventing undue fire exposure of waste containers. If transient/stored combustible materials are found within 5 feet of stored waste containers, the combustible material is to be moved at least 5 feet away from stored waste containers or removed from the facility to re-establish the assumptions of the safety analysis. Four hours provides sufficient time for facility management to recruit the personnel to perform the combustible material relocation and to arrange for proper disposition.

To support limited combustibles in the waste container storage areas, fossil-fueled vehicles are not permitted to be used in waste container storage areas. This is an assumption in the FHA that all forklifts in the facility are electric. If a fossil-fueled vehicle is found to be in a waste container storage area, the vehicle is to be removed to re-establish the assumptions of the safety analysis. One hour provides sufficient time for facility management to recruit the personnel to perform the vehicle removal.

To support limited combustibles in the BUILDING 991 FACILITY, flammable gas cylinders or containers are not permitted to be stored in the facility but may be stored outside of the facility. This is a recommendation in the FHA to remove all unnecessary explosion/flammable gas hazards. If a flammable gas container is found to be stored in the BUILDING 991 FACILITY, the gas container is to be removed to re-establish the assumptions of the safety analysis. One hour provides sufficient time for facility management to recruit the personnel to perform the flammable gas container removal.

To support limited combustibles in the BUILDING 991 FACILITY and to prevent fire propagation due to wooden waste crates, no more than a single wooden waste crate is permitted to be stored or used inside a building in the BUILDING 991 FACILITY. This is an assumption of the safety analysis for preventing undue fire exposure of waste containers to large combustible loads. If more than one wooden waste crate is found to be used or stored inside a facility, the additional crate is to be removed from within the facility to re-establish the assumptions of the safety analysis. Twenty-four hours provides sufficient time for facility management to recruit the personnel to remove the additional wooden waste crate from within a building in the BUILDING 991 FACILITY and to arrange for proper disposition. The single allowed wooden waste crate must be used consistent with Item #5 of AOL 8.

To support limited combustibles in the BUILDING 991 FACILITY and to prevent fire propagation due to excessive combustible materials, combustible materials in the BUILDING 991 FACILITY must be limited to the extent reasonably achievable. This is a recommendation of the FHA for preventing undue fire exposure of waste containers. There is no specific quantity of combustible materials that are permitted in the facility. The guidance in the FHA should be used to identify high combustible load areas that could be remediated. The intent of this item in AOL 8 is to require the continuation of current practices by the facility dealing with combustible loads in waste container storage areas and cleanup of other rooms or areas with excessive combustible material.

AOL 9 BUILDING 991 FACILITY fire phones, fire extinguishers, tunnel/vault smoke detectors, and local fire alarms shall be maintained. The equipment shall be inspected per the recommendations of applicable NFPA standards. Upon failure to meet this requirement at the BUILDING 991 FACILITY, the following REQUIRED ACTIONS must be performed in the specified COMPLETION TIMES:

- **Inform BUILDING 991 FACILITY personnel of any non-functional or non-compliant equipment within eight (8) hours of identification and periodically thereafter until all assigned facility personnel are aware of the situation;**

- **Return the non-functional or non-compliant equipment to functional and compliant status within forty-eight (48) hours <u>OR</u> implement appropriate compensatory measures within forty-eight (48) hours.**

AOL 9 BASIS

Fire watches rely on the availability of the BUILDING 991 FACILITY fire phones to perform Fire Department notification, if needed, as part of the REQUIRED ACTIONS in LCO 3.1. In addition, fire phones are credited in the response to several postulated fire scenarios. Specifically, small internal fire 991 Fire 1, large internal fire 991 Fire 2, dock truck fire 991 Fire 3, and LLW crate fire 991 Fire 4 credit the fire phones as a primary control for rapid response to fires to reduce the likelihood of fire propagation and full MAR involvement. Fire extinguishers provide a defense-in-depth safety function in lieu of Fire Department response for fires that occur when the facility has been informed that the Fire Department is not available, as mentioned in LCO 3.1. They also provide a defense-in-depth safety function for initial response to fires in areas of the BUILDING 991 FACILITY that are not covered by the Automatic Sprinkler System. The smoke detector system also provides a defense-in-depth safety function for detection of fires in areas of the BUILDING 991 FACILITY that are not covered by the Automatic Sprinkler System. Local fire alarms are credited in all the fire scenarios to provide immediate worker notification of the fire and support facility evacuation.

These credited and defense-in-depth safety functions provide additional assurance that fires in the BUILDING 991 FACILITY will involve relatively small numbers of waste containers. They also are important for immediate worker safety by providing initial response capability (fire extinguishers) and detection/alarm capability (smoke detectors, fire phones, and local fire alarms). When these functions are not available, facility personnel should be informed so that they are aware of the loss of the function and can identify alternate options for detection/alarm/response. Eight (8) hours are provided for the facility management to inform personnel of the loss or degradation of a function. The 8 hours would allow the announcement to be made at shift turnover. The notification should continue until all personnel on all shifts are aware of the situation. Action should be taken by facility management to remedy the function loss or to identify appropriate compensatory measures until the equipment can be returned to functional and compliant status. The 48 hours allowed for these actions potentially provides facility management sufficient time to inspect/calibrate out-of-compliance equipment, to replace equipment, or to consult with fire protection personnel to define appropriate compensatory measures.

AOL 10 The BUILDING 991 FACILITY filtered exhaust ventilation function shall be maintained. The equipment shall be inspected and maintained per facility procedures. Upon failure to meet this requirement at the BUILDING 991 FACILITY, the following REQUIRED ACTION must be performed in the specified COMPLETION TIME:

- **Return the non-functional or non-compliant equipment to functional and compliant status within forty-eight (48) hours <u>OR</u> implement appropriate compensatory measures within forty-eight (48) hours.**

AOL 10 BASIS

The small internal fire 991 Fire 1, the small spill 991 Spill 1, and the two hydrogen explosions, 991 Explosion 1 and 991 Explosion 2, all identify the building ventilation system and filtration as a defense-in-depth feature for the mitigation of radioactive material releases from the facility as protection for the public and the collocated worker. This defense-in-depth safety function provides additional assurance that accident scenarios within the buildings of the BUILDING 991 FACILITY will have limited collocated worker and public consequences.

The defense-in-depth functions provided by the filtered exhaust ventilation system is keep a negative pressure in the facility and to filter exhaust air. Therefore, those elements of the BUILDING 991 FACILITY that provide these functions are required to be maintained. This would include the fans and the filters in the filter plenums. The filters are not required to be tested but are required to remain in-place with no visible holes. Fans must be sufficiently operational to make the building negative with respect to the building exterior. Temporary variations in building negative due to door openings or exterior winds are not considered to be failures of this functional requirement.

Good management practices dictate that maintenance of the normal electric power system (i.e., substations, transformers, motor control centers, etc.) is necessary to assure that the ventilation system function is available. Additional assurance would be provided through the maintenance of the alternate electric power system (i.e., the diesel generator and corresponding switchgear). Alternate power to support the ventilation function is not included as part of AOL 10 due to the similar consequences associated with accidents evaluated assuming uncredited/untested filtration (leakpath factor of approximately 0.1) and accidents evaluated assuming ambient conditions (leakpath factor of approximately 0.1).

Upon loss of this function, action should be taken by facility management to remedy the function loss or to identify appropriate compensatory measures until the equipment can be returned to functional and compliant status. The 48 hours allowed for these actions potentially provides facility management sufficient time to inspect/calibrate out-of-compliance equipment, to replace equipment, or to consult with ventilation system personnel to define appropriate compensatory measures.

5.2 PROGRAMMATIC ADMINISTRATIVE CONTROLS

PROGRAMMATIC ADMINISTRATIVE CONTROLS (PACs) complement and provide defense-in-depth to LCO systems and AOLs in order to assure safe operations in the BUILDING 991 FACILITY. The PACs included as part of the BUILDING 991 FACILITY TSRs are the safety management program functional/performance objectives most important to safety in this facility. The program attributes specified in the PACs are not to be interpreted as exemptions from any Federal or State regulatory requirements. The attributes represent those elements of the programs which are credited in the performance of the safety analysis and represent a potential safety concern if they are not in place. Credit is taken for plant management's continuance and assessment of Site-wide administrative programs that provide the infrastructure to meet the PAC functional/performance objectives. Table 6 lists the BUILDING 991 FACILITY PACs and their BASES. The following guidelines apply to the specific PACs listed in Table 6.

5.2.1 Use And Application Of PACs

The following PAC guidelines establish the general requirements applicable to the specific PACs listed in Table 6 at all times. A summary table of the guidelines or topics is presented below and is followed by a more detailed discussion of PAC guidelines and their BASES.

Table 4 SUMMARY OF PAC GUIDELINES

GUIDELINE	REMARKS
PACs shall be met at all times.	This guideline defines when PACs must be met. It also defines what PAC compliance means. Refer to the next guideline when PACs cannot be met.
A PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY shall be declared whenever PACs are not being met.	This guideline indicates that any non-compliance with a PAC is considered an PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY. Refer to the next guideline for response to a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY.
Response to a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY.	The SAFETY SIGNIFICANCE of a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY must be determined and appropriate REQUIRED ACTIONS followed based on the SAFETY SIGNIFICANCE determination.
Response to a PAC VIOLATION.	A PAC VIOLATION occurs when a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY has been declared and corresponding REQUIRED ACTIONS were not completed within specified COMPLETION TIMES. PAC VIOLATIONS must be reported and operations must be suspended.
PAC SRs shall be met.	This guideline defines when PAC SRs must be met. Compliance assessments for PACs must be performed annually.

<u>PACs Shall Be Met At All Times</u>

The PACs shall be met at all times. Compliance with PACs is achieved through the following:

1. Facility management demonstrating that an administrative and physical infrastructure exists to implement each PAC.

    <u>AND</u>

2. Facility management demonstrating that the credited features of each PAC has been implemented in the facility.

    <u>AND</u>

3. Facility management demonstrating that appropriate measures have been taken to correct individual failures to meet PACs.

<u>BASIS:</u> This guideline ensures safe operations of the facility. Each of the PACs in Table 6 are credited as providing worker safety for and defense-in-depth protection against the identified hazards documented in Section 4.4 and the postulated accident scenarios evaluated in Sections 4.5 and 4.6. The PACs are also credited with providing the overall BUILDING 991 FACILITY infrastructure to support implementation of the identified LCOs and AOLs.

Compliance with a PAC can be demonstrated, for example, by having: 1) a specific BUILDING 991 FACILITY or Site-wide program that covers the functional or performance objectives specified in the PAC, 2) a set of procedures in the BUILDING 991 FACILITY that are followed and implement the specific program functional or performance objectives, and 3) a set of documentation indicating past individual failures of the BUILDING 991 FACILITY to meet the program functional or performance objectives and identifying any corrective or compensatory measures that have been taken by the BUILDING 991 FACILITY to respond to the failures and prevent their recurrence. Failure to meet the PACs in Table 6 may result in increased risk to the worker, the public, and/or the environment.

<u>A PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY Shall Be Declared Whenever PACs Are Not Being Met.</u>

<u>BASIS:</u> This guideline establishes when PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCIES occur. If the BUILDING 991 FACILITY cannot demonstrate compliance with a PAC, as defined by the three PACs compliance attributes, a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is declared. That is, if the facility cannot demonstrate an adequate administrative and physical infrastructure, <u>OR</u> implementation of the infrastructure, <u>OR</u> appropriate measures have been taken to address previous individual failures, then the PAC is not being met and the facility is deficient for that PAC.

Response To A PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY.

Facility management shall determine the SAFETY SIGNIFICANCE (as indicated in Table 5) of the PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY within twenty-four (24) hours. Table 5 defines the REQUIRED ACTIONS for responding to a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY at each level of SAFETY SIGNIFICANCE.

Table 5 PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY REQUIRED ACTIONS

CONDITION	REQUIRED ACTION
The PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is determined to have a Mission or High significance level per Site Commitments Management and Corrective Actions Process (CMCAP) procedure.	1. Suspend facility activities affected by the deficiency that pose an immediate-risk or high-risk potential within two (2) hours. **AND** 2. Implement identified short-term corrective actions, as required, within eight (8) hours. **AND** 3. Identify and initiate, within seventy-two (72) hours, corrective actions necessary to bring the facility into compliance with the PAC. **AND** 4. Develop, within ten (10) days, a written action plan including cause analysis, compensatory actions, corrective actions and actions to prevent recurrence. Transmit to the DOE-RFFO.
The PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is determined to have a Moderate significance level per Site CMCAP procedure.	1. Identify and initiate, within ten (10) days, corrective actions to bring the facility into compliance with the PAC. **AND** 2. Develop, within twenty (20) days, a written action plan including cause analysis, compensatory actions, corrective action, and actions to prevent recurrence. Transmit to the DOE-RFFO.
The PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is determined to have a Low significance level per Site CMCAP procedure.	1. Identify and initiate, within twenty (20) days, corrective actions to bring the facility into compliance with the PAC. **AND** 2. Develop, within thirty (30) days, a written action plan including cause analysis, compensatory actions, corrective action, and actions to prevent recurrence. Transmit to the DOE-RFFO.

BASIS: This guideline establishes the REQUIRED ACTIONS that shall be implemented upon identification of a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY. This guideline delineates the time limit to make a SAFETY SIGNIFICANCE determination and initiate REQUIRED ACTIONS for correcting identified deficiencies.

Prompt determination of SAFETY SIGNIFICANCE (as soon as possible within 24 hours) assures that the REQUIRED ACTIONS necessary for continued safe operation of the BUILDING 991 FACILITY are identified.

Suspension of facility activities affected by an immediate-risk or high-risk potential PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is necessary to mitigate the risk(s) associated with continued operation of the BUILDING 991 FACILITY under the identified deficiency. If facility activities are suspended, identification and implementation of short-term corrective action(s) helps ensure that the BUILDING 991 FACILITY can continue to operate (as determined by the suspension) within the safety basis as defined by the FSAR safety analyses.

Corrective actions and a written action plan will help prevent recurrence of an identified PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY. COMPLETION TIMES for the REQUIRED ACTIONS are developed using engineering judgment and reflect the SAFETY SIGNIFICANCE of the deficiency by allowing longer COMPLETION TIMES for similar REQUIRED ACTIONS for PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCIES of lower SAFETY SIGNIFICANCE. The intent behind identifying and initiating corrective actions prior to the development of the action plan is to begin correction of the deficiency as soon as appropriate corrective actions are identified rather than waiting for the completion of the action plan.

Response To A PAC VIOLATION.

If a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY has been declared and the corresponding REQUIRED ACTIONS defined in the previous PAC guideline are not completed within specified COMPLETION TIMES, a PAC VIOLATION has occurred and the following REQUIRED ACTIONS shall be performed:

1. SUSPEND OPERATIONS in the AFFECTED AREA within two (2) hours, **AND**

2. declare a PAC VIOLATION, **AND**

3. notify the DOE-RFFO in accordance with contractor occurrence reporting procedures, **AND**

4. develop a restart plan for DOE-RFFO approval that defines corrective measures to address the PAC VIOLATION and identifies actions to prevent recurrence.

BASIS This guideline establishes the REQUIRED ACTIONS to be taken up declaration of a PAC VIOLATION. If a PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY is identified and the REQUIRED ACTIONS are not taken within the specified COMPLETION TIMES, it is assumed that a major failure in AC implementation has occurred. The safe operation of the facility is no longer assured under these conditions. Therefore, a REQUIRED ACTION to SUSPEND OPERATIONS is identified to place the facility is as safe a configuration as possible.

The REQUIRED ACTIONS defined in this guideline and the declaration of a PAC VIOLATION does not relax the REQUIRED ACTIONS associated with the initial PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY. Any initial short-term corrective actions, other corrective actions, and the action plan addressing the deficiency are all still required.

PAC SRs Shall Be Met

Compliance assessments for PACs shall be performed annually (not to exceed 450 days between assessments).

BASIS: This guideline establishes that the specified SR for PACs shall be met. The SR for PACs is to perform an annual compliance assessment of the facility in meeting the PAC functional or performance objectives. The compliance assessment should investigate each PAC objective and determine if the facility is meeting the objective using the three previously defined compliance attributes. This assures that the PACs are in place and that the facility operations can be performed safely.

5.2.2 PACs For The BUILDING 991 FACILITY

The following PACs, listed in Table 6, establish the safety management program functional or performance objectives that are most important to safety in the facility. The safety analysis was performed under the assumption that the PAC objectives were implemented in the facility. In particular, protection of the immediate worker relies on the implementation of many of the PACs.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 1. Organization and Management	
BUILDING 991 FACILITY Organization and Management shall provide the infrastructure needed to implement and maintain the TSR controls—LCOs, SRs, AOLs, and PACs—so that the BUILDING 991 FACILITY will be operated within its authorization basis. Organization and Management shall include:	Organizational structure and facility management are necessary to ensure that the controls identified in the TSRs are fully implemented and maintained. Specification of controls without an infrastructure to assure implementation and maintenance of the controls is of limited value.
1. A process to implement and maintain the TSR control set including LCOs, SRs, AOLs, and PACs.	1. Facility management is responsible for providing an infrastructure to support the implementation and maintenance of the TSR control set. This includes processes to meet LCO requirements, SRs, AOL requirements, and PAC requirements.
2. A process to develop TSR required determinations in support of REQUIRED ACTIONS.	2. Facility management is required to make various determinations as part of REQUIRED ACTIONS in the TSRs. These include determinations of: AFFECTED AREA, CONDITION entry, OPERABILITY, OUT-OF-SERVICE status, PROGRAMMATIC ADMINISTRATIVE CONTROL DEFICIENCY SAFETY SIGNIFICANCE, activities that must continue under SUSPEND OPERATION CONDITIONS, SR inspection or test risk, and corrective measures/ root causes for VIOLATIONS.
3. A process to define line management responsibility for assignments and work-initiating REQUIRED ACTIONS.	3. Facility management is required to make personnel assignments and perform work as part of various REQUIRED ACTIONS. Line responsibilities for various REQUIRED ACTIONS should be defined to support compliance with REQUIRED ACTION COMPLETION TIMES. Line responsibility definitions include: Fire watch assignments, waste container segregation, combustible material removal, sprinkler operation termination in lieu of Fire Department action, and arrangement of non-compliant material shipment to other facilities.
4. A process to perform, assess, and track surveillances or actions required as part of the TSRs.	4. Facility management is responsible for compliance with the TSRs which define various surveillances and REQUIRED ACTIONS. COMPLETION TIMES and SR frequencies must be tracked, SR results must be documented, programmatic assessments must be performed, and instrumentation used to meet SRs must be calibrated as part of compliance demonstration.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 1. Organization and Management (continued)	
5. A process to notify the DOE-RFFO of VIOLATIONS and planned OUT-OF-TOLERANCES and to deliver restart plans or root cause reports to the DOE-RFFO.	5. Following TSR VIOLATIONS and prior to planned OUT-OF-TOLERANCES, facility management is responsible for notification to the DOE-RFFO. Facility management is also responsible for delivery of various reports dealing with program deficiencies or TSR VIOLATIONS. Infrastructure to support the notification and report delivery processes must be in place to meet required COMPLETION TIMES for the actions.
6. A process to demonstrate compliance with PACs.	6. Facility management must have sufficient infrastructure in place to demonstrate PAC infrastructure, PAC implementation, and programmatic deficiency corrections. Without this infrastructure, PAC compliance cannot be demonstrated for the facility.
7. A process to assure adequate staffing during the performance of SNM and waste handling activities and during storage/facility maintenance operations and during non-working hours.	7. Radiological Control Technician (RCT) support as required by Radiological Work Permit whenever BUILDING 991 FACILITY SNM or waste handling activities occur or whenever storage/facility maintenance operations requiring a RCT are performed. Facility Manager or designee shall be on duty whenever SNM or waste handling activities occur or whenever storage/facility maintenance operations are performed. Facility Manager or designee shall be on call during non-working hours. Criticality Safety personnel shall be on call at all times for response to and assessment of incidents or discovered conditions involving fissile material.
PAC 2. Configuration Management	
A program shall be in place to ensure that SAFETY-CLASS SSCs (including DESIGN FEATURES) are subject to configuration change control. Configuration Management shall include:	The safety analysis of the FSAR makes assumptions about the configuration and operation of SAFETY-CLASS SSCs. The configuration of this equipment must be maintained to ensure that FSAR assumptions are valid.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 2. Configuration Management (continued)	
1. A process for safety and technical review and validation of design modification work on or potentially impacting SAFETY-CLASS SSCs before approval and implementation of the design.	1. The safety and technical review process for design modifications on or potentially impacting SAFETY-CLASS SSCs ensures that the SAFETY-CLASS SSCs will continue to perform their credited and/or intended functions after modification of equipment in the BUILDING 991 FACILITY. This maintains the facility safety basis even though SAFETY-CLASS SSC-impacting modifications are planned.
2. A process to change operating procedures and personnel training affected by modifications to SAFETY-CLASS SSCs.	2. Modifications to SAFETY-CLASS SSCs may result in changes to system operation and/or maintenance. If so, procedures must be changed and personnel must be retrained to ensure that SAFETY-CLASS SSC operation and/or maintenance is performed appropriately and in a manner that does not affect the SAFETY-CLASS SSC credited / intended function. This maintains the facility safety basis following an accepted change to a SAFETY-CLASS SSC.
3. A process for documenting changes to any existing technical baselines (*e.g.*, drawings, FSAR) following any changes to SAFETY-CLASS SSCs.	3. In order to track modifications of SAFETY-CLASS SSCs and maintain an understanding of the facility configuration, changes must be documented. This allows the appropriate determination of the impact of any future modifications of a SAFETY-CLASS SSC.
4. A process for control of changes/revisions to design modification packages.	4. Work being performed on SAFETY-CLASS SSCs or potentially impacting SAFETY-CLASS SSCs must be controlled throughout the modification activity. As changes are made to design modification work packages that directly or indirectly impact SAFETY-CLASS SSCs, it is necessary to control the work package changes to ensure that appropriate work is performed. This maintains the facility safety basis as design modification work is being performed in the facility.
PAC 3. Criticality Safety	
A program shall be in place to ensure that criticality safety controls are implemented. Criticality Safety shall include:	Criticality accidents have been determined to be incredible in the BUILDING 991 FACILITY for the analyzed mission as long as an identified set of controls remains in place. This program supports AOL 6 to ensure that the requirements are met and that the determination that criticalities are incredible remains valid.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 3. Criticality Safety (continued)	
1. A process to assure that any operations conducted in the facility have been evaluated to determine the need for criticality safety controls.	1. Operations that are conducted in the facility can potentially impact the assumed mission or the criticality prevention control set. Each operation conducted in the facility must evaluated for its impact on these assumptions and controls. This maintains the safety analysis assumption that a criticality accident is incredible.
2. A process to develop and implement criticality controls, which ensure double contingency.	2. A set of controls has been identified to make criticality accidents in the BUILDING 991 FACILITY incredible. These controls, which ensure double contingency, must be implemented and maintained throughout changes in the facility operations. This maintains the safety analysis assumption that a criticality accident is incredible.
3. A process to monitor compliance status.	3. By monitoring compliance status, any non-compliance trends that could impact the criticality accident assumptions of the safety analysis can be discovered and can be acted on to maintain the safety analysis assumptions.
4. A process to verify compliance with criticality safety controls prior to performing work that could impact or involves fissile material.	4. Verification that criticality prevention controls are in place and being followed prior to performing work that directly or indirectly involves fissile material provides further assurance that criticality accidents are incredible in the BUILDING 991 FACILITY.
5. A process to respond to and assure assessment by criticality safety personnel of unplanned incidents or discovered conditions involving fissile material.	5. Unplanned incidents or discovered conditions involving fissile material may challenge the criticality analysis assumptions and controls for criticality prevention. The determination of the impact that the incident or condition has on the assumptions and controls can only be made criticality safety personnel.
6. A process to assure that container fissile material loading for storage and handling of waste is in accordance with the facility Nuclear Materials Safety Manual.	6. The fissile material content of waste containers is controlled by AOL 4 that maintain the assumptions of the safety analysis and by the Criticality Safety Program which maintains the assumptions of the criticality analysis. The lower limit for fissile material content of waste containers should be used in the facility. Waste container fissile material loading must be known and must be within the limits imposed by the AOLs and criticality safety.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 4. <u>Emergency Response</u>	
A program shall be in place to ensure that a formalized emergency response capability is maintained. Emergency Response shall include:	Emergency response actions mitigate the consequences of accidents that occur in the facility, particularly for immediate workers.
1. An approved facility emergency plan.	1. Assessment of immediate worker consequences for spills, fires, explosions, and other events consistently assumes worker evacuation from the scene. The facility emergency plan identifies worker response to these types of events.
2. Identified and trained emergency response personnel.	2. Authorized personnel using approved instructions to respond to and minimize the spread of radiological/hazardous material resulting from spills, fires, explosions, and other events reduces the consequences associated with releases.
3. A process for personnel egress/evacuation.	3. Facility evacuation in the event of an incident or spill reduces the number of potential receptors to the incident/spill's consequences and is an assumption in the safety analysis dealing with the immediate worker consequence assessment.
4. Capability for communications to emergency personnel.	4. Communication capability allows notification of incident response personnel in a timely manner. Many of the postulated accidents in the safety analysis are of short duration. Without relatively rapid response capability, the impact that emergency personnel have on consequence mitigation is limited.
5. A process for personnel accountability.	5. Accounting for personnel in the facility permits an assessment of the number of individuals who may still remain in the facility following an incident requiring facility evacuation. Based on this information, emergency response personnel can make decisions regarding the necessity and timelines of facility re-entry following the incident. Knowledge that personnel are impacted by the incident is necessary to support emergency response mitigation of immediate worker consequences.
PAC 5. <u>Environmental Protection and Waste Management</u>	
A program shall be in place to ensure that environmental protection and waste management controls are implemented. Environmental protection and waste management shall include:	In many cases, by meeting the requirements for environmental protection imposed by regulatory agencies, protection is provided to the public and workers.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 5. <u>Environmental Protection and Waste Management</u> (continued)	
1. An established process for the routine surveillance, inspection and monitoring of facility compliance with environmental regulations.	1. Environmental protection is provided, in part, by examining waste containers to detect early signs of container failure. By having routine surveillance, inspection, and monitoring activities for compliance with environmental regulations, degradation of waste containers can be identified before environmental releases occur.
2. An established process to maintain a current, documented inventory of waste.	2. A facility waste inventory is important in the performance of annual surveillances required by several AOLs. Verification of waste container IDC and fissile material loading can be performed.
3. A process shall be in place to ensure that the facility operates the Resource Conservation and Recovery Act (RCRA) satellite storage area in accordance with regulations.	3. The BUILDING 991 FACILITY does not currently contain a RCRA storage area but does have a RCRA satellite storage area for the accumulation of nickel-cadmium batteries. Regulations associated with the satellite storage area must be followed to ensure environmental protection.
4. Waste generated in the facility shall be managed in accordance with appropriate regulations.	4. Significant restrictions are placed on waste containers received by the facility under AOL 1, AOL 3, AOL 4 and AOL 6. While the facility is not expected to generate extensive waste, waste containers, waste forms, and container contents for facility generated waste must be compliant with any appropriate regulations to ensure protection of the public, the workers, and the environment.
5. An established process shall be in place for control of Toxic Substances Control Act (TSCA) regulated substances.	5. The BUILDING 991 FACILITY currently is permitted to store TSCA waste (polychlorinated biphenyl (PCB) contaminated waste). Regulations associated with the TSCA waste storage must be followed to ensure environmental protection and to maintain the low consequence level assigned to this waste by the safety analysis.
PAC 6. <u>Fire Protection</u>	
A program shall be in place to ensure that fire protection controls are implemented. Fire Protection shall include:	The safety analysis places great importance on a combustible material control program to ensure that large fires do not occur in waste storage areas and to ensure that fires in other areas can be contained by the Automatic Sprinkler System.
1. A process to define acceptable combustible material area loading and to remediate any areas found to contain excessive combustible material loading.	1. Determination of acceptable combustible material loading in various areas and maintaining the facility in compliance with the determination are key elements of the control combustibles in the facility.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 6. <u>Fire Protection</u> (continued)	
2. Combustible materials are minimized by work control planning and housekeeping.	2. AOL 8 restrictions on combustibles would be incorporated into work planning and minimize the potential for fire initiation and propagation. Prompt removal of transient combustible material and maintenance of an acceptable loading in Rooms 101, 102, and the dock area minimizes fire fuel loading associated with the facility's highest fire consequence areas.
3. Periodic fire prevention inspections and tours.	3. A combustible material control program must accommodate changes occurring in the facility (maintenance, decommissioning, equipment removal, etc.). These changes may require combustible materials as part of the work package. In order to ensure that combustibles are controlled in the facility, given the transient nature of many combustibles, periodic tours are necessary.
4. A process to develop, issue and control hot work permits for the conduct of spark/heat/flame-producing work.	4. An ignition source control program must accommodate changes occurring in the facility (maintenance, decommissioning, equipment removal, etc.). These changes may require ignition sources (spark/heat/flame producing work) as part of the work package. In order to ensure that ignition sources are controlled in the facility, given the transient nature of many ignition sources, work involving spark/heat/flame producing work must be controlled. This control can take the form of a hot work permit process.
5. Use of flammable gas in the facility shall be analyzed on a case-by-case basis.	5. Limiting flammable gas use in the facility minimizes the explosive and energetic fire potential associated with the gas. Flammable gases are restricted from the facility in AOL 8. This restriction is imposed because the FSAR has not analyzed potential accidents involving the gases. In order to use flammable gases in the facility, an analysis of their use must be performed relative to the FSAR safety analysis and TSR control set. Due to the variety of potential uses and areas of use, the analysis should be performed on a case-by-case basis.
PAC 7. <u>Industrial Hygiene and Safety</u>	
A program shall be in place to provide for worker protection from physical, biological and chemical hazards associated with work conducted in the facility. Industrial Hygiene and Safety shall include:	Much of the immediate worker protection from standard industrial accidents is provided by controls developed under the Industrial Hygiene and Safety Program.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 7. <u>Industrial Hygiene and Safety</u> (continued)	
1. A process to identify and assess physical, biological and chemical hazards.	1. In order to develop an appropriate set of controls, the physical, biological, and chemical hazards encountered in the facility must be known. Therefore, a process to identify physical, biological, and chemical hazards to the worker is needed.
2. A process to establish appropriate controls for identified physical, biological and chemical hazards.	2. As physical, biological, and chemical hazards are identified, an appropriate control to protect the worker must be identified. This provides worker safety against physical, biological, and chemical hazards in the BUILDING 991 FACILITY.
3. A process for worker involvement in work planning, including the communication of identified hazards and appropriate protective measures.	3. As a defense-in-depth measure, worker involvement in work planning provides additional assurance that hazards associated with the planned activity are identified. This involvement also makes the worker aware of hazards and corresponding protective measures, further ensuring that the protective measures will be implemented.
PAC 8. <u>Maintenance</u>	
A program shall in place for control of maintenance activities. Maintenance shall include:	The safety analysis of the FSAR makes assumptions about the availability of SAFETY SSCs. This equipment must be maintained to ensure that FSAR assumptions are valid.
1. A process for safety and technical review and approval of maintenance work packages on or potentially impacting SAFETY-CLASS SSCs.	1. The safety and technical review process for maintenance work packages on or potentially impacting SAFETY-CLASS SSCs ensures that the SAFETY-CLASS SSCs will continue to perform their credited and/or intended functions after maintenance of equipment in the BUILDING 991 FACILITY. This maintains the facility safety basis even though SAFETY-CLASS SSC-impacting maintenance work is planned.
2. A process for control of changes/revisions to maintenance work packages.	2. Work being performed on SAFETY-CLASS SSCs or potentially impacting SAFETY-CLASS SSCs must be controlled during the maintenance activity. As changes are made to maintenance work packages that directly or indirectly impact SAFETY-CLASS SSCs, it is necessary to control the work package changes to ensure that appropriate work is performed. This maintains the facility safety basis as maintenance work is performed in the facility.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 8. Maintenance (continued)	
3. Inspection and/or acceptance testing of SAFETY-CLASS SSCs following maintenance work on or potentially impacting the SAFETY-CLASS SSCs.	3. Maintenance and potential restoration activities can be performed incorrectly or inadequately, leading to the failure or degradation of SAFETY-CLASS SSCs. In order to ensure that the SAFETY-CLASS SSC is OPERABLE following maintenance on the equipment, an inspection and/or acceptance test should be performed on the SAFETY-CLASS SSC.
4. A process to assess the need for and to establish preventive maintenance requirements to protect the function(s) provided by SAFETY-CLASS SSCs (includes DESIGN FEATURES).	4. SAFETY-CLASS SSC failure may be unacceptable from a risk standpoint or from facility availability considerations. The choice between allowing SAFETY-CLASS SSCs to degrade over time until failure versus performing preventive maintenance on the equipment should be made by facility management. The choice should not be made without an understanding of the alternatives. The process to assess the need for preventive maintenance provides facility management with the needed information.
5. A process for safety and technical review of maintenance work packages on SAFETY-SIGNIFICANT SSCs.	5. The safety and technical review process for maintenance work packages on or potentially impacting SAFETY-SIGNIFICANT SSCs ensures that the SAFETY-SIGNIFICANT SSCs will continue to perform their credited and/or intended functions after maintenance of equipment in the BUILDING 991 FACILITY. This maintains the facility safety basis even though SAFETY-SIGNIFICANT SSC-impacting maintenance work is planned
6. A process for periodic inspection of SAFETY-SIGNIFICANT SSCs.	6. SAFETY-SIGNIFICANT SSCs do not have the extent of surveillance requirements that are associated with SAFETY-CLASS SSCs. However, the functionality of the SAFETY-SIGNIFICANT SSCs is important for defense-in-depth or worker protection. Surveillances on the SAFETY-SIGNIFICANT SSCs are necessary to verify their functionality and a process for performing the necessary inspections provides added assurance that the SAFETY-SIGNIFICANT SSCs are functioning as intended.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 8. <u>Maintenance</u> (continued)	
7. Inspection and/or acceptance testing of SAFETY-SIGNIFICANT SSCs following maintenance work on or potentially impacting the SAFETY-SIGNIFICANT SSCs.	7. Maintenance and potential restoration activities can be performed incorrectly or inadequately, leading to the failure or degradation of SAFETY-SIGNIFICANT SSCs. In order to ensure that the SAFETY-SIGNIFICANT SSC is functional following maintenance on the equipment, an inspection and/or acceptance test should be performed on the SAFETY-SIGNIFICANT SSC.
PAC 9. <u>Nuclear Safety</u>	
A program shall be in place to provide a formal, documented system for the control of nuclear safety parameters and their bases, identification , and verification. Nuclear Safety shall include:	The identified hazards, assumptions and defined controls included in the FSAR safety analysis must be constantly verified as changes occur in the facility to ensure that the safety analysis remains valid.
1. Activities in the BUILDING 991 FACILITY shall have an approved hazard assessment or shall have been shown to be the same as previously authorized activities before being authorized for performance on the Plan of the Day (POD).	1. Prior to authorizing the performance of an activity, any associated activity hazard must be identified. One method of ensuring that hazards associated with an activity have been identified is to compare the activity with other previously characterized activities. In those cases where no similar activity is found, the new activity must have its own hazard assessment. This process ensures that unknown hazards are not introduced into the facility. Appropriate controls for any new hazards must also be identified in the hazard assessment process.
2. A process for safety and technical review/verification of work instructions, including changes and revisions, and for validation of operations procedures and testing instructions.	2. Providing an established process for safety review of work instructions (e.g., operating procedures, maintenance procedures, test instructions) ensures that the performance of the activity associated with the work instruction does not introduce new hazards into the facility.
3. A process for ensuring a nuclear safety review of all SAFETY SSC maintenance and modification work packages against the authorization basis to make an Unreviewed Safety Question Determination.	3. Providing an established process for safety review of maintenance and modification work packages ensures that the performance of the maintenance or modification work does not introduce new hazards into the facility. This review also ensures that appropriate controls for any identified hazards are required by the work package or the TSRs.
PAC 10. <u>Occurrence Reporting</u>	
A program shall be in place to ensure timely reporting of occurrences which could affect the workers, the public or the environment. Occurrence Reporting shall include:	While occurrence reporting does not directly impact facility safety, it is a requirement of the TSRs in many cases and provides a mechanism for improvement of facility safety.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 10. <u>Occurrence Reporting</u> (continued)	
1. A process for occurrence categorization, notification and investigation.	1. Occurrences related to TSR VIOLATIONS require DOE-RFFO notification and require the preparation of a report dealing with the event. The preparation of the report requires an investigation of the event to be performed. For PAC VIOLATIONS, a event SAFETY SIGNIFICANCE must be determined which categorizes the event into one of three CONDITION levels. Occurrences that do not deal with VIOLATIONS, while not covered by the TSRs, could use the same process for categorization, notification, and investigation.
2. A process for conducting root cause analysis and establishing lessons learned.	2. Occurrences related to TSR VIOLATIONS require the preparation of a report dealing with the event. The report is required to cover root cause of the event, corrective actions that are currently taken to mitigate the event, and corrective actions to be taken to prevent recurrence of the event. The information provided in the report, if acted upon, ensures that departures from the safety basis that are associated with TSR VIOLATIONS are not a frequent occurrence.
3. A process of developing corrective action.	3. Occurrences related to TSR VIOLATIONS require the preparation of a report dealing with the event that covers corrective actions that are currently taken to mitigate the event and corrective actions to be taken to prevent recurrence of the event. A process to determine appropriate corrective actions is needed to ensure that the facility is placed in a safe configuration following the occurrence.
PAC 11. <u>Quality Assurance</u>	
A program shall be in place for control of the BUILDING 991 FACILITY Quality Assurance. Quality Assurance shall include:	Quality Assurance is a fundamental assumption of the safety analysis. The assumptions dealing with the facility configuration and operation require Quality Assurance to be maintained.
1. A process for controlling non-conforming items.	1. Non-conforming items can include non-compliant waste containers or SNM containers. The AOLs specify segregation of non-conforming items in many cases. These items must be controlled until removed from the facility to ensure that they are not re-entered in the inventory or that a new non-compliant CONDITION is not entered.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 11. <u>Quality Assurance</u> (continued)	
2. A process for ensuring corrective actions and issues management.	2. TSR VIOLATIONS as well as other elements of the TSRs require the determination of corrective actions for undesirable facility configurations. In the case of VIOLATIONS, the recurrence of the VIOLATION is to be avoided. A process for implementing corrective actions and tracking other actions related to the event ensures that the facility is placed in a safer configuration and that undesirable facility configurations are not re-entered.
3. A process to establish requirements for procured items and services affecting SAFETY-CLASS SSCs.	3. Due to the importance of SAFETY-CLASS SSCs in protecting the public and collocated workers, the reliability / availability of a SAFETY-CLASS SSC should be high. Procurement of quality items and services related to the SAFETY-CLASS SSC provides high reliability / availability of the SAFETY-CLASS SSC. Determination of acceptance criteria for the items and services is necessary in order that the corresponding high reliability / availability is realized.
4. A process for identification and control of items covered by LCOs (e.g., hardware, procedures, training).	4. Items covered by LCOs are of importance in protecting the public and collocated workers. As such, procedures, procured items or services, maintenance practices, and training associated with the LCO items are at a higher pedigree, relative to other items in the facility. Determination of the scope of LCO items and their subsequent control must be done to ensure that the items included in the higher pedigree set are sufficient (nothing is left out that should be included) and necessary (nothing is included that should be left out).
PAC 12. <u>Radiation Protection</u>	
A program shall be in place to provide for worker protection from radiological hazards associated with work conducted in the facility. Radiation Protection shall include:	Much of the immediate worker protection from radiation exposure is provided by controls developed under the Radiation Protection Program.
1. A process to identify and assess radiological hazards.	1. In order to develop an appropriate set of controls, the radiological hazards encountered in the facility must be known. Therefore, a process to identify radiological hazards to the worker is needed.
2. A process to establish appropriate controls for identified radiological hazards.	2. As hazards are identified, an appropriate control to protect the worker must be identified. This provides worker safety against radiological hazards in the BUILDING 991 FACILITY.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 12. Radiation Protection (continued)	
3. A process for worker involvement in work planning, including the communication of identified radiological hazards and appropriate protective measures.	3. As a defense-in-depth measure, worker involvement in work planning provides additional assurance that radiological hazards associated with the planned activity are identified. This involvement also makes the worker aware of hazards and corresponding protective measures, further ensuring that the protective measures will be implemented.
PAC 13. Records Management and Document Control	
A program shall be in place for ensuring that the BUILDING 991 FACILITY records retention practices are in accordance with the Quality Assurance Plan and records management directive. Records Management and Document Control shall include:	This process ensures the use of appropriate and current documents for operations and maintenance. It also ensures that the records of compliance are available to demonstrate the ongoing protection of the public, the worker, and the environment.
1. A process to identify and control quality records.	1. The facility generates a significant number and type of records during operation. A process for the identification of records that should be controlled and the control of the identified records provides assurance that work is performed as desired (latest revisions of work packages) and that compliance to the TSRs and other regulations has occurred.
PAC 14. Training	
A program shall be in place to ensure that work is performed by trained personnel. Training shall include:	Personnel performing work in the facility have the potential to negatively impact facility safety through errors of omission (not doing something) or commission (doing something not allowed or expected). One means of reducing these types of errors is to train the personnel performing the work.
1. A designation of organizational responsibilities for managing, supervising and implementing training for facility personnel.	1. A process or organization needs to be in place to manage the training of facility personnel to ensure that personnel doing the work are properly trained for the work being performed.
2. Development and maintenance of a summary of personnel qualification and certification requirements (*e.g.,* Training Implementation Matrix) with emphasis on the following elements: Authorization Basis Compliance, Area-Specific Training, Job-Specific Training, and Emergency Response Training.	2. Different work in the facility requires different types of expertise and training. The development and maintenance of the personnel qualifications and certifications needed to perform various tasks ensures that training requirements are defined for each activity in the facility.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 14. <u>Training</u> (continued)	
3. Development and maintenance of a list of qualified individuals.	3. Different work in the facility requires different types of expertise and training. The development and maintenance of a listing of qualified individuals to perform work ensures that work is assigned to personnel that are adequately trained to perform the work.
PAC 15. <u>Transportation</u>	
A program shall be in place for control of facility radioactive and hazardous materials transportation, shipping, and receiving. Transportation shall include:	The BUILDING 991 FACILITY serves as a holding point for waste containers and SNM containers and relies heavily on container strength and integrity driven by on-site or off-site shipping requirements.
1. Visual inspections, that focus on identifying degradation of waste container integrity (*e.g.*, indentations, punctures), performed on all waste containers upon receipt at the dock area and prior to staging for shipment from the dock area.	1. Inspection of waste containers upon receipt and prior to staging for shipment minimizes the likelihood of a spill during loading and unloading as a result of degraded waste containers.
2. A process to identify on-site and off-site shipping requirements and to implement these requirements for waste and SNM containers.	2. The FSAR safety analysis assumptions dealing with container strength and integrity stem from the containers meeting various requirements for safe transport of the containers. These requirements need to be maintained to ensure that the containers located in the facility are consistent with the safety analysis assumptions.
3. Maintenance, inspection, and repair of on-site vehicles used in the transport of waste containers to and from the BUILDING 991 FACILITY.	3. The FSAR safety analysis assumptions dealing the likelihood of truck fires at the docks stem from the transport vehicles being well maintained. These requirements need to be maintained to ensure that the likelihood of vehicle related dock fires are consistent with the safety analysis assumptions.
PAC 16. <u>Work Control</u>	
A program shall be in place to ensure that activities in the building are conducted in a formal and controlled manner. Work Control shall include:	Conducting work in a formal and controlled manner helps to minimize the consequences and occurrence of unauthorized work in the facility.
1. A process to ensure that work is performed using approved work instructions/ procedures.	1. Providing an established process to verify that approved work instructions are used for performing work ensures that the performance of the activity associated with the work instruction does not introduce new hazards into the facility and has adequate controls in place to protect the worker.

Table 6 BUILDING 991 FACILITY PACs

PROGRAMMATIC ADMINISTRATIVE CONTROL	BASIS
PAC 16. <u>Work Control</u> (continued)	
2. Development and maintenance of a facility work planning and approval document, including the designation of approval authority and organizational responsibilities.	2. By having a facility work planning and approval document which designates approval authority for work and organizational responsibilities, control can be exercised over activities conducted in the facility. The approval authority becomes aware of concurrent activities that may be conducted in the facility and can avoid undesirable interactions by the approval process.
3. Conduct of a daily facility work planning and approval meeting.	3. An awareness of all activities to be conducted in the facility at any one time is necessary to avoid activity interactions that may introduce hazards in the facility. By having a facility work planning and approval meeting each day, the likelihood of undesirable activity interactions is reduced. Also, workers are made aware of other hazards in the facility that are not associated with their work which aids in worker protection.
4. A process to conduct Pre-Evolution Briefings.	4. By briefing all participants in an activity before performing the activity, personnel are made aware of the hazards, the controls, the work instructions associated with the activity. This briefing helps to ensure that the work is performed as expected and that appropriate procedures and controls are used in the performance of the work.
5. Formal shift relief and turnover following a change in Building Manager.	5. Off-normal facility configurations and other noteworthy situations must be communicated as management personnel change. AOL 9 specifically requires communication of non-functional fire protection equipment. A formal shift turnover facilitates this communication and helps to ensure that management personnel are aware of facility hazardous conditions.
6. A tracking system to support surveillance of LCOs, AOLs, and PACs	6. SR performance and results are required to be documented and maintained by SR 4.0.4. A process must be in place to comply with this requirement. Also, REQUIRED ACTION COMPLETION TIMES must be tracked to assure compliance with the LCOs, AOLs, and PACs. A tracking system dealing with the TSR surveillances or REQUIRED ACTIONS facilitates compliance with the requirements of the TSRs.

6 DESIGN FEATURES

The purpose of this section is to list passive DESIGN FEATURES important to safety in the BUILDING 991 FACILITY. DESIGN FEATURES are passive features that reduce the frequency and/or mitigate the consequences of uncontrolled releases of radioactive or other hazardous materials from the facility to protect the health and safety of the public or collocated workers. Passive features credited in the accident analyses are discussed in Table 7. Configuration management and maintenance of DESIGN FEATURES important for safety of the immediate worker are addressed in Section 5.2, Programmatic Administrative Controls.

Table 7 BUILDING 991 FACILITY DESIGN FEATURES

DESIGN FEATURE	BASIS
Gross Facility External Structure Integrity	Maintenance of the external facility structure protects the facility contents from fires exterior to the facility (particularly on the west dock exterior canopy area) and lightning strikes.

7. REFERENCES

A-1 *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, NFPA 25, National Fire Protection Association, Quincy, MA, 1995.

A-2 *National Fire Alarm Code,* **NFPA 72**, National Fire Protection Association, Quincy, MA, 1996.

A-3 *Standard for the Installation of Sprinkler Systems,* **NFPA 13**, National Fire Protection Association, Quincy, MA, 1991.

A-4 *Standard for General Storage*, **NFPA 231**, National Fire Protection Association, Quincy, MA, 1995

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CRITICALITY SAFETY EVALUATION

TITLE: Criticality Controls in Building 991

BUILDING: 991

DATE OF EVALUATION: August 7, 1997

	Print Name	Signature	Date
Criticality Safety Engineer:	B.S. Mo	[signature]	8/7/97
Independent Reviewer:	JEFF PAYNTER	[signature]	8/26/97
Criticality Safety Manager Approval:	G.S. Hoovler	[signature]	8/27/97
Operations Concurrence:	CARL TRUMP	[signature]	8/28/97

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1.0 Introduction

The objective of this analysis is to provide the qualitative justification for not installing criticality accident alarm systems within Building 991 based on DOE Order 420.1[1] and the site *Nuclear Criticality Safety Manual*[2]. The analysis provides a qualitative assessment of established criticality controls for storage areas containing solid form transuranic wastes in 55-gallon drums, ATMX crates or TRUPACT-II Standard Waste Boxes (SWBs) in Building 991. As controls for these containerized wastes are identical to those in Buildings 440 and 664, criticality safety evaluation JP-410, which justified no criticality accident alarm systems in those buildings, is used as the basis for this evaluation. However, approved shipping containers of SNM staged for shipment are also present in room 150 of Building 991, thus additional analytical justification is made demonstrating that a criticality outside of this room is equivalent to incredible. Note that current RFETS policy exempts SNM pending shipment, such as in room 150, Building 991, from criticality accident alarm system coverage. Note also that, for purposes of this evaluation, Building 991 includes both the 96 and 98 tunnels, as well as, vaults 96, 97, 98, and 99.

Wastes packaged in 55-gallon drums, ATMX crates and TRUPACT-II SWBs have been evaluated to 3-B69-NSPM-5B-01 for Criticality Safety Operating Limits (CSOLs) and Nuclear Materials Safety Limits (NMSLs) for numerous buildings onsite. This evaluation was conducted in accordance with procedure 3-91000-NSPM-5B-02.

2.0 Assumptions

Assumptions, as applicable, are discussed in Section 5.0.

3.0 Discussion

3.1 Requirements

The documents that provide guidance on the applicability of criticality alarm systems are ANSI/ANS 8.3[6] (ANS/ANSI 1986), DOE Order 420.1[1] and the site *Nuclear Criticality Safety Manual*[2].

ANSI Standard 8.3 Section 4.1.1 states:

> Alarm systems shall be provided wherever it is deemed that they will result in a reduction of total risk. Consideration shall be given to hazards that may result from false alarms.

Section 4.3.3 (e) of DOE Order 420.1 provides the following instructions:

> . . . .In what follows, 10^{-6} per year is used as the measure of credibility, and does not mean that a probabilistic risk assessment (PRA) has to be performed. Reasonable grounds for incredibility may be presented on the basis of commonly accepted engineering judgment. . . . . or the probability of occurrence is determined to be less than 10^{-6} per year (as documented in a DOE-approved SAR or in the supporting analysis in a SAR or in other appropriate documentation), neither a Criticality Alarm System or Criticality Detection System is required.

Section 10.2 of the *Nuclear Criticality Safety Manual* requires criticality accident alarm systems for facilities that contain over 450 grams Pu and:

> the probability of occurrence of criticality is greater than 10^{-6} per year, based on quantitative analysis or engineering judgment.

3.2 Scope

Three types of containers are used to store transuranic waste in Building 991 and adjoining areas. The containers are 55-gallon drums, ATMX crates, and TRUPACT-II SWBs. The activities covered by this evaluation are storage and handling of transuranic wastes without opening the containers. Treatment of wastes is not covered by this evaluation.

Low-level wastes are also stored in Building 991. For the purposes of this evaluation, low-level waste is waste that is verified or known to contain ≤ 100 ηCi/gram transuranics and ≤ 15 grams U-233 + U-235. Low-level wastes do not require NMSLs and "....even an infinite three dimensional array of low-level waste containers poses no credible criticality concerns and will remain subcritical in all possible configurations.[3]" Therefore, low-level waste will not require further evaluation or be subject to the criticality controls specified in this evaluation.

Containers of transuranic waste are received from Protected Area (PA) storage areas. The containers are assayed for fissile materials prior to receipt in Building 991. Mechanically compacted wastes, such as those from the Building 776 supercompactor, are prohibited from storage in Building 991 by the Nuclear Materials Safety Manual (NMSM) for Building 991. This NMSM also prohibits SNM from all areas of Building 991, except for those items staged for shipment in room 150.

4.0 Methodology

The containers used for storing transuranic waste have been evaluated for NMSLs and CSOLs at

Rocky Flats using computer calculations involving the KENO Monte Carlo criticality computer code. This document will draw on previous evaluation results applicable to transuranic waste storage areas in Buildings 440 and 664, which are similar to those in Building 991.

For evaluation of nonhydrogenous and graphite waste, KENO models from previous evaluations (References 7 and 8) were revised for evaluation JP-410. The revised model was evaluated using the SCALE package, version 4.3. This package contains KENO V.a, a multigroup Monte Carlo code used to determine k-effective for systems containing fissile material. Also in the SCALE package are BONAMI-II and NITAWL-II modules, which perform the resonance shielding of nuclides incumbent upon the multigroup approach. Invoking the CSAS25 sequence, as done in these calculations, automatically activates BONAMI-II, NITAWL-II, and KENOV.a. The cross section library used was the 27-group ENDF/B-IV library, and an infinite homogeneous medium was assumed for cross section processing. The calculations were performed on a personal computer located at the Rocky Flats Environmental Technology Site.

The validation of SCALE 4.3 executed on Pentium processor personal computers at RFETS for uranium and plutonium systems has been documented[9]. The validation is attached in Appendix C of JP-410.

The analysis for 55-gallon drums is limited to 200 grams of fissile material, a maximum of 4-high stacking, no mechanical compaction of hydrogenous wastes, no stacking of beryllium IDCs, and a maximum of 200 pounds graphite per drum. TRUPACT-II SWBs are limited to a maximum of 4-high stacking, 320 grams of fissile material, and no mechanical compaction of hydrogenous wastes. Mechanically compacted wastes are identified with unique IDCs at the site.

The ATMX crates are no longer generated at the site. These crates have been replaced by the TRUPACT-II SWB. While the limit for ATMX crates in Building 991 is a maximum of 320 grams, there are no remaining crates with over 139 grams Pu.[5]

Assay uncertainty is addressed in the CSOL/NMSL evaluations referenced in this report. The assay uncertainty is accounted for by adding 10% to the mass limit (220 grams per drum, 360 grams for the SWBs). The justification for the 10% assay uncertainty is as follows:

> Several segmented-gamma scan (SGS) and destructive assay comparison studies of several waste forms indicate SGS assay biases of 10% or less, at the 95% confidence level. Assay biases for low-density waste matrices contained in 208 liter drum packages are 5% or less.[10]

Assay uncertainty associated with Passive/Active Neutron equipment is less than 10% for containers loaded with 200 grams of fissile material.

5.0 Discussion of Contingencies

5.1 Transuranic Waste Storage Areas

There are many administrative controls placed on transuranic waste storage areas in Building 991. The controls are repeated by various organizations in some cases to assure that NMSL/CSOL contingencies are in place. These administrative controls provide barriers to a criticality accident.

Transuranic wastes stored in Building 991 are assayed, inspected, and verified prior to reaching the storage area. These inspections include:

(1) verification, by two persons, that the waste complies with waste generation procedures prior to placement in the waste container - Procedure WO-1100[11] requires that waste packages be verified by two trained waste generators prior to placement in a waste container. The requirement to have the waste verified by two persons (either two generators or a generator and a waste inspector) can be traced back in procedures until at least October 13, 1986 in Revision C of WO-4034[12]. Based on information in the Waste and Environmental Management System (WEMS), 5,133 of the 5,680 55-gallon drums of transuranic waste onsite were generated on or after 10/13/86. This is 90% of the transuranic waste drums onsite. Of the remaining 10% of the inventory, 484 drums do not have the date of generation (fill date) entered in the system. Only 63 of the total inventory (5,680 drums) can be confirmed to be generated prior to 10/13/86. This represents 1% of the inventory. These drums are insignificant to the arrays evaluated in this document.

(2) Shipment verification by the shipping organization and by the receiving organization - Section 5 of the *Safeguards and Accountability Manual*[13] requires that the transferring organization (shipper) and the receiving organization both concur that the NMSLs/CSOLs will not be exceeded during any part of the material transfer. The concurrence signatures are required on the Nuclear Material and Drum Transfer Report or equivalent form which accompanies the shipment.

(3) Fissile material assay - Special Nuclear Material (SNM) assay of containers generated within a Material Access Area (MAA) is required prior to receipt in Building 991 by Operations Order in Building 991.

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(4) Container weighing - containers are weighed when assayed to determine compliance with weight limits (i.e. 200 pound graphite per drum) and to calculate the grams SNM/grams net matrix weight for the waste/residue discard determination. The weighing is controlled by individual assay equipment procedures.

Mass of the fissile material within each drum is the most crucial control. Approximately 17,000 drums of Rocky Flats generated waste have been independently assayed at the INEL Radioactive Waste Management Complex.[14] Of these 17,000 drums, 37 are suspected of containing ≥ 200 grams Pu . Eleven of the 37 drums are suspected to contain ≥ 380 grams Pu.[15] Establishing the amount of fissile material in these 11 drums is difficult with the Passive-Active Neutron (PAN) assay used at RWMC since these drums contain significant amounts of chlorine and fluoride which interfere with the assay.

> It should be noted that the validity of the measured mass values greater than ≈400 grams cannot be determined since it was not possible to obtain calibrations for more than 308 grams of ^{239}Pu (corresponding to 328 grams of WG Pu), or to verify proper system operation at the high (α, n) rates produced by these drums.[15]

While these eleven drums most likely contain over 200 grams, the precise amount of fissile material has not been established. In conclusion, 99.78% of the ~17,000 drums were confirmed to be within the 200 gram limit by independent assay. Of the remaining 0.22% , two thirds of the drums were confirmed to be less than 400 grams. The remaining 0.07% (11 drums) need further evaluation to characterize the contents of the drum. These few drums will not influence the reactivity of an infinite drum array. Based on WEMS information obtained on 4/7/97 for assayed transuranic wastes, 81 of 2,091 (< 4%) 55-gallon drums currently stored at Rocky Flats contain 100 to 200 grams of plutonium.

Based on data from RTR inspections, fissile liquid has never been discovered in the 200 gram waste drums in Building 664. The only liquids discovered in greater than 4-liter quantities by RTR are liquids separating from solidified organic waste or wastewater treatment sludges.[23] Therefore, the existing controls are judged to be adequate to make storage of fissile liquid an unlikely event in Building 991.

The design features credited in this evaluation are the dimensions of the 55-gallon drums, ATMX crates, and TRUPACT-II SWB. The 55-gallon drums must be manufactured in accordance with Rocky Flats Plant Standard SX-200. The TRUPACT-II SWB dimensions must conform with drawing 165-F-001-W, minimum dimensions 69"x52.5"x37". ATMX crates were manufactured in four sizes ranging from 39" x 54" x 68" to 54" x 54" x 84" as shown on drawings D 26383-1 through D 26383-4.

The following table lists the controls credited in Section 5.0 of this evaluation, the implementing document(s), and the criticality safety evaluations that require the controls.

Control	Implementation Documents	Criticality Evaluation
200 grams fissile material per drum	Building 991 NMSLs, Intraplant Shipment NMSLs	BSM-563, MVM-15
320 grams fissile material per ATMX crate	Building 991 NMSLs	BSM-563
320 grams fissile material per SWB	Building 991 NMSLs, Intraplant Shipment NMSLs	BSM-563, BSM-568
no fissile liquid	Building 991 NMSLs	BSM-563
no mechanically compacted hydrogenous waste	Building 991 NMSLs, Intraplant Shipment NMSLs	MVM-015, BSM-563
maximum of 200 pounds graphite per drum	Building 991 NMSLs, Intraplant Shipment NMSLs, and WO-1100	MVM-015, BSM-563
limited number of drums with beryllium IDCs	Building 991 NMSLs, Building 991 Operations Order	BSM-563, BSM-583
two person verification of waste at container loading	WO-1100	MVM-015, BSM-583
fissile material assay before receipt in Building 991	Building 991 Operations Order	BSM-583
weighing of graphite drums	Building 991 Operations Order	BSM-583
shipment verification of NMSL/CSOL compliance by the shipper and receiver	Safeguards and Accountability Manual	BSM-583
maximum four-high stacking	Building 991 NMSLs	BSM-563
transuranic waste containers are not opened within Building 991	Building 991 NMSLs	BSM-563

5.2 SNM Staging

Building 991 NMSLs only allow SNM in room 150. This SNM must be in DOT approved shipping containers intended for off-site shipment. Since these containers are only staged for shipment and not stored, criticality accident alarm system coverage is not required in room 150 per procedure 1-91000-NSM-03.05. This room is secured as a vault and access can only be made in the presence of NMC personnel and security forces. Thus, any scenarios involving intermixing SNM containers with TRU wastes is judged to be incredible.

6.0 Analysis and Results

6.1 55-Gallon Drums

NMSL/CSOL evaluations for Building 776 (Reference 7) and Building 559 (Reference 16) document extensively the subcriticality of 55-gallon drum arrays when each drum is loaded with 200 grams of fissile material.

6.1.1 Non-Hydrogenous Wastes in Drums

As part of Criticality Safety Evaluation JW-235, non-hydrogenous waste in 55-gallon drums is subcritical in an infinite planar array with each drum loaded with 1,275 grams plutonium with water flooding between and surrounding the drums (Walton 1989). The evaluation considered an ash matrix with H/Pu ratios of 0 to 120. Unmoderated material is currently defined as (H+C)/Pu < 3. The evaluation covered both unmoderated material and moderated material up to H/Pu=120. The evaluation considered six different distributions of fissile material throughout the drums. The distributions varied from a homogenous distribution throughout the drum to the fissile material concentrated in a sphere offset in the drum for maximum interaction with adjacent drums. The evaluation used six different models to determine the most reactive distribution of fissile material. The KENO results for all the analyzed arrangements were subcritical. The most reactive normal conditions configuration from JW-235 was modeled as an infinite six-high array in this evaluation with 440 grams. The most reactive configuration was the material distributed in 28 4-liter bottles (H/Pu=50) within each drum without water between drums. The added water (H/Pu=50) and the polyethylene mass per drum (9.4 kg for 28 bottles) make the array a moderated material. The resulting k-effective was 0.82176 +/- 0.002.[7] This demonstrates an infinite x 6-high array of non-hydrogenous waste double batched with the most reactive distribution of fissile material within the drums is subcritical.

Contingency	It is not credible that the following barriers would fail simultaneously:
>440 grams in all drums within the array	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Drum assay.
> 4 high stacking	(1) > 4-high stacking of transuranic waste is not allowed onsite, (2) Ceiling height precludes > 4-high stacking in Building 991.
> H/Pu=3 in all drums	(1) characterization of the moderation by Item Description Code

This type of analysis for transuranic waste storage represents the failure of three barriers in multiple non-hydrogenous waste drums. A criticality accident is not possible for drums containing 200 grams of fissile material in non-hydrogenous transuranic waste even if these contingencies are violated. The 440 gram drums represent over twice the mass control plus 10% assay uncertainty allowance in each drum. Based on the independent assay results from the INEL, 99.78% of the drums meet the 200 gram limit even without the implementation of the shipper/receiver check barrier. Therefore a criticality accident associated with these drums is judged to be not credible.

6.1.2 Hydrogenous Waste in Drums

Hydrogenous wastes are the most reactive loadings for transuranic waste drums. Polyethylene has been shown to be the most reactive moderator of all hydrogenous wastes. Polyethylene sheeting can be hand packaged into a drum up to a density equivalent to only 8% of the theoretical density for polyethylene, based on data gathered for the ATMX rail car SARP.[17] The KENO models referenced in this section were modeled with 39% relative density polyethylene. This density represents over four times the density of hand-packed polyethylene sheeting and was shown to provide optimum moderation in criticality safety evaluation DH-2.[20] A KENO model of an infinite x infinite x 4-high array of drums, each loaded with 220 grams of plutonium with one in four of the drums loaded with 440 grams of plutonium, was shown to be subcritical with a variety of reflector materials. CSOL Evaluation JJ-249.3 cites previous evaluations that show the fissile material is more reactive in a sphere offset within the drums, for maximum interaction of the drums, rather than fissile material distributed throughout the volume of the drums. The evaluation demonstrated this array of drums is still subcritical using the offset sphere model. A sketch of the offset sphere model can be found in Appendix B.

Contingency	It is not credible that the following barriers would fail simultaneously:
25% of the drums loaded to >440 grams within the array	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Drum assay.
an infinite by 4-high array of mechanically compacted hydrogenous waste	(1) supercompacted waste is identified by IDC (2)Shipper and receiver check to determine compliance with the limits (verify IDC) prior to transfer.

Violation of the credited assay barrier would require a factor of two error in the calibration or equipment failure for 25% of the drums within the array. The evaluation indicates 25% of the drums loaded with 440 grams of plutonium is subcritical (a factor of two assay error). A working standard is "counted" by the assay equipment at the beginning of each shift. Also, since the drums are assayed prior to receipt in Building 991, any assay inaccuracies would be discovered before the drums were moved to Building 991 storage areas. The evaluation with 25% of the drums double batched is very conservative for these storage areas.

This type of analysis for transuranic waste storage represents the failure of multiple barriers and both contingencies in multiple hydrogenous waste drums. A criticality accident is not possible for drums containing 200 grams of fissile material in hydrogenous transuranic waste even if these contingencies are violated. The 440 gram drum represent over twice the mass control plus 10% assay uncertainty allowance in 25% of the drums within the array. 99.78% of the drums independently assayed by the INEL meet the 200 gram limit even without the implementation of the shipper/receiver check barrier. The hydrogenous waste drums are subcritical even with the polyethylene density at four times the handpacked density of polyethylene sheeting. Therefore a criticality accident associated with these drums is judged to be not credible.

6.1.3 Graphite Waste in Drums

As part of Criticality Safety Evaluation JH-098, graphite waste in 55-gallon drums loaded with 1,250 grams plutonium is evaluated in planar and two-high arrays with each drum containing 10 to 100 kilograms of waste.[8] Evaluation JH-098 considered a worst case combination of graphite, cellulose, and polyethylene within each drum based on visual examination and weighing of materials contained within the drums. Cellulose (fiberboard) and polyethylene can be present in the graphite drums as packaging materials. The drums modeled with 100 kilograms (220 pounds) of waste were the most reactive. Graphite drums are limited to 200 pounds of waste. The drum geometry and contents from JH-098 was modeled in an infinite four-high array with a nominal 220 grams per drum. Twenty-five percent of the drums were modeled with 440 grams plutonium. The array was modeled with 100 kilograms and 330 kilograms of waste per drum.. The maximum amount of any waste allowed in a drum is 800 lb -75 pounds tare weight = 725 pounds (330 kilograms). In the 330 kilogram model, the drum was filled entirely with graphite. The k-effective for 100 kilograms per drum is 0.82658 ± 0.001 and 0.92041 ± 0.002 for 330 kilograms per drum.[8]

The current limit for graphite waste drums is 200 lb of waste per drum. All of the drums with net weights entered into the WEMS system meet this requirement. There have been > 200 lb net weight graphite drums shipped offsite, based on database records obtained from the INEL. Of the 1300+ drums of graphite waste in the database, 49 drums exceed the 200 pound limit. Based on this information, less than 5% of the drums exceeded the limit. The drum with the largest recorded weight is 210 kilograms[462 pounds] gross (176 kilograms [387 pounds] net weight).

Contingency	It is not credible that the following barriers would fail simultaneously:
25% of the drums loaded to >440 grams within the array	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Drum assay .
> 200 pounds graphite/drum	(1) container weighing with assay (2) Shipper and receiver check to determine compliance with the drum weight limits prior to transfer. (3)Two person verification of drum packaging including graphite weight limits.

Violation of the credited assay barrier would require a factor of two error in the calibration or equipment failure for 25% of the drums within the array. The evaluation indicates 25% of the drums loaded with 440 grams of plutonium is subcritical (a factor of two assay error). A working standard is "counted" by the assay equipment at the beginning of each shift. Also, since the drums are assayed prior to receipt in Building 991, any assay inaccuracies would be discovered before the drums were moved to Building 991 storage areas. The evaluation with 25% of the drums double batched is very conservative for these storage areas.

This type of analysis for transuranic waste storage represents the failure of multiple barriers and both contingencies in multiple graphite waste drums. A criticality accident is not possible for drums containing 200 grams of fissile material in graphite transuranic waste even if these contingencies are violated. The 440 gram drum represent over twice the mass control plus 10% assay uncertainty allowance in 25% of the drums within the array. 100% of the graphite drums independently assayed by the INEL meet the 200 gram limit even without the implementation of the shipper/receiver check barrier. The graphite drums are subcritical even with the 200 pound contingency violated by over a factor of three. Therefore a criticality accident associated with these drums is judged to be not credible.

6.1.4 Fissile Solution in Drums

Fissile solution in drums is not a normal condition in transuranic waste storage areas in Building 991. While liquids have been detected in drums, the liquids are not concentrated fissile solutions e.g. > 7 g/l solutions. The liquids in the drums are water separated from wastewater treatment sludge, residual liquids from emptied containers, condensation, etc. While these liquids can add moderation to the drums (like a solid hydrogenous waste), they do not contain sufficient dispersed fissile material to be a criticality hazard. For a criticality accident to occur within a single drum, the subcritical limits of a 10-liter sphere of solution and 570 grams of plutonium would have to be exceeded.[18] A drum loaded with at least 570 grams represents nearly a triple batching of the mass limit. For a criticality accident to occur in a 55-gallon drum, the generator verification of mass and drum assay would need to occur simultaneously. If these errors were to all occur to the same drum, resulting in an optimum geometry and full reflection with over 570 grams of plutonium, criticality would occur long before the drum reached the storage areas in Building 991.

An infinite 4-high array of 200 gram plutonium fissile solution drums has been shown to be subcritical.[19] The fissile liquid was modeled within 4-liter containers per the approved packaging for liquids inside the PA for drums.

Contingency	It is not credible that the following barriers would fail simultaneously:
25% of the drums loaded to >440 grams within the array	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Drum assay. (4) Liquid waste limits have always been 200 grams per drum at the site.
Fissile liquid	(1) fissile liquid waste is identified by IDC (2) Shipper and receiver check to determine compliance with the limits (verify IDC) prior to transfer.

This type of analysis for transuranic waste storage represents the failure of multiple barriers and both contingencies in multiple waste drums. A criticality accident is not possible for drums containing 200 grams of fissile material in liquid form even if these contingencies are violated. The 440 gram drum represent over twice the mass control plus 10% assay uncertainty allowance in 25% of the drums within the array. 99.78% of the drums independently assayed by the INEL meet the 200 gram limit even without the implementation of the shipper/receiver check barrier. There are no records indicating fissile liquids were shipped to the INEL. This information illustrates the effectiveness of the assay and limit controls before the two person verification of packaging and shipment. Fissile liquids are not accepted for storage in Building 991. Therefore a criticality accident associated with these drums is judged to be not credible.

6.1.5 Beryllium IDCs

There are currently three beryllium IDCs at the site. These are IDC 489 (classified beryllium shapes), 854 (unclassified beryllium), and 870 (beryllium powder). There are no containers of unclassified transuranic beryllium waste IDCs, i.e., 854 and 870, at the site, according to the information in the Waste and Environmental Management System (WEMS). There are 34 drums of IDC 489 stored within the PA due to security requirements, of which 16 drums, as specified in Appendix B, are located in Building 991.

Evaluation JJ-249[16] demonstrated that an infinite two-high array of beryllium drums with 25% overbatched to 440 grams plutonium was subcritical with each drum loaded with up to about 25% Be or 200 pounds. Note that a graph of the results from JJ-249 can be found in Appendix C. Based on the WEMS information, there are not enough drums to assemble an array that approaches infinite, nor does any single drum containing Be in Building 991 exceed 12 grams of fissile material. Thus, a criticality accident associated with these drums is judged to not be credible.

6.2 TRUPACT-II SWBs

The NMSL evaluation for Building 664 evaluated stacked SWBs with 360 grams of fissile material, full density polyethylene, and fissile material at a density of 100 g/ft^3.[20] The calculations from DH-2 were validated in a more recent evaluation for Building 707 in which it was also shown that fissile material density need not be controlled.[21] The extra 40 grams per SWB was intended to cover any assay uncertainty. According to information in WEMS, eleven SWBs have been assayed. The maximum fissile material content in 73 grams. The modeling for the array in this evaluation was very conservative. The SWBs have rounded ends that were converted to squares to maximize the interaction. The fissile material was distributed within polyethylene in a cube. The cube size was dictated by the H/Pu ratio and the fissile material density (100 grams/ft^3). The cubes were placed in the adjacent corners of the boxes as shown in Appendix B. The evaluation considered moderation from full density polyethylene to no interspersed moderation (H/Pu=8879 to 0). The fissile material was placed in full density polyethylene which is not possible with the wastes loaded in SWBs. The boxes were shown to be subcritical in the evaluation with one in eight boxes double batched, the plutonium density doubled to 200 g/ft^3, or one in sixteen boxes flooded with water.

Contingency	Barriers
Box geometry deformed to a square from existing rounded ends	There is no credible scenario that converts the SWBs from rounded ends to square ends.
Mechanically compacted hydrogenous waste	(1) supercompacted waste is identified by IDC (2) Shipper and receiver check to determine compliance with the limits (verify IDC) prior to transfer. (3) Mechanically compacted wastes are not loaded into SWBs at the site.

The SWB evaluation for Building 707[21] presents two credible criticality scenarios for the operations evaluated. The first is the combination of overbatching to 520 g Pu and optimum moderation and reflection. This is not a credible scenario in Building 991 since the SWBs are assayed prior to receipt in Building 991 (not a control in Building 707) and flooding of SWB is not credible when the boxes are closed, like in Building 991. The second scenario requires flooding the inside of multiple crates, which is not credible in Building 991.

This type of analysis for transuranic waste storage illustrates that there are no credible criticality scenarios for 320-gram fissile material SWBs containing transuranic waste.

6.3 ATMX Crates

As presented earlier in this evaluation, ATMX crates are no longer used to package transuranic waste onsite. However, there are several ATMX crates in storage onsite. According to information in WEMS, the maximum fissile content of any remaining ATMX crate is 129 grams. The major differences between the SWBs and ATMX crates, from a criticality analysis standpoint, is the shape and volume. The ATMX crate is square (instead of the rounded end SWBs) and is nearly twice the volume of the SWB. If no further ATMX crates were to be generated, the 55-gallon drum evaluation would bound the crates. This judgment is based on the greater mass limit (200 grams vs. 129 grams) and greater interaction (smaller dimensions for the drum vs. crate). The 320 gram limit for the ATMX crate is bounded by the SWB evaluation.[21,22] The two credible criticality scenarios for Building 707 from this reference are addressed below.

SCENARIO #1

Contingency	It is not credible that the following mass and optimum moderation barriers would fail simultaneously:
Box overbatched to ≥520 grams Pu	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Crate assay
Optimum Moderation and Reflection	(1) Mechanically compacted wastes were never loaded into ATMX crates at the site (2) Shipper and receiver check to determine compliance with the limits (verify IDC) prior to transfer. (3) Crates are not opened in Building 991 (precludes inadvertent flooding).

SCENARIO #2

Contingency	It is not credible that the following mass and optimum moderation barriers would fail simultaneously:
Box contains ≥360 grams Pu in optimum polyethylene moderation and reflection	(1) Two person verification of drum packaging including limits. (2) Shipper and receiver check to determine compliance with the limits prior to transfer. (3) Crate assay
Multiple crates flooded	It is not credible the following barrier be violated at the same time a fire occurs (fire fighting water source): (1) Crates are not opened in Building 991 (precludes inadvertent flooding).

Neither of these scenarios is credible for Building 991 based on the controls in place within these buildings.

6.4 Seismic Events

An infinite 4-high stacked array of TRU waste drums was shown to be subcritical in BSM-563-1 for seismic events involving deformation and flooding. Based on this information, a seismic event does not constitute a credible criticality scenario

7.0 Summary and Conclusions

This evaluation identified no credible criticality accident scenarios associated with current activities of TRU Waste Storage and SNM Staging in Building 991. Thus, a criticality accident alarm system need not be maintained in Building 991 and adjoining areas, including both 96 and 98 tunnels, as well as, vaults 96, 97, 98, and 99, provided that controls cited in section 5.0 are in place.

8.0 References

(1) *Facility Safety*, U.S. Department of Energy Order 420.1, 10-24-96

(2) *Nuclear Criticality Safety Manual*, Revision 0

(3) *Criticality Analysis of Rocky Flats Plant Low Level Waste*, NSTR-0002-93, February 23, 1993

(4) Mo, B.S., Waste Container Storage Criticality Safety Evaluation, BSM-563-1

(5) Telecon between J.K. Paynter and K. Ricks, July 31, 1997

(6) *Criticality Accident Alarm System*, American Nuclear Society, ANSI/ANS-8.3-1986

(7) Walton, J., 55 Gallons Drums, >1000 grams in 776 Basement Storage Area, JMW Data Book #4, JW-235

(8) Hicks, J., Storage and Transfer of 55-Gallon Drums Containing More than 200 Gram Fissile Material Criticality Safety Evaluation. JH-98

(9) Wilkinson, A., Moderated Materials for the 10-Position Cart Criticality Safety Evaluation, ADW-007

(10) *Safety Analysis Report for the TRUPACT-II Shipping Package*, Attachment 3.0 to Appendix 1.3.7, Revision 0, Nuclear Packaging, February 1989.

(11) Procedure WO-1100, *Packaging Wastes within the Protected Area*

(12) *Packaging Wastes for Shipment Offsite (U)*, Revision C, effective date 10/13/86

(13) *Safeguards and Accountability Manual*, September 30, 1996

(14) Personal communication with Greg Becker, Lockheed Martin (INEL)

(15) *Suspect Drum Remeasurement Results*, INEL-95/024, Lockheed Idaho Technologies Company.

(16) Joyce, J., 55 Gallon Drums - 200 Grams Criticality Safety Evaluation. JJ-249.3.

(17) Paynter, J., ATMX Rail Car SARP Evaluation Data Book.

(18) *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*, American Nuclear Society, ANSI/ANS-8.1-1983 R88

(19) Sentieri, P., 55 Gallon Drums, 200 Gram Fissile Solution. PJS Data Book #2, PS-4

(20) Heinrichs, D., TRUPACT II SWB Evaluation. DH Data Book #1, DH-2

(21) Mo, B., TRU Waste Crates and TRUPACT-II Standard Waste Boxes Criticality Safety Evaluation, BSM-568.

APPENDIX A

Comment Review Sheets

FOR INFORMATION ONl

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EVALUATION REVIEW SHEET

- ☐ Technical Review
- ☐ Second Engineer Review
- ☐ Validation
- ☒ Management Review
- ☐ Other

BSM-583 — Evaluation ID Number | ϕ — Rev. | 7/22/97 — Draft

Title: Criticality Controls in Bldg 991

FOR INFORMATION ONLY

☐ No comments

Reference Page	Comment	Disposition	Disposition Accepted Init/Date
General	Use "58-02".	Done	GSH
pg 10	What did the offset sphere model look like?	Sketch added to Appendix B.	
pg 10	How were the 440 gram drums interspersed in the array	see sketch in Appendix B.	
pg 10	Is 39% poly the most reactive configuration?	yes. reference to DH-2 added in sec 6.1.2.	GSH
pg 15	Why 100 gm/ft³?	In previous eval, i.e., DH-2 a fissile mat'l density restriction was imposed on moderated mat'ls in SWBs. This was later found to be conservative + unnecessary in BSM-568. Note of this made in sec 6.2.	GSH
pg 15	Does the last sentence mean one in eight boxes has 200 g/ft³ or all?	only one in eight.	GSH
pg 15	were the cubes juxtaposed for 8, 4, or 2 boxes?	sketch added to Appendix B showing this.	GSH

Reviewer: *(Comments not signed by the reviewer will be considered as unofficial comments)*

Reviewer's Name	Signature	Ext	Bldg / Dept	Date
G.S. Hoovler		2296	CSE	

Resolutions Accepted

Initials	Date

EVALUATION REVIEW SHEET

- ■ Technical Review
- ☐ Second Engineer Review
- ☐ Validation
- ☐ Management Review
- ☐ Other ________

BSM-583 — Evaluation ID Number; 0 — Rev.; ________ Draft

Criticality Controls in Building 991 — Title

☐ No Comments

Reference Page	Comment	Disposition	Disposition Accepted Init./Date
General	See editorial comments marked on the draft copy	Noted	
5	Check on the 129 grams max number. While there are no new ATMX crates being generated, they are still assaying them.	The current max is 139 grams for crate M00822, per Kristin Ricks, WEMS.	[initials] 8/1/97
15	Building 991 contains vaults that could accept classifed waste. Credit a control that keeps the classifed Be out of the drum stack (in addition to the NMSL).	Section 5.0 now requires Building 991 ops order prohibiting storage of Be waste.	[initials] 8/1/97

FOR INFORMATION ONLY

Reviewer: (Comments not signed by the reviewer will be considered as unofficial comments)

Reviewer	Signature	Ext.	Bldg./Dept.	Date
Jeff Paynter	[signature]	8220	T886B/Subcontractor to Crit Engr	7/31/97

Resolutions Accepted

Initials: [initials] Date: 8/1/97

APPENDIX B

Miscellaneous

FOR INFORMATION ONLY

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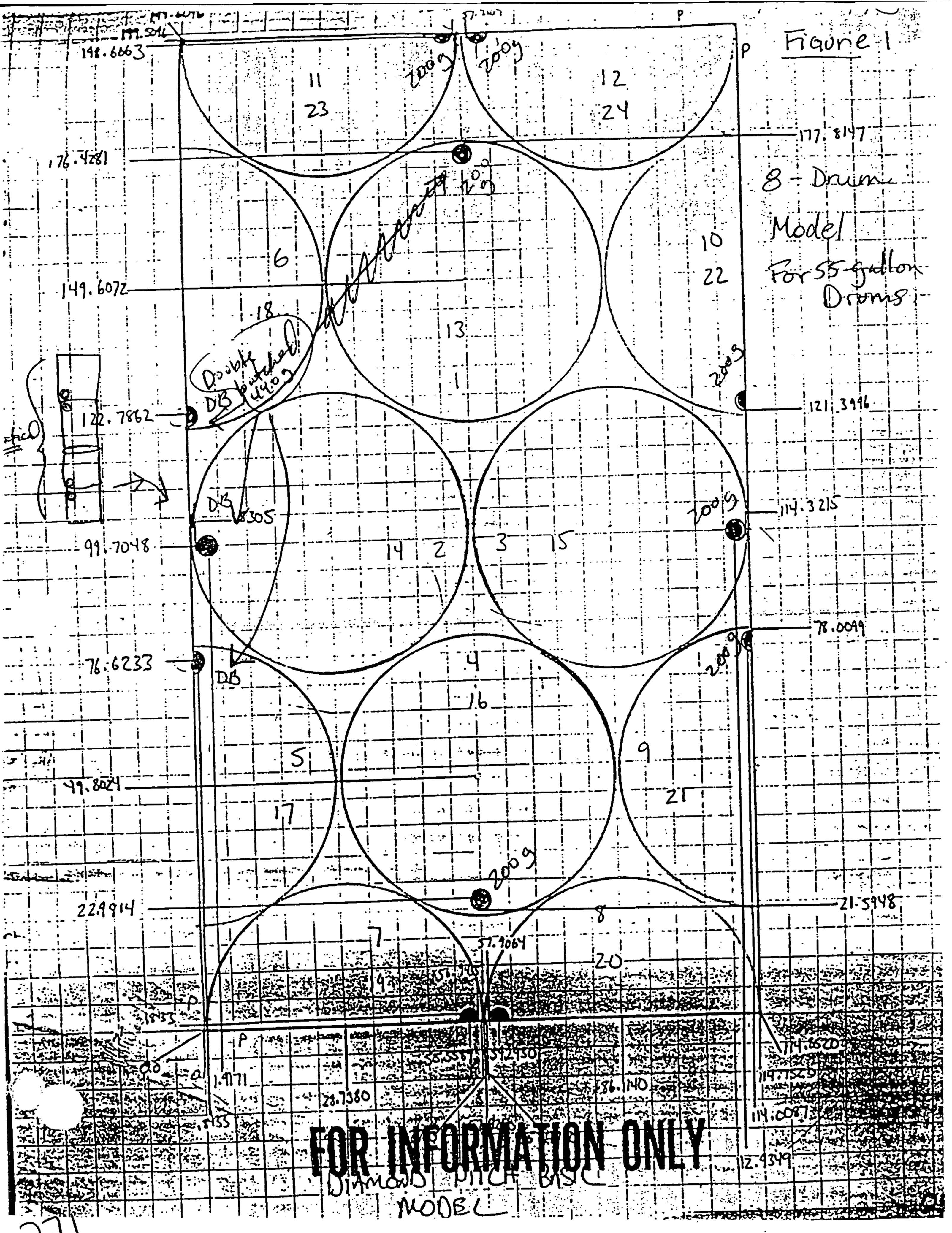
Figure 1
8 - Drum Model For 55-gallon Drums
198.6663
176.4281
177.8147
149.6072
122.7862
121.3996
114.3215
99.7048
78.0049
76.6233
49.8024
22.9814
21.5948
57.9064
Double batched 440 g
DB
305
200 g
11
23
12
24
6
18
13
1
10
22
14
2
3
15
4
16
5
17
9
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114.0087
12.9349
DIAMOND PITCH BASE MODEL

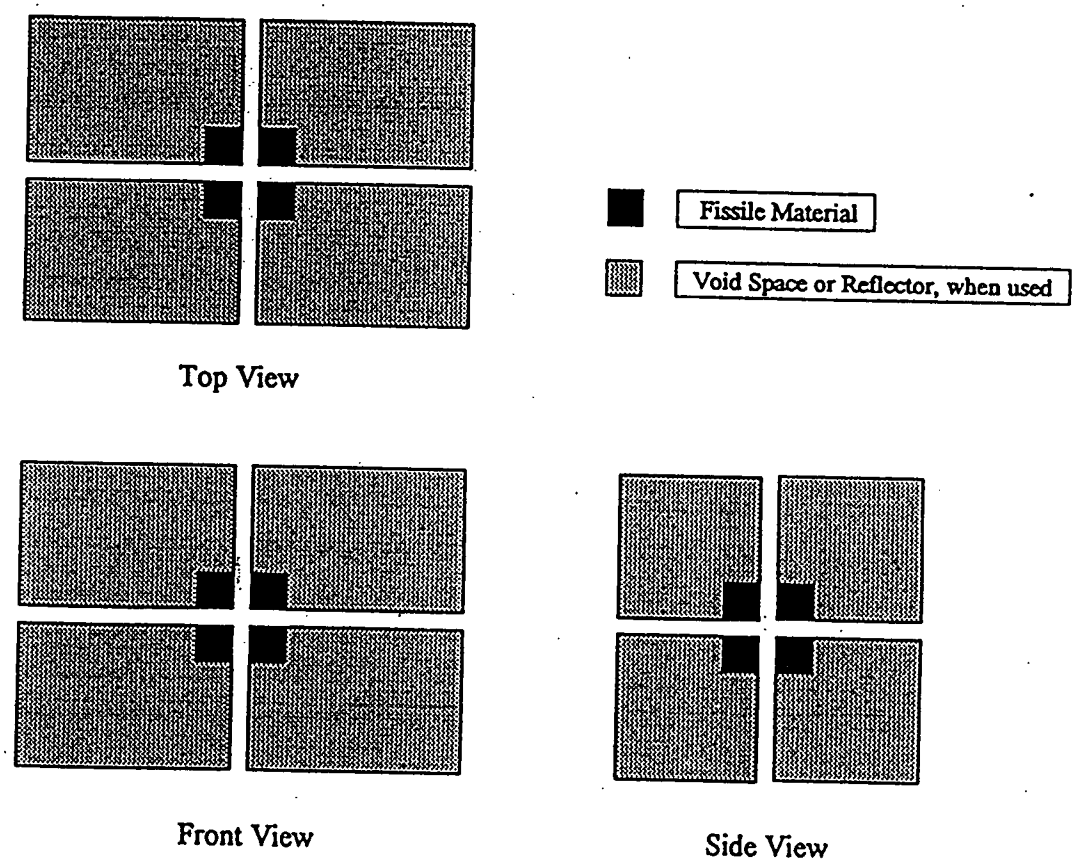

Figure 1 Calculational Model Schematic For TRUPACT II SWBs,
not drawn to scale

DRUM COUNT 16

WEIGHT (IN GRAMS)

Drum WT	SHIP#	DATE REC.	FROM	DRUM	IDC	LOCATION	COMMENTS	Pu	AM 241	AM 241x66	U 235	U 238
198.4	68	7/18/97	777	41991	489	996 VAULT C-1	CLASSIFIED BE SCRAP METAL SHAPES	3.000				
169.8	61	7/7/97	777	44610	489	996 VAULT B ROW 3	CLASSIFIED BE SCRAP METAL SHAPES	6.000				
174.2	68	7/18/97	777	46551	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	1.000				
145.5	68	7/18/97	777	51455	489	996 VAULT C-1	CLASSIFIED BE SCRAP METAL SHAPES	0.000				
220.5	68	7/18/97	777	52957	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	0.000				
187.4	68	7/18/97	777	53149	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	7.000				
156.5	68	7/18/97	777	53209	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	4.000				
205	68	7/18/97	777	53383	489	996 VAULT C-1	CLASSIFIED BE SCRAP METAL SHAPES	1.000				
187.4	68	7/18/97	777	53512	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	10.000				
158.7	68	7/18/97	777	53848	489	996 VAULT C-1	CLASSIFIED BE SCRAP METAL SHAPES	1.000				
198.4	68	7/18/97	777	54174	489	996 VAULT C-3	CLASSIFIED BE SCRAP METAL SHAPES	8.000				
165.3	68	7/18/97	777	55133	489	996 VAULT C-1	CLASSIFIED BE SCRAP METAL SHAPES	1.000	0.000	0.000		
202.4	54	6/18/97	777	56083	489	996 VAULT D ROW 1	CLASSIFIED BE SCRAP METAL SHAPES	0.000				
145.2	54	6/18/97	777	56689	489	996 VAULT D ROW 1	CLASSIFIED BE SCRAP METAL SHAPES	12.000				
184.8	54	6/18/97	777	59345	489	996 VAULT D ROW 1	CLASSIFIED BE SCRAP METAL SHAPES	0.000				
125.4	62	6/25/97	777	64280	489	996 VAULT B ROW 1	CLASSIFIED BE SCRAP METAL SHAPES	0.000				

FOR INFORMATION ON

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APPENDIX C

Graph of JJ-249 Be Results

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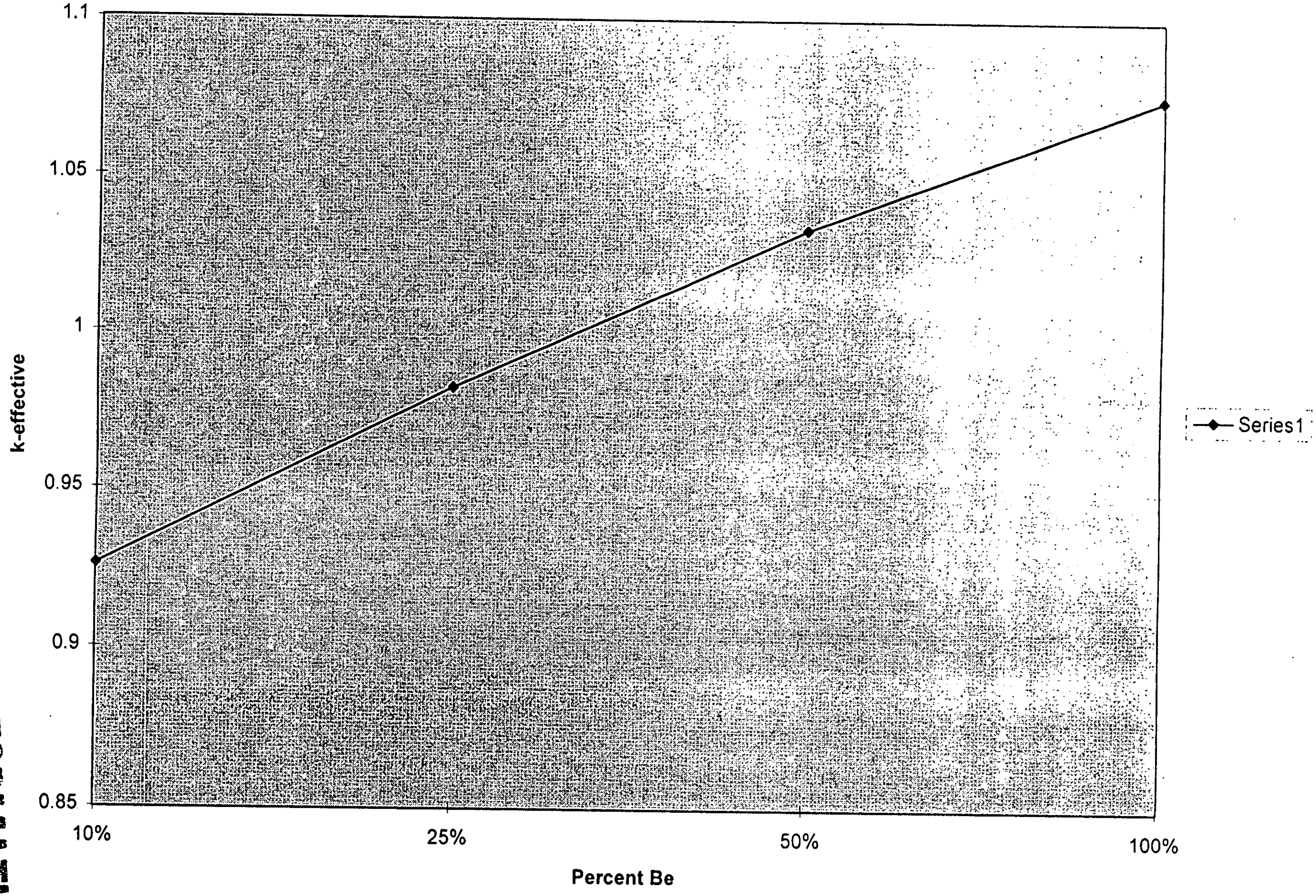
Chart5

Graph of JJ-249 Be Results



ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

FIRE HAZARDS ANALYSIS

BUILDING 991 COMPLEX

FHA-991-003

Revision: 0

Prepared By:

B.T. Rhodes, 8-26-97
Fire Protection Engineer
Date:

M.J. Ferreira, P.E., 8-26-97
Fire Protection Engineer
Date:

Reviewed for Classification/UCNI
By: (UNFPD) Reviewing Official
Date: 8/28/97

INFORMATION ONLY

Concurrence By:

18/28/97
Date:
Fire Protection Technical Reviewer

Joe Galaska 18-28-97
Date:
Manager, Fire Protection

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Reviewed for Classification/UCNI/OUO
By: Janet Nesheim, Derivative Classifier
DOE, EMCBC & UCNI RO
Date: 12-15-08
Confirmed Unclassified, Not UCNI/Not OUO
OK for public release

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CONTENTS

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[redacted]

CONTENTS (Continued)

CONTENTS (Concluded)

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[redacted]

FIGURES

Page

[redacted]

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TABLES

ACRONYMS

BEST	Building Emergency Support Team
CAS	Central Alarm Station
DBE	Design Basis Earthquake
DOE	Department of Energy
DSAR	Draft Safety Analysis Report
FHA	Fire Hazard Analysis
FPE	Fire Protection Engineering
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air Conditioning Systems
kW	kilowatt
LDPE	Low Density Polyethylene
LLW	Low Level Waste
MCFL	Maximum Credible Fire Loss
MPFL	Maximum Possible Fire Loss
NFPA	National Fire Protection Association
OSR	Operational Safety Requirements
PIV	Post Indicating Valve
RFETS	Rocky Flats Environmental Technology Site
SIO	System Input/Output
SNM	Special Nuclear Materials
TSR	Technical Safety Requirements
UBC	Uniform Building Code

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REVISION SUMMARY

This is the initial issue of this Fire Hazards Analysis. This Fire Hazard Analysis supersedes the previous analysis entitled "Fire Hazards Analysis of Building 991," FHA-991-002, Rev. 0, September, 1995.

EXECUTIVE SUMMARY

A Fire Hazard Analysis (FHA) was conducted by Hughes Associates, Inc. for the Building 991 Complex. This FHA is an evaluation of the fire hazards (1) that expose the facilities comprising the Building 991 Complex, or (2) that are inherent in building operations. Included in the analysis are Buildings 991, 984, 985, 989, 992, 996, 997, 998, and 999. The adequacy of the fire safety features in each building was determined, along with the degree of compliance of the facility with the fire protection objectives outlined in paragraph four of DOE Order 5480.7A, *Fire Protection* [DOE, 1993], and related engineering codes and standards. The fire hazards present and potential extent of fire damage were analyzed in relation to DOE specified loss limitations.

With the exception of Building 984, the Building 991 Complex satisfies the fire protection objectives outlined in DOE Order 5480.7A Paragraph Four. In general, the fire hazards in the building were found to be typical of storage, business, and industrial facilities. Bounding fire scenarios were identified and evaluated in order to determine the Maximum Possible Fire Loss for each of the facilities in the Building 991 Complex. Building 984 currently does not comply with DOE loss limitations since it is not sprinklered and the MPFL exceeds $1 million. Recommendations are provided in order to satisfy the DOE requirements.

Building 991 is divided into three fire areas by 2 hour fire resistance rated barriers. Potential fire hazards include ordinary combustibles typical of office and storage facilities. Fire spread throughout given fire areas was postulated. For the Maximum Possible Fire Loss, contamination spread is possible due to venting of the LLW storage drums. However, fire spread into the drum storage areas and fire involvement of the drum contents is not expected. The Maximum Possible Fire Loss for Building 991 was estimated at $30.1 million.

Egress from the tunnels and vaults and from the basement level of Building 991 present a life safety concern in that they exceed the allowable travel distances, dead end corridors, and common paths of travel permitted by NFPA 101. Since installing additional means of egress is not feasible, recommendations have been provided to limit storage in these areas to noncombustible materials only, with the exception of materials contained in sealed steel drums. Doing so allows these areas to be classified as low hazard Storage occupancies. Under these conditions, egress from the tunnels and vaults (with the exception of Building 998) and from the basement level of Building 991 comply with NFPA 101 life safety provisions. Egress from Tunnel and Vault 998 does not comply with NFPA 101 criteria. While recommendations are provided to reduce the hazard in this area, a formal DOE approved Exemption should be obtained to document the code compliance issue.

Minor deficiencies are noted in this FHA pertaining to sprinkler system issues, location of miscellaneous storage, adequacy of fire doors, and location of fire dampers. Recommendations are provided to correct these deficiencies and improve the overall fire protection/life safety features of the Building 991 Complex.

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[redacted]

1.0 INTRODUCTION

This Fire Hazard Analysis (FHA) examines the Building 991 Complex at the Department of Energy's (DOE) Rocky Flats Environmental Technology Site (RFETS). The complex includes Buildings 991, 984, 985, 989, 992, 996, 997, 998, and 999. This FHA was conducted in accordance in accordance with Fire Protection Technical Position No. FPTP-96-002, *Administrative and Technical Guidance for Performance of Fire Hazard Analyses and Fire Protection Assessments of Nuclear and Non Nuclear Facilities* [Rocky Flats Field Office, 1996]. This Technical Position was issued as a supplement to DOE Order 5480.7A, *Fire Protection* [DOE, 1993], and addresses the following objectives as stated in paragraph four of DOE Order 5480.7A:

(1) Minimize the potential for the occurrence of a fire;

(2) Ensure that fire does not cause an on-site or off-site release of radiological and other hazardous material that will threaten the public health and safety or the environment;

(3) Establish requirements that will provide an acceptable degree of safety to DOE and contractor personnel and that there are no undue hazards to the public from fire and its effects in DOE facilities;

(4) Ensure that process control and safety systems are not damaged by fire or related perils;

(5) Ensure that vital DOE programs will not suffer unacceptable delays as a result of fire and its effects; and

(6) Ensure that property damage from fire and related perils does not exceed an acceptable level.

This FHA is an evaluation of the fire hazards (1) that expose the facilities comprising the Building 991 Complex, or (2) that are inherent in building operations. The adequacy of the fire safety features in each building and the degree of compliance of the facility with specific fire safety provisions in DOE orders, and related engineering codes and standards, were determined. The results of the analyses are presented in terms of the fire hazards present, the potential extent of fire damage, and the impact on employee and public safety. In addition, the effectiveness of existing facility fire protection features was considered.

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2.0 METHODOLOGY

The development of the Building 991 Complex FHA included document review, consultation with site personnel, a site walkdown, and review of facility drawings and site plans/documents for all facilities included in the Building 991 Complex. Document review included the previous FHA for the facility [Lendian & Associates, 1995] and open Fire Prevention Bureau inspection items. This review helped identify facility information and previously defined fire hazards and deficiencies. The *Draft Safety Analysis Report Building 991* (DSAR) [EG&G, 1981] was also consulted for information pertaining to building construction, fire protection features, and utilities. The RFETS Fire Protection Engineering (FPE) building files for the facility were reviewed to identify outstanding issues or deficiencies.

Prior to performing a walkthrough of the Building 991 Complex, building personnel and representatives from Nuclear Safety were contacted to communicate the objectives of the FHA and discuss initial concerns pertaining to individual buildings or areas. During these discussions, no areas of special concern were identified. The facility walkthrough was performed on April 10, 1997. Subsequent to the walkthrough, a memo was issued through FPE [Galaska, 1997] to building personnel and Nuclear Safety which summarized the potential fire hazards and initial findings identified during the walkthrough.

2.1 Basis for Analysis

Each of the FHA elements identified in DOE 5480.7A was addressed in this FHA. Requirements in DOE Order 6430.1A, *General Design Criteria* [DOE, 1989], applicable National Fire Protection Association (NFPA) standards, and the Uniform Building Code (UBC) were addressed in the context of individual elements of the FHA. DOE Order 6430.1A criteria apply to only new construction and any major modifications made to the building since the Order's implementation.

Analysis of potential fire scenarios is presented in Section 5 of this FHA. The primary focus of this report is on Building 991. However, the supporting structures are also discussed and recommendations regarding fire safety of these structures are included where warranted.

This FHA utilized a graded approach to the extent that representative worst case fire hazards were assessed and considered to bound all other potential fire hazards. Resulting conclusions and recommendations apply only to the buildings and areas within the scope of this FHA.

The analyses were conducted within the context of Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL) limits specified in DOE Order 5480.7A. The MPFL was estimated by determining the replacement cost of the damaged structure and equipment in addition to cleanup costs associated with contamination spread.

Where necessary, quantitative analysis consisting of computer fire modeling and engineering calculations was performed for specific fire scenario evaluation.

In keeping with sound engineering practice, in the absence of technical information, conservative "worst case" assumptions were made regarding fuel loading, fuel package burning rates, fire spread, and thermophysical effects. In the event that such an analysis demonstrated minimal or no impact on fire hazard potential, no further analysis was performed. The results presented in this report should not be readily applied to other "apparently" similar problems without careful review and consideration of the assumptions and procedures documented in this report.

2.2 Assumptions and Limitations

The results of this study were based on the assumption that the types and quantities of combustibles observed during the walkthrough and identified by building personnel are representative of the potential fire hazards in the Building 991 Complex. Quantities of combustible materials greater than those discussed in Section 5 may invalidate the basis for determining the candidate fire scenarios and their potential impact, as presented in this FHA. The MPFL fire scenarios evaluate a maximum quantity of combustibles which should not be exceeded without further evaluation.

This FHA incorporates a review of the potential fire hazards associated with operations that are currently in, or planned to be in, the facilities comprising the Building 991 Complex. All evaluations were based on information that was available to Hughes Associates, Inc. at the time of the analysis. Information provided in cited documents, drawings, and plans was assumed to be accurate. These sources were identified to Site personnel during related discussions and were confirmed to be the most accurate and applicable information sources available.

Fire detection, suppression, and alarm systems that are in service were assumed to be functional. Tests were not performed to confirm the functionality and/or operability of these systems. These systems are subject to regular inspections by Fire Systems Services, who were contacted to identify any problems or concerns relating to the fire protection systems. Unless problems were identified by Fire System Services or unless a system was placed out of service, the fire protection systems were assumed to be operable in accordance with applicable NFPA requirements.

Fire detection and suppression system details were not reviewed for line-by-line compliance. However, as part of this FHA, these systems were reviewed for general compliance and condition, applicability to existing hazards, and potential for proper operation as installed. Administrative factors related to the design, testing, and use of fire protection equipment and systems were not considered in this analysis.

The life safety analysis presented in this FHA was limited to certain aspects of NFPA 101, *Life Safety Code* [NFPA, 1994]. The following aspects were considered:

(1) Capacity and number of means of egress;

(2) Means of egress components;

(3) Arrangement of means of egress;

(4) Travel distance limits;

(5) Exit discharge;

(6) Emergency lighting;

(7) Marking of means of egress (signage);

(8) Construction and compartmentation; and

(9) Interior finish.

These aspects were examined to the extent that the walkthrough would allow, relying on a qualitative rather than quantitative evaluation. Exact measurements were not taken; therefore, building plans were consulted for determination of travel distances, common path of travel, and dead ends. Other than those allowances permitted by NFPA 101, this report did not consider the impact of automatic systems or manual suppression activities on life safety.

An evaluation of fire-induced failures of electrical circuits, which can potentially prevent or impede the operation of systems or components performing safety class functions, was not within the scope of this analysis. Those systems or components identified as performing safety class functions which could be directly impacted by a fire were considered. Where known, the impact of a fire on these components or systems is provided in the analysis sections of this FHA.

Additional assumptions and limitations pertaining to specific fire scenario evaluations are addressed in other sections of this report.

[redacted]

3.0 FACILITY CONSTRUCTION, PROCESS, AND EQUIPMENT DESCRIPTION

The Building 991 Complex is located in the eastern portion of the Protected Area of RFETS. The original use of the building was for storage of special nuclear and other certified product materials. Its mission has not significantly changed even though plutonium operations were curtailed at the Site in November 1989. The Building 991 Complex consists of the following structures:

- Building 991, the primary structure in the complex, is a single story concrete building with basement. The U-shaped basement is 482 m^2 (5,190 ft^2). The rectangular first floor is 3038 m^2 (32,690 ft^2). East to west, the building measures approximately 72 m (237 ft), north to south 46 m (150 ft), and varies from 4.3 to 8.2 m (14 to 27 ft) high. Around the building the ground slopes from the roof line on the north side to the first floor level on the south.

- Building 984, Shipping Container Storage Building, 297 m^2 (3200 ft^2), is approximately 12 m (40 ft) south of Building 991.

- Building 985, Filter Plenum Facility, 223 m^2 (2400 ft^2), is approximately 3 m (10 ft) from the northwest corner of Building 991.

- Building 989, is the Emergency Generator Facility, is rectangular; it is 7.3 m x 4.9 m x 3.7 m (24 ft x 16 ft x 12 ft), and about 6.1 m (20 ft) east of Building 991.

- Building 992, Guard Post is 46.5 m^2 (500 ft^2).

- Tunnel 996 is an inverted Y-shaped concrete underground corridor 3.0 to 3.7 m (10 to 12 ft) wide and 3.4 to 4.0 m (11 to 13 ft) high.

- Vault 996, at the north end of Tunnel 996, is an underground chamber whose rectangular shape is divided by heavy walls into five nearly equal rooms and an entryway.

- Tunnel 997, or Corridor C Tunnel, is an east-west corridor, beginning at the north end of Tunnel 996. It is about 2.4 m (8 ft) wide and 3.0 m (10 ft) high.

- Vault 997 at the west end of Tunnel 997 is an underground chamber, a duplicate of Vault 996.

- Tunnel 998, or Corridor A Tunnel, runs north, underground, from the north side of Building 991. It is 2.3 m (7-1/2 ft) wide and 3.0 m (10 ft) high.

- Vault 998 is an underground chamber west of the north end of Tunnel 998.

- Vault 999, midway along and north of Tunnel 997, is a 3-room chamber.

3.1 Facility Construction

Details of the construction features of the various facilities within the Building 991 Complex were obtained primarily from the previous FHA, DSAR, and facility drawings. Information obtained from these sources was augmented by the site walkthrough. While general construction features were observed, a detailed inspection of facility construction was not conducted as part of this FHA.

3.1.1 Building 991

Building 991 was constructed in 1952 and is a single story structure with a partial basement. The building is classified as a *Storage Occupancy* per NFPA 101, *Life Safety Code®*. The building's construction is classified as mostly Type II (111) and partly Type II (000) in accordance with NFPA 220, *Standard on Types of Building Construction* [1992]. The original structure has been added to three times. The additions include (1) the loading dock on the west side (1957), (2) a radiography vault which is now used for radiography and storage only (1959), and (3) a covered loading dock and storage area. The first floor occupies an area of 3038 m^2 (32690 ft^2) and the basement occupies 482 m^2 (5190 ft^2). The dimensions and general layout of the facility are shown in Figures 3-1, 3-2, and 3-3.

Load bearing walls and intermediate concrete columns make up the structural framing of the building. Intermediate columns are reinforced concrete, ranging from 305 by 406 mm (12 by 16 in.) to 356 mm (14 in.) and 457 mm (18 in.) square. The first floor slab is 152 mm (6 in.) thick concrete reinforced with wire mesh. Except over the basement tunnels, the first floor slab is poured on grade or compacted fill.

All exterior walls are load bearing. The walls are constructed of reinforced concrete and vary from 305 mm (12 in.) thick (majority of the structure) to 1.64 m (1-1/2 ft) thick (north side of the building). The radiography vaults, occupying the northeast corner of the building, have 0.91 m (3 ft) thick, reinforced concrete walls. The maintenance shop addition has 203 mm (8 in.) thick, concrete block bearing walls. The building walls vary in height from 4.3 m (14 ft) on the south to 8.2 m (27 ft) in the center to 5.5 m (18 ft) on the north side.

There are four different roofs on Building 991. The original building has a reinforced concrete slab supported by concrete beams. The concrete slab varies in thickness from 102 to 381 mm (4 to 15 in.). On top of the slab is 25 mm (1 in.) thick foam insulation and built-up roofing. The roof of the radiography addition is 152 mm (6 in.) thick reinforced concrete with 38 mm (1-1/2 in.) of insulation and then built-up roofing.

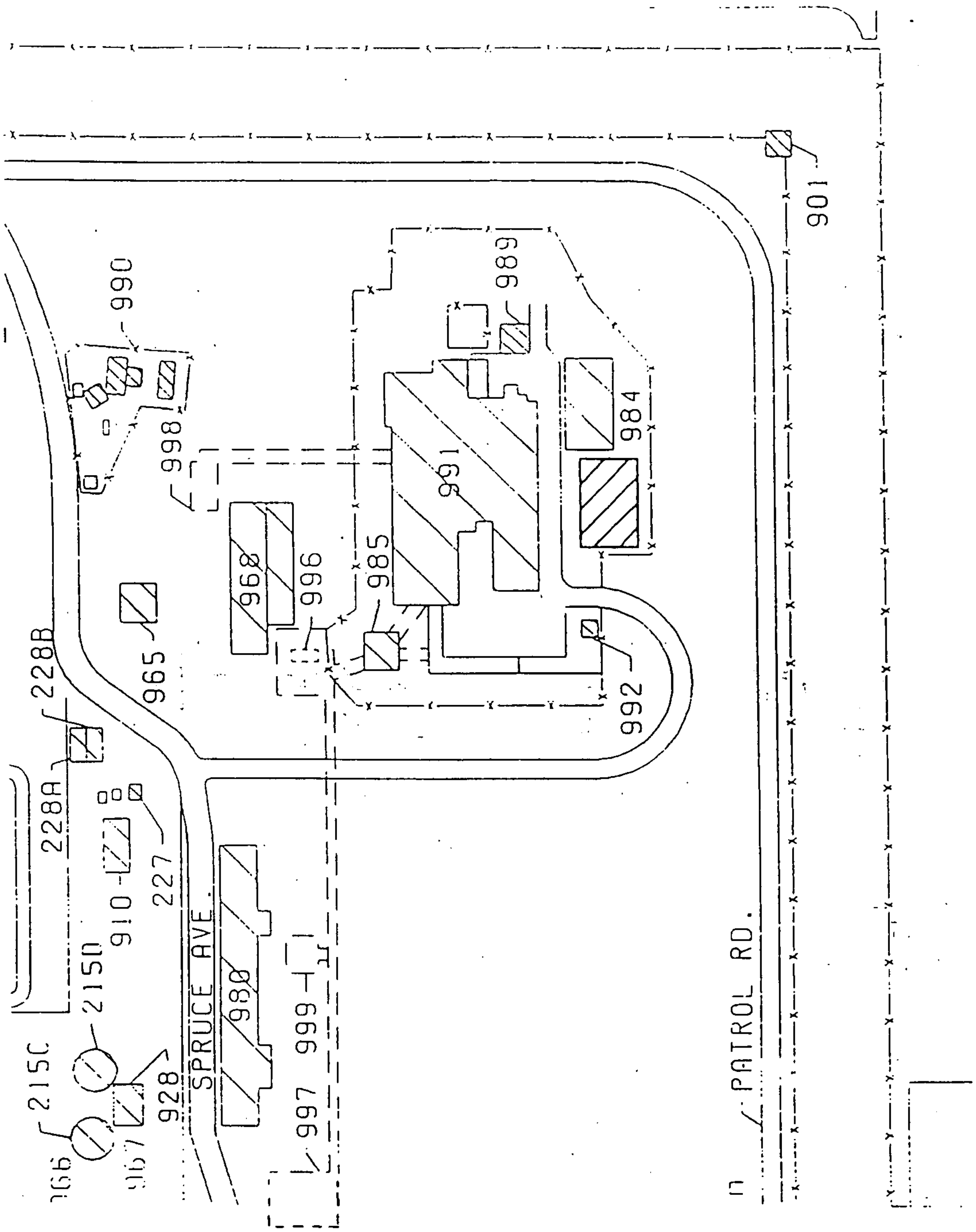

Figure 3-1 Building 991 Assembly Areas

[redacted]

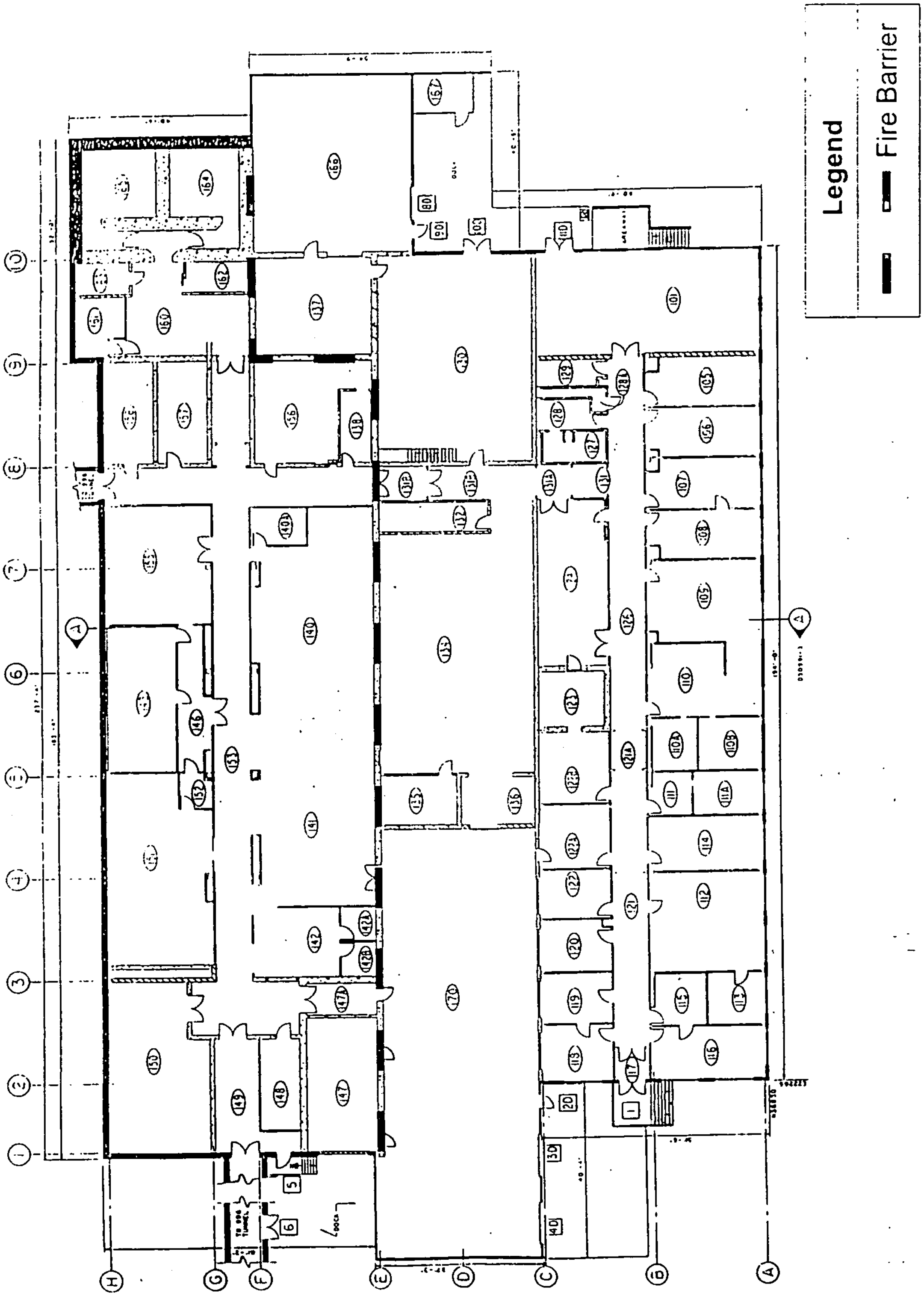

Figure 3-2 Building 991 Ground Floor Plan

[redacted]

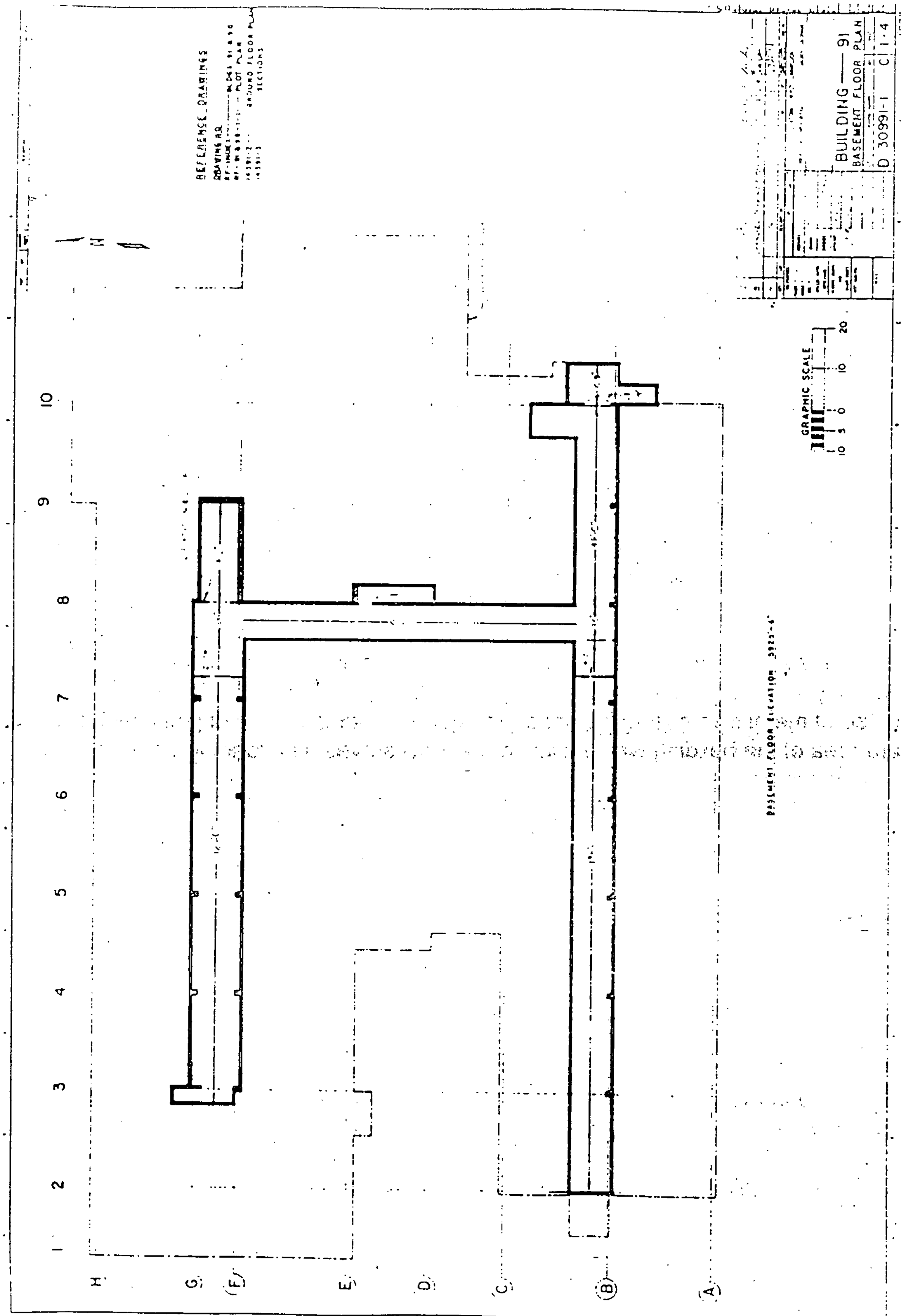

Figure 3-3 Basement Floor Elevation

[redacted]

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The second building addition has structural steel roof framing with corrugated asbestos cement roofing. One structural steel column and the existing concrete walls support the roof framing for the addition. The third building addition has open-web steel roof joists with metal decking covered with insulation and built-up roofing.

There are a variety of interior walls in Building 991. Interior bearing walls supporting roofs are constructed of reinforced concrete. The main east-west dividing wall has a 2 hour fire resistance rating. Rest room and locker room walls are 203 mm (8 in.) thick concrete block. The office and warehouse sections of the building are separated by either ceiling-high transite cement asbestos board partitions mounted on metal framing or metal wall panels with honeycomb or fiberglass interiors.

Ceilings are mostly the exposed undersides of roofs. Minor exceptions to this are acoustical tile glued to the underside of roofs in the office areas. The main corridors and a few rooms have suspended ceilings. Cafeteria ceilings are plaster over metal lath.

The utility tunnel basement is approximately U-shaped, just like the main floor corridors above it. The north leg is 47.5 m (156 ft) long, the south is about 62.1 m (204 ft) long, and the north-south cross leg is over 24 m (78 ft) long. The north leg is 3.5 m (11-1/2 ft) wide, the south leg is 2.9 m (9-1/2 ft) wide, and the north-south leg is 2.4 m (8 ft) wide. The tunnel height is 2.7 m (9 ft).

The only exterior windows in Building 991 are in offices, meeting rooms, the metallography laboratory, and the cafeteria in the south wing. These windows are constructed of metal frame, single glazed, and bottom opening. The original center courtyard area of the building was enclosed and now serves as a loading dock. The windows in place on the north side of the south wing have been covered with metal plates as part of the building modification.

Most of the interior walls are painted concrete. Floors in work areas are sealed concrete, carpeted in offices, vinyl asbestos tile in hallways, and coated with polyurethane in restrooms. The walls in restrooms and locker rooms are partially covered with tile. The former cafeteria area, hallways, and some work areas, have painted ceilings.

3.1.2 Tunnel and Vault Structures

The tunnel and vault structures include Tunnels 996, 997, 998 and Vaults 996, 997, 998, and 999 (see Figure 3-4). The underground tunnels and vaults are constructed of concrete with a 381 mm (15 in.) thick floor slab and are inter-connected with Building 991. These structures are classified as *Storage Occupancies* per NFPA 101, *Life Safety Code*®. The building's construction is classified as Type I (443) in accordance with NFPA 220 [1992].

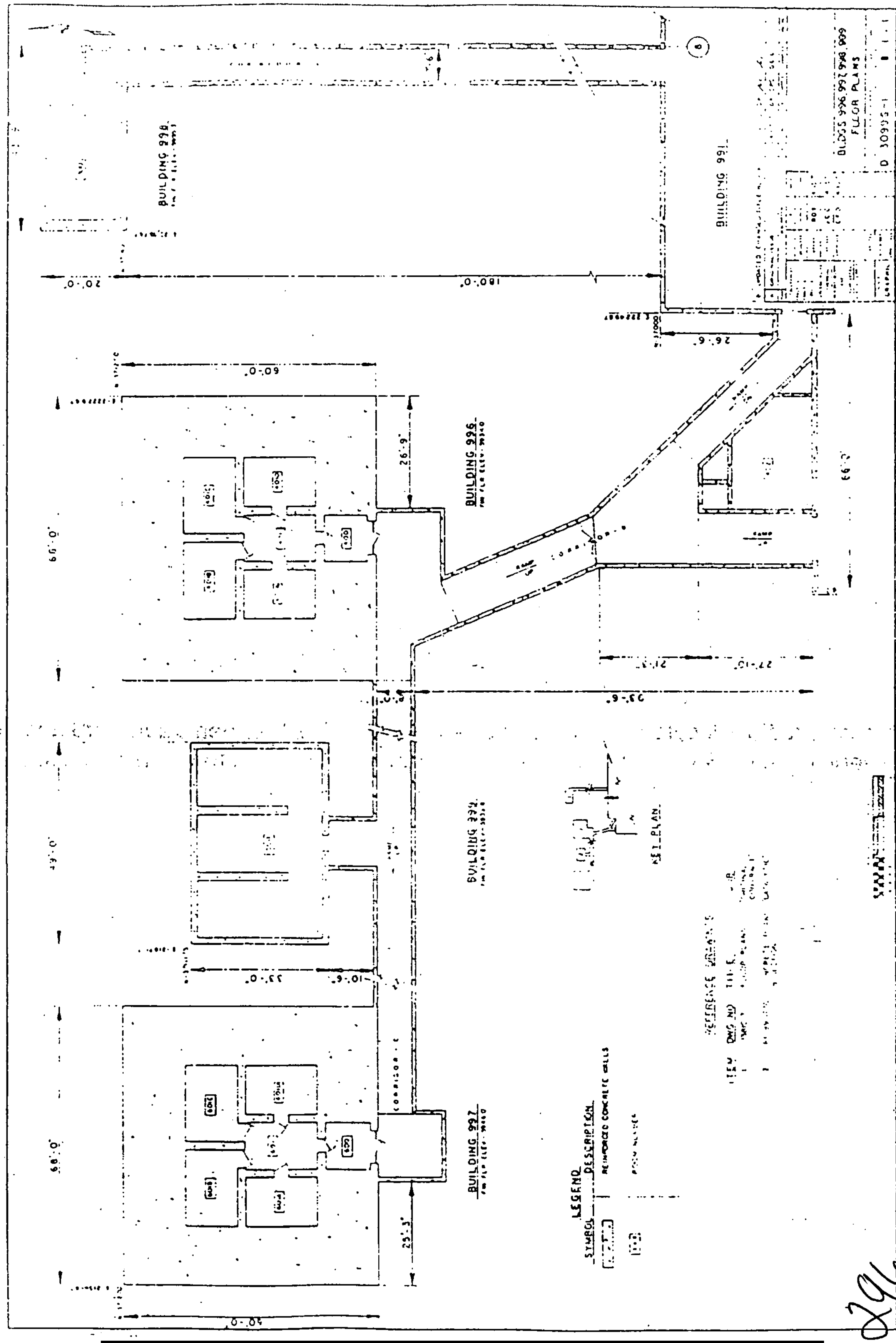

Figure 3-4 Tunnel and Vault Site Plan

[redacted]

Tunnel 998 (Corridor A) runs north to Vault 998, from the north side of Building 991. The tunnel is 2.3 m (7-1/2 ft) wide and 3.0 m (10 ft) high, with reinforced concrete walls, floor, and roof 381 mm (15 in.) thick. The earth cover varies from 0.6 to 4.0 m (2 to 13 ft).

Building 998 storage vault has only one room and lies west off the north end of Tunnel 998. The vault is 6.1 m (20 ft) wide, 13.1 m (43 ft) long, 3.0 m (10 ft) high, with reinforced concrete walls, floor, and roof which are 762 mm (30 in.) thick. The earth cover is approximately 4.0 m (13 ft).

Tunnel 996 runs from Building 991 northwest to Vault 996 and the east end of Tunnel 997. Two entrances to the tunnel form an inverted Y (See Figure 3-4). The tunnel is 3.0 to 3.7 m (10 to 12 ft) wide and 3.4 to 4.0 m (11 to 13 ft) high, and approximately 30.5 m (100 ft) long. There is a security door to Tunnel 996 beyond the inverted Y entryways.

Buildings 996 and 997 are identical underground storage vaults constructed in 1952. The vaults are connected by Tunnel 997 and are each partitioned into four rooms. Each vault is 18.3 m by 20.7 m (60 by 68 ft) with 4.4 m (14-1/2 ft) thick walls, 3.65 m (12 ft) thick roof, and 1.8 m (6 ft) thick floor. The dimensions of each of the four rooms are 3.65 m by 5.6 m (12 ft by 18-1/2 ft) with a 3.0 m (10 ft) high ceiling. The earth cover varies from 0.3 to 3.0 m (1 to 10 ft).

The Building 999 storage vault, built in 1956, is an underground, reinforced concrete structure located on the north side of Tunnel 997 between Vaults 996 and 997. The vault is 10 m (33 ft) wide by 15 m (49 ft) long with 381 mm (15 in.) thick walls, 533 mm (21 in.) thick roof, and 152 mm (6 in.) thick floor. The vault is partitioned (610 mm thick walls) into three rooms. Each room is 4.3 by 6.7 m (14 by 22 ft) with a 3.0 m (10 ft) ceiling. The earth cover is approximately 457 mm (18 in.).

Tunnel 997 (Corridor C Tunnel) runs along the south sides of Vaults 996, 999, and 997. The tunnel is 2.4 m (8 ft) wide and 3.0 m (10 ft) high, approximately 183 m (600 ft) long with reinforced concrete walls, floor, and roof 381 mm (15 in.) thick. The earth cover is approximately 3.65 m (12 ft).

Corridor C has a documented history of cracks in its concrete structure and groundwater infiltration associated with many of the cracks since the 1970s. A bounding structural analysis performed in July 1992 confirmed that inadequate reinforcing steel was installed in the structure to meet existing design standards for support of the original and current level of soil overburden. However, the analysis concluded that catastrophic failure was not imminent from a structural view, and that it was reasonable to continue operations (with compensatory actions), until a safe and orderly restoration of safe material storage conditions can be accomplished.

3.1.3 Building 984, Shipping Container Storage Building

Building 984 is a storage facility housing the empty shipping containers for use in the 991 complex operations. The facility is an uninsulated pre-fabricated building located 12 m (40 ft) south of Building 991. The building's construction is classified as Type II (000) in accordance with NFPA 220 [1992]. Building 984 is approximately 12 m (40 ft) wide, 23 m (75 ft) long, and 4.9 m (16 ft) in height at the eaves. The structural members are exposed, unprotected steel and the walls are uninsulated steel sheeting.

Building 984 contains new and used steel shipping containers and piles of Celotex packaging materials stored on pallets. The drums stored here were formerly certified by DOT as Interstate Shipping Containers, but have since lost their certification. The drums may not be used for shipments to and from the site, however, they have some salvage value.

Since the facility walkthrough, Building 984 has been slated to be used for wood crate storage. The crates will contain used HEPA filters and are considered LLW storage.

3.1.4 Building 985, Filter Plenum Facility

The Filter Plenum Facility, constructed in 1972, is a one-story structure approximately 18.3 m (60 ft) long by 12 m (40 ft) wide and 4.6 m (15 ft) high. The building contains the exhaust air plenum for Tunnels 996 and 997, Vaults 996, 997, and 999, and an air supply plenum for its own air.

The construction of Building 985 is classified as Type II (111) in accordance with NFPA 220 [1992]. The exterior walls of the building are precast concrete, 152 mm (6 in.) thick except in the airlocks, where they are 203 mm (8 in.) thick concrete block. The precast concrete walls are over 4.0 m (13 ft) high and either 330 mm (13 in.) or 292 mm (11-1/2 in.) wide. Cast-in-place straight wall and corner wall connections and continuous perimeter concrete roof beams bond the walls together. Windbreak walls for the entryway airlocks are built with 305 mm (12 in.) thick concrete block.

The main roof is precast concrete, twin tee construction with a 51 mm (2 in.) thick wire mesh reinforced concrete topping, 38 mm (1-1/2 in.) thick insulation, and built up roofing. The airlock roofs are cast-in-place concrete.

The east end of the building is a pit with 305 mm (12 in.) thick reinforced concrete walls and an average height of 4.0 m (13 ft). The pit is fitted with a tank for collecting water from activation of the plenum fire protection deluge system.

[redacted]

Structural framing in Building 985 is poor due to excessive ground erosion at the west end and south side of the building. The entryway and walkway is sinking and pulling away from the building.

3.1.5 Building 989, Emergency Generator Facility

Building 989 serves as the Emergency Generator Facility and was constructed in 1973. The building is a one-story structure, 7.3 m (24 ft) long by 4.9 m (16 ft) wide and 3.65 m (12 ft) high. The construction of Building 989 is classified as Type II (000) in accordance with NFPA 220 [1992]. The foundation is reinforced concrete, 203 mm (8 in.) thick and 1.5 m (5 ft) deep. There is a 152 mm (6 in.) thick concrete floor slab, reinforced with two layers of welded wire mesh. The walls above grade are 203 mm (8 in.) thick concrete block. The building has a double-sloping, reinforced concrete roof slab, 127 mm (5 in.) thick on one side and 229 mm (9 in.) on the opposite side. The roof slab is covered with 38 mm (1-1/2 in.) of insulation and finished with built-up roofing.

Building 989 houses a 256-kW emergency generator, diesel engine, diesel fuel oil day tank, starting batteries and associated charger for the diesel engine, generator control panel, and the remainder of the equipment necessary for the operation of the emergency generator. An exhaust fan in the west wall of the building cools the building when the generator is in operation. Building 989 is heated by two 7-kW electric heaters at the north end of the building. The exhaust fan and heaters maintain the emergency generator and the associated equipment within temperature limits required for proper operation.

The old 11,350 L (3000 gal) underground diesel fuel storage tank has been drained and foam filled. A 3,785 L (1000 gal), above ground fiberglass supply tank was put into service May of 1997 to replace the underground tank. The day tank inside Building 989 holds 680 L (180 gal) of diesel fuel oil.

The structural framing in Building 989 is poor due to ground erosion on the east side of the building. Leaks are evident along the upper portion of the walls because of the erosion. The emergency generator is conditionally operational. There are several oil leaks around the generator. The above conditions were first identified in 1991.

3.1.6 Building 992, Guard Post

Building 992 is a two story building which at one time served as the Guard Post. Currently, the building is out of service. Building 992 has dimensions of 4.9 by 4.9 m (16 by 16 ft) and is constructed of concrete slab on grade, with poured concrete walls and concrete roof. The building's construction is classified as Type II (000) in accordance with NFPA 220 [1992]. The second story of this building is a 2.4 m (8 ft) diameter octagonal shaped, glassed-in room. A 2.7 m by 4.6 m (9 ft by 15 ft) out-building constructed of noncombustible material has been added to the west end.

3.2 Facility Operations and Processes

Building 991 continues to support the shipment, receipt, and storage of nuclear materials and TRU waste. Currently, the building is also operated as a tenant facility for Plant Maintenance Alarms, a Metallography Laboratory, and Non Destructive Testing. A description of each activity is provided in the following sections.

3.2.1 Shipping, Receiving, and Storage Operations

The primary use for Building 991 and its associated underground tunnels and vaults is storing special nuclear and other certified product and materials (including non-nuclear materials). Operations in the building are the standard warehousing functions of ordering, receiving, storage, and shipment of these materials, both on and off the plant site supported by Nuclear Materials Handling and Packaging.

All radioactive materials received at Building 991 are in DOT-approved shipping containers. Material storage is predominately in 208 L (55 gal) drums. Currently, Rooms 134, 140, 141, 142, 143, and 151 serves as the primary storage area along with the vaults. However, other areas of the building are planned to be cleared and used for drum storage. Drum storage is planned to be the primary function of Building 991. The west covered dock area is used for shipping and loading purposes. Radiological materials are shipped from Building 991 in approved shipping containers.

3.2.2 Electronic Maintenance

Electronic Maintenance provides on-site maintenance support for various electronic systems through the following maintenance units: Maintenance Alarms, Maintenance Control Systems, Maintenance Communications, and Maintenance Radiation Instrumentation. All units work in three shifts to achieve 24-hour coverage.

3.2.3 Metallography

Metal specimens are received by the Metallography Laboratory from various locations on-site and from off-site vendors. The evaluations are used for quality assurance. Samples are analyzed for hardness, elemental composition, and grain structure.

3.2.4 Nondestructive Testing

Metal parts are examined by X-ray analysis using a photographic process. The mobile X-ray services utilizes a portable X-ray source, Iridium-192. Exposed film is returned to Building 991 and processed in Room 160. The X-ray film developing process is automated and is a closed system.

Ultrasonic testing is used to determine material thickness and other hidden defects in materials under examination. These measurements are primarily performed on drums to verify that thickness registers between minimum and maximum limits. This testing technique is portable and can be carried to the test site.

3.3 Critical Process Equipment and High Value Components

Critical process equipment includes any equipment that is considered vital to the RFETS mission. Criteria for making this determination are not clearly defined by DOE Order 5480.7A. Input from site personnel was relied upon in making this determination. High value property is classified by RFETS as any equipment having a value which exceeds $500,000.

There is no critical process equipment in Building 991 or any of the support facilities.

There are two items of High Value within Building 991. Room 155 contains a computerized gas chromatograph and mass spectrometer instrument, valued at approximately $800,000. The same room contains a System Microprobe Scanning Auger, which is an advanced form of electron microscope. Along with its computerized controls, it is valued at approximately $1 million. This equipment is scheduled to be moved to the Savannah River Site in the near future.

3.4 Essential Safety Class Equipment

DOE Order 5480.7A defines safety class equipment as systems, structures, or components including primary environmental monitors and portions of process systems, whose failure could adversely affect the environment, or the safety and health of the public. Based on DOE Order 5480.7A Paragraph 7-p, safety class equipment includes those systems, structures, or components with the following characteristics:

(1) Those where a failure would produce exposure consequences that would exceed DOE established guidelines at the site boundary or nearest point of uncontrolled public access;

(2) Those required to maintain operating parameters within the safety limits specified in Technical Safety Requirements (TSRs) or Operational Safety Requirements (OSRs);

(3) Those required for nuclear criticality safety;

(4) Those required to monitor the release of radioactive materials to the environment during and after a design basis accident;

[redacted]

(5) Those required to monitor and maintain the facility in a safe shutdown condition; and

(6) Those that control the safety systems described above.

Based on the above definition, there are no safety class systems in Building 991. Currently, there is no loose contamination in the facility, Special Nuclear Materials (SNM) are stored in inner and outer containers, radiological processing is not performed, and loss of the power and/or ventilation systems, although undesirable, would have no unacceptable consequences.

The Building 991 Operational Safety Requirements (OSRs), updated June 1994 as provided in the DSAR, indicates that no measurable process variables require Safety Limits because they, by themselves or in combination with failure of their equipment specific safety features (e.g., high temperature sensors/alarms/interlocks), do not relate to "maximum credible accidents" or "design basis accidents" that could breach the structure and result in an unfiltered release of radioactive material which could exceed DOE guidelines at the plant boundary. The OSR supports the conclusion that there are no safety class systems in Building 991.

3.5 Utilities and Services

Utilities and services discussed in this section serve Building 911 and its support buildings. The descriptions are provided here for information only. Additional descriptive information can be found for credited systems in the appropriate engineering documents (e.g., drawings, calculations, Engineering Operability Evaluations, System Evaluation Reports, etc.). Controlled Engineering documents are the only approved sources of design information regarding these systems.

3.5.1 Heating, Ventilation, and Air Conditioning (HVAC) Systems

The purpose of the HVAC system is to provide the desired air volume changes, temperature, and humidity control of the atmosphere within Buildings 991 and 985, and Vaults and Tunnels 996, 997, 998, and 999. Because radioactive material confinement is not a critical problem in Building 991, as it is in plutonium processing buildings, the ventilation system is primarily for air circulation.

The Building 991 ventilation system is designed to condition the air for office, shop, lab, and storage areas. The system maintains a slight negative pressure (approximately -0.05 in. w.g.) between the building and the outside environment. Building 991 air is exhausted through a one-stage HEPA filter plenum located on the roof of the building. A slight negative air pressure (approximately -0.01 in. w.g.) is also maintained in the storage vault in Room 150 of Building 991, and Vaults 996, 997, 998, and 999. Vault 998 and Tunnel 998 air is also exhausted through the plenum on the roof of Building 991 after

[redacted]

passing through another one-stage HEPA filter plenum. The Building 991 exhaust system normally operates with one exhaust fan and two standby fans.

Vaults 996, 997, and 999, and their access Tunnels 996 and 997, are exhausted through a two-stage HEPA filter plenum (FP-601) in Building 985. The entryway into 996 vault also has a non-credited single-stage HEPA filtered exhaust system that empties into plenum FP-601. The FP-601 exhaust system normally operates with one exhaust fan and one standby fan.

An alarm is generated on a loss of flow through any exhaust fan. An interlock automatically shuts down the supply fans upon loss of exhaust flow.

3.5.2 Electrical Systems

The Public Service Company of Colorado supplies power to RFETS with two 115-kV lines from Valmont and Boulder. Building 991 is served by two 13.8-kV feeders. Each feeder is sized to carry the entire load of the buildings. Substations 555 and 558 provide power to Transformers 991-1, 991-2, and 995 which provide normal and alternate power for distribution within the buildings.

There are three basic electrical systems for the Building 991 Complex:

(1) Normal electrical power,

(2) Emergency electrical power,

(3) Grounding and lightning protection.

Switchgear 991-1, 991-2, and 995 provide normal 480-V power received from building switchgear transformers 991-1, 991-2, and 995, respectively. The switchgear distributes the 480-V normal power to power panels, Motor Control Centers (MCCs), bus ducts, and Emergency Motor Control Centers (EMCCs). The power panels, MCCs, bus ducts, and EMCCs distribute 480-V normal power to the larger normal power loads. Smaller loads and 120-V loads receive their power from lighting panels and standard receptacles.

A diesel-powered electrical generator provides standby emergency power from Building 989. The emergency distribution panels receive power from the standby generator during a loss of normal power and functions to distribute emergency power to critical loads. Critical loads are specified in the DSAR.

Buildings 985, 989, and 991 each have grounding electrodes (ground rods) buried about their perimeters interconnected by buried grounding conductors. The perimeter grounding conductors of Buildings 985 and 989 are each connected by two buried

[redacted]

conductors to the perimeter grounding of Building 991, lowering the effective grounding resistance and improving the effectiveness of the total grounding system. Vaults and Tunnels 996, 997, 998, and 999 are grounded by connections to the Building 991 perimeter grounding conductors.

Lightning protection systems are in place for Buildings 985 and 991. These systems carry high currents of lightning strikes safely to the grounding system. Lightning protection consists of copper air terminals uniformly spaced along the periphery of the roof, across open roof areas, and on equipment on the roof that is susceptible to lightning strikes, such as metal ventilation ducts and filter plenum enclosures.

The surrounding terrain provides some degree of shielding from lightning strikes. This shielding is a result of the roof line of Building 991 being within a few feet of local grade level. Building 989, because of its low profile close to Building 991 and surrounding structures, is effectively shielded and does not require a lightning protection system. Lightning protection for the vaults and tunnels is not required since these structures are underground.

3.5.3 <u>Water</u>

Treated water is provided to Building 991 by the plant distribution system. One 152 mm (6 in.) main supplies the facility from the southeast or Building 991. The water is used for the domestic and process water systems.

Fire sprinklers and water spray nozzles installed in the Building 991 Complex are fed from the domestic cold water lines with backflow prevention. Fire protection water supply is discussed further in Section 4.5.

3.5.4 <u>Waste Systems</u>

The sanitary sewer system services showers, washrooms, toilets, and janitor closets. The system also handles blowdown from cooling towers, as well as overflow and relief valve effluent. Waste water is delivered to the waste treatment plant in Building 995 through a 300 mm (12 in.) vitreous clay sewer main.

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4.0 FIRE PROTECTION AND LIFE SAFETY FEATURES

Fire protection features present in the Building 991 Complex include both active and passive features. Included are: fire protection water supply, fire hydrants, automatic fire sprinkler systems, fire detection, alarm and reporting systems, standpipes, portable fire extinguishers, smoke and ventilation control systems, fire barriers, and associated protective devices. Some of these features can also be considered life safety features in that they directly impact the egress of people from the buildings. However, items such as signage or egress markings are strictly life safety features as they will have no impact on a fire's development or containment.

This section describes the existing fire protection features in the Building 991 Complex. Where deficiencies have been noted, recommendations for system repair, reconfiguration, or augmentation are included. An evaluation of the compliance of Building 991 with NFPA 101, *Life Safety Code*, is presented in Section 5.4.

4.1 Suppression Systems

Buildings 991, 985, 989, and Tunnel/Vault 998 are provided with automatic sprinkler systems. Buildings 984 and 992, and the remaining tunnels and vaults are not provided with automatic suppression. The exhaust filter plenums in Buildings 985 are equipped with automatic and manual water spray systems to protect the HEPA filter systems. Each of the water-based suppression systems in the 991 Complex is supplied by the RFETS site Plant Domestic Cold Water System. A discussion of water supply availability is presented in Section 4.5.

4.1.1 Building 991

Building 991 is protected by two sprinkler systems designated as Systems "A" and "B". The systems provide full sprinkler coverage with sprinklers located at the ceiling levels for both the ground floor and partial basement. Each system was designed and installed in accordance with NFPA 13, *Installation of Sprinkler Systems* according to the Ordinary Hazard pipe schedule method.

The "A" sprinkler system is a wet pipe system and protects the heated areas of the building. The sprinkler nozzles installed include old-style and Grinnell Duraspeed sprinklers. The "B" sprinkler system is a dry pipe system, protecting the enclosed dock area (Room 170) and the external canopy area to the west of the building. In addition to the "A" and "B" systems, a dry pipe system valve fed from the "A" system provides coverage for the east loading dock and the diesel generator building (Building 989).

The sprinkler systems appear to comply with Ordinary Hazard pipe schedule design criteria. The systems are maintained and tested periodically by the Site Fire Systems Services personnel to ensure their continued operability. During the walkthrough, there were no major deficiencies identified for the sprinkler systems. An

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[redacted]

open Fire Prevention Bureau finding indicates that a light hazard sidewall sprinkler has been installed in a portion of the west dock area. Since Building 991 is an Ordinary Hazard occupancy per NFPA 13, the sprinkler should be replaced with a sprinkler listed for use in Ordinary Hazard occupancies.

991-97-001 *Replace the Light Hazard sidewall sprinkler in the west dock area with a sprinkler approved for use in Ordinary Hazard occupancies.*

The 1994 edition of NFPA 13 does not distinguish between Ordinary Hazard Group I and Ordinary Hazard Group II hazard classifications for pipe schedule systems. A combined "Ordinary Hazard" classification requires a minimum residual pressure of 138 kPa (20 psi) and a required flow rate at the base of the riser of 3217 to 5678 Lpm (850-1500 gpm). The pressure requirement is for the highest elevation in the system. The required flow rate includes both the sprinkler system and the hose stream demands. The 1989 edition of NFPA 13 [1989] included separate requirements for Ordinary Hazard Group I and Group II pipe schedule designs. These requirements were similar to those outlined above for Ordinary Hazard protection under the 1994 edition of NFPA 13.

Figure 4-1 (Section 4.5) depicts the minimum available water supply versus the sprinkler system demand for Ordinary Hazard occupancies. The available water supply curve was constructed using the fire department flow test results for hydrant 9-4 located on the west side of Building 991, near the security fence in the courtyard. Table 4.1 summarizes the static pressures measured at the risers (supply side of alarm valve) for the sprinkler systems during the walkthrough.

Table 4.1 Sprinkler System Pressures

Sprinkler Riser	Static Pressure kPa (psi)
A	792 (115)
B	772 (112)

The static pressures measured at the sprinkler risers were higher than the static pressure measured for hydrant 9-4 (used in the water supply discussion in Section 4.5). While the 1994 edition of NFPA 13 does not distinguish between Ordinary Hazard groups for pipe schedule design, such a distinction existed up through the 1989 edition NFPA 13. The available pressure and flow rates for the first floor sprinkler systems in Building 991 exceed the required minimum for pipe schedule systems: (1) for Ordinary Hazard Group II occupancy under the 1989 edition of NFPA 13, and (2) for Ordinary Hazard occupancy under the 1994 edition of NFPA 13.

Based on the available water supply, the spacing and number of sprinklers on each branch line, and pipe layout, which all meet the requirements of the 1989 edition of NFPA 13 for Ordinary Hazard Group II protection, the existing sprinkler systems are expected to perform satisfactorily for the hazards observed during the walkthrough as well as hazards defined under the 1994 edition of NFPA 13 for Ordinary Hazard Group II occupancies.

4.1.2 <u>Building 985</u>

The Building 985 Filter Plenum structure is provided with an automatic sprinkler system throughout. At the time of the walkthrough, the system was out-of-service due to a damaged retard chamber. The water supply to the system was shut-off at the post indicating valve (PIV) outside of the building. A roving fire watch (every four hours) has been established for the building while the suppression system is out-of-service. However, since automatic suppression is needed in this building, the system should be placed back-in-service.

991-97-002 Repair or replace the damaged retard chamber on the Building 985 automatic sprinkler system riser and restore the suppression system.

Deluge sprinkler systems are provided in the exhaust filter plenum in Building 985. The plenum deluge system is actuated by 88°C (190°F) heat detectors located in the inlet duct. The actuation of the heat detector activates a local alarm and sends an alarm to the Fire Dispatch Center.

The filter plenum is preceded by a chamber containing demister screens with automatically actuated water spray nozzles located upstream from the demister screens. The purpose of the demister chamber deluge system is to protect the HEPA filters in the event of a fire by cooling the air stream with an array of water spray nozzles. The demister screens remove much of the water from the air stream before it reaches the HEPA filters. The HEPA filters are also protected by spray nozzles located in front of the first stage. Because HEPA filters plug faster when water is supplied, the direct water sprayed on the HEPA filter is manually controlled and is used only if the automatic cooling spray does not function adequately. Both the demister chamber and the first stage of the filter plenum have drain lines.

4.1.3 <u>Tunnels and Vaults</u>

Tunnel and Vault 998 is provided with automatic sprinkler protection served by the Building 991 "A" system. The remaining tunnels and vaults are provided with automatic smoke detection; however, they are not provided with automatic suppression systems.

4.1.4 Manual Extinguishers/Standpipe Connections

Portable fire extinguishers are located throughout the 991 Complex and are readily accessible. Extinguisher locations and conditions are in accordance with NFPA 10, *Portable Fire Extinguishers*. Extinguisher types are determined based on the most likely class of fire that might occur within the area served by the extinguisher.

Building 991 contains a horizontal standpipe system with eight 38 mm (1-1/2 in.) hose connections available for fire department use. Hose, racks, and nozzles have been removed from these installations. The 64 mm (2-1/2 in.) piping system is fed by an external fire department connection, a normally closed valve to the domestic cold water supply, and a normally open 38 mm (1-1/2 in.) cross tie to the "A" wet pipe sprinkler system. The horizontal standpipe system is not required by code, nor is it a part of the Fire Department's Pre-Fire Plan.

4.2 Detection and Alarm Systems

Manual fire alarm systems (e.g., fire phones) are located in corridors, exits, and other strategic locations in the 991 Complex. Initiation of the fire alarm systems cause both local and Plant alarms to sound. The emergency telephone lines permit instantaneous communication with the RFETS Fire Department and provides voice communication to the Central Alarm Station (CAS). The CAS is the plantwide fire and security monitoring system. All fire, supervisory, and trouble signals are transmitted to data gathering panels located in buildings throughout the Site. The data gathering panels report to a central processor located in the Plant Security Central Alarm Station (Building 121). Signals sent to the CAS are annunciated both at the Plant Security Central Alarm Station and the Fire Department.

Waterflow switches installed on sprinkler system risers provide indication of system usage. Upon flow detection, an alarm signal is sent to the CAS via the Signal Input/Output (SIO) panel.

Each of the vault storage rooms and tunnel areas (except 998 which is sprinklered) is provided with Pyrotronics high-voltage DC ionization smoke detectors. A smoke detection system is not required per NFPA 101 for the tunnels and vaults. Two code deficiencies were observed for the smoke detection system. In some areas, the detectors are installed on the bottom of ducts, which are more than 457 mm (18 in.) below the ceiling. In the long tunnels, smoke detectors are installed approximately 16.8 m (55 ft) apart. Listed spacing for the detectors would be a maximum of 12.5 m (41 ft). Since the system is existing and is not required by NFPA 101, repairing the defficiencies is not considered to be necessary. However, according to FPE, the smoke detection system in the tunnels and vaults is planned to be replaced with a like-for-like system. The new system design will not meet current NFPA 72 criteria. Although the system is not required, any modifications to the smoke detection system should be in accordance with NFPA 72.

991-97-003 *Modifications to the existing smoke detection system installed in the tunnels and vaults should comply with NFPA 72 criteria.*

The fire alarm system also consists of automatic alarms triggered by heat detectors in plenum inlets and by sprinkler water flow. System testing and inspection is performed by a combination of Fire System Services and Alarms Maintenance.

In the event of loss of electrical power, the fire alarm system has backup power supplied from 12-volt batteries fed through an inverter, plus additional backup from the emergency generator power. The Pyrotronics smoke detectors have approximately 24 hours of battery capacity and the remainder of the fire alarm panels have a minimum 4 hour battery backup capacity. The automatic fire alarms are tested periodically by the Fire Department to be sure that they will function in an emergency.

4.3 Passive Protection Features

Building 991 is divided by a 2 hour fire resistance rated barrier, running east and west, from the north side of the west dock to the north side of the east dock. The double doors connecting Rooms 140 and 170 were held open at the time of the walkthrough. The automatic closing device failed to operate when tested. Also, these doors do not latch properly. Since these doors are part of the 2 hour fire barrier assembly, they must be repaired such that they automatically close and latch properly.

991-97-004 *Repair the doors in the fire barrier which connect Rooms 140 and 170 so that they automatically close and latch properly.*

Two unprotected duct penetrations are in the fire barrier between Rooms 134 and 140. Duct penetrations through 2 hour fire resistance rated barriers are required by NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems* [1993] to have 1½ hour fire-rated dampers. Since these duct penetrations do not meet the requirements of the DOE Exemption Request, RFP-DOE-5480.7-EX-1, *Use of Fire Dampers with HVAC Ductwork (for buildings containing fissile nuclear material)*, granted by DOE in 1991, dampers are required.

991-97-005 *The duct penetrations in the credited 2 hour fire resistance rated barrier between Rooms 134 and 140 must be equipped with 1½ hour fire-rated dampers or constructed in a manner that is equivalent to the construction requirements outlined in DOE Exemption Request, RFP-DOE-5480.7-EX-1, Use of Fire Dampers with HVAC Ductwork. Alternative measures, other than those presented above, such as limiting combustible loading or activities in the area may be acceptable but must be supported by appropriate engineering analyses and approved by FPE.*

Several other interior walls within the building are of adequate construction to function as fire barriers. However, there are no requirements to further subdivide the building into smaller fire areas (see Section 5.1). Being unnecessary for life safety or property loss considerations, no additional walls were designated as fire walls. This minimizes the continuing upkeep and maintenance required of fire door and penetration seal maintenance programs.

The doors which separate Tunnel and Vault 998 from Building 991 are self-closing fire doors. Similarly, the walls and doors which separate the Building 996/997/999 tunnel and vault complex from Building 991 are also of sufficient fire rated construction to prevent a fire from spreading from one facility to the other. At the present time, all of the doors within the 996/997/999 vaults are open, and do not have door closers. The doors are required to be kept open in order to prevent accidentally locking someone in a vault.

4.4 Smoke and Heat Ventilation

The facilities in the Building 991 complex do not have dedicated smoke and heat ventilation systems. Smoke and heat ventilation, in the event of a fire, is limited to the normal exhaust capacity of the building HVAC system.

4.5 Water Supply

The Plant Domestic Cold Water System provides water for fire suppression. A 1,100,000 L (300,000 gal) elevated tank (Tank 215A) is located adjacent to Building 124, the Water Treatment Plant. Tank 215A is automatically supplied by pumps located in Water Treatment Plant 124. This system consists of mostly 254 mm (10 in.) looped or gridded water mains. Water is distributed to most of the Site by the underground water mains. A secondary 2,900,000 L (500,000 gal) supply tank (Tank 215C) provides an additional source of fire protection water and is distributed by two, remote manually-started, 9500 Lpm (2500 gpm) fire pumps (one electric and one diesel) located in Building 928.

DOE Order 6430.1A, Paragraph 0266-4 requires that each hydrant supplied by the water distribution system deliver a minimum 63 L/s (1000 gpm) at a residual pressure of 69 kPa (10 psi). The DOE order also requires the following:

(1) Hydrants are spaced no more than 122 m (400 ft) apart,

(2) Fire hydrant branches are no less than 150 mm (6 in.) in diameter and no longer than 91 m (300 ft),

(3) Hydrants are no more than 91 m (300 ft) from the buildings to be protected,

(4) Each building is protected by a minimum of two hydrants, and

(5) Adequate flow and pressure is provided to maintain operation of any automatic sprinkler in the building.

There are two accessible fire hydrants located within 23 m (75 ft) of the facility which provide adequate coverage for the building, meeting the requirements of NFPA 24 *Standard for the Installation of Private Fire Service Mains and Their Appurtenances.* Hydrant 9-4 is located near the southwest corner of the building at a convenient location for access and to pump into the sprinkler system and standpipe fire department connections. Hydrant 9-5 is located near the southeast corner of the building in a useful position for interior attack via the external doors at this end of the building. The previous FHA noted wood pallets, crates and other combustible storage within 3 m (10 ft) of Hydrant 9-4. Since that time, the storage has been removed and clear access provided to the hydrant.

Table 4.2 summarizes recent hydrant flow test results and available water supply for the hydrants serving Building 991 based on the Pre-Fire Plan for Building 991 [Rocky Flats Fire Department, 1997]. The available water supply for Building 991 satisfies the DOE Order 6430.1A requirement that the hydrant system deliver a minimum of 3785 Lpm (1000 gpm) at 69 kPa (10 psi).

Table 4.2 Hydrant Flow Data

Hydrant	Static Pressure kPa (psi)	Residual Pressure kPa (psi)	Flow Lpm (gpm)
9-3	717 (104)	551 (80)	5855 (1547)
9-4	758 (110)	579 (84)	5889 (1556)
9-5	765 (111)	358 (52)	4648 (1228)

The water supply (based on flow data for hydrant 9-4) and demand curves for the Building 991 sprinkler systems are shown in Figure 4-1. Based on the method prescribed in Section 5-2.2 of NFPA 13, *Installation of Sprinkler Systems* (1994 ed.) for determining the minimum water supply required for pipe schedule sprinkler systems, the available water supply for the 991 Complex satisfies Ordinary Hazard criteria (see Section 4.1).

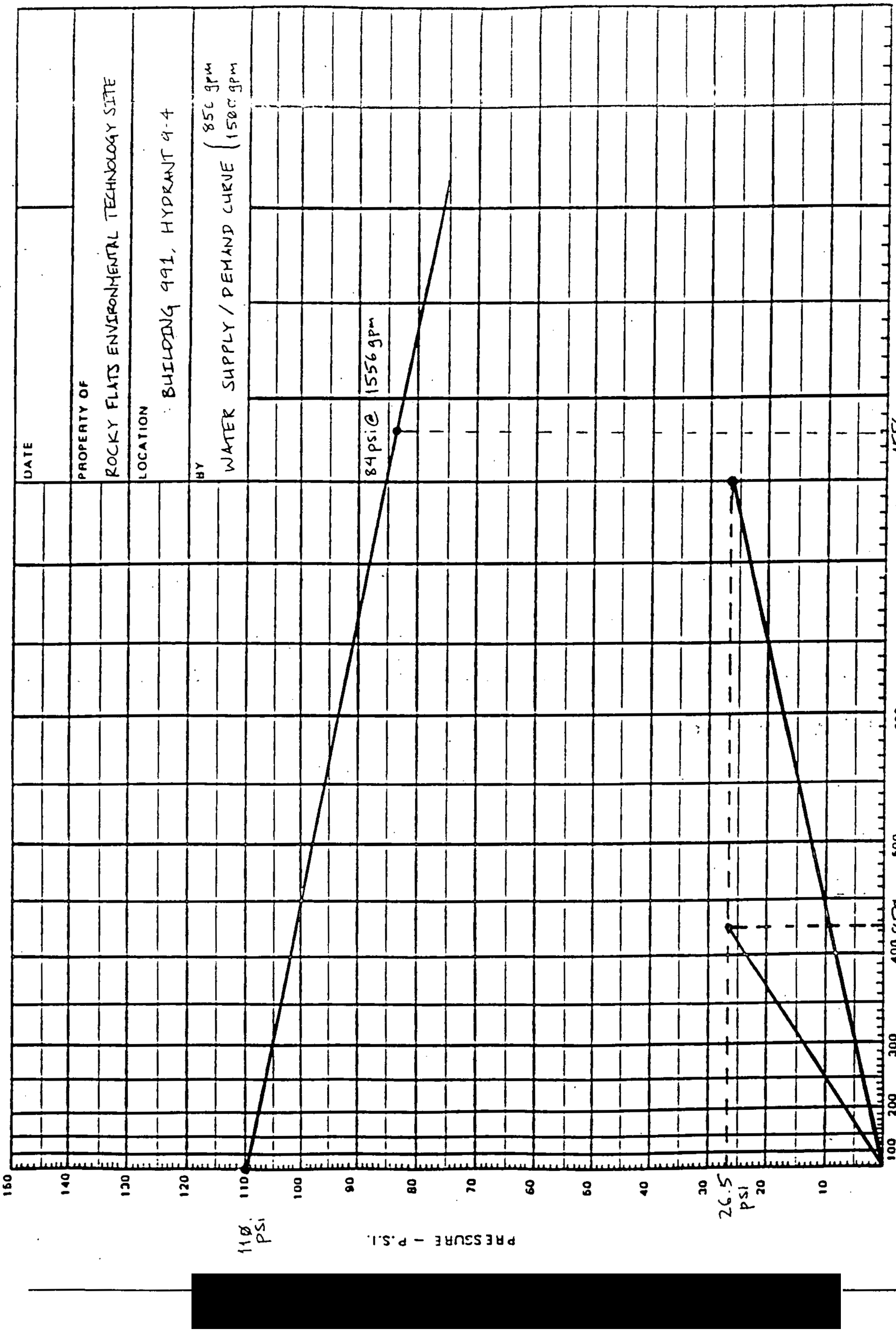

Figure 4-1 Water Supply Graph

[redacted]

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According to NFPA 13, a minimum residual pressure of 138 kPa (20 psi) is required at the elevation of the highest sprinkler. The required pressure is calculated by multiplying the elevation difference from the base of the riser to the highest sprinkler by the elevation head loss of 9.8 kPa/m (0.433 psi/ft) and adding the result to the minimum pressure, 138 kPa (20 psi), required at the sprinkler. The use of 138 kPa (20 psi) as the minimum pressure at the highest sprinkler, contained in the 1994 edition of NFPA 13, is a more conservative approach than using the 1989 edition of NFPA 13, which requires only 100 kPa (15 psi) at the highest sprinkler.

The available water supply satisfies the required demand, which ranges from 3217 Lpm (850 gpm) to 5678 Lpm (1500 gpm), based on the requirements for "Ordinary Hazard" sprinkler design in accordance with NFPA 13 [1994]. In addition, the supply exceeds the flow and pressure requirements for "Ordinary Hazard Group II" design under the pipe schedule method prescribed in the 1989 edition of NFPA 13, which was the last edition of NFPA 13 that distinguished between Ordinary Hazard Group I and Group II for pipe schedule design.

In addition to the method described above, the sprinkler system in Building 991 has also been analyzed using the hydraulic calculation method prescribed in NFPA 13 [Campbell, 1987]. Hydraulic calculations were performed for the sprinklers in Room 134, the high bay storage area. The analysis indicated that the 25 sprinklers in the 202 m^2 (2170 ft^2) design area (i.e., the entire room) provide densities at the most hydraulically remote area ranging between 0.20 gpm/ft^2 to 0.21 gpm/ft^2 delivered at 7 psi, which is the minimum pressure required by NFPA 13. A density of 0.20 gpm/ft^2 satisfies NFPA 13 [1994] required application rate densities for Ordinary Hazard Group II sprinkler systems.

4.6 Life Safety Features

The facilities in the Building 991 Complex are equipped with emergency lighting and illuminated exit signs to enhance egress capabilities. Generally, these are operational and placed in accordance with NFPA 101. Building wide notification systems are provided and Buildings 991, 985, 989, and Tunnel/Vault 998 are provided with automatic sprinkler protection. A complete discussion and analysis of life safety issues is provided in Section 5.4.

[redacted]

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5.0 FIRE HAZARD AND LIFE SAFETY ANALYSIS

This section identifies and assesses the fire hazards, fire protection features, protection of safety class equipment, life safety features, special hazards, and fire loss potential for the Building 991 Complex. Each of the facilities identified in Section 1.0 was addressed. Where buildings are divided into multiple fire areas by fire resistance rated construction, the fire hazards and relevant features of each fire area are addressed.

5.1 Fire Area Description

A Fire Area is defined by DOE Order 5480.7A as a location bounded by construction having a minimum fire resistance rating of 2 hours with openings protected by appropriately fire-rated doors, dampers, or penetration seals. This section defines and describes the fire areas for each of the facilities in the 991 Complex. The fuel loading and fire potential within the fire areas are addressed in Section 5.2.

5.1.1 Building 991

The first floor of Building 991 is divided into two fire areas, North and South, by 2 hour fire resistance rated barriers (see Figure 3-2). The South fire area is comprised of office spaces, laboratories, workshops, mechanical rooms, drum storage areas, a shipping/receiving dock, and a lunchroom. The different usage areas (e.g., office, lab, storage) are not considered to be separate fire areas because there are no maintained fire barriers between these spaces. The North fire area is primarily dedicated to the storage and handling of radioactive materials. Also contained in this area are the radiography vaults, inactive laboratories, and storage rooms.

The basement level of Building 991 is considered a separate fire area from the first floor (see Figure 3-3). A single stair connects the basement and first floor. A fire door located at the basement level of the stair provides separation between the two levels. The basement consists of three utility tunnels which are used for storage purposes.

5.1.2 Tunnels and Vaults

Tunnel and Vault 998, which are remotely located from the other tunnels and vaults, are treated as an individual fire area. Tunnel 998 is separated from Building 991 by a 1.64 m (1½ ft) thick concrete wall and self-closing fire rated doors.

Tunnel and Vaults 996, 997, and 999 are connected to one another via a common tunnel (i.e., Tunnel 997). Since the structures are open to one another, they are considered a single fire area. The tunnel and vault area is separated from Building 991 by a 305 mm (12 in.) thick concrete wall and self-closing fire rated doors.

5.1.3 Building 984

Building 984 is a Butler-type structure used for storing steel shipping containers, wood crates, and combustible packing materials. The building does not have any fire rated separations. Therefore, Building 984 comprises a single fire area.

5.1.4 Building 985

Building 985 contains the exhaust filter plenums for the tunnel and vault areas. There are no fire rated separations in Building 985. Therefore, the building comprises a single fire area.

5.1.5 Building 989

Building 989 houses the emergency generator for Building 991. There are no fire rated separations in Building 989. Therefore, the building comprises a single fire area.

5.1.6 Building 992

Building 992 is an out-of-service guard house. The building does not have any fire rated separations. Therefore, Building 992 comprises a single fire area.

5.2 Fire Hazards

This section describes the potential fire hazards in each fire area. Fuel loading estimates were based on information gathered during the FHA walkthrough and discussions with facility personnel regarding current and future operations. While possible ignition sources and relative fire risk are briefly discussed, an ignition source was assumed to be available in order to evaluate the potential impact of the fire scenarios in each fire area. This assumption is consistent with the basis of the FHA in which the potential consequences, as opposed to the overall risk, is assessed to determine the MPFL for the facility. The probability and associated risk for the identified fire scenarios are addressed in the Building 991 DSAR.

The impact of specific fire scenarios, for the most part, was evaluated qualitatively based on worst case fuel loading conditions. While worst case conditions do not necessarily represent the existing or future conditions in a given area, it provides for a conservative analysis which bounds all other plausible fire scenarios. Where simple, qualitative analysis methods yielded acceptable results in terms of impact on facility and occupant life safety, further analysis was not performed. In cases where a qualitative analysis did not provide the insight needed to evaluate the impact of a specific fire scenario, more detailed quantitative methods were used. In these cases, computer fire modeling and engineering calculations were typically utilized to help evaluate the scenarios.

The Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL) were determined in accordance with DOE Order 5480.7A, based on an evaluation of the identified fire scenarios. For the MPFL, automatic and manual suppression systems were assumed to be unavailable/inoperable. For the MCFL, consideration was given to the presence of automatic suppression systems in the facility or fire area. In Section 5.3, based on the MPFL and MCFL scenarios, compliance with DOE loss limitations and fire protection requirements was determined.

Since automatic and manual suppression systems are not credited for MPFL scenarios, fire spread is limited solely by the available fuel/oxygen supply and passive constraints (e.g., fire barriers, doors, floor/ceiling assemblies). To the extent that sufficient fuel was available in a fire area, interior partitions which do not have a maintained fire resistance rating (based on FPE master drawings) were not credited with providing passive fire protection. While in practice, solid partitions such as gypsum, plaster, and concrete will provide some level of passive protection, they were not relied upon in this analysis due to unprotected openings and penetrations which may currently exist or may exist in the future. In addition, relying only on fire rated partitions and separations for passive control provided a conservative assessment of potential fire spread and impact on the facility. Such assumptions are appropriate for MPFL scenario evaluations.

5.2.1 Building 991

As indicated in Section 5.1.1, Building 991 contains three fire areas; two on the first floor, and the basement. The fuel loading and potential fire hazards are described for each fire area. Where necessary, additional analysis is provided for specific fire scenarios.

5.2.1.1 Fuel Loading and Fire Hazard Potential

South Fire Area

The South fire area includes office spaces, laboratories, workshops, mechanical rooms, drum storage areas, a shipping/receiving covered dock, and a lunchroom. The fuel loading and fire potential in this fire area was generally found to be low.

The office areas include typical furnishings such as desks, chairs, filing cabinets, and book shelves. The fuel loading is low to moderate, typical of office spaces. A common corridor connects the office spaces with several small laboratories, workshops and the cafeteria. The fuel loading in the laboratories and workshops is also low to moderate, typical of such areas. The lunchroom (Room 101) contains a low fuel loading consisting primarily of tables and chairs. There were no unique fire hazards found in these areas during the walkthrough. A fire in any of these areas is expected to be controlled by the automatic sprinkler system (see Section 5.2.1.3).

Rooms 130 and 137 are mechanical equipment rooms. The fuel loading and fire potential in both rooms is low. Adjacent to Room 137 is Room 166 which, at the time of the facility walkthrough, was used for rack storage. The 3.0 m (10 ft) racks were used primarily for storing cardboard boxes containing records and files. The fuel loading in Room 166 was heavy and could result in a severe fire. However, the storage is scheduled to be removed and Room 166 is planned to be used for 4-tier high drum storage. While the fuel loading and fire potential in Room 166 are severe, a fire in this area is expected to be controlled by the automatic sprinkler system.

The east dock contained a moderate to heavy fuel loading during the walkthrough. The dock is protected by an automatic dry-pipe sprinkler system. An unchecked fire on the dock could potentially spread into Room 166 and/or Room 130 since both rooms connect to the dock. However, the automatic sprinkler system is expected to control any such fire.

Rooms 134, 140, 141, 142, 143, and 151 serve as the primary storage area along with the vaults. In addition, other areas of the building are planned to be cleared and used for drum storage. Drum storage is planned to be the primary function of Building 991. Drums will be stacked up to 4 tier high on either metal pallets or plywood sheets. Wood pallets are not permitted to be used for drum storage in Building 991.

The storage of waste drums does not present a significant hazard with regard to fuel loading or fire propagation. However, a fire involving other combustibles located near the drums can potentially expose the drums and lead to fire involvement of the drum contents. Fire involvement of the drum contents will result in contamination spread via smoke and combustion products and can lead to considerable cleanup costs. Therefore, preventing undue fire exposures of the storage drums is important.

A test series and subsequent analyses conducted by Hughes Associates, Inc. [Hughes, 1995a; Hughes, 1995b] concluded that severe thermal exposures are required to cause drum lid loss. Such exposures can result from liquid pool fires or a heavy combustible loading directly adjacent to the sealed drums. Appendix A summarizes the results of the drum fire tests and also provides an assessment of drum exposures resulting from fires involving nearby storage materials. Based on the fire tests and analyses, general guidelines have been established regarding drum storage in buildings. At the time of the walkthrough, there were no significant fire hazards found in Building 991 associated with drum(s) storage and general housekeeping in the storage areas was maintained in good condition. Therefore, the storage guidelines presented herein are provided for reference purposes only.

- Flammable/combustible liquids should not be used or stored outside of an approved flammable liquids cabinet in the same room or area with drums containing radiological wastes. If flammable/combustible liquids are required to be used in these areas, diking or some other means of containment should be provided around either the storage drums or flammable/combustible liquids, providing at least a 1.5 m (5 ft) separation between the waste drums and potential liquid spill.

- Any plastics of the types subject to melting (e.g., LDPE, HDPE, etc.) should be properly containerized in metal drums or cans such that if a fire occurs, a spreading pool fire will not result. If separation and/or containment of these plastics is not possible, diking should be provided around either the waste storage drums or the plastics providing at least 1.5 m (5 ft) separation distance between the waste drums and potential spreading pool fire.

- Combustible loading in waste drum storage rooms and areas should be maintained as low as reasonably achievable. A minimum separation distance of 1.5 m (5 ft) should be maintained between the waste drums and any combustible materials stored in the same room or area. This provides adequate access to the drums, reduces the potential heat flux exposure to the drums in the event of a fire, and provides a "buffer zone" to allow some movement (spread) of combustibles during a fire without causing direct flame exposures capable of causing lid loss failure.

- Maintain a minimum clearance of 457 mm (18 in.) between stacked storage drums and the level of the automatic sprinklers in accordance with NFPA 13.

Currently, the areas in Building 991 which are used for drum storage comply with the above guidelines. As additional areas of the building are used for drum storage, the above guidelines should be maintained.

The west covered dock area (Room 170) was found to contain a low fuel loading. Some wood pallets were located in the dock and limited amounts of miscellaneous combustibles throughout. The forklifts used in the dock area are electric; however, they contain small quantities of combustible hydraulic fluids. Based on the low fuel loading, the fire potential in the covered dock area is limited.

The covered dock area is supported by exposed structural steel members (e.g., columns, beams). Because steel members begin to lose their structural integrity at temperatures exceeding 500°C, a fire in Room 170 has the potential to cause structural failure/collapse in areas exposed to the fire. The covered dock was added on after the original construction (see Section 3.1.1) and is not part of the original structural framework. Therefore, failure of the dock's structural members would not cause collapse of the adjacent rooms which are part of the original construction. Based on the limited fuel loading and automatic sprinkler protection in the dock area, fire exposure and collapse of the structural members is not expected to be a problem. However, the fuel loading should be limited as part of the facilities combustible control program.

A worst case fire in the South fire area could result in fire spread throughout the office, laboratory, workshops, and mechanical rooms. While fire spread into the drum storage areas is not anticipated due to lack of fuel loading, hot gases and combustion products from fire in other areas of the building could cause heating of the drums. As a result, venting of the containers and limited pyrolysis of the drum contents may occur (see Appendix A). Therefore, limited contamination spread throughout the building is conceivable and was assumed for estimating the MPFL.

A fire in the South fire area is not expected to spread beyond the 2 hour fire resistance rated barrier separating the North fire area due to the limited fuel loading and passive protection provided by the barrier. The passive protection provided by the fire barrier was based on the anticipated implementation of Recommendation 991-97-004, which required repairing the fire door connecting Rooms 170 and 141.

Such an extreme fire is unlikely in Building 991; however, it serves as a bounding worst case event which was used to estimate the MPFL. Since the building is provided with an automatic sprinkler system, fire spread and damage will be limited. For the MCFL scenario, fire spread is expected to be limited to the design area of the sprinkler system (i.e., 140 m^2 (1500 ft^2) based on NFPA 13). Contamination spread due to drum venting was not anticipated for the MCFL event based on the current segregation of drums from other substantial fuel sources. Future drum storage is anticipated to be similar to the existing storage configurations and should continue to comply with the general drum storage guidelines presented earlier. If combustible materials are stored in areas used for drum storage, fire exposure of the drums and subsequent contamination spread may result.

North Fire Area

The North fire area is primarily dedicated to the storage and handling of radiological materials. Also contained in this area are the radiography vaults, inactive laboratories, and storage rooms. The fuel loading and fire hazards in the North fire area are similar to those found in the storage areas in South fire area. Many of the rooms which currently contain miscellaneous storage are planned to be used for future drum storage. These areas should comply with the previous guidelines provided for drum storage areas.

The greatest fuel loading observed in the North fire area was in Room 155. Room 155 is an inactive laboratory which contains miscellaneous computer equipment, box storage, flammable liquids stored in approved cabinets, and compressed gas cylinders. Since the time of the walkthrough, all gas cylinders have been removed from the building.

During the facility walkthrough, moderate fuel loading was also observed in Room 143. The area contained 2.1 m (7 ft) high racks used for miscellaneous storage. Since the walkthrough, the racks and storage items have been removed from Room 143. The room is to be used for drum storage.

Room 150 is a secured vault used to stage SNM. The vault was not accessible during the walkthrough. Based on information from facility staff, the fuel loading in the vault is low. The SNM are staged in shipping containers and the room is sprinklered. Fire spread to or from the vault is not expected to be a problem.

As for the South fire area, a severe fire in the North fire area could result in fire damage throughout the fire area. While fire spread into the drum storage areas is not anticipated due to lack of fuel loading, hot gases and combustion products from fire in other areas of the building could cause heating and subsequent venting of the drums. As a result, limited contamination spread throughout the building could result.

A fire in the North fire area is not expected to spread beyond the 2 hour fire resistance rated barrier separating the South fire area due to the limited fuel loading and passive protection provided by the barrier. The passive protection provided by the fire barrier was based on the anticipated implementation of Recommendation 991-97-004, which required repairing the fire door connecting Rooms 170 and 141. A fire in the North fire area is also not expected to spread to the adjacent tunnels and vaults due to their separation and lack of combustibles in the tunnels.

Since the building is provided with an automatic sprinkler system, fire spread and damage will likely be limited. For the MCFL scenario, fire spread is expected to be limited to the design area of the sprinkler system (i.e., 140 m^2 (1500 ft^2) based on NFPA 13). Contamination spread due to drum venting is not anticipated for the MCFL event.

Basement

The basement area is used for miscellaneous storage purposes. The fuel loading in this area is low and consists primarily of cardboard boxes containing equipment. The boxes are stored on 1.5 m (5 ft) high racks which extend the length of the corridors along the walls. The storage materials and racks did not obstruct the sprinklers during the inspection and should not as additional storage is relocated to the basement. Based on the limited fuel loading, the automatic sprinkler system is expected to control a fire involving the storage materials in the basement.

During the walkthrough, the fire door serving the stair to the first floor was being held open. Since the stair is open on the first floor level, this door provides the only separation between the two floors. Therefore, this door is required to be closed in order to prevent fire spread from the basement to the first floor.

991-97-006 Insure that the fire door separating the basement from the first floor operates properly and is not blocked open.

5.2.1.2 Exposure Hazards

There are several buildings and/or fuel sources which present a potential fire exposure hazard to Building 991. However, none of the exposures are expected to have a detrimental impact on Building 991.

South (12 m) of Building 991 is an unsprinklered metal building (984) used for warehousing of combustible materials. A fire in this building presents an exposure to Building 991. However, a fire in Building 984 is not expected to spread to Building 991 due to the separation and the Building 991 concrete exterior wall.

At the time of the walkthrough, unused wooden pallets stacked 1.8 m (6 ft) high were being stored in an outdoor area to the east of Building 984. The pallets were approximately 4 m (13 ft) from the corner of the building. A fire in the unsprinklered warehouse would likely spread to the pallet storage. Likewise, a fire in the pallets could spread to the warehouse building. In accordance with NFPA 231, *Standard for General Storage* [1995], pallet storage must be located at least 9.1 m (30 ft) away from all buildings if there are less than 200 pallets, or at least 15.2 m (50 ft) away from all buildings if there are more than 200 pallets. Since the walkthrough, the pallets have been removed and no longer present an exposure hazard to any of the 991 Complex facilities.

Approximately 23 m (75 ft) north of the north exterior wall of Building 991 and located uphill at a steep grade, is an area used to store flammable and combustible liquids which are used at the adjacent maintenance facility. At one location there are approximately sixteen 208 L (55 gal) drums of ethylene glycol (anti-freeze), combustible hydraulic fluids, and motor oils. Nearby is a 6.1 m x 2.1 m x 2.1 m (20 ft x 7 ft x 7 ft) shipping container, which holds approximately 3,785 L (1,000 gal) of paints, epoxy resins, mineral spirits, and paint thinners. These flammable liquids are in all sizes of containers. Combustible or flammable liquids not contained in the cargo container could result in a spill fire which could run downhill and impact the roof and HEPA filters plenum structure on the roof. Since there are no doors or windows on this side of the building and the roof is constructed of concrete slab, fire propagation into the facility is not postulated. However, damage to the built-up roofing could result. This finding results from the previous FHA and was not verified during the current inspection. Section 5.5 contains previous findings/recommendations and addresses this exposure hazard.

There are two oil-filled 13.2 kV transformers located outside the east end of Building 991, north of Building 989. The transformers are provided with dikes to prevent a oil spill from spreading. While damage to the transformers will result from a fire, because the facing building walls of 991 and 989 are concrete and windowless, fire propagation into the facilities is not expected.

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[redacted]

5.2.1.3 Impact of Automatic Sprinkler System

The automatic sprinkler system in Building 991 complies with NFPA 13 criteria for Ordinary Hazard Group II occupancies (see Section [illegible]). Based on NFPA 13, a system meeting this classification is appropriate where the quantity and combustibility of contents is moderate to high, stockpile storage less than 3.7 m (12 ft) in height exists, and fires with moderate to high rates of heat release are expected. The fuel loading and fire potential in Building 991 is less severe than that defined for Ordinary Hazard Group II. There were no areas found which exceeded the combustible storage capacity of the installed sprinkler system.

5.2.1.4 Impact of Natural Hazards on Fire Safety

Natural hazards are addressed by the DSAR for the essential structures in the Building 991 complex. The essential structures include Buildings 991, 985, 989, 996, 997, 998, and 999. (Buildings 992 and 984 are considered to be expendable if subjected to severe natural hazards.) The essential structures are those that must retain their integrity to confine radioactive material.

Structural design criteria are addressed in Chapter 4 of the Facility DSAR and accident analyses for natural phenomena are addressed in Chapter 8. The essential structures in the Building 991 complex are expected to be relatively unaffected by a design basis earthquake (DBE). Safety equipment was originally designed for loading other than a DBE (i.e., blast loads) but is expected to be adequate for the DBE. However, internal to the building, local over-stressing may occur, and could impact fire safety by degrading the integrity of the sprinkler system's piping.

Wind and tornado loadings are expected to have no significant consequence to the building in terms of wind pressure and wind-induced missile impacts. Originally, the building and components were designed to withstand specific wind loading plus a blast loading that exceeds any wind load criteria. Building 991 was determined to be adequate for tornado resistance as discussed in the DSAR.

The Building 991 Complex is located in a small natural valley. It has been determined that precipitation from a 125 year period of recurrence storm in the water shed upstream of Building 991 could cause flooding of the Building 991 basement. However, this is not significant from a fire protection perspective.

The lightning risk index relative to surrounding structures and terrain for Building 991 is moderate to severe, using the risk assessment guidelines of NFPA 780, *Lightning Protection Code* [1992]. Building 991's location nestled down in a narrow valley minimizes the risk of a direct strike. Higher nearby structures, such as the protected area fencing and guard towers are much more likely to be struck. Building 991 has lightning protection, consisting of numerous air terminals and grounding conductors on the roofs

[redacted]

and roof-top structures. These appear in good condition, and adequate for the task. Lightning has not been a problem for Building 991 in the past.

In summary, the hazard of natural phenomena has been determined to be satisfactorily offset by the facility design and construction. For further information, refer to the Facility DSAR.

5.2.1.5 Potential for a Toxic, Biological and/or Radiation Incident Due to Fire

Because this facility performs no chemical processes, does not open shipping containers of special nuclear materials, and contains only gram quantities of potentially toxic laboratory chemicals, the potential for fire-induced toxic, biological, and radiation incident is very low. The probability and consequences of such an incident are addressed in the facility DSAR as of such low probability as to be incredible.

No biological agents are used in this building. Radioactive materials are contained within inner and outer shipping containers. In order to prevent fire involvement of the drum contents, the recommended storage guidelines established in Section 5.2.1.1 should be followed.

None of the structures in the Building 991 Complex contain loose contamination which would be spread by sprinkler or firefighting operations. No areas in these buildings are *Contamination Areas* requiring the wearing of protective clothing. The main floor of Building 991 contains no floor drains. Firefighting water could spread within the building, and eventually make its way to the environment out a normal access door with no more concern to the environment than a fire in a non-nuclear facility. A part of such firefighting water could flow downstairs into the below-ground basement area. Several small floor drains are provided in the basement utility tunnels. It is unknown where these drain to, but is of no consequence as previously discussed.

Minimal quantities of toxic materials were observed during the building evaluation. Several 208 L (55 gal) sealed steel drums containing beryllium parts were observed in storage. While beryllium fines and shavings can be toxic if inhaled or ingested, the materials herein are large metallic parts and are packaged within plastic bags or liners, and then sealed within 208 L (55 gal) drums. In their current configuration, the beryllium does not present a health hazard to building occupants.

Asbestos was a common building material at the time of Building 991's construction. Transite cement-asbestos boards, and asbestos pipe insulation materials are used in this building. Since they are fixed in place, and not loose friable fibers, they do not present a toxic or biological hazard from a fire protection perspective. Truck company salvage and overhaul activities have the potential to disturb asbestos-containing materials, but firefighters are aware of such hazards. The potential hazards of asbestos will have to be addressed before the ultimate demolition of the structure.

[redacted]

5.2.2 Tunnels and Vaults

Vault 998 is connected to Building 991 via Tunnel 998. Both the tunnel and vault are provided with an automatic sprinkler system. At the time of the walkthrough, the vault contained only a few empty drums; however, future use of the vault will be for radiological drum storage. Several drums containing beryllium were stored in Tunnel 998 at the time of the walkthrough. According to facility personnel, these drums are to be removed in the near future. In the meantime, these drums do not present a serious fire hazard.

Vaults 996, 997, and 999 are currently used for radiological drum storage. No storage was located or is planned to be located in the tunnels serving the vaults. Neither the vaults nor the tunnels connecting the vaults to Building 991 are provided with an automatic sprinkler system; however, an automatic smoke detection system is provided throughout.

The fire hazards associated with the storage materials in the vaults and tunnels are minimal. The primary concern with these areas is the travel distances and common paths of travel which, depending upon the use of the tunnels and vaults, may exceed those permitted by NFPA 101, *Life Safety Code*. A life safety evaluation is provided in Section 5.4 of this FHA.

5.2.3 Building 984

Building 984 is a Butler-type structure used for storing shipping containers and wood crates containing LLW. No detection or suppression system is provided. The fuel load in the facility was found to be low. Approximately 12 wood crates were located in the building at the time of the walkthrough. In addition, Building 984 is used to store Celotex and foam plastic shipping container internals. While this storage does not present a severe hazard, a fire involving these materials could cause damage to the structure. In addition, a fire involving the LLW crates could result in contamination cleanup of the building and potentially areas outside of the building. The level of cleanup will depend upon the number of crates involved in a fire and the radiological inventories of the crates.

5.2.4 Building 985

Building 985 contains the exhaust filter plenums for tunnel and vault areas. The fuel loading and fire potential was found to be low. Miscellaneous combustible storage located in the northwest corner of the facility was the primary fire hazard observed during the walkthrough. A fire involving these materials would have minimal impact on the structure; however, it could cause limited damage to the HEPA filter plenums and electrical switch gear and cabling. Since the sprinkler system was not operational at the time of the walkthrough, the combustible loading in Building 985 should be minimized.

991-97-007 *Remove/relocate the miscellaneous storage materials in Building 985 to an area which will not expose the HEPA filter plenums.*

5.2.5 Building 989

Building 989 contains the emergency generator for Building 991. The building contains a day tank which serves the generator. The day tank holds 680 L (180 gal) of diesel fuel. The building contained no other combustible materials. A fire involving the contents of the day tank represents the worst case fire scenario for the building. Such a fire would damage the structure and all its contents.

Building 989 is provided with an automatic dry-pipe sprinkler system. Automatic sprinkler systems are not always effective in extinguishing or controlling liquid pool fires [Kokkala, 1992]. However, given the small size of the building and adequate water supply provided to the sprinkler system, and because the oil is a high-flashpoint combustible liquid, the sprinkler system is expected to control and likely extinguish an oil fire. While damage to the structure would likely be prevented due to sprinkler actuation, damage to the generator and other building contents could still result.

5.2.6 Building 992

Building 992 is an out-of-service guard house. The fuel loading and fire potential are typical of an office area. A worst case fire could result in damage to the building and loss of all contents. Building 992 is not provided with any automatic suppression systems.

5.3 Maximum Possible Fire Loss and Maximum Credible Fire Loss

Estimates of damage potential were based on worst case fire events in each of the facilities. Cost estimates include loss of contents, structural damage to the buildings, and contamination cleanup costs. Loss of production or program continuity, in general, was not included in the damage potential since the current mission of the site is decontamination & decommissioning rather than production. All operations in the Building 991 Complex can be relocated to another on-site facility or contracted off-site.

Based on DOE Order 5480.7A, estimates of the MPFL were based on the assumption that automatic suppression systems fail. In addition, no credit was taken for manual fire fighting efforts. Estimates of the MCFL were based on the assumption that the existing fire protection features, including automatic sprinkler systems, function as designed. The MPFL and MCFL estimates are based on the damage potential described in Section 5.2 for each of the facilities. Table 5.1 summarizes the MPFL and MCFL costs for the Building 991 Complex.

Table 5.1 Summary of MPFL and MCFL Costs

Building	MPFL	MCFL
991	30.1 million	$840,000
Tunnels and Vaults	$0*	$0*
984	$1.9 million	$1.9 million
985	$250,000	$250,000
989	$1.3 million	$100,000
992	$500,000	$500,000

* see Section 5.3.2

In accordance with DOE Order 5480.7A, facilities having an MPFL is excess of $1 million require an automatic sprinkler system designed in accordance with applicable NFPA standards. Where the MPFL exceeds $50 million, a redundant fire protection system is required such that, despite the failure of the primary fire protection system, the loss will be limited to $50 million. Where the MPFL exceeds $150 million, a redundant fire protection system and a 3 hour fire resistance rated barrier are required to limit the MPFL to $150 million.

The replacement costs of the building structure and contents were based on capital equipment costs for the entire facility distributed on a per unit area based on the total floor area of the facility. In some areas where high value equipment is located, replacement cost estimates were provided by facility personnel.

The determination of contamination cleanup costs was based on broad estimates due to the limited data available for actual cleanup efforts. As directed by FPE, cleanup costs for fire scenarios involving low level contamination spread were based on "Clean-up Costs for Use in FHAs (U)" [Allison, 1993]. This reference provides cleanup costs for low level waste spills resulting from fire fighting operations (e.g., sprinklers, hose streams). Cleanup costs, including materials and overhead, amount to $6,450 per square meter ($600 per square foot) for porous surfaces (e.g., concrete, asphalt) and $1,075 per square meter ($100 per square foot) for polished surfaces (stainless steel, plastic). The values were calculated based on the floor area impacted by the fire and subjected to smoke/contamination spread.

Treating each unit area of the building as having equivalent value is a simplification. While more accurate fire damage costs could have been calculated, it was not necessary to determine compliance with DOE loss limitations. The cost estimates provided in this section are expected to be conservative estimates of the actual damage potential resulting from a fire.

The post-fire recovery potential of the Building 991 Complex is good. The heavy building construction is unlikely to be badly damaged even by a severe fire. There are no undue hazards within the building that would prevent it from being cleaned up and repaired. However, with the overall mission [illegible] having been curtailed and the planned decommissioning of this building, it is unlikely that the building would be repaired or replaced subsequent to a major fire.

5.3.1 Building 991

The fire potential in Building 991 is limited due to the low to moderate fuel loading and non-hazardous building operations. However, as noted in Section 5.2.1, a worst case fire scenario could spread throughout a given fire area. Since the South fire area comprises the largest area, a fire in this space can potentially result in the greatest fire spread and damage.

The value of the entire Building 991 structure is approximately \$16 million. The South fire area occupies roughly half the total floor area of Building 991 (including the basement). Therefore, damage to the structure is estimated to be \$8 million. The total value of the contents in Building 991 is approximately \$5 million. Therefore, damage of contents in the South fire area results in a loss of approximately \$2.5 million. Contamination spread is postulated to result for the MPFL scenario. The associated cleanup cost which results from spread throughout the first floor is approximately \$19.6 million (3038 m^2 x \$6450/m^2). This yields a total MPFL of \$30.1 million.

The MCFL scenario results in damage to contents and structure over a 140 m^2 (1500 ft^2) area, or roughly 4 percent of the total building. This results in approximately \$640,000 damage to the structure and \$200,000 in contents. As described in Section 5.2.1.1, there is no contamination cleanup anticipated for the MCFL scenario. Therefore, the total MCFL for Building 991 is \$840,000.

Building 991 is provided throughout with an automatic sprinkler system. Since the MPFL is less than \$50 million, the facility is in compliance with DOE Order 5480.7A loss limitations.

5.3.2 Tunnels and Vaults

The fire potential in the tunnels and vaults is minimal based on the lack of combustible fuel loading. The only items which will be stored in these areas are sealed drums. While the drums may contain combustible materials, there is no means of exposing the drums and involving the contents in fire. As described in Appendix A, severe fire exposures are required to cause drum failure. Based on the lack of combustibles observed during the walkthrough and the recommendations provided in this FHA which prohibit the presence of combustible materials outside of drums in the tunnels and vaults, fire involvement of the drum contents is not expected.

[redacted]

If combustible materials are stored in the tunnels and vaults, a fire could result which could involve the drum contents thereby causing contamination spread. Contamination spread throughout the tunnels in vaults would result in a cleanup cost in [illegible] million (based on \$6,450/m^2). Under these conditions, an automatic sprinkler system would be required per DOE Order 5480.7A loss limitations. Since installing an automatic sprinkler system throughout the tunnels and vaults would not be cost effective, preventing potential contamination spread is necessary. As noted above, as long as combustible materials outside of the drums will not be kept in the tunnels and vaults, contamination spread will not result. The potential consequences of fire involvement of the drum contents further illustrates the need to prohibit combustible materials in these areas.

Since there are no credible fire scenarios in the tunnels and vaults due to the lack of combustible materials, the MPFL and MCFL are negligible. Since the MPFL is less than \$1 million, an automatic sprinkler system is not required in the tunnel and vaults based on DOE Order 5480.7A loss limitations.

5.3.3 Building 984

A fire in Building 984 could involve the packaging materials or wood crates. In either case, a severe fire could result in damage to the structure and contents. Based on capital equipment costs provided by FPE, the cost of the structure is approximately \$100,000 and the value of the contents in Building 984 is approximately \$10,000. Since the crates will contain LLW, contamination cleanup will be required. The extent of contamination spread will be dependent upon the severity of the fire, number of LLW crates involved, radiological inventory of the crates, and the damage to the structure. As a minimum, cleanup of the contaminated structure will be required. This yields a contamination cleanup cost of approximately \$1,780,000 (276 m^2 x \$6,450/m^2). The total MPFL for Building 984 including loss of structure, contents, and contamination cleanup is approximately \$1.9 million. Since the building is not provided with an automatic sprinkler system, the MCFL is equal to the MPFL.

Since the MPFL is greater than \$1 million, an automatic sprinkler system is required in Building 984 based on DOE Order 5480.7A loss limitations. Currently, Building 984 does not comply with DOE Order 5480.7A loss limitations. Either the building needs to be provided with an automatic sprinkler system, or radiological materials should not be stored in the building.

991-97-008 *Since the MPFL for Building 984 is greater than \$1 million, an automatic sprinkler system is required per DOE Order 5480.7A. Either install an automatic sprinkler system or do not store radiological materials in the building.*

[redacted]

Based on information provided by Site personnel, the radiological inventories of the crates are expected to be low. As a result, the level of cleanup required following a fire may be less than that estimated above using the cleanup costs found in the reference "Clean-up Costs for Use in FHAs (U)," [Allison, 1993]. However, more appropriate cleanup costs were not available for use in this FHA. If the values used in this FHA are not applicable based on the type and quantity of radiological materials to be stored in Building 984, an analysis should be performed to determine appropriate cleanup costs for a fire involving the LLW storage crates.

5.3.4 Building 985

A fire involving stored miscellaneous combustibles is the worst case fire scenario for Building 985. At the time of the walkthrough, there was sufficient combustibles materials being stored in the building to result in a severe fire. Since the combustible materials were isolated in one area of the building and no combustible materials were being stored elsewhere, fire spread would be limited. However, heat and smoke from a fire could damage the HVAC equipment in the building. Since there are no separations in the building, equipment throughout the facility could be damaged.

Based on the maximum anticipated fuel loading and fire potential in the building, a fire is not expected to breach the filter plenums and involve the HEPA filters in fire. While a fire could damage contents within the building, damage to the structure is not expected based on the limited potential fire size and the building's concrete construction. Therefore, the MPFL for Building 985 is limited to loss of building contents.

The MPFL for Building 985 is equal to the value of the contents in Building 985, or $250,000. Since the automatic sprinkler system was not operational at the time of the walkthrough, the MCFL is equal to the MPFL. Since the MPFL is less than $1 million, Building 985 does not require automatic sprinklers based on DOE Order 5480.7A loss limitations. However, since the facility houses the HEPA exhaust plenums for the tunnels and vaults, maintaining the existing automatic sprinkler system is desirable. As recommended in Section 4.1.2, the sprinkler system should be repaired and placed back-in-service.

5.3.5 Building 989

A fire involving the diesel fuel contents of the day tank could cause damage to the entire structure and loss of all contents in Building 989. Since there are no radiological materials in the building, contamination cleanup would not be required. The cost of the structure is approximately $1.2 million. The value of the contents in Building 989 is approximately $100,000. This yields an MPFL of $1.3 million.

[redacted]

The automatic dry-pipe sprinkler system is expected to prevent damage to the structure in the event of a diesel fire. However, damage to the generator and other contents in the building could still result. Therefore, the MCFL is equal to $100,000.

Building 989 is provided throughout with an automatic sprinkler system. Since the MPFL is less than $50 million, the facility is in compliance with DOE Order 5480.7A loss limitations.

5.3.6 Building 992

A severe fire in Building 992 would result in loss of the structure and all of its contents. Since there are no radiological materials in the building, contamination cleanup would not be required. The cost of the structure is approximately $300,000. The value of the contents in Building 992 is approximately $200,000. This yields a MPFL of $500,000. Since the building does not have an automatic sprinkler system, the MCFL is equal to the MPFL.

Since the MPFL is less than $1 million, an automatic sprinkler system is not required in Building 992 based on DOE Order 5480.7A loss limitations.

5.4 Life Safety Analysis

The evaluation of life safety within the Building 991 Complex was based on a variety of features including: building use and potential fire severity, installed fire barriers and suppression systems, occupant loading, available egress components, and facility specific operational requirements. NFPA 101, *Life Safety Code* [NFPA, 1994], was used as the primary reference for this evaluation. Since this document is referenced in DOE Order 5480.7A, the minimum requirements of NFPA 101 must be satisfied in order to comply with DOE criteria.

5.4.1 Occupancy and Hazard Classification

Building 991 is classified as a Mixed-Use occupancy consisting of Storage and Business occupancies per NFPA 101. The business areas of the building occupy portions south of column-line "C" (see Figure 3-2) with the remainder of the building being used for storage. The tunnels and vaults connected to Building 991 are used solely for storage and are therefore classified as Storage occupancies. Likewise, Building 984 is also classified as a Storage occupancy. Building 992 is classified as a Business occupancy. The remainder of the buildings in the 991 Complex are classified as Industrial occupancies per NFPA 101. Table 5.2 summarizes the occupancy classifications for each of the buildings in the 991 Complex along with the classification of the hazard of contents for each of the facilities.

[redacted]

Table 5.2 Occupancy Classification and Hazard of Contents

Bldg. No.	Name	Occupancy Type	Classification of Hazard of Contents
991	Production Warehouse	Mixed Use - Storage and Business	Ordinary
992	Guard Post	Business	Ordinary
997, 999, 996	Vaults and Tunnels (West, Center, East)	Storage	Low
998	Vault (North)	Storage	Ordinary*
989	Emergency Power Bldg	Industrial	Ordinary
985	Filter Plenum Bldg	Industrial	Ordinary
984	Shipping Container Storage	Storage	Ordinary

* Although the contents may qualify as low hazard, the only egress is through Building 991, which is ordinary hazard.

The classification of the hazard of contents, per NFPA 101, is based primarily on the combustibility characteristics of the building contents. Classifications are defined as follows:

- Low hazard contents are those of such low combustibility that self-propagating fires can not occur;
- Ordinary hazard contents are those that are likely to burn with moderate rapidity, or to give off a considerable volume of smoke; and
- High hazard contents are those which are likely to burn with extreme rapidity or from which explosions are likely.

The general requirements of NFPA 101 are based on an ordinary hazard classification since this classification represents the conditions found in most buildings. However, in Storage occupancies, NFPA 101 recognizes the storage of noncombustible materials or contents which will not lead to self-propagating fires as low hazard. Therefore, storage areas such as the tunnels and vaults which contain only sealed steel drums may qualify as low hazard per NFPA 101. Although the LLW in the drums presents a radiological concern, the presence of nuclear materials does not increase the hazard of contents as defined by NFPA 101. A low hazard classification, however, necessitates that no other combustible materials be stored in these areas. Full scale drum fire tests [Hughes, 1995a; 1995b] have shown that self-propagating fire between drums will not result without external fire exposures. Therefore, if no other combustible materials are stored in the tunnels or vaults, fire propagation can not occur.

As will be discussed in later sections, maintaining a low hazard classification is necessary in order to satisfy the life safety requirements of NFPA 101 in the tunnel and vault areas.

Although Building 991 may present firefighters some of the difficulties of a "windowless structure", it does not qualify as a "windowless structure" per NFPA 101 because it has doors at grade on three sides. Similarly, it does not qualify as an "underground structure" per NFPA 101.

5.4.2 Occupant Load

The occupant load is the number of persons for which egress capacity must be provided. For Business and Industrial occupancies, the occupant load is calculated based on one occupant per 9.3 m^2 (100 ft^2) of gross floor area. For Storage occupancies, the occupant load is based on the maximum number of people expected in a building at any given time. In this FHA, the occupant load for Building 991, which contains both Storage and Business occupancies, was based on the requirements for a Business occupancy in order to provide a conservative estimate of occupant load and required egress capacity. Since the floor area of Building 991 is 3520 m^2 (37,880 ft^2), the minimum calculated occupant load is 379. Table 5.3 summarizes the occupant loads and exit capacities for the Building 991 facilities.

Table 5.3 Occupant Load and Exit Capacity

Bldg. No.	Name	Calculated Occupant Load	Normal Occupant Load	Number of Exits	Exit Capacity
991	Storage Warehouse	379	110	3	660
992	Guard Post	3	0	1	180
997, 999, 996	Vaults and Tunnels (West, Center, East)	7*	0	1	360
998	Vault (North)	7*	0	1	360
989	Emergency Power Bldg	4	0	2	360
985	Filter Plenum Bldg	24	0	2	720
984	Shipping Container Storage	30	0	2	360

* Based on maximum anticipated number of occupants

From the facility emergency plan, the actual building population is anticipated to be 110 people on day shift, 16 people on 2nd shift, and 10 people on 3rd shift. A minimum of 4 alarm technician personnel occupy Building 991 even during holidays and weekends.

The actual occupant load is appropriately less than the calculated maximum occupant load used to determine required egress capacity.

5.4.3 Capacity of Means of Egress

The egress capacity was calculated in accordance with NFPA 101, Section 5-3.3.1. The egress factor for stairs is 8 mm per person (0.3 in. per person) and for level exits is 5 mm per person (0.2 in. per person). The width of the exit is divided by the appropriate factor to determine the capacity of the exit.

As illustrated in Table 5.3, the capacity of the means of egress from all of the Building 991 Complex facilities exceeds the individual buildings' calculated occupant load and also exceeds the normal occupant loads. Exit access widths exceed 711 mm (28 in.) throughout the buildings, the minimum allowable width per NFPA 101, Section 5-3.4.1 Exception No. 3.

5.4.4 Number of Means of Egress

A minimum of two remotely spaced means of egress are required and are available in Buildings 991, 985, and 984. Small structures, like the Guard Post and the Emergency Generator Building, are only required to have one means of egress. Both these buildings meet or exceed that requirement.

Although Storage occupancies are normally required to have at least two remotely spaced means of egress, since Vaults and Tunnels 996/997/999 are currently considered a low hazard occupancy, only a single means of egress is required per NFPA 101 (Section 29-2.4.1, Exception No. 1). It should be noted that although only a single qualified exit exists for these vaults and tunnels (due to remoteness), occupants can either exit into the northwest corner of Building 991 or out through the covered dock to the outside. Therefore, if one exit is blocked due to a fire in either Building 991 or the covered dock, a second exit is available.

Since the Vaults and Tunnels 996/997/998 are being exempted from the more stringent egress requirements of NFPA 101 due to their low hazard classification, it is necessary to ensure that the level of hazard does not increase in these areas. Additionally, since Building 991 is considered an ordinary hazard occupancy, provisions must be made to prevent a fire in Building 991 from blocking egress from the tunnel and vault areas. While the current separation will adequately prevent fire spread between the two areas, smoke spread into the tunnels could inhibit egress. Therefore, providing a smoke barrier between the vault and tunnel areas and Building 991, in addition to the existing fire barrier, is required.

991-97-009 *In order to maintain a low hazard occupancy classification, which is necessary to comply with NFPA 101 egress criteria, implement a formal administrative control program which prohibits the storage of combustible materials, other than within sealed steel drums, in Vaults and Tunnels 996/997/999. Additionally, provide smoke-tight doors between the tunnel and vault areas and Building 991 in order to prevent a fire in Building 991 from inhibiting egress in the tunnel and vault areas.*

Alternatively, if maintaining a low hazard classification is not feasible within Vaults and Tunnels 996/997/999, a second remote means of egress must be provided in accordance with NFPA 101.

5.4.5 <u>Dead ends and Common Path of Travel</u>

NFPA 101 limits dead end corridors in Business and Industrial occupancies to 15 m (50 ft) in length. In Storage occupancies, the dead end limit is based on the hazard of contents classification. For ordinary hazard, dead end corridors are permitted to 15 m (50 ft) in unsprinklered areas or 30 m (100 ft) in fully sprinklered buildings. In low hazard Storage occupancies, there is no limit on dead end corridors.

Common paths of travel in Business, Industrial, and ordinary hazard Storage occupancies are permitted to 15 m (50 ft) in unsprinklered areas or 30 m (100 ft) in fully sprinklered buildings. For low hazard Storage occupancies, there is no limit on common paths of travel (NFPA 101, Section 29-2.5.2). Table 5.4 summarizes the dead end and common paths of travel for the Building 991 facilities.

The main floor of Building 991 has limited dead end hallways, all of which are within the code allowed maximums. The maximum common path of travel originates in the northeast corner of the building, in the radiography rooms behind labyrinth entrances. The common path of travel from this area is approximately 30 m (100 ft), the maximum permitted by NFPA 101.

The basement of Building 991 has two means of egress. One is an exterior door which discharges upstairs to grade. The second means of egress, upstairs to the first floor, requires occupants to travel through an electrical and mechanical equipment room (Room 130). Because the building is categorized primarily as a Storage facility and the level of hazard in Room 130 is comparable to the remainder of the building, this pathway is considered to be an acceptable means of egress. However, as seen in Table 5.4, exiting distances in the basement exceed the allowed maximums. Therefore, egress conditions in the basement do not comply with NFPA 101 criteria.

Table 5.4 Dead-end and Common Path of Travel

Bldg. No.	Name	Actual Dead-end distance m (ft)	Max allowed Dead-end m (ft)	Actual Common Path of Travel m (ft)	Max allowed Com. Path m (ft)
991	Storage Warehouse (Storage Area)	9 (30)	30 (100)	30 (100)	30 (100)
991	Storage Warehouse (Office Area)	0 (0)	15 (50)	12 (40)	15 (50)
991	Storage Warehouse (basement)	49 (160)	30 (100)	49 (160)	30 (100)
992	Guard Post	0 (0)	15 (50)	9 (30)	15 (50)
997, 999, 996	Vaults and Tunnels (West, Center, East)	221 (725)	No Limit	238 (780)	No Limit
998	Vault (North)	55 (180)	30 (100)	76 (250)	30 (100)
989	Emergency Generator	0 (0)	15 (50)	0 (0)	30 (100)
985	Filter Plenum Bldg	0 (0)	15 (50)	15 (50)	30 (100)
984	Shipping Container Storage	0 (0)	15 (50)	0 (0)	15 (50)

In order to satisfy the requirements of NFPA 101 without providing additional means of egress, the basement area can be classified as a low hazard occupancy. Under these conditions, there are no limitations on dead end corridors or common paths of travel per NFPA 101. As discussed in Section 5.4.2, low hazard occupancies can only contain contents of such low combustibility that self-propagating fires cannot occur. Therefore, in order to be considered a low hazard occupancy, all combustible storage must be removed form the basement.

991-97-010 *Exiting distances in the Building 991 basement exceed allowed maximums for dead ends, common path, and total travel distance. In order to qualify as a low hazard occupancy and satisfy NFPA 101 egress requirements, storage in the basement must be limited to noncombustible materials. Implement a formal administrative control program which prohibits the storage of combustible materials, other than within sealed steel drums, in the basement.*

Maintaining a low hazard occupancy does not prohibit storage of noncombustible materials in the basement. Likewise, as discussed earlier, storage within sealed steel drums qualifies as low hazard since a self-propagating fire cannot result. If limiting the storage in the basement to noncombustible materials is not a feasible option, alternative approaches exist such as sealing off the basement or providing additional exiting from the basement.

Since Vaults and Tunnels 996/997/999 are classified as a low hazard occupancy, there are no limitations on dead end corridors or common paths of travel. However, if these areas were classified as ordinary hazard, they would exceed the allowable dead end and common path of travel distances by a factor of five to fifteen times. Therefore, it is necessary to maintain a low hazard classification for these areas, as recommended previously, in order to satisfy NFPA 101 criteria.

Building 998, the north storage vault and tunnel, exceeds the NFPA 101 dead end corridors and common paths of travel limits by a factor of two. Because the only means of egress is through Building 991, which is classified as ordinary hazard, Building 998 cannot be classified as a low hazard storage facility. Short of installing a second means of egress from the tunnel and vault area, egress conditions in Building 998 will not meet NFPA 101 criteria. However, automatic sprinklers in these areas provide an added level of protection to occupants. In addition, it would be advisable to implement a formal administrative control procedure that prohibited all storage of combustible materials in the tunnel and vault, including wood pallets used for drum storage. While minimizing the fuel loading increases the level of safety, the egress conditions in Building 998 represent a code deficiency and require a formal DOE approved Exemption to document the code compliance issue.

991-97-011 *Building 998, the north storage vault and tunnel, exceeds the NFPA 101 allowable dead end and common path travel distance limits by a factor of two. To compensate for this hazard, implement a formal administrative control procedure that prohibits all storage of combustible materials in this area. Additionally, a formal DOE approved Exemption should be obtained to document this code compliance issue.*

The small size of Building 992 causes no difficulties with dead ends or common path of travel. The remaining facilities, Building 985, Building 984, and Building 989, all have two remotely spaced exits and thus comply with requirements for dead end hallways and common paths of travel.

5.4.6 Travel Distance to Exits

Travel distance is defined as the length of a path from the point farthest in the building to its nearest exit. Normal exits are exterior doors which permit egress into a "public way," or in this case, the outside yard and roads. Horizontal exits are doors in minimum 2 hour fire resistance rated barriers. Thus a person crossing a fire barrier and

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closing fire doors behind him is determined to be safe from a fire; thus travel distance stops at the fire doors. Table 5.5 summarizes the maximum allowable travel distances per NFPA 101 for Storage, Business, and Industrial facilities and Table 5.6 summarizes the travel distances for the Building 991 facilities.

Table 5.5 Travel Distance Requirements

Occupancy	Required Travel Distance to Exit m (ft)
Storage - unsprinklered	60 (200)
- sprinklered	122 (400)
- low hazard	No Limit
Business - unsprinklered	60 (200)
- sprinklered	91 (300)
Industrial - sprinklered	76 (250)

Table 5.6 Building 991 Complex Travel Distances

Bldg. No.	Name	Max Allowed Travel Distance	Actual Travel distance to Exit
991	Storage Warehouse (main level storage areas)	122 (400)	76 (250)
991	Storage Warehouse (main level business area)	91 (300)	46 (150)
991	Storage Warehouse (basement)	122 (400)	79 (260)
992	Guard Post	60 (200)	9 (30)
997, 999, 996	Vaults and Tunnels (West, Center, East)	No Limit	268 (880)
998	Vault (North)	122 (400)	85 (280)
989	Emergency Generator	76 (250)	6 (20)
985	Filter Plenum Bldg	76 (250)	15 (50)
984	Shipping Container Storage	60 (200)	15 (50)

The maximum travel distances throughout all areas of Building 991 are within code-allowed limits.

Travel distances within Vaults and Tunnels 996/997/999 are not limited as long as a low hazard occupancy classification is maintained. If combustible materials are stored in these areas, an ordinary hazard classification would result and travel distances would exceed the maximum allowable by a factor of four. Again, this potential egress deficiency illustrates the need to maintain the low hazard classification as recommended earlier.

Travel distance to the outside from Building 998, the north tunnel and vault, exceeds the maximum allowable travel distance to an exit. However, the horizontal exit in the main north-south corridor of Building 991 provides an additional exit which is reached well within the allowable travel distance. Therefore, travel distance form Building 998 satisfies NFPA 101 criteria.

The smaller out buildings in the Building 991 complex comply with NFPA 101 travel distance requirements, as noted in Table 5.6.

5.4.7 Lighting and Marking of Exits

Normal illumination of exits in all of the Building 991 Complex facilities is adequate. Emergency lighting in Building 991 is provided by a combination of dual lamp sealed beam battery powered units mounted on walls, and emergency diesel generator backup power provided to the ceiling fluorescent lighting system.

Doors and exit access corridors are clearly marked with illuminated exit signs. The doors are kept unobstructed and all the doors swing in the direction of egress.

5.4.8 Minimum Construction Requirements

There are no minimum construction requirements for Storage, Business, or Industrial occupancies.

5.4.9 Interior Finish

Interior finish is required to have a maximum flame spread rating of 200 and a maximum smoke developed rating of 450 per NFPA 101. Interior finish in the Building 991 facilities is primarily paint on concrete, concrete block, or gypsum board. Interior finish is in accordance with NFPA 101 requirements in Building 991 and all its support facilities.

5.4.10 Safeguards and Security Considerations

The Building 991 Complex facilities have a number of Safeguards and Security features which restrict access to certain areas. However, with few exceptions, these functions do not impede egress from the building in an emergency. As an example, many

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[redacted]

of the exterior doors are locked from the outside, and alarmed if opened, but they are not locked to prevent movement in the direction of egress.

There is a 1.67 m (66 in.) wide hinged screen door in Tunnel 996, which has a 25 mm (1 in.) diameter twist-type thumb knob to operate the latch for egress. This lock does not comply with Code requirements. However, given the limited occupancy of this area, and occupant familiarity, this door is not considered to be a problem.

At the time of inspection, all the heavy bank vault-type doors were ajar and did not have automatic door closers. Several minor concerns exist with these doors. If someone were to be inadvertently locked in a vault, several of the doors have no means of opening from the inside, the remaining doors have a difficult multi-step operation required to open from the inside. Additionally, due to lack of use and personnel attrition, the combinations are no longer available for some of the vaults. It is recommended that one or more of the following options be implemented:

- Rework the locking mechanisms so that egress from inside is always readily available;
- Mechanically secure the doors in the open position, or mechanically restrict the doors from closing;
- Rework the doors so that all the combinations are available in an emergency;
- Install a "panic button" on the inside of any room in which people might be trapped; and/or
- Implement a formal "two man rule" administrative control, whereby every person entering any such room always has a "buddy" who stands by immediately <u>outside</u> the doors in question, to prevent difficulties, and summon help in an emergency.

The previous FHA addressed this issue and provided appropriate recommendations to resolve the deficiency. Previous findings/recommendations are presented in Section 5.5 of this FHA.

5.5 Review of Open Fire Protection Items

This section identifies all "open" fire protection issues from previous FHAs and Fire Prevention inspections. Table 5.7 summarizes all previously identified findings and deficiencies for the Building 991 Complex. The status of the findings was verified to the extent possible through the facility walkthrough, conversations with Site personnel, and review of the FPE building files. Items which warrant particular attention are also discussed within the context of this FHA.

Table 5.7 Previously Identified Findings/Deficiencies

Bldg	Room	DATE	SOURCE	RECOMMENDATION/VIOLATION	STATUS	COMMENTS
991	base-ment	9/1/95	FHA, 991-95-1	Exiting distances in the Building 991 basement exceed allowed maximums for dead ends, common path, and total travel distance.	Current	Addressed in Section 5.4. A new recommendation has been provided to address this issue. Old recommendation should therefore be closed.
vaults, tunnels		9/1/95	FHA, 991-95-2	Vaults and Tunnels 996/997/999 grossly exceed the allowable dead end, common path, and total travel distances by a factor of 5 to 15 times.	Closed	Addressed in Section 5.4. As long as a low hazard occupancy classification is maintained, egress conditions are compliant with NFPA 101.
998		9/1/95	FHA, 991-95-3	Building 998, the north storage vault and tunnel, exceeds the allowable dead end, common path, and total travel distance limits by a factor of 2 and 4.	Current	Addressed in Section 5.4. Travel distance is within code allowed limits, however, dead end and common path exceed NFPA 101 criteria. New recommendation provided. Old recommendation should be closed.
vaults		9/1/95	FHA, 991-95-4	Several minor concerns exist with the 996/997/999 vault doors. Implement an optional solution such as mechanically securing the doors in the open position.	Current	Addressed in Section 5.4. Recommendation carried over.
991	outside	9/1/95	FHA, 991-95-5	Combustible commodities storage near Hydrant #9-4 must be relocated 40 ft away from the hydrants.	Closed	Storage removed.
991	134	9/1/95	FHA, 991-95-6	A fire in Room 134 rack storage could grow unchecked and overtax the sprinkler system, causing total loss of the building contents due to smoke and heat damage.	Closed	Combustible storage has been removed from Room 134. The area is used solely for drum storage and does not present a hazard which will challenge the sprinkler system.
991	134/140	9/1/95	FHA, 991-95-7	Two small duct penetrations were observed in the wall between Room 134 and Room 140, which do not have fire dampers. Penetrations through rated barriers are required to have Class B (1-1/2 hour) fire dampers.	Current	Addressed in Section 4.3. New recommendation provided. Old recommendation should be closed.
991	134	9/1/95	FHA, 991-95-8	Palletized storage of Celotex materials reduce the required 8 foot aisle space in Room 134 to 5 feet, overloading the room with combustible materials.	Closed	Combustible storage has been removed from Room 134. The area is used solely for drum storage and does not present a hazard which will challenge the sprinkler system.
991	170	9/1/95	FHA, 991-95-9	Repair or replace the fire door from Room 170, the enclosed dock area, to Room 141, I&C area.	Current	Addressed in Section 4.3. New recommendation provided.
991		9/1/95	FHA, 991-95-10	Establish a formal documented fire protection program in place for Building 991. It should document formal lines of fire protection responsibility within the facility, for routine and emergency situations, coordinating with the emergency plan.	Current	Recommendation carried over.
991	158	9/1/95	FHA, 991-95-11	A determination needs to be made if the x-ray films that are stored in Vault Room 158 are Vital.	Closed	X-ray film has been removed from Room 158 and relocated to another facility.
984	outside	9/1/95	FHA, 991-95-12	Relocate piled pallet storage at least 50 ft away from Building 984.	Closed	Storage has been removed.

Table 5.7 Previously Identified Findings/Deficiencies

Bldg	Room	DATE	SOURCE	RECOMMENDATION/VIOLATION	STATUS	COMMENTS
991	outside	9/1/95	FHA, 991-95-13	Relocate the outdoor storage of flammable liquids at the maintenance facility north of Building 991 so they cannot run down hill and impact Building 991.	Current	This was not verified during the latest inspection; however, if the flammable liquids still exist, they should be relocated accordingly. Recommendation carried over.
991	outside	9/1/95	FHA, 991-95-14	Cut the weeds and brush around the two oil-filled transformers at the east end of Building 991.	Closed	Weeds and brush were cut and did not present an exposure hazard at the time of the walkthrough.
991		9/1/95	FHA, 991-95-15	Correct the labeling on numerous 55-gallon sealed steel drums containing beryllium parts that were labeled "Poison."	Current	This was not verified during the latest inspection, however should be resolved. Recommendation carried over.
991	143, 300, 170	9/1/95	FHA, 991-95-16	Resolve sprinkler head spacing difficulties in Room 143, 300, and west canopy area.	Closed	The spacing in Rooms 143 did not present a serious problem; Room 300 was not identified during the inspection.
991	base-ment	9/1/95	FHA, 991-95-17	Rearrange storage in the basement utility tunnel that is within 18" of the sprinkler heads.	Closed	Storage was not within 18 in. of the sprinklers. As additional storage is moved to the basement, an 18 in. clearance must be maintained.
991	riser	9/1/95	FHA, 991-95-18	Upsize the horizontal standpipe system 12" feed to 22" near the main riser. This would require replacing a short (4 foot) piece of pipe.	Closed	The horizontal standpipe system is not required by code, nor is it a part of the Fire Department's Pre-Fire Plan.
991	base-ment	9/1/95	FHA, 991-95-19	Resolve smoke detector spacing minor deficiencies in vault storage rooms and tunnel areas.	Closed	Existing system is not required per NFPA 101. Any modifications to the system should comply with NFPA 72. New recommendation provided.
991		9/1/95	FHA, 991-95-20	Remove stenciled signs indicating fire walls from those locations not required to be fire walls, such as the south wall of Room 134.	Current	Several walls which are not maintained fire walls still have stencil markings. Recommendation carried over.
991	130	6/20/95	FPB, 991-95-0183	Fire door number 991-002 does not close and latch completely.	Closed	Door is not in a maintained fire barrier and is therefore, not required.
991	130	2/14/97	FPB, 991-97-027	Fire door number 02 is blocked open.	Closed	Door was not blocked open during inspection. Door is not in a maintained fire barrier and is therefore, not required.
991/996	149	6/20/95	FPB, 991-95-0184	Fire door number 991-011 does not close and latch completely.	Current	Door separates Room 149 from the 996 tunnels and should be maintained in proper working order. A new recommendation is provided to replace this door with a smoke tight door.
991	170	6/4/96	FPB, 991-96-076	Sprinkler head not approved for use, wrong type installed.	Current	Sidewall sprinkler should be replaced with sprinkler listed for Ordinary Hazard. New recommendation provided.

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6.0 FIRE DEPARTMENT RESPONSE AND EMERGENCY PLANNING/RECOVERY POTENTIAL

The Rocky Flats Environmental Technology Site maintains a well trained and professionally staffed fire department. Operations within the department include; fire suppression, emergency medical and hazardous material response, training, and the Fire Prevention Bureau activities. Firefighters have been trained and certified by the State of Colorado for fire fighting and hazardous materials emergency response in addition to meeting the Department of Energy's training requirements to comply with NFPA 1500, *Fire Department Occupational Safety and Health Program*.

The Fire Department is staffed 24 hours a day, seven days a week. The Fire Department maintains an operational level of 12 (two of which must be ranked Captain or above). Each Engine Company is staffed with four personnel. The Fire Department station is located approximately 3/4 mile west of the 991 Complex. Response time to Building 991 is less than 5 minutes and the time for the fire fighters to begin suppression activities is estimated at 15 minutes.

A detailed, current Pre-Fire Plan [Rocky Flats Fire Department, 1997] has been developed for Building 991. The plan is well written and addresses the issues that are important to responding Fire Department personnel. The Fire Department responds to a first alarm with two engine companies, a medical unit, and a Battalion Chief command. The first engine response is determined by the Company Officer's initial size-up. The second engine connects to the fire area sprinkler system and supports interior fire suppression.

Fire Department response is credited in the accident analyses of the DSAR; however, in accordance with DOE Order 5480.7A, the Fire Department is not credited in the MPFL and MCFL analyses for the FHA.

6.1 Emergency Response Equipment

The following numbers and types of mobile fire (and other emergency response) apparatus and equipment are available at this Site:

(3) Class "A" 1250 gpm engines, one is a reserve pumper
(2) ALS Rated ambulances
(1) Heavy Rescue Unit
(1) Haz-Mat Van
(1) Haz-Mat Trailer
(1) Breathing Air Trailer
(1) Technical Rescue Trailer
(1) Command Suburban
(4) Mobile Support Units
(3) Central Supply Haz-Mat Cargo Containers

Most of the apparatus was purchased in 1992, so it is relatively new. Vehicle access to the 991 Complex is via paved roads.

6.2 BEST Team

Buildings 991 does not maintain a Building Emergency Support Team (BEST) program.

6.3 Mutual Aid

The Site has mutual aid agreements in place with three nearby district fire departments (Coal Creek, City of Westminster, and Jefferson County). According to FPE personnel, the mutual aid is limited to assistance outside the nuclear buildings; i.e. exposure protection, external fires, trailer fires, and non-nuclear facility fires.

7.0 TABULATION OF FINDINGS, DEFICIENCIES, AND RECOMMENDATIONS

This section of the report consolidates all of the recommendations presented elsewhere in this FHA. The recommendations are provided to improve the level of safety and minimize the potential fire hazard for the Building 991 Complex. Should prioritization of recommendations be required, please contact the Manager of FPE for concurrence prior to implementation.

991-97-001 *Replace the Light Hazard sidewall sprinkler in the west dock area with a sprinkler approved for use in Ordinary Hazard occupancies.*

991-97-002 *Repair or replace the damaged retard chamber on the Building 985 automatic sprinkler system riser and restore the suppression system.*

991-97-003 *Modifications to the existing smoke detection system installed in the tunnels and vaults should comply with NFPA 72 criteria.*

991-97-004 *Repair the doors in the fire barrier which connect Rooms 140 and 170 so that they automatically close and latch properly.*

991-97-005 *The duct penetrations in the credited 2 hour fire resistance rated barrier between Rooms 134 and 140 must be equipped with 1½ hour fire-rated dampers or constructed in a manner that is equivalent to the construction requirements outlined in DOE Exemption Request, RFP-DOE-5480.7-EX-1, Use of Fire Dampers with HVAC Ductwork. Alternative measures, other than those presented above, such as limiting combustible loading or activities in the area may be acceptable but must be supported by appropriate engineering analyses and approved by FPE.*

991-97-006 *Insure that the fire door separating the basement from the first floor operates properly and is not blocked open.*

991-97-007 *Remove/relocate the miscellaneous storage materials in Building 985 to an area which will not expose the HEPA filter plenums.*

991-97-008 *Since the MPFL for Building 984 is greater than $1 million, an automatic sprinkler system is required per DOE Order 5480.7A. Either install an automatic sprinkler system or do not store radiological materials in the building.*

991-97-009 *In order to maintain a low hazard occupancy classification, which is necessary to comply with NFPA 101 egress criteria, implement a formal administrative control program which prohibits the storage of combustible materials, other than within sealed steel drums, in Vaults and Tunnels*

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996/997/999. Additionally, provide smoke-tight doors between the tunnel and vault areas and Building 991 in order to prevent a fire in Building 991 from inhibiting egress in the tunnel and vault areas.

991-97-010 *Exiting distances in the Building 991 basement exceed allowed maximums for dead ends, common path, and total travel distance. In order to qualify as a low hazard occupancy and satisfy NFPA 101 egress requirements, storage in the basement must be limited to noncombustible materials. Implement a formal administrative control program which prohibits the storage of combustible materials, other than within sealed steel drums, in the basement.*

991-97-011 *Building 998, the north storage vault and tunnel, exceeds the NFPA 101 allowable dead end and common path travel distance limits by a factor of two. To compensate for this hazard, implement a formal administrative control procedure that prohibits all storage of combustible materials in this area. Additionally, a formal DOE approved Exemption should be obtained to document this code compliance issue.*

Previously Identified "Open" Deficiencies

991-95-4 Several minor concerns exist with the 996/997/999 vault doors. Implement an optional solution such as mechanically securing the doors in the open position.

991-95-10 Establish a formal documented fire protection program in place for Building 991. It should document formal lines of fire protection responsibility within the facility, for routine and emergency situations, coordinating with the emergency plan.

991-95-13 Relocate the outdoor storage of flammable liquids at the maintenance facility north of Building 991 so they cannot run down hill and impact Building 991.

991-95-15 Correct the labeling on numerous 55-gallon sealed steel drums containing beryllium parts that were labeled "Poison."

991-95-20 Remove stenciled signs indicating fire walls from those locations not required to be fire walls, such as the south wall of Room 134.

8.0 REFERENCES

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APPENDIX A

ANALYSIS OF DRUM FIRE EXPOSURE AS A FUNCTION OF SEPARATION DISTANCE

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The purpose of this appendix is to establish acceptable separation guidelines between combustible fuel packages and solid waste storage drums containing radiological materials. Minimum separation distances were determined based on the maximum radiative heat exposure to drums from a fire involving nearby storage materials in conjunction with drum failure criteria developed from full scale fire tests.

In this analysis, combustible fuel packages were treated as an all inclusive group in order to provide general guidelines which could be applied to any combustible storage materials and/or configurations. However, specific scenarios may exist which warrant individual analyses. Such analyses may demonstrate the need for lesser or greater separation distances depending upon the potential fire exposure and/or radiological risk. In general, the guidelines established herein provide a feasible means of preventing undue fire exposures to solid waste drums from fires involving typical ordinary combustible materials.

Guidelines have been specified for assessing potential fire development in drum storage areas [Hughes, 1996]. The *Drum Methodology* outlined in the guidelines provides a tool for predicting the performance of drums under various fire exposures in order to assess the extent of fire spread. While the analysis presented in this appendix follows the documented methodology, the purpose of this analysis is not to predict the extent of drum involvement or fire spread. Rather, this analysis is intended to provide a basis for determining acceptable operational guidelines with respect to combustible storage in areas containing solid waste drums. The operational guidelines were designed to minimize the potential risk of fire involvement and radiological release; therefore, conservative assumptions and engineering judgement were used in conjunction with the *Drum Methodology* to provide acceptable storage criteria.

The approach used in this analysis was to provide a bounding representation of the potential storage fires in a space in order to determine the impact of their exposure on solid waste storage drums. The hazard presented by exposing solid waste storage drums to fire is the potential for causing lid loss or lid seal failure of the drums and subsequent fire involvement of the contents. Involving the contents of the drums can increase the level of contamination cleanup required due to smoke spread through a facility and in some cases can result in a potential release of contamination to the outside.

Quantification of drum performance under fire conditions was based on full scale fire test results and analytical analyses performed by Hughes Associates, Inc. [1995a, 1995b]. The results of these studies indicate that different modes of drum failure can occur, ranging from complete lid loss with subsequent burning of drum contents to venting of the drum due to degradation of the lid gasket material.

Following lid loss failure, the drum contents are exposed to the fire (some of the contents may be expelled from the drum during lid loss) and will burn until all of the combustible fuel is consumed. When venting occurs, rather than lid loss, the combustible contents in the drum will pyrolize but typically have insufficient oxygen to support flaming combustion inside the drum. However, pyrolysis gases venting from the drum often form flaming jets which can expose nearby drums and/or combustible materials. Although the total quantity of drum contents which will burn following venting is small compared to the quantity involved following lid loss, contamination spread can still result due to heated air and pyrolysis products escaping from the drum at the lid seal.

Drum lid loss occurs as a result of a rapid pressure rise within the drum prior to significant degradation of the seal gasket. In order for this to occur, the drum must be exposed to an intense heat flux over a short period of time. The *Drum Methodology* [Hughes, 1996] establishes guidelines which can be used to predict lid loss failure. The drum fire testing and heat transfer analyses outlined in the methodology indicate that if a target drum is exposed to an incident heat flux of less than 45 kW/m^2, lid seal failure, rather than lid loss is expected. For fire exposures of 45 to 75 kW/m^2, either lid loss or lid seal failure is possible. For incident heat fluxes greater than 75 kW/m^2, lid loss is expected. The use of 45 kW/m^2 as a critical limit for lid loss represents the most conservative analysis.

During the full scale drum testing, drums located outside the initiating fire did not experience lid loss due to fire radiation. However, fire radiation did result in pyrolysis of the combustible drum contents and venting of the contaminated combustion products. Since radiant exposures greater than 45 kW/m^2 are possible for drums located outside the fire, lid loss failure for these drums is considered possible. In this analysis, separation distances between drums and fuel packages were established to negate the possibility of lid loss failure and to minimize the potential for venting.

For the full scale tests resulting in lid loss, the average fire exposure time required to cause lid loss was approximately 120 seconds. Additionally, drum wall temperatures in excess of 600°C were observed in all tests resulting in lid loss failure. Under less severe exposures (less than 45 kW/m^2), degradation of the drum lid seal gasket occurs, thus allowing the drum to vent before sufficient pressure is generated in the drum to cause lid loss. Although no general criteria was established for lid seal failure from the tests, exposure temperatures on the order of 100-200°C were found to be sufficient to cause drum venting due to degradation of the lid seal gasket.

Figure A-1 illustrates the heat transfer mechanisms involved with a burning fuel package radiating to a nearby storage drum. The radiative heat flux incident upon the drum is a function of both the emissive power of the flame and the separation distance from the fire. The incident radiative heat flux is given as [Drysdale, 1985]:

 [redacted]

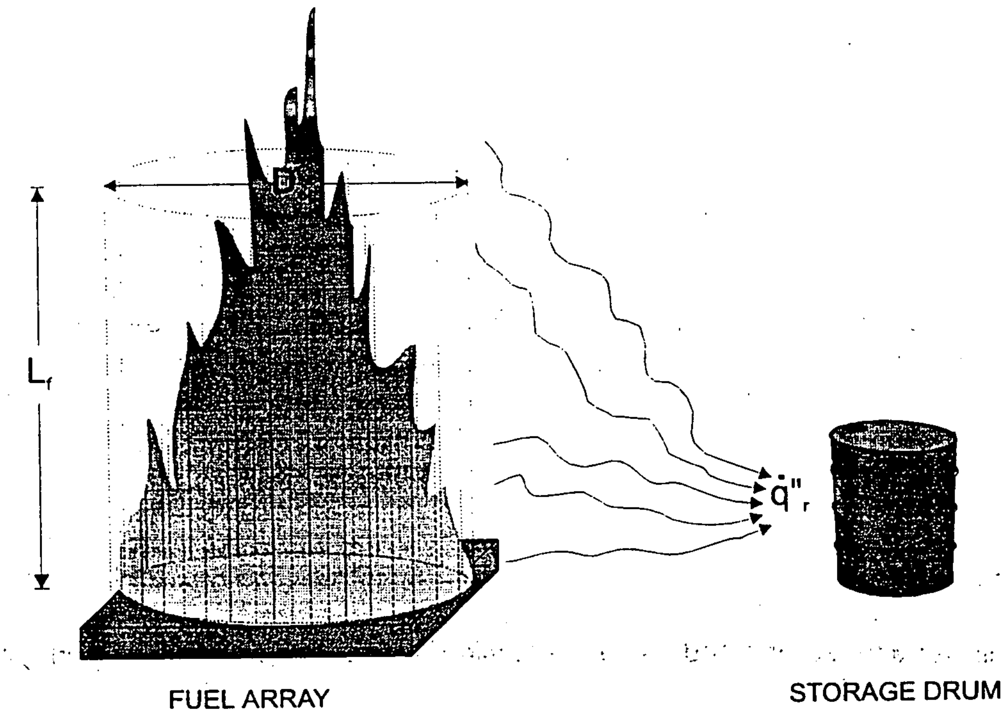


Figure A-1. Fuel Array

$$\dot{q}_r'' = \dot{q}_{fl}'' \, F_{drum-fl} \tag{A-1}$$

where $\dot{q}''_r$ is the incident radiative heat flux to the drum,
$\dot{q}''_{fl}$ is the emissive power of the flame, and
$F_{drum-fl}$ is the configuration shape factor between the drum and the flame.

The emissive power of the flame is dependant upon both the fuel and fire size. Ample data is available in the literature for the emissive power of liquid pool fires (e.g., gasoline, LNG, LPG, etc.) [Mudan and Croce, 1995]; however, data are not widely available for ordinary combustible fires. Therefore, in this analysis, data for liquid pool fires was used to estimate the emissive power of the various fires.

Two principle correlations of emissive power are available by Mudan and Croce [1995], and Shokri and Beyler [1989]. The Mudan and Croce correlation estimates the emissive power to be in the range of 120 kW/m^2 for pool fire diameters of 1 to 2 meters. For the same fire sizes, Shokri and Beyler estimate the emissive power to be roughly 60 kW/m^2. In order to provide a bounding analysis, an emissive power of 120 kW/m^2 was assumed for the fires considered herein. This emissive power is expected to be a bounding value for fires involving ordinary combustibles.

The configuration shape factor between the fire and the drum was estimated by treating the flame as a cylinder. The diameter of the cylinder was assumed to be that of a circular fuel source having an area equivalent to the actual fuel package. The height of the cylinder was determined using the Heskestad flame height correlation, given as [Heskestad, 1983]:

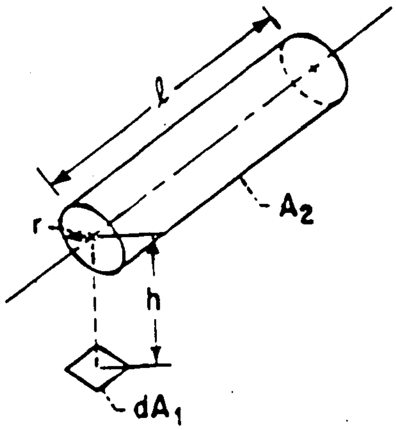
$$L_f = 0.23\dot{Q}^{2/5} - 1.02D \tag{A-2}$$

where L_f is the flame height (m),
Q is the heat release rate of the fire (kW), and
D is the equivalent diameter of the fire (m).

The configuration shape factor between the drum and fire was based on a plane element to a right circular cylinder of finite length and radius as shown in Figure C-2. Radiation to an element yields the maximum radiative heat flux estimate to the drum since the element is perpendicular to the cylinder axis. For a drum, the actual incident heat flux will decrease from the point perpendicular to the fire along the curvature of the drum wall.

[redacted]

CONFIGURATION: Plane element to right circular cylinder of finite length and radius, normal to element passes through one end of cylinder and is perpendicular to cylinder axis.



DEFINITIONS: $L = \ell / r \qquad H = h/r$

$X = (1 + H)^2 + L^2$

$Y = (1 - H)^2 + L^2$

GOVERNING EQUATION:

$$F_{d1-2} = \frac{1}{\pi H} \tan^{-1} \frac{L}{\sqrt{H^2 - 1}} + \frac{L}{\pi}\left[\frac{X - 2H}{H\sqrt{XY}} \tan^{-1}\sqrt{\frac{X(H - 1)}{Y(H + 1)}} - \frac{1}{H} \tan^{-1}\sqrt{\frac{H - 1}{H + 1}}\right]$$

Figure A-2. Configuration Shape Factor

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Several different fuel packages were considered in order to estimate the radiative heat exposure to a drum. The primary fuel packages considered consist of mixed cellulosic and plastic combustibles representing miscellaneous storage materials. The heat release rate per unit area was estimated as 400 kW/m^2 based on experimental data for similar fuels [Babrauskas, 1995]. In order to bound the fire sizes which are likely to expose a storage drum, a number of fire areas were chosen ranging from 1 to 10 m^2 (11 to 108 ft^2). This yielded fire sizes ranging from 400 to 4,000 kW. Although a fire may be larger than this in a space, the portion of fire which exposes a given drum is expected to be bounded by the above fire sizes.

Also considered was the fire involvement of a 1.2 m (4 ft) high stack of wood pallets. The heat release rate per unit area was based on fire test data for wood pallets and was estimated as 2,500 kW/m^2 [Babrauskas, 1995]. For the 1.5 m^2 stack of pallets, this yielded a peak fire size of approximately 3,750 kW.

Table A-1 summarizes the maximum incident radiative heat flux to a drum at various separation distances from the edge of the fuel package for a number of different fuel packages. As seen from the results, the radiative heat flux quickly drops as the drum is moved away from the fire.

Table A-1 Summary of Radiative Heat Flux Based on Separation Distance

Diameter (m)	HRR (kW)	L_f (m)	Maximum Radiative Heat Flux to Drum (kW/m^2)				
			0.5 m	1.0 m	1.5 m	2.0 m	2.5 m
Mixed Combustibles							
1.1	400	1.4	32.9	20.5	13.5	9.3	6.8
1.6	800	1.7	38.7	26.7	18.8	13.7	10.3
2.5	2,000	2.3	44.8	34.5	26.6	20.7	16.4
3.6	4,000	2.7	48.9	40.3	32.9	26.8	22.0
1.2 m High Wood Pallet Stack							
1.4	3,750	4.8	35.9	25.7	19.9	16.1	13.3

Determining an acceptable separation distance between drums and fuel packages was based on a number of factors. The most important criteria was to prevent the possibility of lid loss and subsequent fire involvement of the drum contents. In addition to lid loss, minimizing the potential for lid seal failure was important also. While lid seal failure is less severe than lid loss, it can still result in contamination spread due to venting.

Table A-1 provides an indication of the minimum separation distances required to prevent specific radiative heat exposures to a drum. However, the analysis did not account for any potential movement of the fuel package and/or drums prior to or during a fire event. Such movement could result from instability of the fuel package while it is burning, an accident involving the fuel package and/or drums, or where administrative controls were not strictly followed. The determination of acceptable storage guidelines must also consider unforseen circumstances and should not be based on the absolute minimum acceptable limit.

A separation distance of 1.0 m (3.2 ft) yields incident heat fluxes less than 45 kW/m^2, the critical limit for lid loss failure (see Table A-1). However, at this distance, the radiative heat fluxes will likely cause drum venting and pyrolysis of the combustible contents. In addition, a 1.0 m (3.2 ft) separation distance does not allow leeway for shifting or movement of a fuel package and/or drums. Shifting of a fuel package or drum toward one another can result in radiative heat exposures exceeding 45 kW/m^2. Therefore, providing an additional factor of safety is desirable. A minimum separation distance of 1.5 m (5 ft) is considered reasonable to minimize the possibility of drum lid loss and to also provide low radiant exposures to the drum thereby reducing the possibility of drum venting.

The fuel packages considered in this analysis do not represent all possible fire scenarios; however, they provide a representative basis for determining general storage separation criteria. In cases where maintaining such recommended separation distances is not possible or will cause undue hardship, less stringent criteria may be acceptable. For these cases, a separate analysis should be conducted which considers the specifics of the individual scenario. Depending upon the scenario, less conservative assumptions than those used in this analysis may be appropriate. Using less conservative assumptions will result in smaller required separation distances. However, caution should be used when reducing the separation distance between drums and fuel packages since doing so increases the risk of drum failure and subsequent contamination release from the exposed drums.

DRAFT

BUILDING 991

FINAL SAFETY ANALYSIS REPORT

IMPLEMENTATION PLAN

Revision 0
August 29, 1997

DRAFT

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Implementation Plan
for the
Building 991 Final Safety Analysis Report

Prepared by:

James L. Morse (E2), Editor
RMRS Field Services

Peter M. Sauer
RMRS Building 991 Facility Manager

Richard P. Dunn, Manager
RMRS Solid Waste Operations

Approved by:

Martin Wheeler, Vice President
RMRS Waste Management Operations

Implementation Plan
for the
Building 991 Final Safety Analysis Report

1.0 PURPOSE

The purpose of this Implementation Plan is to inform the Rocky Flats Field Office (RFFO) of the plan to achieve full compliance with the requirements contained in the Building 991 Final Safety Analysis Report (FSAR). This Plan provides:

- A justification of the adequacy of the plan to achieve full FSAR implementation, and
- The planned actions and schedule to achieve full compliance

2.0 JUSTIFICATION OF ADEQUACY

2.1 INTRODUCTION

This justification of adequacy depicts a performance-based rationale for the adequacy of the plan for implementation of the Final Safety Analysis Report. Implementation of the FSAR for Building 991 relies on completing those actions necessary to ensure adequate control and institutionalization of the Authorization Basis for the performance of baseline activities. The method of implementation is based on the hazards identified in the building, the risks associated with baseline activities, the current physical condition of the facility and its hardware systems, and the mission of the facility.

2.2 FACILITY INORMATION

The primary mission of Building 991 and its associated underground tunnels and vaults includes warehousing functions of receiving, storage, and shipping of special nuclear material (SNM), fissile or radioactive product materials, and transuranic (TRU) and low-level wastes. The building is equipped with a shipping/receiving dock with the capability of and specialized equipment to handle shipments via Safe-Secure Trailers (SSTs), which are required for all shipments of SNM. The facility also houses several operations involving maintenance and repair of site-wide alarm systems, several functional laboratories that are currently inactive, and the nondestructive testing department. Continued operation of Building 991 as a TRU waste storage, transfer, and shipping facility is anticipated during the transitional time that facilities will be converted to a decontamination and decommissioning (D&D) ready phase, as well as throughout actual D&D and environmental restoration phases for all plutonium buildings at RFETS. A complete description of the building operation and history is found in the Building 991 Final Safety Analysis Report, August 1997.

A nuclear facility hazard classification of Hazard Category 2 has been assigned to Building 991 based on radionuclide inventory.

The method of implementation, the risks associated with baseline activities, and the facility hardware systems credited as controls are described later in this plan.

2.3 CHARACTERIZATION OF HAZARDS AND CONDITIONS IN BUILDING 991

An assessment of known characteristics of the facility was conducted by a team of three safety analysts with frequent interfacing with facility and programmatic subjects matter experts. The safety analysis team had sole responsibility for the evaluation of the information presented and began the hazards analysis process by becoming familiar with the physical building, its proposed inventory of wastes, and specific operations as detailed by the waste operations staff. Early hazards analysis sessions identified: 1) the hazards associated with the building, 2) the inventory of the wastes to be handled, and 3) the waste activities to be performed. By reviewing various inventories, conducting walk-downs, and performing a walk-through of each operation, the Building 991 safety analysis team identified hazardous materials and operations located in Building 991. A standardized checklist of hazards identified potential hazard types that could be present in Building 991.

An activity-based hazards analysis of the Building 991 Complex was performed to identify, evaluate, and control hazards associated with waste receipt, storage, transfer and shipping operations. The hazard evaluation identified five accident scenario categories that required evaluation. The four postulated accident categories that could result in a radiological release from the Building 991 Complex are (1) fire, (2) spills, (3) explosion, and (4) natural phenomena (earthquake). Each of the postulated accident categories were evaluated to determine frequency of initiating events, the probable effective Material-At-Risk (MAR) for scenarios, the consequences of releases, and the risk to the maximum offsite individual (MOI) (also known as public), collocated workers, and immediate workers. The risk classes determined from the evaluations credited the preventive and mitigative features currently present in the Building 991 Complex.

Postulated accident scenarios found to be Risk Class I (major risk) or Risk Class II (serious risk) were evaluated to determine if any preventive or mitigative features exist which, if implemented, could reduce the risk to Risk Class III (marginal risk) or Risk Class IV (negligible risk). These features were noted for inclusion in the control set defined by the Technical Safety Requirements (TSRs). The risk associated with postulated accidents scenarios found to be Risk Class III or Risk Class IV are low enough to not require further evaluation. Seven of the eight accident scenarios evaluated resulted in a Risk Class I or Risk Class II to either the MOI, collocated worker, or immediate worker. The acceptability of these risks were evaluated in Section 4.6 of the FSAR. Of the accident scenarios evaluated, none resulted in a MOI dose exceeding 5 rem.

The earthquake scenario is the only scenario resulting in a risk to the collocated and immediate workers of Risk Class I even after additional preventive and mitigative features were

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considered. This risk was deemed acceptable due to the conservatism built into the analysis in respect to the number of waste containers involved in the accident and the quantity of material available for release from the involved drums. Many of the accident scenarios evaluated resulted in a Risk Class II to either the MOI, collocated worker, or immediate worker after additional preventive and mitigative features were considered. These accident scenarios were (1) a fire initiated in the Building 991 office area resulting in heating of drum contents in an adjacent room, pyrolization of the contents, and venting of radiological material through failed drum lid seals, (2) a fire in a LLW crate postulated to be stored under the Building 991 west dock area canopy, (3) a hydrogen explosion in the waste containers (55-gallon drums, TRUPACT II Standard Waste Box (SWB), or metal waste box), and (4) a breach of two 55-gallon drums by a forklift. The conservatism built into the analysis of each of these scenarios as it pertains to the number of waste containers involved in each accident, the quantity of material in each of the involved waste containers, the use of conservative meteorology, and the probability of the event occurring makes these acceptable risks.

Acceptable risk to the public is assumed whenever the low frequency/higher consequence accident scenarios result in "acceptable" radiological doses off-Site. These doses also translate into very minor environmental risks in the unlikely/extremely unlikely probability of the occurrence of these scenarios.

2.4 FSAR IMPLEMENTATION STRATEGY/APPROACH

In order to authorize the continued Building 991 operation, it will be necessary to show that the controls contained in the FSAR have been satisfactorily implemented and verified by an RMRS Readiness Assessment. The FSAR controls are an integrated set. As such, partial implementation would not meet the performance expectations of the control set as described in the FSAR. Therefore, full implementation will be shown in this document and demonstrated during an RMRS Readiness Assessment. Full implementation in this context means:

- Approved facility procedures/operations orders/plans that implement control requirements and their associated bases.
- Approved Training Implementation Matrix (TIM) and documented evidence that the staff has been trained and qualified.
- Facility management systems and infrastructure is in place to manage operations in accordance with administrative control requirements and the administrative program descriptions.

This FSAR Implementation Plan defines the performance criteria against which adequacy of implementation is assessed. The Building 569 Basis of Interim Operation (BIO) Implementation Plan was used as a model. This Plan includes the following:

- For each TSR control and associated Surveillance Requirement(s), the Plan describes how the facility intends to implement and maintain compliance with the control/surveillance expectation (approved procedures, plans, Operations Orders,

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TIM, etc.). Each deliverable is defined so that satisfactory completion can be accepted as evidence of control implementation.

- For each administrative control, the Plan matrices will identify specific Site or RMRS infrastructure procedures to provide the safety function that is in the Programmatic Administrative Control description.
- Identification of the facility management systems and infrastructure that will be in place to maintain compliance with the control set.

Since full implementation is the strategy planned, there will be no need to request approval of short term compensatory actions. Inclusion of a schedule for completion of each committed deliverable is provided in the control tables of this plan aiding in the management of implementation actions.

Although it is the responsibility of RMRS to develop and approve the FSAR Implementation plan, informational copies of the approved plan will be distributed to Kaiser-Hill and to DOE/RFFO.

3.0 IMPLEMENTATION PLAN

The FSAR utilizes four basic types of controls to maintain the facility's safety envelope. These controls are included in the FSAR Appendix A, Building 991 Facility Technical Safety Requirements (TSRs). These controls are described as follows;

- Limiting Conditions for Operations (LCOs) - LCOs are imposed on safety-class structures, systems, or components credited in the FSAR to reduce the frequency of postulated accidents or mitigate the consequences of postulated accidents to the public and/or collocated worker. Building 991 contains LCOs regarding one building system--the fire suppression and flow alarm transmittal system. See Table 1 for implementation details.
- Surveillance Requirements associated with the LCOs - these surveillance requirements involve the testing or inspection of the systems with identified LCOs. See Table 1 (which combines the related surveillance requirements with their corresponding LCOs) for implementation details.
- Administrative Controls - These controls consist of two types--Administrative Operating Limits (AOLs) and Programmatic Administrative Controls (PACs). AOLs include waste container specifications, limits on radioactive materials, and restriction of selected items. PACs include facility-specific implementation of specific attributes of safety management programs that are necessary to maintain the safety envelope described in the safety analysis and TSRs. The PACs cover the programmatic functions credited for reduction in accident frequency or consequences. See Tables 2 and 3 for implementation details. Credit is taken in the PACs for plant management's continuance and assessment of Site-wide administrative programs that provide the

infrastructure to meet the functional/performance objectives that are specified in Table 6 of the TSRs. Management and operation of Building 991 will be performed by RMRS Waste Management Operations. Facility Management is provided by the Waste Storage Facility/Operations group of Waste Operations. The conduct of waste management activities is the responsibility of Solid Material Operations group, also within Waste Management Operations. Surveillance requirement for these administrative controls are called out in the following tables and associated text describing the controls.

- Design Features - These features are the passive features that reduce the frequency and/or mitigate the consequences of uncontrolled releases of radioactive or other hazardous materials from the facility to protect the health and safety of the public or collocated workers. The only design feature credited in the FSAR is the gross facility external structure which protects the facility contents from fires exterior to the facility and lightning strikes. See Table 4 for implementation details. Configuration management (PAC 2) requires that a program be in place to ensure that design features are subject to configuration change control.

A schedule for preparing or revising facility-specific procedures/plans for implementation of the identified controls are included in Tables 1 through 4. Note that building-specific documents are scheduled for completion within 120 days following approval of this IP.

More definitive completion date information will be forthcoming in the next revision to this plan. Site-wide programs identified in the following matrices are assumed to be implemented and are so noted.

Verification of implementation will be achieved during the readiness assessment process. Kaiser-Hill and DOE/RFFO operational reviews may also follow at the prerogative of the IMC and the DOE. These reviews, if necessary, will serve as the final verification of readiness.

Table 1 Building 991 Limiting Conditions for Operation (LCOs) and Corresponding Surveillance Requirements (SRs)				
LCO	**SR**	**Basis**	**Implementation Method**	**Implementation Date**
LCO 3.0.1 - LCO 3.0.9 General Requirements	N/A	N/A	Facility Operations Order	120 days following IP approval.
SR 4.0.1 - SR 4.0.4 General Requirements	N/A	N/A	Facility Operations Order	120 days following IP approval.
LCO 3.1 Building 991 Facility Fire Water Systems and Flow Alarms LCO: The Building 991 Facility automatic sprinkler system and flow alarm transmittal system and fire service main system shall be operable.	(see SRs below)	The automatic sprinkler system is a recognized control credited in the analysis of postulated fire accident scenarios in Section 4.5.2 of the FSAR. The flow alarm transmittal system and the fire service main system are recognized controls providing immediate worker or defense-in-depth protection against postulated fire accident scenarios. Fires impacting a significant number of waste containers yield unacceptable dose consequence results to the collocated worker and the public. Basically, any releases from waste containers are unmitigated by HEPA filtration, due to a single stage of uncredited (assumed to be untested) HEPA filters and due to the potential impact of a large fire on the filter stage. For this reason, large fires in the Building 991 facility are unacceptable.	Functional performance and maintenance expectations are established for these systems in Site procedures, which are based on accepted industry standards such as NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, NFPA 72, *National Fire Alarm Code*; and NFPA 13, *Standard for the Installation of Sprinkler Systems.*	(see SR dates)

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Table 1 Building 991 Limiting Conditions for Operation (LCOs) and Corresponding Surveillance Requirements (SRs)				
LCO	**SR**	**Basis**	**Implementation Method**	**Implementation Date**
(see LCO above)	**SR 4.1.1** Verify the correct positioning of post indicating valves; sprinkler control valves, and fire service main valves.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.2** Verify adequate static pressure in Sprinkler System Risers A and B.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.3** Verify adequate air pressure in dry pipe Sprinkler System B and in the dry pipe portion of Sprinkler System A.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.4** Perform a main drain flow test at Sprinkler System Risers A and B.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.5** Perform a water flow alarm test at an inspector's test connection and verify Sprinkler System Riser A and B alarm transmittal to Fire Department.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.

Table 1 Building 991 Limiting Conditions for Operation (LCOs) and Corresponding Surveillance Requirements (SRs)				
LCO	**SR**	**Basis**	**Implementation Method**	**Implementation Date**
(see LCO above)	**SR 4.1.6** Perform a visual inspection of the Sprinkler Systems A, and B.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.7** Perform operational test of dry pipe Sprinkler System B and the dry pipe portion of Sprinkler System A..	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.
(see LCO above)	**SR 4.1.8** Perform operational test of fire service main hydrants and valves.	(see LCO above)	Fire Department Procedures LCO Tracking System	**Implemented** Revision 120 days following IP approval.

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 1 Metal waste containers received at and stored in the Building 991 Facility shall meet on-site shipping specifications and/or shall meet or formerly have met DOT specifications. Metal waste container integrity is a part of meeting the specifications. All metal waste containers received at the Building 991 Facility docks shall be inspected for compliance with this requirement either before shipment or at receipt. Upon failure to meet this requirement at the Building 991 Facility docks, the following Required Actions must be performed in the specified Completion Times: • Segregate the non-compliant waste container within one (1) hour. • Develop and begin implementation of an action plan defining necessary short-term compensatory measures and final disposition of the non-compliant waste container within twenty-four (24) hours. • Bring the non-compliant waste container into compliance or remove from the Building 991 Facility within one (1) week. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Actions must be performed in the specified Completion Times: • Segregate the non-compliant waste container within eight (8) hours. • Develop and begin implementation of an action plan defining necessary short-term compensatory measures and final disposition of the non-compliant waste container within twenty-four (24) hours. • Bring the non-compliant waste container into compliance or remove from the Building 991 Facility within one (1) week.	Postulated accident scenarios dealing with spills and fires, both internally and externally initiated, credit the capabilities of the waste containers to withstand drops and to provide some confinement in response to fires.	*RFETS Receiving, Certification, and Inspection Programs* Waste Packaging (WO-1100, 1101, 1102, 4034, 5220) Internal Surveillance Procedure NMSL 3.12	**Implemented** **Implemented** 120 days following IP approval. Revision 120 days following IP approval.

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Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 2 Special Nuclear Material (SNM) containers staged in the Building 991 Facility shall meet DOT Type B shipping container certification. All SNM containers received at the Building 991 Facility docks shall be verified to be compliant with this requirement. Upon failure to meet this requirement at the Building 991 Facility docks, the following Required Action must be performed in the specified Completion Time: • Remove the non-compliant SNM container from the Building 991 Facility within four (4) hours.	The accident analyses credit the certified DOT Type B shipping containers for preventing the release of the SNM contents in postulated fire, spill, and earthquake scenarios. The certified Type B shipping container is also credited to reduce accidental criticality likelihood to the incredible frequency range.	*RFETS Receiving, Certification, and Inspection Programs* Facility Shift/Operations Order NMSL 3.12	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval.
AOL 3 Metal waste containers received at and stored in the Building 991 Facility shall be vented. All metal waste containers received at the Building 991 Facility docks shall be inspected for compliance with this requirement. Upon failure to meet this requirement at the Building 991 Facility docks, the following Required Actions must be performed in the specified Completion Times: • Segregate the unvented waste container within one (1) hour. • Remove the unvented waste container from the Building 991 Facility by the end of the day shift of the next regular work day. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Actions must be performed in the specified Completion Times: • Segregate the unvented waste container within eight (8) hours. • Remove the unvented waste container from the Building 991 Facility by the end of the day shift of the third regular work day.	Postulated accident scenarios dealing with hydrogen explosions credit the venting of waste containers to reduce the hydrogen gas buildup in the container to safe levels.	*RFETS Receiving, Certification, and Inspection Programs* Waste Packaging (WO-1100, 1101, 1102, 4034, 5220) Internal Surveillance Procedure Facility Shift/Operations Order	**Implemented** **Implemented** 120 days following IP approval. Revision 120 days following IP approval.

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Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 4 The quantities of radioactive material in waste drums and waste crates received at and stored in the Building 991 Facility shall not exceed 200 grams Weapons Grade Plutonium equivalent and 320 grams Weapons Grade Plutonium equivalent, respectively. All waste containers received at the Building 991 Facility docks shall be verified to be compliant with this requirement. Upon failure to meet this requirement at the Building 991 Facility docks, the following Required Action must be performed in the specified Completion Time: • Remove the excessive radioactive material waste container from the Building 991 Facility by the end of the day shift of the next regular work day if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Action must be performed in the specified Completion Time: • Remove the excessive radioactive material waste container from the Building 991 Facility by the end of the day shift of the next regular work day after a receiving facility is identified if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.	All postulated accident scenarios in the safety analysis make MAR assumptions associated with the accident scenarios. These MAR assumptions are generally tied to assumed waste container radioactive material limits. (Waste drum, ID number 84291 is permitted to remain in the Building 991 Facility even though it contains 208 grams WG Pu equivalent. It is assumed that no other non-compliant waste containers are introduced into the Building 991 Facility prior to implementation of these TSRs).	RFETS Transportation, Safety Manuals NMSL 3.12 Facility Shift/Operations Order Building Surveillance Book RFETS Safeguards Accountability Manual	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval. Revision 120 days following IP approval. **Implemented**

[redacted]

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 5 Wooden LLW crates stored at the Building 991 Facility shall be located outside of buildings, shall be located in areas covered by the Automatic Sprinkler System, and shall be located in compliance with NFPA requirements. No more than fifty (50) wooden LLW crates may be stored at the Building 991 Facility. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Actions must be performed in the specified Completion Time: • Relocate any misplaced wooden LLW crates to compliant locations within eight (8) hours. • Remove any excess wooden LLW crates from the Building 991 Facility by the end of the day shift of the third regular work day.	A postulated accident scenario dealing with a dock fire credits a limit on wooden LLW crates and credits fire suppression capability. Specifically, a maximum inventory of 50 wooden LLW crates and Automatic Sprinkler System coverage of the LLW crate storage area is analyzed. In addition, the accident analysis credits the Building 991 structure to prevent the crate fire from propagating into the building and impacting TRU waste storage areas.	Building Surveillance Book Surveillance Operations Order/Procedure	Revision 120 days following IP approval. 120 days following IP approval.

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 6 Waste containers received at and stored in the Building 991 Facility shall be compliant with all requirements specified in the Criticality Safety Evaluation justifying that criticality accidents are incredible. All waste containers received at the Building 991 Facility docks shall be inspected for compliance with this requirement. Upon failure to meet this requirement at the Building 991 Facility docks, the following Required Actions must be performed in the specified Completion Times: • Segregate the non-compliant waste container within one (1) hour if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety. • Remove the non-compliant waste container from the Building 991 Facility by the end of the day shift of the next regular work day if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Actions must be performed in the specified Completion Times: • Segregate the non-compliant waste container within eight (8) hours if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety. • Remove the non-compliant waste container from the Building 991 Facility by the end of the day shift of the third regular work day if the movement is permitted by Criticality Safety, or within the requirements of the Criticality Safety Program if the movement is restricted by Criticality Safety.	Criticality accident scenarios are not addressed in the FSAR safety analysis due to a determination that criticalities are incredible as long as specified controls are in place. This AOL elevates the requirements specified in the Criticality Safety Evaluation (CSE) that make criticality scenarios incredible to TSR and AOL requirements. Non-compliance with the CSE requirements significantly impacts the assumptions made in the safety analysis for excluding criticality accidents from consideration.	RFETS Transportation, Safety Manuals NMSL 3.12 Facility Shift/Operations Order Building Surveillance Book RFETS Safeguards Accountability Manual Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval. Revision 120 days following IP approval. **Implemented** 120 days following IP approval.

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 7 The fourth tier of 55-gallon waste drums shall be banded. All stacked drum storage areas shall be surveilled during normal facility tours for verification of compliance with this requirement. Upon identification of a failure to meet this requirement during operations or facility tours in the Building 991 Facility, the following Required Action must be performed in the specified Completion Time: • Remove non-banded drums from the fourth tier or band the non-compliant drums within eight (8) hours.	Postulated accident scenarios dealing with spills, both internally and externally initiated, credit the capabilities of the waste containers to withstand drops.	Facility Shift/Operations Order	Revision 120 days following IP approval.
AOL 8 Fuel and combustible loading in the Building 991 Facility in the following manner: 1. Wooden pallets shall not be used for waste container storage; 2. Flammable/combustible liquids shall not be stored outside of a NFPA-approved cabinet or container; 3. Bulk flammable/combustible liquids shall not be located in the same room or area with stored waste containers without adequate diking to contain the liquids at least 1.5 meters (5 feet) from the waste containers; 4. Significant quantities of plastics subject to melting that are located in the same room or area with stored waste containers shall be properly containerized or diked to assure that pooling following a fire remains at least 1.5 meters (5 feet) from the waste containers; 5. Transient/stored combustible materials in the same room or area with stored waste containers shall be separated from the waste containers by at least 1.5 meters (5 feet);	A major premise of the safety analysis is that only small fires will occur in the waste container storage areas and only small fires will occur in the entire Building 991 Facility as long as the Automatic Sprinkler System functions. In order to support this premise, the facility must implement a stringent combustible material control program.	Fire Department Inspections Facility Shift/Operations Order Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. 120 days following IP approval.

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 8 (continued) 6. No fossil-fueled vehicles shall be used in waste container storage rooms or areas; 7. No flammable gas cylinders or containers shall be located in the Building 991 Facility; 8. Wooden waste crates inside buildings in the Building 991 Facility shall be limited to a single wooden waste crate; and 9. Combustible loading in all areas of the Building 991 Facility shall be maintained as low as reasonably achievable. Compliance with the above requirements shall be surveilled during normal facility tours. Upon failure to meet the above requirements in the Building 991 Facility, the following corresponding Required Actions must be performed in the specified Completion Times: 1. Remove the wooden pallet from the waste container storage area within four (4) hours; 2. Store the flammable/combustible liquid in an approved container within four (4) hours OR remove the flammable/combustible liquid from the Building 991 Facility within four (4) hours; 3. Remove the bulk flammable/combustible liquid from the waste container storage area within twenty-four (24) hours OR come into compliance within twenty-four (24) hours; 4. Remove the plastic from the waste container storage area within twenty-four (24) hours OR come into compliance within twenty-four (24) hours; 5. Remove the transient/stored combustible materials from the waste container storage area within four (4) hours OR come into compliance within four (4) hours;	(see above)	(see above)	(see above)

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Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 8 (continued) 6. Remove the fossil-fueled vehicle from the waste container storage area within one (1) hour; 7. Remove the flammable gas cylinder or container from the Building 991 Facility within one (1) hour; 8. Remove any additional wooden waste crates from the Building 991 Facility within twenty-four (24) hours; and 9. Remove excessive combustible materials from the Building 991 Facility as soon as reasonably achievable.	(see above)	(see above)	(see above)
AOL 9 Building 991 Facility fire phones, fire extinguishers, tunnel/ vault smoke detectors, and local fire alarms shall be maintained. The equipment shall be inspected per the recommendations of applicable NFPA standards. Upon failure to meet this requirement at the Building 991 Facility, the following Required Actions must be performed in the specified Completion Times: • Inform Building 991 Facility personnel of any non-functional or non-compliant equipment within eight (8) hours of identification and periodically thereafter until all assigned facility personnel are aware of the situation; • Return the non-functional or non-compliant equipment to functional and compliant status within forty-eight (48) hours <u>OR</u> implement appropriate compensatory measures within forty-eight (48) hours.	Fire watches rely on fire phones to perform Fire Department notification. Fire extinguishers provide a defense-in-depth safety function in lieu of Fire Department response. The smoke detector system also provides a defense-in-depth safety function for detection of fires in areas not covered by the Automatic Sprinkler System. Local fire alarms are credited in all the fire scenarios to provide immediate worker notification of the fire.	Fire Department Procedures Facility Shift/Operations Order Building Surveillance Book	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval.

Table 2 Building 991 Administrative Operating Limits (AOLs)			
AOL and Corresponding SR	**Basis**	**Implementation Method**	**Implementation Date**
AOL 10 The Building 991 Facility filtered exhaust ventilation function shall be maintained. The equipment shall be inspected and maintained per facility procedures. Upon failure to meet this requirement at the Building 991 Facility, the following Required Action must be performed in the specified Completion Time:	The small internal fire, the small spill, and the two hydrogen explosions, all identify the building ventilation system and filtration as a defense-in-depth feature for the protection of the public and the collocated worker.	Building Surveillance Book	Revision 120 days following IP approval.
• Return the non-functional or non-compliant equipment to functional and compliant status within forty-eight (48) hours OR implement appropriate compensatory measures within forty-eight (48) hours.		Building Surveillance Procedure 4-T05-991-01	Revision 120 days following IP approval.

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Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 1. Organization and Management Building 991 Facility Organization and Management shall provide the infrastructure needed to implement and maintain the TSR controls—LCOs, SRs, AOLs, and PACs—so that the Building 991 Facility will be operated within its authorization basis. Organization and Management shall include: 1. A process to implement and maintain the TSR control set including LCOs, SRs, AOLs, and PACs. 2. A process to develop TSR required determinations in support of Required Actions. 3. A process to define line management responsibility for assignments and work-initiating Required Actions. 4. A process to perform, assess, and track surveillances or actions required as part of the TSRs. 5. A process to notify the DOE-RFFO of Violations and planned Out-Of-Tolerances and to deliver restart plans or root cause reports to the DOE-RFFO. 6. A process to demonstrate compliance with PACs. 7. A process to assure adequate staffing during the performance of SNM and waste handling activities and during storage/facility maintenance operations and during non-working hours.	Site Procedures Facility Shift/Operations Order Roles & Responsibilities Organizational Chart Notification of DOE Internal Surveillance Procedure LCO Tracking System	**Implemented** Revision 120 days following IP approval. 120 days following IP approval. Revision 120 days following IP approval.
PAC 2. Configuration Management A program shall be in place to ensure that Safety-Class SSCs (including Design Features) are subject to configuration change control. Configuration Management shall include: 1. A process for safety and technical review and validation of design modification work on or potentially impacting Safety-Class SSCs before approval and implementation of the design. 2. A process to change operating procedures and personnel training affected by modifications to Safety-Class SSCs. 3. A process for documenting changes to any existing technical baselines (*e.g.*, drawings, FSAR) following any changes to Safety-Class SSCs. 4. A process for control of changes/revisions to design modification packages.	Site Procedures CCCP Facility Shift/Operations Order Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. 120 days following IP approval.

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Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 3. <u>Criticality Safety</u> A program shall be in place to ensure that criticality safety controls are implemented. Criticality Safety shall include: 1. A process to assure that any operations conducted in the facility have been evaluated to determine the need for criticality safety controls. 2. A process to develop and implement criticality controls, which ensure double contingency. 3. A process to monitor compliance status. 4. A process to verify compliance with criticality safety controls prior to performing work that could impact or involves fissile material. 5. A process to respond to and assure assessment by criticality safety personnel of unplanned incidents or discovered conditions involving fissile material. 6. A process to assure that container fissile material loading for storage and handling of waste is in accordance with the facility Nuclear Materials Safety Manual.	Site Procedures NMSLs Facility Shift/Operations Order Building Surveillance Book	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval. Revision 120 days following IP approval.
PAC 4. <u>Emergency Response</u> A program shall be in place to ensure that a formalized emergency response capability is maintained. Emergency Response shall include: 1. An approved facility emergency plan. 2. Identified and trained emergency response personnel *(no BEST team)*. 3. A process for personnel egress/evacuation. 4. Capability for communications to emergency personnel. 5. A process for personnel accountability.	Site Emergency Plan Procedures Building Emergency Plan Procedure Revision Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. 120 days following IP approval.

Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 5. <u>Environmental Protection and Waste Management</u> A program shall be in place to ensure that environmental protection and waste management controls are implemented. Environmental protection and waste management shall include: 1. An established process for the routine surveillance, inspection and monitoring of facility compliance with environmental regulations. 2. An established process to maintain a current, documented inventory of waste. 3. A process shall be in place to ensure that the facility operates the Resource Conservation and Recovery Act (RCRA) satellite storage area in accordance with regulations. 4. Waste generated in the facility shall be managed in accordance with appropriate regulations. 5. An established process shall be in place for control of Toxic Substances Control Act (TSCA) regulated substances.	Site Procedures RCRA TSCA WEMS Internal Surveillance Procedure	**Implemented** 120 days following IP approval.
PAC 6. <u>Fire Protection</u> A program shall be in place to ensure that fire protection controls are implemented. Fire Protection shall include: 1. A process to define acceptable combustible material area loading and to remediate any areas found to contain excessive combustible material loading. 2. Combustible materials are minimized by work control planning and housekeeping. 3. Periodic fire prevention inspections and tours. 4. A process to develop, issue and control hot work permits for the conduct of spark/heat/flame-producing work. 5. Use of flammable gas in the facility shall be analyzed on a case-by-case basis.	Fire Department Procedures Facility Shift/Operations Order Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. 120 days following IP approval.

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Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 7. <u>Industrial Hygiene and Safety</u> A program shall be in place to provide for worker protection from physical, biological and chemical hazards associated with work conducted in the facility. Industrial Hygiene and Safety shall include: 1. A process to identify and assess physical, biological and chemical hazards. 2. A process to establish appropriate controls for identified physical, biological and chemical hazards. 3. A process for worker involvement in work planning, including the communication of identified hazards and appropriate protective measures.	Health and Safety Plan Revision Internal Surveillance Procedure	Revision 120 days following IP approval. 120 days following IP approval.
PAC 8. <u>Maintenance</u> A program shall in place for control of maintenance activities. Maintenance shall include: 1. A process for safety and technical review and approval of maintenance work packages on or potentially impacting Safety-Class SSCs. 2. A process for control of changes/revisions to maintenance work packages. 3. Inspection and/or acceptance testing of Safety-Class SSCs following maintenance work on or potentially impacting the Safety-Class SSCs. 4. A process to assess the need for and to establish preventive maintenance requirements to protect the function(s) provided by Safety-Class SSCs (includes Design Features). 5. A process for safety and technical review of maintenance work packages on Safety-Significant SSCs. 6. A process for periodic inspection of Safety-Significant SSCs. 7. Inspection and/or acceptance testing of Safety-Significant SSCs following maintenance work on or potentially impacting the Safety-Significant SSCs.	Site Procedures IWCP CCCP Internal Surveillance Procedure	**Implemented** 120 days following IP approval.

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Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 9. <u>Nuclear Safety</u> A program shall be in place to provide a formal, documented system for the control of nuclear safety parameters and their bases, identification, and verification. Nuclear Safety shall include: 1. Activities in the Building 991 Facility shall have an approved hazard assessment or shall have been shown to be the same as previously authorized activities before being authorized for performance on the Plan of the Day (POD). 2. A process for safety and technical review/verification of work instructions, including changes and revisions, and for validation of operations procedures and testing instructions. 3. A process for ensuring a nuclear safety review of all Safety SSC maintenance and modification work packages against the authorization basis to make an Unreviewed Safety Question Determination.	Site Procedures Nuclear Safety Program Internal Surveillance Procedure	**Implemented** 120 days following IP approval.
PAC 10. <u>Occurrence Reporting</u> A program shall be in place to ensure timely reporting of occurrences which could affect the workers, the public or the environment. Occurrence Reporting shall include: 1. A process for occurrence categorization, notification and investigation. 2. A process for conducting root cause analysis and establishing lessons learned. 3. A process of developing corrective action.	Site Procedures Internal Surveillance Procedure	**Implemented** 120 days following IP approval.
PAC 11. <u>Quality Assurance</u> A program shall be in place for control of Building 991 Facility Quality Assurance. Quality Assurance shall include: 1. A process for controlling non-conforming items. 2. A process for ensuring corrective actions and issues management. 3. A process to establish requirements for procured items and services affecting Safety-Class SSCs. 4. A process for identification and control of items covered by LCOs (e.g., hardware, procedures, training).	Site Procedures Internal Surveillance Procedure	**Implemented** 120 days following IP approval.

Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 12. <u>Radiation Protection</u> A program shall be in place to provide for worker protection from radiological hazards associated with work conducted in the facility. Radiation Protection shall include: 1. A process to identify and assess radiological hazards. 2. A process to establish appropriate controls for identified radiological hazards. 3. A process for worker involvement in work planning, including the communication of identified radiological hazards and appropriate protective measures.	Site Procedures Internal Surveillance Procedure	**Implemented** 120 days following IP approval.
PAC 13. <u>Records Management and Document Control</u> A program shall be in place for ensuring that the Building 991 Facility records retention practices are in accordance with the Quality Assurance Plan and records management directive. Records Management and Document Control shall include: 1. A process to identify and control quality records.	Site Procedures Building Surveillance Book	**Implemented** Revision 120 days following IP approval.
PAC 14. <u>Training</u> A program shall be in place to ensure that work is performed by trained personnel. Training shall include: 1. A designation of organizational responsibilities for managing, supervising and implementing training for facility personnel. 2. Development and maintenance of a summary of personnel qualification and certification requirements (*e.g.,* Training Implementation Matrix) with emphasis on the following elements: Authorization Basis Compliance, Area-Specific Training, Job-Specific Training, and Emergency Response Training. 3. Development and maintenance of a list of qualified individuals.	Site Training Procedures Training Implementation Matrix Facility Shift/Operations Order Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. Revision 120 days following IP approval. 120 days following IP approval.

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Table 3 Building 991 Programmatic Administrative Controls (PACs)		
PAC	**Implementation Method**	**Implementation Date**
PAC 15. <u>Transportation</u> A program shall be in place for control of facility radioactive and hazardous materials transportation, shipping, and receiving. Transportation shall include: 1. Visual inspections, that focus on identifying degradation of waste container integrity (*e.g.*, indentations, punctures), performed on all waste containers upon receipt at the dock area and prior to staging for shipment from the dock area. 2. A process to identify on-site and off-site shipping requirements and to implement these requirements for waste and SNM containers. 3. Maintenance, inspection, and repair of on-site vehicles used in the transport of waste containers to and from the Building 991 Facility.	RFETS Transportation Safety Manuals Site Safeguards and Account Manual Facility Shift/Operations Order RMRS WO-5220, WO-1100, 1101, 1102, 4034 Internal Surveillance Procedure	**Implemented** **Implemented** Revision 120 days following IP approval. **Implemented** 120 days following IP approval.
PAC 16. <u>Work Control</u> A program shall be in place to ensure that activities in the building are conducted in a formal and controlled manner. Work Control shall include: 1. A process to ensure that work is performed using approved work instructions/procedures. 2. Development and maintenance of a facility work planning and approval document, including the designation of approval authority and organizational responsibilities. 3. Conduct of a daily facility work planning and approval meeting. 4. A process to conduct Pre-Evolution Briefings. 5. Formal shift relief and turnover following a change in Building Manager. 6. A tracking system to support surveillance of LCOs, AOLs, and PACs.	Site Procedures COOP CMCAP IWCP LCO Tracking System Internal Surveillance Procedure	**Implemented** Revision 120 days following IP approval. 120 days following IP approval.

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Table 4 Building 991 Design Features			
Design Feature	**Basis**	**Implementation Method**	**Implementation Date**
Gross Facility External Structural Integrity	Maintenance of the external facility structure protects the facility contents from fires exterior to the facility (particularly on the west dock exterior canopy area) and lightning strikes.	Site Procedures ..CCCP Internal Surveillance Procedure	**Implemented** 120 days following IP approval.

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4 SUMMARY AND CONCLUSIONS

The proceeding implementation plan presents a graded and phased approach to implementing the FSAR. The emphasis is on implementing those actions necessary to ensure adequate control and institutionalization of the Authorization Basis for the performance of baseline and analyzed activities. This is considered appropriate since facility risk is effectively managed with the implementation of those actions deemed integral to the Authorization Basis. The method and depth of implementation is based on the hazards identified in the building, the risks associated with baseline and analyzed activities, the current physical condition of the building and its hardware systems, and the current mission of the facility.