DOE/WIPP-06-3174
REVISION 0
MARCH 2006

WASTE ISOLATION PILOT PLANT REMOTE HANDLED (RH) WASTE DOCUMENTED SAFETY ANALYSIS

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CONTENTS

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ACRONYMS

1	**A**	Anticipated
2	**AA**	Accident Analysis
3	**AC**	Administrative Control
4	**ACGIH**	American Conference of Governmental Industrial Hygienists
5	**AIS**	Air Intake Shaft
6	**ALARA**	As Low As Reasonably Achievable
7	**ARF**	Airborne Release Fraction
8	**ARM**	Area Radiation Monitor
9	**BEU**	Beyond Extremely Unlikely
10	**BG**	Building General
11	**BLM**	Bureau of Land Management
12	**BOP**	Balance of Plant
13	**CAM**	Continuous Air Monitor
14	**CBFO**	Carlsbad Field Office
15	**CCA**	WIPP Compliance Certification Application
16	**CCTV**	Closed Circuit Television
17	**CEDE**	50-year Committed Effective Dose Equivalent
18	**CFR**	Code of Federal Regulation
19	**CH**	Contact Handled
20	**CLR**	Conveyance Loading Room
21	**CM**	Crisis Manager
22	**CMR**	Central Monitoring Room
23	**CMRO**	Central Monitoring Room Operator
24	**CMS**	Central Monitoring System
25	**CUR**	Cask Unloading Room
26	**DBA**	Design Basis Accident
27	**DBE**	Design Basis Earthquake
28	**DBT**	Design Basis Tornado
29	**DCF**	Dose Conversion Factor
30	**D&D**	Decontamination and Decommissioning
31	**DID**	Defense in Depth
32	**DF**	Design Feature
33	**DOE**	Department of Energy
34	**DOT**	Department of Transportation
35	**DR**	Damage Ratio
36	**DSA**	Documented Safety Analysis
37	**EAL**	Emergency Action Level
38	**EFB**	Exhaust Filter Building
39	**EG**	Evaluation Guideline
40	**EM**	Environmental Restoration and Waste Management
41	**EMP**	Emergency Management Program
42	**EOC**	Emergency Operations Center
43	**EPA**	Environmental Protection Agency
44	**EST**	Emergency Services Technician

ACRONYMS

1	**EU**	Extremely Unlikely
2	**EUA**	Exclusive Use Area
3	**FAA**	Federal Aviation Administration
4	**FAS**	Fixed Air Sampling
5	**FCLR**	Facility Cask Loading Room
6	**FCRD**	Facility Cask Rotating Device
7	**FCTC**	Facility Cask Transfer Car
8	**FGE**	Fissile Gram Equivalent
9	**FHA**	Fire Hazard Analysis
10	**FMEC**	Factory Mutual Engineering Corporation
11	**FSM**	Facility Shift Manager
12	**GE**	General Emergency
13	**GET**	General Employee Training
14	**GPDD**	General Plant Design Description
15	**HA**	Hazard Analysis
16	**HEPA**	High Efficiency Particulate Air
17	**HERE**	Horizontal Emplacement and Retrieval Equipment
18	**HVAC**	Heating, Ventilation, and Air Conditioning
19	**HWFP**	Hazardous Waste Facility Permit
20	**HWMP**	Hazardous Waste Management Program
21	**IC**	Initial Condition
22	**ICRP**	International Commission on Radiological Protection
23	**ID**	Identification
24	**IV**	Inner Vessel
25	**IS&H**	Industrial Safety and Hygiene
26	**JIC**	Joint Infomation Center
27	**LCO**	Limiting Condition for Operation
28	**LCS**	Limiting Control Setting
29	**LFL**	Lower Flammability Limit
30	**LPF**	Leakpath Factor
31	**LPU**	Local Processing Unit
32	**LWA**	Land Withdrawal Act
33	**MAR**	Material at Risk
34	**MC**	Management Charter
35	**MHE**	Mitigated Hazard Evaluation
36	**MOC**	Management and Operating Contractor
37	**MOI**	Maximally Exposed Offsite Individual
38	**MOU**	Memorandum of Understanding
39	**MP**	Management Policy
40	**MRT**	Mine Rescue Team

ACRONYMS

1	**MSDS**	Material Safety Data Sheets
2	**MSHA**	Mine Safety and Health Administration
3	**M&TE**	Measuring and Test Equipment
4	**NCSE**	Nuclear Criticality Safety Evaluation
5	**NFPA**	National Fire Protection Association
6	**NIST**	National Institute of Standards and Technology
7	**NMIMT**	New Mexico Institute of Mining and Technology
8	**NPH**	Natural Phenomena Hazards
9	**NRC**	Nuclear Regulatory Commission
10	**NUREG**	Nuclear Regulatory Guide
11	**NVP**	Natural Ventilation Pressure
12	**OA**	Outside Area
13	**OC**	Outer Cask
14	**OJT**	On-the-Job Training
15	**ORNL**	Oak Ridge National Laboratory
16	**OSHA**	Occupational Safety and Health Administration
17	**PA**	Public Address
18	**PAC**	Programmatic Administrative Control
19	**PAG**	Protective Action Guidelines
20	**PE-Ci**	Plutonium-239 Equivalent Curies
21	**PPA**	Property Protection Area
22	**PPE**	Personal Protective Equipment
23	**QA**	Quality Assurance
24	**QAPD**	Quality Assurance Program Description
25	**RCRA**	Resource Conservation and Recovery Act
26	**RCT**	Radiological Control Technicians
27	**RCTC**	Road Cask Transfer Car
28	**REMS**	Radioactive Effluent Air Monitor
29	**RF**	Respirable Fraction
30	**RH**	Remote Handled
31	**RH WAC**	RH Waste Acceptance Criteria
32	**RIDS**	Records Inventory and Disposition Schedule
33	**RS&EM**	Radiation Safety and Emergency Management
34	**RWP**	Radiological Work Permit
35	**SAC**	Specific Administrative Control
36	**SAE**	Site Area Emergency
37	**SAR**	Safety Analysis Report
38	**SDD**	System Design Descriptions
39	**SC**	Safety Class
40	**SEC**	Site Environmental Compliance
41	**SIH**	Standard Industrial Hazard
42	**SL**	Safety Limit

ACRONYMS

1	**SME**	Subject Matter Expert
2	**SNS**	Site Notification System
3	**SS**	Safety Significant
4	**SSC**	Structures, Systems, and Components
5	**STD**	Standard
6	**STE**	Start-up Test Engineer
7	**SR**	Surveillance Requirement
8	**TEDE**	Total Effective Dose Equivalent
9	**TIM**	Training Implementation Matrix
10	**TLV**	Threshold Limit Values
11	**TMF**	TRUPACT Maintenance Facility
12	**TRU**	Transuranic
13	**TSDF**	Treatment Storage Disposal Facility
14	**TSR**	Technical Safety Requirement
15	**U**	Unlikely
16	**UG**	Underground Area
17	**UHE**	Unmitigated Hazard Evaluation
18	**UL**	Underwriters Laboratories
19	**UPS**	Uninterriuptible Power Supply

EXECUTIVE SUMMARY

Facility Background and Mission

The United States Department of Energy (DOE) was authorized by Public Law 96-164[1] to provide a research and development facility for demonstrating the safe permanent disposal of transuranic (TRU) wastes from national defense activities and programs of the United States exempted from regulations by the U.S. Nuclear Regulatory Commission. The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico near Carlsbad, was constructed as an underground repository for disposal of TRU wastes.

In accordance with the 1981 and 1990 Records of Decision,[2, 3] the development of the WIPP began with a siting phase, during which several sites were evaluated and the present site selected based on extensive geotechnical research, supplemented by testing. The U.S. Congress enacted the WIPP Land Withdrawal Act[5] of 1992 (Public Law 102-579) to remove the WIPP from resource extraction and other land use that could impact the long term confinement of radioactive materials.

CH waste disposal operations began in March 1999. Disposal operations consist of receiving the TRU waste shipping casks, removing the waste containers from the shipping cask, transporting the waste containers to the underground, and placing the waste in the disposal rooms. The WIPP is currently planning to receive remote handled (RH) waste in late 2006.

This RH Documented Safety Analysis (DSA) determines the RH safety basis necessary to ensure the safety of workers, the public, and the environment from the hazards associated with RH waste handling and disposal operations at the WIPP.

Facility Overview

The WIPP is located in Eddy County in southeastern New Mexico as shown in Figure 1.3-2. The WIPP is located in an area of low population density with no industrial, commercial, institutional, recreational or residential structures within the WIPP site boundary.

The WIPP is designed to receive and handle 500,000 cubic feet per year (ft^3/yr) CH waste and 10,000 ft^3/yr RH waste. The WIPP has a TRU waste disposal capacity of 6.2 million ft^3, of which 250,000 ft^3 is RH waste as established in the Record of Decision[2] as a total volume. The WIPP LWA of 1992[5] limits the total RH TRU activity to 5.1 million curies.

The WIPP is divided into surface structures, shafts, and subsurface structures as shown in Figure 2.4.3. The WIPP surface structures accommodate the personnel, equipment, and support services required for the receipt, preparation, and transfer of waste from the surface to the underground. The surface structures are located in an area within a perimeter security fence. Waste handling operations at the WIPP are conducted in the Waste Handling Building (WHB), which is divided into the CH waste handling area, the RH waste handling area, and support areas. The RH waste handling area includes the RH bay, hot cell complex, and hot cell HEPA filter gallery.

Vertical shafts, including the waste shaft, the salt handling shaft, the exhaust shaft, and the air intake shaft, extend from the surface to the underground horizon as shown in Figure 2.4-3. The waste shaft is located between the CH and RH areas in the WHB.

The WIPP underground consists of the waste disposal area, construction area, north area, and the waste shaft station area. The WIPP underground ventilation allows mining and disposal operations to proceed simultaneously. The CH and RH waste disposal area is a 100 acre area on a horizon located 2,150 feet beneath the surface in a deep, bedded salt formation. Waste is transferred from the surface to the disposal horizon through the waste shaft using a hoist and conveyance. Disposal is permanent with no intent to retrieve at this time.

A typical disposal panel consists of seven disposal rooms. Each room is 33 feet wide, 13 feet high, and 300 feet long. The disposal rooms are separated by pillars of salt 100 feet wide and 300 feet long. Panel entries at the end of each of these disposal rooms are also 33 feet wide and 13 feet high and will be used for waste disposal, except for the first 200 feet from the main entries. The first 200 feet are used for installation of the panel closure, not disposal. The RH waste canisters will be disposed of in boreholes in the walls of the disposal rooms and panel entries. When RH waste handling operations start, the RH waste will be emplaced in disposal boreholes, prior to filling a disposal room with CH waste.

Facility Hazard Categorization

The WIPP is classified as a Hazard Category 2 facility. The hazard categorization was determined in accordance with DOE-STD-1027-92,[6] and is based on the maximum radiological contents of a single 55-gallon drum of CH waste at 80 plutonium-239 equivalent curies (PE-Ci) as derived in Chapter 3.

Safety Analysis Overview

The principal operations at the WIPP involve the receipt and disposal of TRU mixed waste. WIPP RH waste handling operations considered in this DSA include the following:

- Receipt and disposal of RH waste containers including movement of the RH waste containers by transfer cars, cranes, the waste hoist, and the underground 41-ton forklift
- Receipt and disposal of waste containers
- Waste handling equipment maintenance and operation
- Waste handling, storage, and disposal facilities maintenance
- Inclement weather events (rain, snow, tornado, high wind) impacting waste handling and storage facilities
- Vehicles (trucks and air craft) impacting WHB

Hazards associated with normal WIPP operations include mining dangers, high voltage, compressed gases, confined spaces, radiological and non-radiological hazardous materials, non-ionizing radiation, high noise levels, mechanical and moving equipment dangers, working at heights, construction, and material handling dangers. Waste handling operations at the WIPP do not involve high temperature and pressure systems, or electromagnetic fields. Routine occupational hazards are regulated by DOE-prescribed Occupational Safety and Health Administration and by Mine Safety and Health Administration standards. Programs for protecting WIPP workers from hazardous materials are discussed in Chapter 8.

The RH accident analysis complies with the requirements of DOE-STD-3009-94[7] and DOE-STD-1027-92.[6] The accidents selected for quantitative analysis are considered Derivative Design Basis Accidents (DBAs), as defined in DOE Standard 3009-94.[7] The DBAs are used to evaluate the consequences and the response of WIPP structures, systems and components (SSCs) to the range of bounding accident scenarios to which the facility could be subjected. Events are grouped into accident categories including operational events and natural phenomena and external events. Operational events include fire, explosion, waste container breach due to drop, crush, or puncture, and criticality. Operational, natural, and external initiating events are listed below.

Operational Events

- RH-1 Fire in the WHB
- RH-2 Fire in the Underground
- RH-3 Explosions Followed by Fire in the WHB
- RH-4 Explosions in the Underground
- RH-5 Waste Container(s) Breach in the WHB
- RH-6 Waste Container(s) Breach in the Underground

Natural Events

- RH-8 Seismic
- RH-10 Lighting Strikes WHB - Damages Waste Containers
- RH-11 Snow/Ice Load on WHB Roof Causes Roof to Fall - Damages Waste Containers
- RH-12 Loss of Electrical Power

External Events

- RH-7 Aircraft Crash
- RH-9 External Fires Damage WHB and Waste Containers

Criticality is not included as analysis has shown that criticality is incredible at the WIPP for waste that meets the fissile limits imposed in the TSRs and implemented at generator sites through adherence to DOE/WIPP 02-3122, Rev. 5 (Draft), *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant.*[8] Some of the preventive features identified in the RH DSA include the safety class WHB, hot cell complex, and automatic /manual fire suppression system on underground waste handling equipment and the safety significant fire water supply and distribution, and WHB fire suppression system. Chapter 4 identifies the safety class and safety significant SSCs and Chapter 5 identifies the credited controls to prevent a release of radiological or hazardous material at WIPP.

Organizations

DOE has the overall responsibility for the design, construction, operation, and decommissioning of the WIPP. Within the DOE, the Assistant Secretary for Environmental Restoration and Waste Management (EM) is responsible for implementing the radioactive waste disposal policy. In 1993, the DOE Carlsbad Area Office, now the Carlsbad Field Office (CBFO), was created to be directly responsible for the WIPP Project. The CBFO has overall quality assurance responsibility for the WIPP. The CBFO reports to the DOE-EM.

Sandia National Laboratory is currently responsible for performance assessment of the WIPP in compliance with 40 CFR 191 Subparts B and C.[4]

Washington TRU Solutions LLC (WTS) is the current MOC. The preparation of this RH DSA was developed under direction of WTS, using support services of Washington Safety Management Solutions.

Safety Analysis Conclusions

This DSA describes the RH waste handling operations at the WIPP including the waste received, handled and disposed of, the associated hazards, and controls necessary to protect workers, the public, and environment. The safety basis demonstrates that WIPP can be operated with an acceptable level of safety compliant with 10 CFR 830, Subpart B.[9]

DSA Organization

Revision 0 of the WIPP RH DSA is a 17 chapter document that includes the content required by DOE-STD-3009-94.[7]

References for Executive Summary

1. Public Law 96-164, Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980, December 29, 1979.

2. U.S. Department of Energy, 46 FR 9162, Record of Decision, Waste Isolation Pilot Plant, January 28, 1981.

3. U.S. Department of Energy, 55 FR 256892, Record of Decision, Waste Isolation Pilot Plant, June 22, 1990.

4. 40 CFR 191, U.S. Environmental Protection Agency, Environmental Radiation Protection for Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Wastes, Subpart B, Environmental Standards for Disposal, July 1994.

5. Public Law 102-579, Waste Isolation Pilot Plant Land Withdrawal Act, U.S. Congress, October 1992 [as amended by Public Law 104-201].

6. DOE-STD-1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, 1992.

7. DOE-STD-3009-94, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses, Change 2, April 2002.

8. DOE/WIPP 02-3123, Rev. 5 (Draft), Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, November 2005.

9. 10 CFR Part 830, Subpart B, Safety Basis Requirements.

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SITE CHARACTERISTICS

1.1 Introduction

This chapter provides information on the location of the Waste Isolation Pilot Plant (WIPP) site and the site characteristics to support assumptions used in the hazards and accident analysis for potential external and natural event accident initiators and accident consequences. Included is information on: (1) site geography, (2) demographics, (3) nearby land use, (4) meteorology and (5) seismicity.

1.2 Requirements

The United States Department of Energy (DOE) was authorized by Public Law 96-164, Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980,[1] to provide a research and development facility for demonstrating the safe permanent disposal of transuranic (TRU) wastes from national defense activities and programs of the United States exempted from regulations by the U.S. Nuclear Regulatory Commission (NRC). In accordance with the 1981 and 1990 Records of Decision,[2, 3] the development of the WIPP was to proceed with a phased approach. Development of the WIPP began with a siting phase, during which several sites were evaluated and the present site was selected based on extensive geotechnical research and testing. Information relating to ecology, extractable resources, water and air quality, environmental radioactivity, surface and ground water hydrology, and geology, necessary to support the long term performance assessment of the repository, is found in *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant*, DOE/CAO-1996-2184.[4]

During construction all the federal lands within the WIPP Site Boundary were managed in accordance with the terms of Public Land Order 6403[5] and a DOE/U.S. Bureau of Land Management (BLM) Memorandum of Understanding.[6]

On October 30, 1992, the WIPP Land Withdrawal Act (LWA), Public Law 102-579, as amended by Public Law 104-201[7] transferred the land from the U.S. Department of the Interior to the DOE. Consistent with the WIPP mission, lands within and around the WIPP Site Boundary are administered according to a multiple land use policy. During operations, the area within the WIPP site boundary will remain under federal control.

1.3 Site Description

1.3.1 Geography

The WIPP site is located in Eddy County in southeastern New Mexico (Figure 1.3-1). The center of the WIPP site is approximately 103°47'27" West longitude and 32°22'11" North latitude.

Prominent natural features within five miles (8.0 km) of the center of the WIPP site include Livingston Ridge and Nash Draw, which are located about five miles (8.0 km) west (Figure 1.3-2). Livingston Ridge, the most prominent physiographic feature near the WIPP site, is a northwest facing bluff (about 75 ft or 22.9 m high) that marks the east edge of Nash Draw (a shallow drainage course about five miles [8.0 km] wide).

The Pecos River is about 12 miles (19.3 km) west of the WIPP site at its nearest point. The Guadalupe Mountains are about 42 miles (67 km) and the Guadalupe Mountains National Park is about 65 miles (104.5 km) from the WIPP site. The nearest prominent man-made features are oil well drilling and piping equipment, the city of Loving (with a 2000 population of 1,326) which is 18 miles (29.0 km) west southwest, and the city of Carlsbad (with a 2000 population of 25,625) which is 26 miles (41.8 km) west.

1.3.1.1 WIPP Area

The area of land that lies within the WIPP Land Withdrawal Area forms a square, four miles (6.4 km) on a side. It contains 10,240 acres or 4,146 hectares (16 mi^2 or 41.4 km^2) including Sections 15-22 and 27-34 in Township 22 South, Range 31 East. The area containing the WIPP surface structures is surrounded with a chain link fence and covers about 34 acres or 14 hectares in Sections 20 and 21 of Township 22 South, Range 31 East. This fenced area is the WIPP Property Protection Area (PPA). The location and orientation of the WIPP surface structures are shown in Figure 2.4-1. These structures include but are not limited to the Waste Handling Building (WHB) where radioactive waste is received and prepared for underground disposal, four shafts to the underground area, a Support Building containing laboratory and office facilities, showers, change rooms for underground workers, an exhaust filter building, water storage tanks and pump house, trailers and auxiliary buildings for personnel offices, and two warehouses. Support structures outside of the chain link fence include sewage stabilization ponds, two meteorological towers, a communication tower, two mined-rock (salt) piles, and evaporation ponds for managing site runoff.

There are no industrial, commercial, institutional, recreational or residential structures within the WIPP site boundary. Access to the WIPP site is provided by two roads that connect with U.S. Highway 62/180, 13 miles (21 km) to the north, and New Mexico Highway 128, 4 miles (6.4 km) to the south. The north access road is used to transport TRU mixed waste from U.S. Highway 62/180 to the site. The north access road is used by personnel, agents and contractors of the DOE on official business related to the WIPP and personnel, permittees, licensees, or lessees of the BLM. The south access road is maintained by Eddy County and multiple use access is allowed.

There are several oil and gas wells around the periphery of the WIPP Site Boundary. One gas pipeline is within the WIPP Site Boundary, oriented northeast southwest, and is about 1.2 miles (1.9 km) north of the center of the WIPP surface structures at its closest point.

The areas that have been designated as subdivisions within the WIPP Site Boundary are defined below and depicted in Figure 1.3-3.

The WIPP Land Withdrawal Area forms a square, four miles (6.4 km) on a side and contains 10,240 acres (4,146 hectares).

The WIPP PPA is an area of approximately 35 acres (14 hectares) surrounded by a chain link fence topped with barbed wire.

The WIPP site boundary, Exclusive Use Area (EUA) is an area of approximately 290 acres (117 hectares) that contains the PPA. It is surrounded by a barbed wire fence, posted no trespassing and is restricted to DOE use only.

The Off-Limits Area is an area of approximately 1,421 acres (575 hectares) that contains the WIPP Site Boundary. This area is posted "No Trespassing," but is leased for grazing and hunting is allowed.

The Evaluation Guideline is applied at the EUA boundary. The EUA boundary is approximately 285 meters (m) from the underground ventilation exhaust and the WHB. The PPA boundary is the public exclusion and access control point.

A zone, provided between the mined area underground and the WIPP site boundary is a minimum of one mile (1.6 km) wide. This thickness was specified based on recommendations made by Oak Ridge National Laboratory (ORNL). The ORNL recommendation of one to five miles (1.6 to 8.0 km) for the size of the zone of intact salt was to preclude unacceptable penetration of the salt formation. The ORNL stated that the actual size of the zone must be based on site dependent factors including drilling operations, mining operations and salt dissolution rates. This was addressed in SAND 78-1596, *Geological Characterization Report*,[8] where the authors state that the one mile (1.6 km) thickness should provide more than 250,000 years of isolation using very conservative dissolution assumptions.

1.3.1.2 Exclusion Area Land Use and Control

On October 30, 1992, the WIPP LWA[7] transferred the land from the U.S. Department of the Interior to the DOE. Consistent with the WIPP mission, lands within and around the WIPP site boundary are administered according to a multiple land use policy. During operations, the area within the WIPP site boundary will remain under federal control.

The *Waste Isolation Pilot Plant Land Management Plan* (DOE/WIPP 93-004)[9] allows public access to the WIPP 16-section area up to the DOE EUA for grazing purposes and up to the DOE Off-Limits Area for recreational purposes. Public access is controlled by the WIPP site 24-hour security force.

The DOE will not permit subsurface mining, drilling, or resource exploration unrelated to the WIPP within the WIPP Site Boundary during facility operation or during the period of active institutional controls. Mining and drilling for purposes other than those which support the WIPP are prohibited within the 16 sections by the LWA. This prohibition precludes slant drilling under the WIPP site from within or outside the site, with the exception of existing rights under federal oil and gas leases No. NMNM 02953 and NMNM 02953C, which shall not be affected unless a determination is made to require the acquisition of such leases to comply with final disposal regulations or with the solid waste disposal act.

Within the PPA, public access is restricted to employees and approved visitors. Within the EUA access is restricted to authorized personnel and vehicles. In addition, small areas have been fenced to control access to material storage areas, borrow pits, the sewage stabilization ponds, and biological study plots.

1.3.1.2.1 Agricultural Uses

The five-mile (8.0 km) radius encompasses grazing allotments of three separate ranches. All the land within the WIPP site boundary except for the EUA (290 acres [117 hectares]) has been leased for grazing, which is the only significant agricultural activity in the vicinity of the WIPP. Grazing operates within the authorization of the Taylor Grazing Act of 1934, the Federal Land Policy and Management Act, the Public Rangelands Improvement Act of 1978, and the Bankhead-Jones Farm Tenant Act of 1973. Portions of two grazing allotments administered by the BLM fall within the Land Withdrawal Area: Livingston Ridge (No. 77027), and Antelope Ridge (No. 77032) (DOE/WIPP 93-004).[9] The Smith Ranch, owned by Kenneth Smith, Inc. of Carlsbad, New Mexico, has lease rights to 2,880 acres (1,166 hectares) within the northern portion of the WIPP site boundary. J. C. Mills of Abernathy, Texas, owner of the Mills Ranch, has lease rights to 7,360 acres (2,980 hectares) within the southern portion of the WIPP site boundary. The Mills ranch house is located about 3.5 miles (5.6 km) from the center of the WIPP site but outside the WIPP site boundary.

1.3.1.2.2 Water Use

Uses of surface or groundwater in the vicinity of the WIPP site include several windmills throughout the area to pump groundwater for livestock, and several ponds to capture runoff for livestock. The WIPP fire and potable water are obtained via 10 inch (25.4 centimeter) water pipeline managed by the city of Carlsbad.

1.3.2 Demography

The WIPP site is located in the southeastern part of Eddy County, near Lea County. The population density of Eddy County is 11.63 persons per square mile (4.49 persons /km^2); the Lea County population density is 12.69 persons per square mile (4.90 persons/km^2) (Census of Population).[10] The Demographics as of 2000 for the communities surrounding the WIPP site are listed below, by county.

EDDY COUNTY

Community	Population	Location Relative to the WIPP Site
Artesia	10,692	53 miles (85.3 km) northwest
Carlsbad	25,625	26 miles (41.8 km) west
Loving	1,326	18 miles (29.0 km) west-southwest
Total Eddy County	51,658	

LEA COUNTY

Community	Population	Location Relative to the WIPP Site
Eunice	2,562	37 miles (59.5 km) east
Hobbs	28,657	44 miles (70.8 km) northeast
Jal	1,996	45 miles (72.4 km) southeast
Lovington	9,471	50 miles (80.5 km) northeast
Total Lea County	55,511	

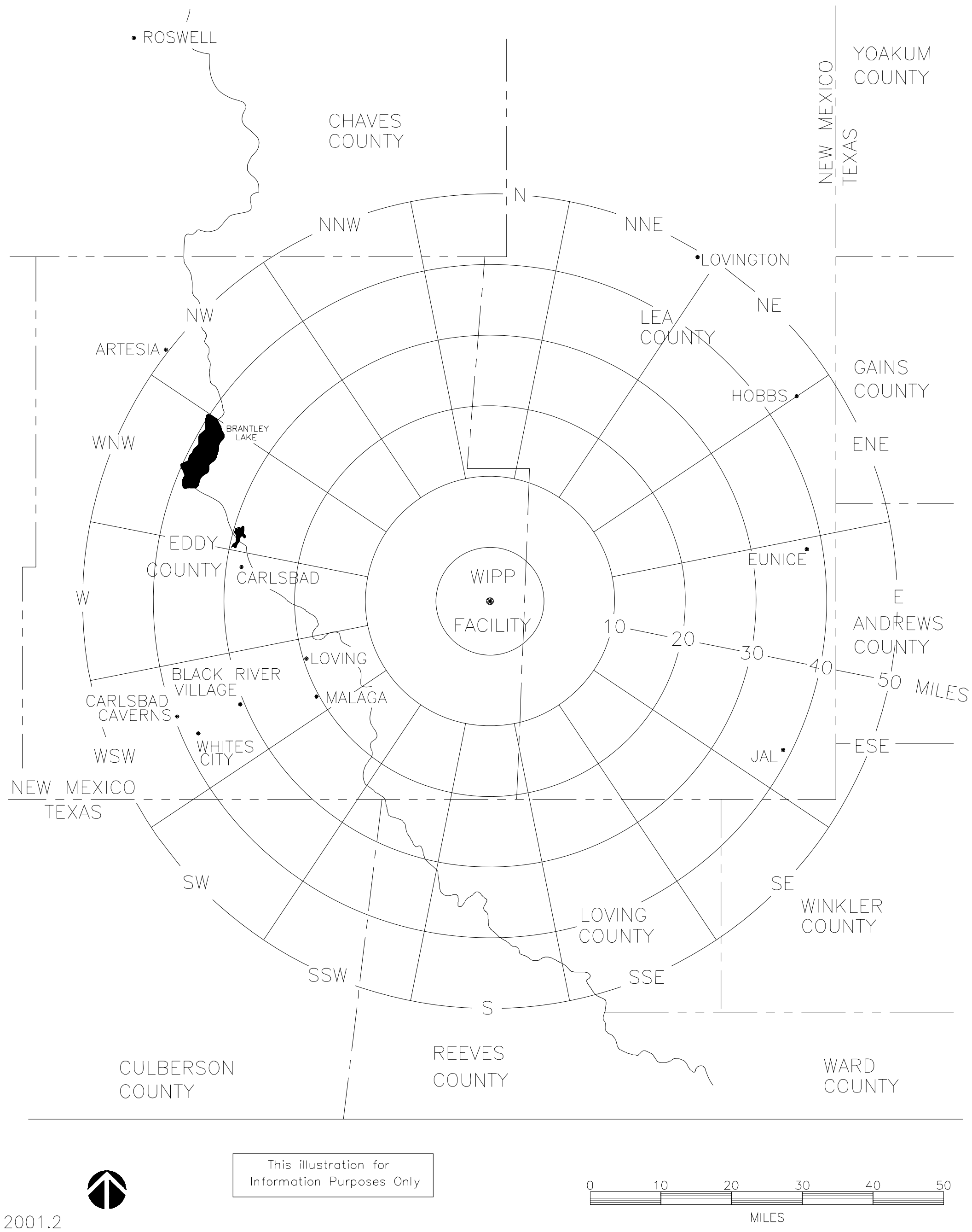

Figure 1.3-1, Region Surrounding the WIPP Site

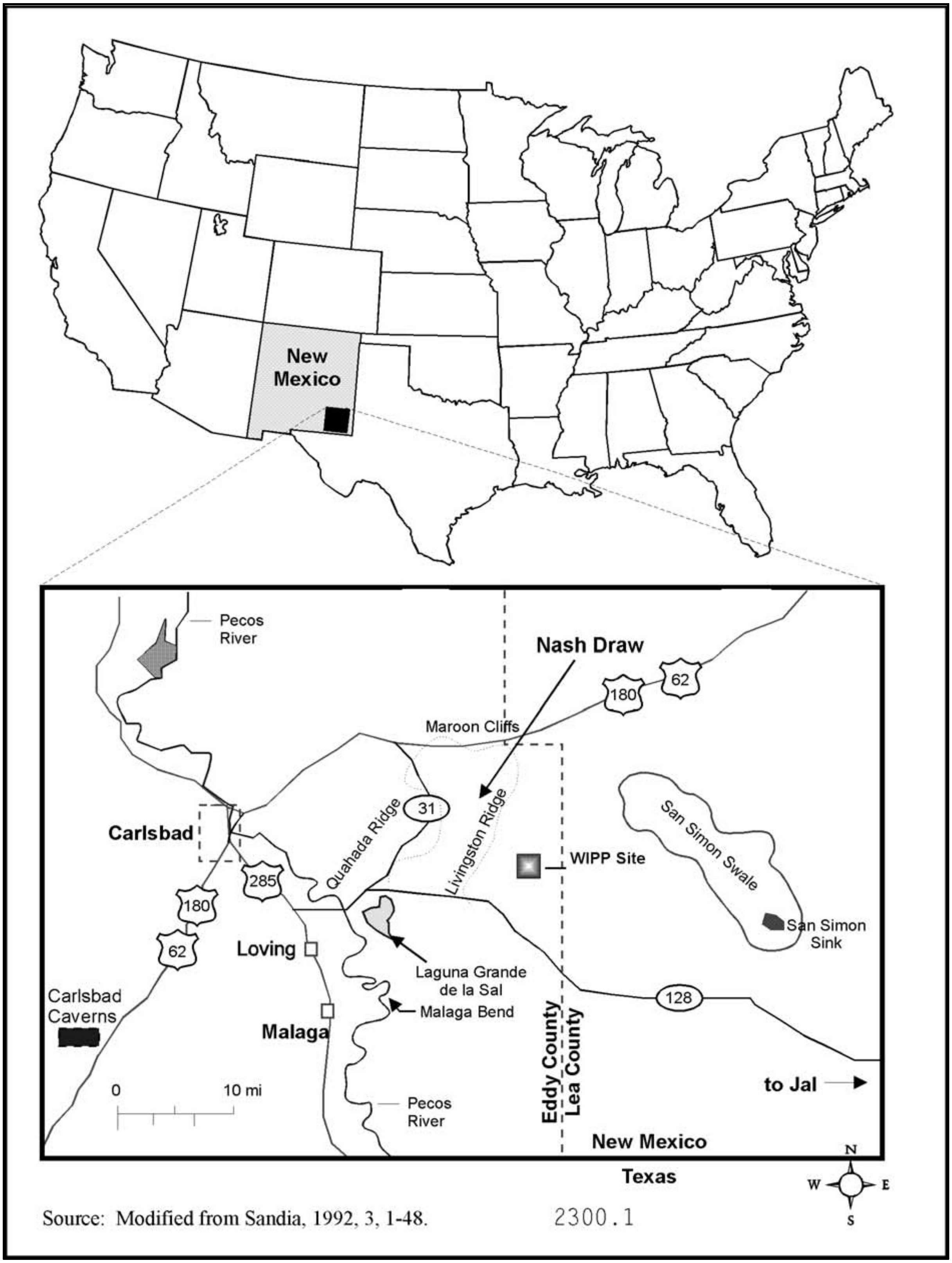

Figure 1.3-2, WIPP Location in Southeastern New Mexico

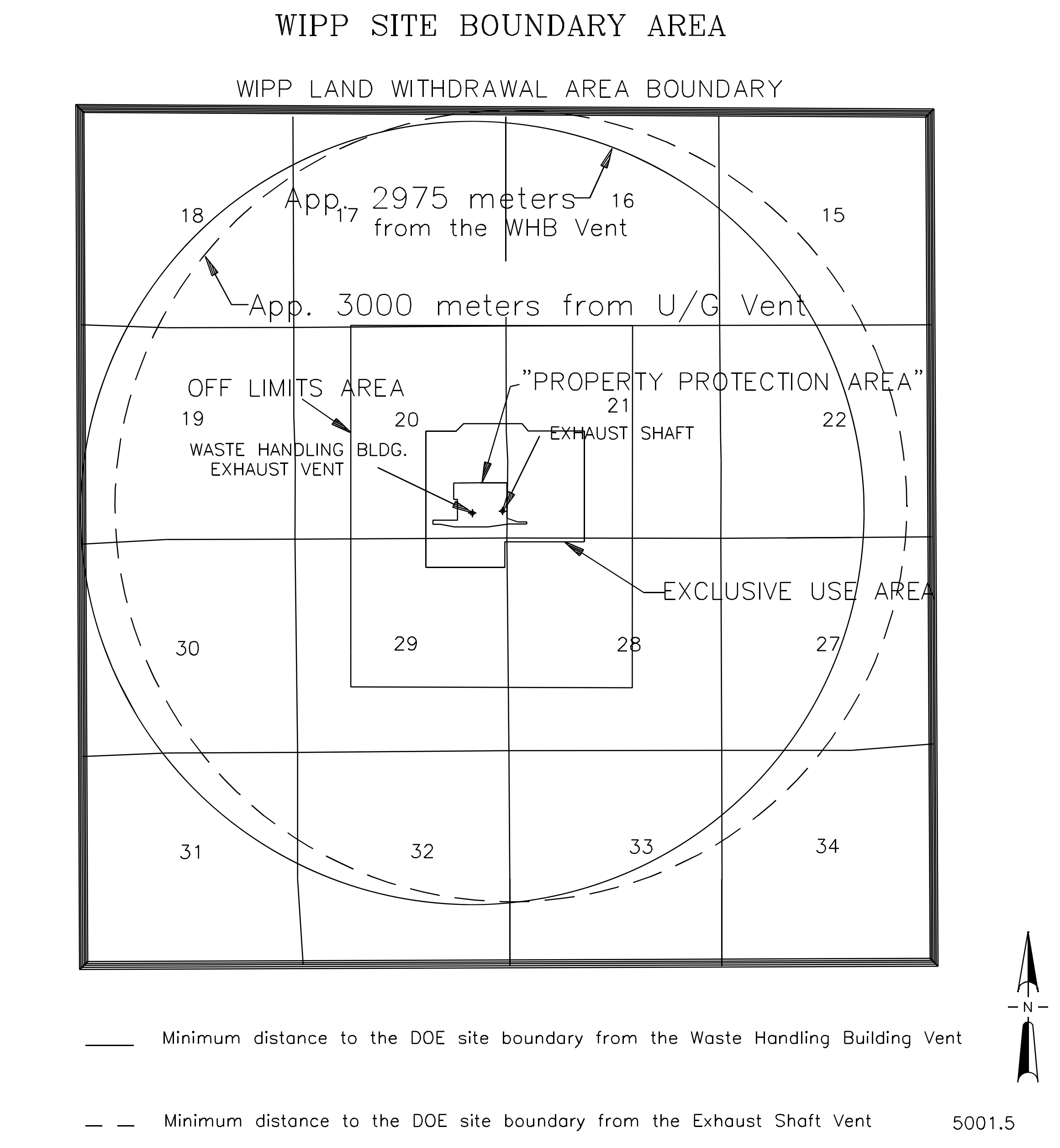

Figure 1.3-3, WIPP Site Boundary Area

1.4 Environmental Description

1.4.1 Meteorological Conditions for Design and Operating Basis

The climate of the region is semiarid, with generally mild temperatures, low precipitation and humidity, and a high evaporation rate. Winds are mostly from the southeast and moderate. In late winter and spring, there are strong west winds and dust storms. During the winter, the weather is often dominated by a high pressure system situated in the central portion of the western United States and a low pressure system located in north-central Mexico. During the summer, the region is affected by a low pressure system normally situated over Arizona.[11]

1.4.1.1 Precipitation Summary

Precipitation at WIPP is light and unevenly distributed throughout the year, averaging 13 inches (in.) (33 centimeters [cm]) annually.[12] Winter is the season of least precipitation, averaging less than 0.6 in. (1.5 cm) of rainfall per month. Snow averages about 5 in. (13 cm) per year at the site and seldom remains on the ground for more than a day at a time because of the typically above-freezing temperatures in the afternoon. Approximately half the annual precipitation comes from frequent thunderstorms in June through September. Rains are usually brief, but occasionally intense, when moisture from the Gulf of Mexico spreads over the region.[11] The WIPP region has about one day of freezing rain or drizzle a year.[16] An ice accumulation of 0.25 in. (0.63 cm) is typical.

At the time the WIPP location was selected, the maximum recorded 24-hour rainfall near the WIPP site was 5.65 in. (14.4 cm) in Roswell, in November 1901.[14] The maximum recorded 24-hour snowfall was 15.3 in. (38.9 cm) in Roswell, in December 1960. The greatest recorded snowfall during a one month period was 23.3 in. (59.2 cm) in February 1905.[15] The annual precipitation at the WIPP site was 20.8 in. (528 millimeters [mm]) for 2004.[13]

The 100-year recurrence maximum snow pack for the WIPP region is 10 lb/ft^2 (0.5 kPa).[17] The probable maximum winter precipitation in the WIPP region is taken to be the probable maximum 48-hour precipitation during the winter months of December through February. The probable maximum winter precipitation for the WIPP region is estimated to be 12.8 in (32.5 cm) of rain (i.e., 66 lb/ft^2 or 3.2 kPa).[18, 19] The snow load for the WIPP region is calculated (ground level equivalent) to be 27 lb/ft^2 (1.3 kPa). Specific roof loads are estimated based on American National Standards Institute (ANSI) methodology.[17]

The region has about 40 thunderstorm days annually. About 87.5 percent of these occur from May to September.[14] A thunderstorm day is recorded if thunder is heard, but the thunderstorm record is not related to observations of rain or lightning and does not indicate the severity of storms in the region.

Hail usually occurs in April through June and is not likely to develop more than three times a year. During a 39-year period at Roswell, hail was observed 97 times (about 2.5 times a year), occurring nearly two thirds of the time between April and June.[16] For the 1° square (32° to 33° N by 103° to 104°W) surrounding the WIPP site, hailstones 0.75 in. (1.9 cm) and larger were reported eight times from 1955 to 1967 (slightly less than once a year). There were no significant hail storms noted in the *Waste Isolation Pilot Plant 2004 Site Environmental Report* (DOE/WIPP 04-2225).[13]

1.4.1.2 Tornadoes

For the period 1916-1958, 75 tornadoes were reported in New Mexico on 58 tornado days.[20] Data for 1953 through 1976 indicate a statewide total of 205 tornadoes on 152 tornado days,[12] or an average of 9 tornadoes a year on 6 tornado days. The greatest number of tornadoes in one year was 18 in 1972; the least was 0 in 1953. The average tornado density in New Mexico during this period was 0.7 per 1,000 mi^2 (2,590 km^2). Most tornadoes occur in May and June.[21] From 1955 through 1967, 15 tornadoes were reported within the 1° square containing the WIPP surface facility.[22]

H.C.S. Thom has developed a procedure for estimating the probability of a tornado striking a given point.[23] The method uses a mean tornado path length and width and a site-specific frequency. Applying Thom's method to the WIPP yields a point probability of 0.00081 on an annual basis, or a recurrence interval of 1,235 years. An analysis by Fujita yields a point tornado recurrence interval of 2,832 years in the Pecos River Valley.[24]

According to Fujita, the WIPP design basis tornado (DBT) with a million year return period has a maximum wind speed of 183 mi/h (294.6 km/hr), translational velocity of 41 mi/h (66 km/hr), a maximum rotational velocity radius of 325 ft (99.1 km), a pressure drop of 0.5 lb/in.^{2} (3.4 kPa), and a pressure drop rate of 0.09 lb/in.^{2}/s (0.62 kPa/s). There have been no tornadoes touch down at the WIPP.

1.4.1.3 Winds

The maximum 1 minute wind speeds recorded at Roswell are shown in Table 1.4-1. The fastest 1 minute wind ever recorded at Roswell was 75 mi/h (120.7 km/h) from the west in April 1953.[25] Windstorms with speeds of 57.6 mi/h (93 km/hr) or more occurred ten times (during the period between 1955 and 1967) about one a year.[25] The mean recurrence interval for high winds at 30 ft (9.1 m) above the ground in southeastern New Mexico is shown in Table 1.4-2.[17, 23] The 100-year recurrence 30-ft (9.1 m) level wind speed in southeastern New Mexico is 82 mi/h (132 km/hr). Based on a gust factor of 1.3,[26] the highest instantaneous gust expected once in 100 years at 30 ft (9.1 m) above grade is 107 mi/h (172.2 km/h). The vertical wind profile for two 100-year recurrence intervals has been estimated from the 30-ft (9.1 m) values and is presented in Table 1.4-2.

The predominant wind direction at the WIPP site is from the southeast. For accident consequence calculations, the most current three years of wind speed data are used.

From the WIPP site meteorological tower recorded data, March 2004 had the highest wind speeds of the year. The highest wind speed measured at the 10 meter level was 33 mph (14.77 m/s) and at the 50 meter level was 40.5 mph (18.11 m/s).

1.4.1.4 Sandstorms

Blowing dust or sand may occur in the region due to the combination of strong winds, sparse vegetation and the semiarid climate. High winds associated with thunderstorms are frequently a source of localized blowing dust. Dust storms covering an extensive area occur occasionally and may reduce visibility to less than 1 mi (1.6 km). Winds of 50 to 60 mi/h (80.5 to 96.6 km/h) and higher may persist for several days if the strongest pressure gradients, which are most likely to occur during winter and early spring, become stationary.[15] Ten windstorms of 58 mi/h (93.4 km/h) and greater were reported during 1955-1967 within the 1° square in which the WIPP site is located.[21] The 2004 site environmental report[13] did not report any significant sandstorms.

1.4.1.5 Temperature Summary

Temperatures are moderate throughout the year, although seasonal changes are distinct. The mean annual temperature in southeastern New Mexico is 63°F (17.2°C). In the winter (December through February), night time lows average near 23°F (−5°C), and average maxima are in the 50s. The lowest recorded temperature at the nearest Class A weather station in Roswell was −29°F (−33.8°C) in February 1905. In the summer (June through August), the daytime temperature exceeds 90°F (32.2°C) approximately 75 percent of the time.[11] The National Weather Service documented a measurement of 122°F (50°C) at the WIPP site as the record high temperature for New Mexico. This measurement occurred on June 27, 1994. From the 2004 site environmental report,[13] the minimum average temperature recorded for the WIPP region was 26.7°F (-2.92°C) in January and the maximum high temperature recorded was 100.45°F (30.53°C) in July 2004.

1.4.1.6 Site Meteorological Tower

The WIPP site meteorological tower and station is located approximately 1,970 ft (600m) northeast of the WHB. The meteorological station measures and records wind speed, wind direction, and temperature at elevations of 6.5, 33, and 165 ft (2, 10, and 50m). The data is measured and recorded every fifteen minutes. The data is validated and certified by a Certified Meteorologist which is required for use for atmospheric dispersion calculations.

1.4.2 Hydrology

Surface and ground hydrology information can be found in DOE/CAO-1996-2184.[4] There are no major surface water bodies located within 10 miles of the WIPP site. Several bodies of water including Brantley Lake and Lake Carlsbad are over 30 miles to the north of the WIPP site and are at an approximate elevation of 3,245 ft. and 3,097 ft. respectively. The elevation of the WIPP surface is approximately 3,410 ft above mean sea level, however, surface runoff from the WIPP site does not flow north. The Pecos River is about 14 miles west of the WIPP site its closest point. In the vicinity of the WIPP site, there are limited occurrences of potable water and several water-bearing zones produce poor quality water. In the immediate vicinity of the WIPP site, groundwater above the Salado Formation is commonly of such poor quality that it is not usable for most purposes. There is shallow groundwater at the WIPP site. Hydrological characteristics of the WIPP site do not pose any operational safety hazards.

1.4.3 Geology

The land surface in the vicinity of the WIPP site is a semiarid, wind blown plain sloping gently to the west and southwest. Its surface is characterized by an abundance of sand ridges and dunes. The average slope within a 3-mi (4.8 km) radius is about 50 ft/mi (9.5 m/km) from the east to west. A plot of terrain profiles from the center of the WIPP site out to 5 miles (8.1 km) is presented in Figure 1.4-1A through 1.4-1D for each of the 16 direction sectors.

Some of the tectonic structures of the region are shown in Figure 1.4-2, with the hatched lines indicating boundaries between the Central Basin Platform, the Midland Basin, and the Delaware Basin and the solid lines indicating pre-Permian age faults. Most of the large scale structures, including the Central Basin Platform, the Midland Basin, and the Delaware Basin developed from the late Pennsylvanian to early Permian time, about 270 million years ago.

The WIPP site is located in the Delaware Basin, a subbasin of the Permian Basin, about 60 miles (97 km) east of the western margin of the Permian Basin. The geologic structure and tectonic pattern of the Permian Basin are chiefly the result of large-scale subsidence and uplift during the Paleozoic era (about

305 to 225 million years ago). The Permian Basin is divided into subbasins, which passed through their last stage of significant subsidence during the late Permian age, about 230 million years ago.

All major tectonic elements of the Delaware Basin were essentially formed before deposition of the Permian evaporites, and the region has been relatively stable since then. Deep-seated faults are rare, except along the western and eastern basin margins, and there is no evidence of young, deep-seated faults inside the basin. A detailed description of the west Texas and southeast New Mexico geologic structures and tectonics is contained in Sandia National Laboratories report SAND 78-1596.[8]

Table 1.4-1, Maximum Wind Speeds for Roswell, New Mexico*

Month	Max Wind Speed, MPH	Month	Max Wind Speed, MPH
January	67	July	66
February	70	August	72
March	66	September	54
April	75	October	66
May	72	November	65**
June	73	December	72

* Climates of the States, Vol. 2 - Western States, Roswell, NM, U.S. National Oceanic and Atmospheric Administration (NOAA), Water Information Center, Inc., Asheville, NC, 1974, p. 804. Local Climatological Data, Annual Summary 1985, Roswell, NM, NOAA-ED.

** Occurred more than once.

Table 1.4-2, Recurrence Intervals for High Winds in Southeastern New Mexico*

	Speed, mph			
Recurrence, years	30'	50'	100'	150'
2	58	62	65	73
10	68	73	81	86
25	72	77	86	91
50	80	86	95	101
100	82	88	97	103

*O. G. Sutton, Micrometeorology (McGraw-Hill Book Co., Inc., New York, 1953), p. 238.

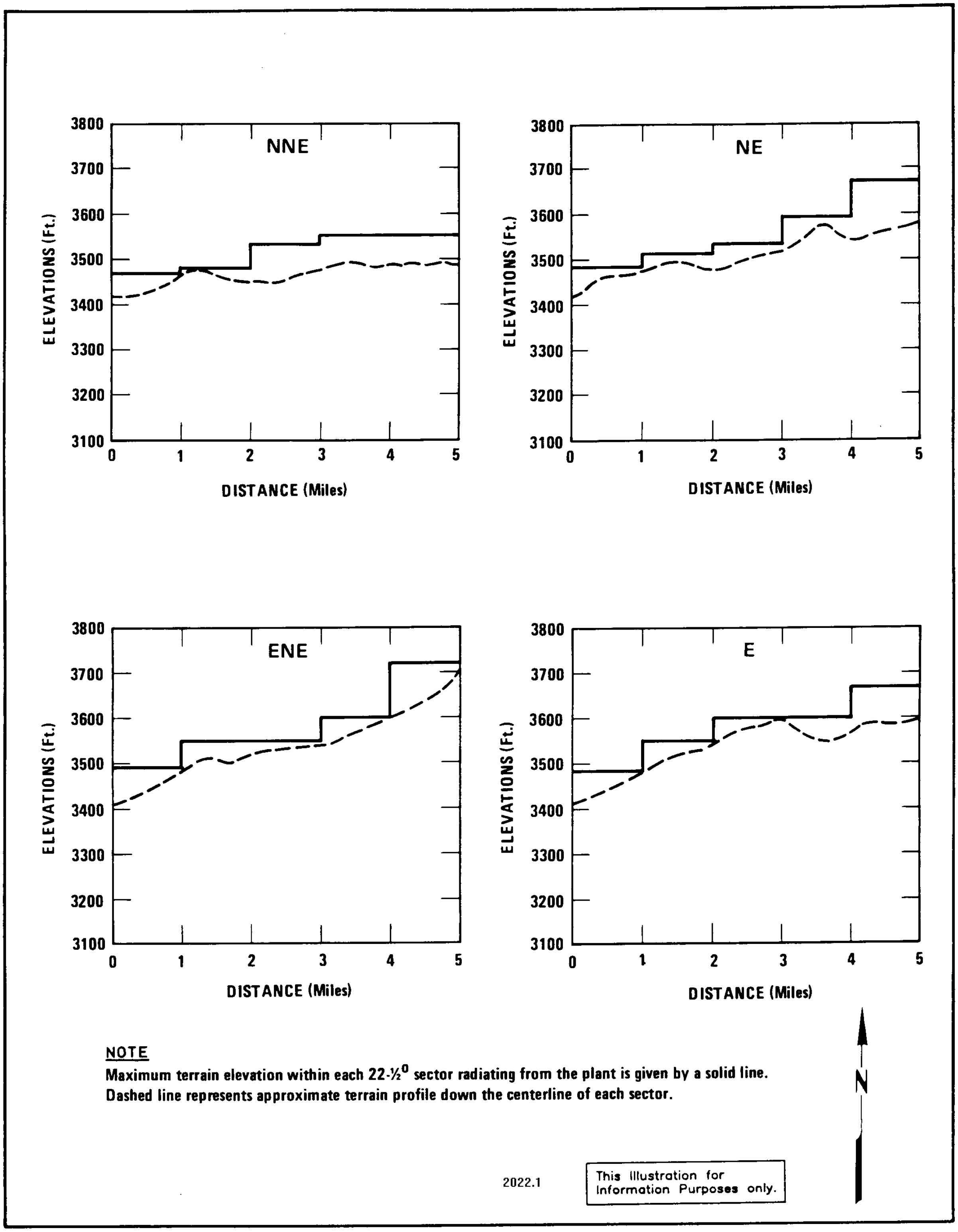

Figure 1.4-1A, Terrain Elevations Out to Five Miles from Center of WIPP

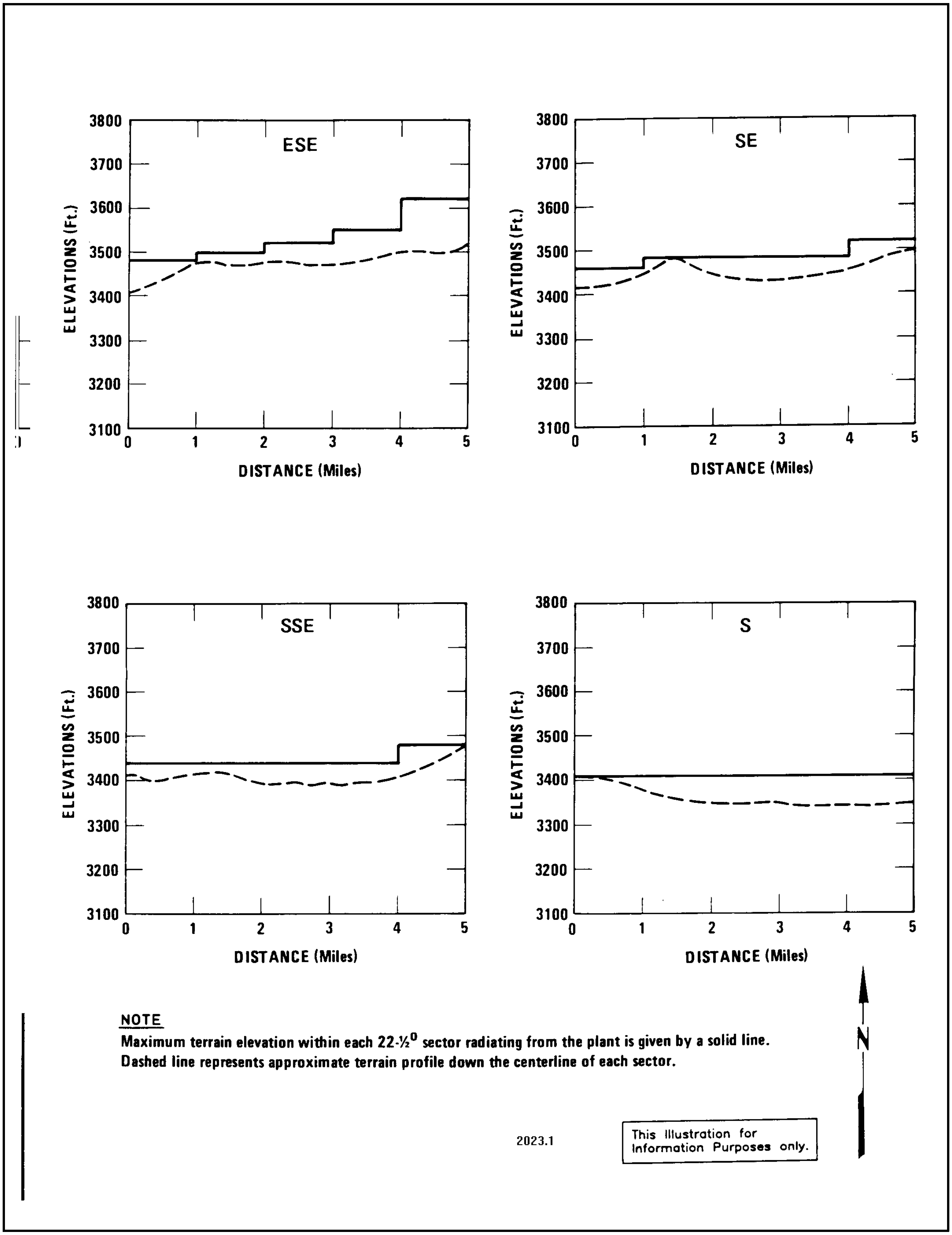

Figure 1.4-1B, Terrain Elevations Out to Five Miles from Center of WIPP

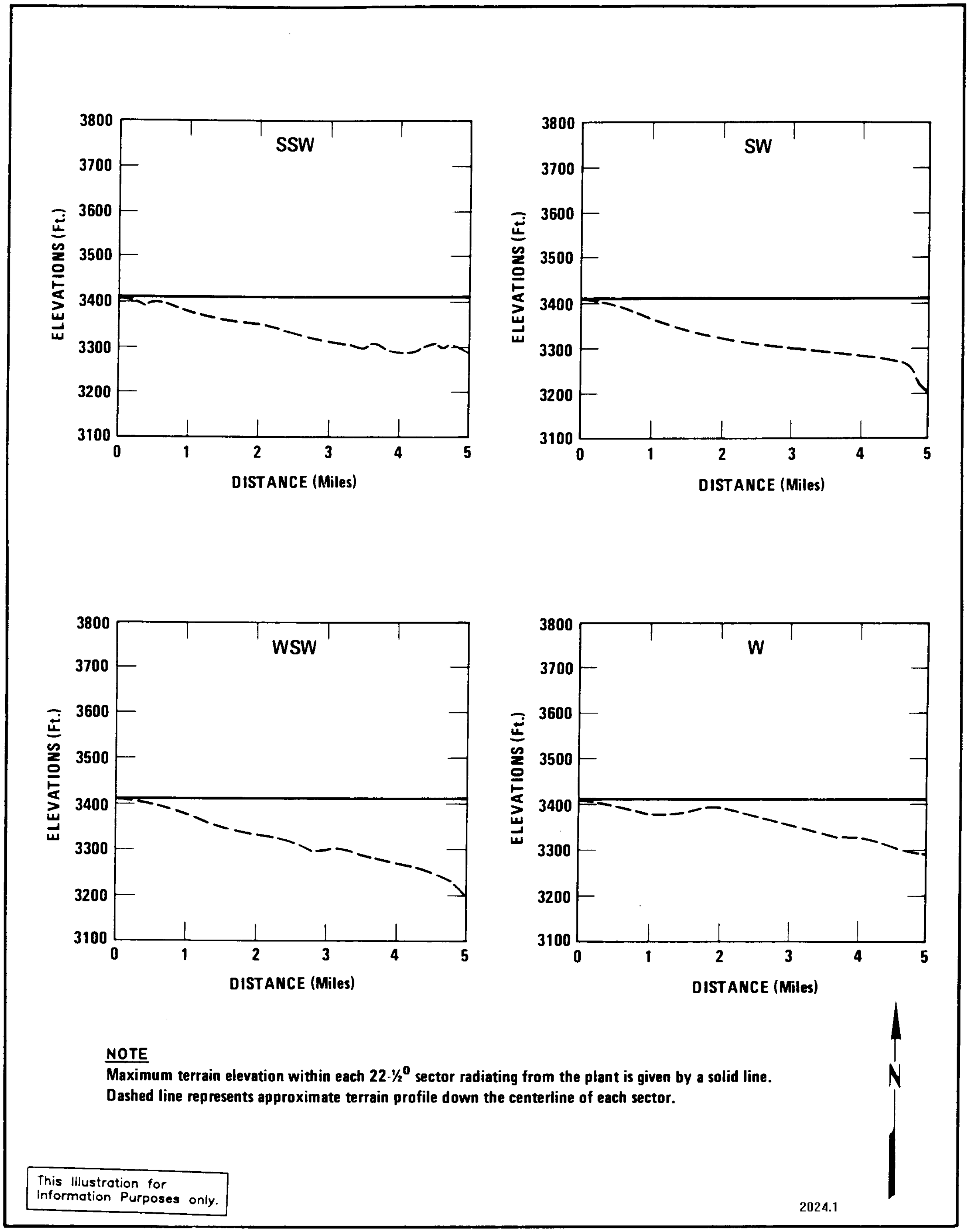

Figure 1.4-1C, Terrain Elevations Out to Five Miles from Center of WIPP

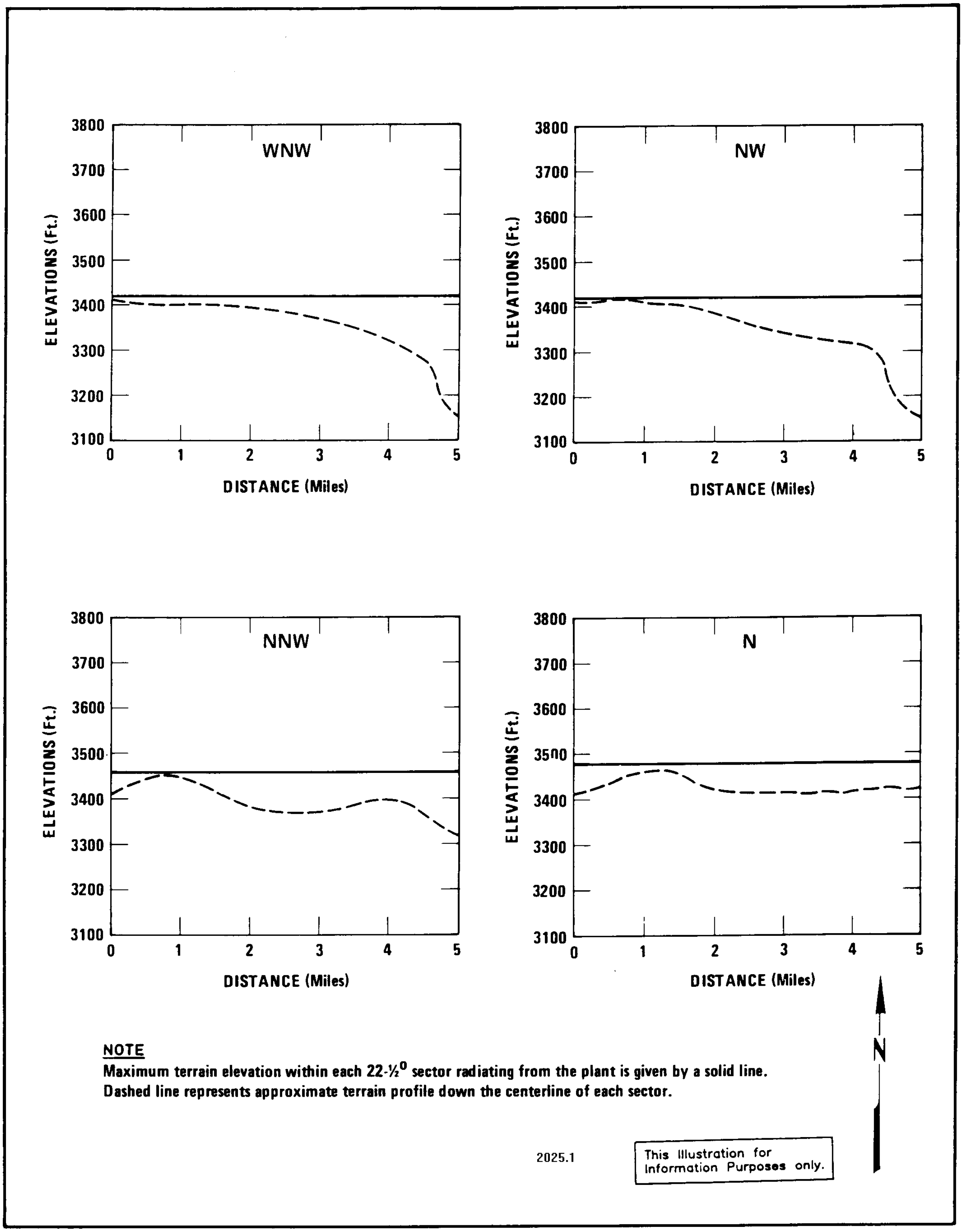

Figure 1.4-1D, Terrain Elevations Out to Five Miles from Center of WIPP

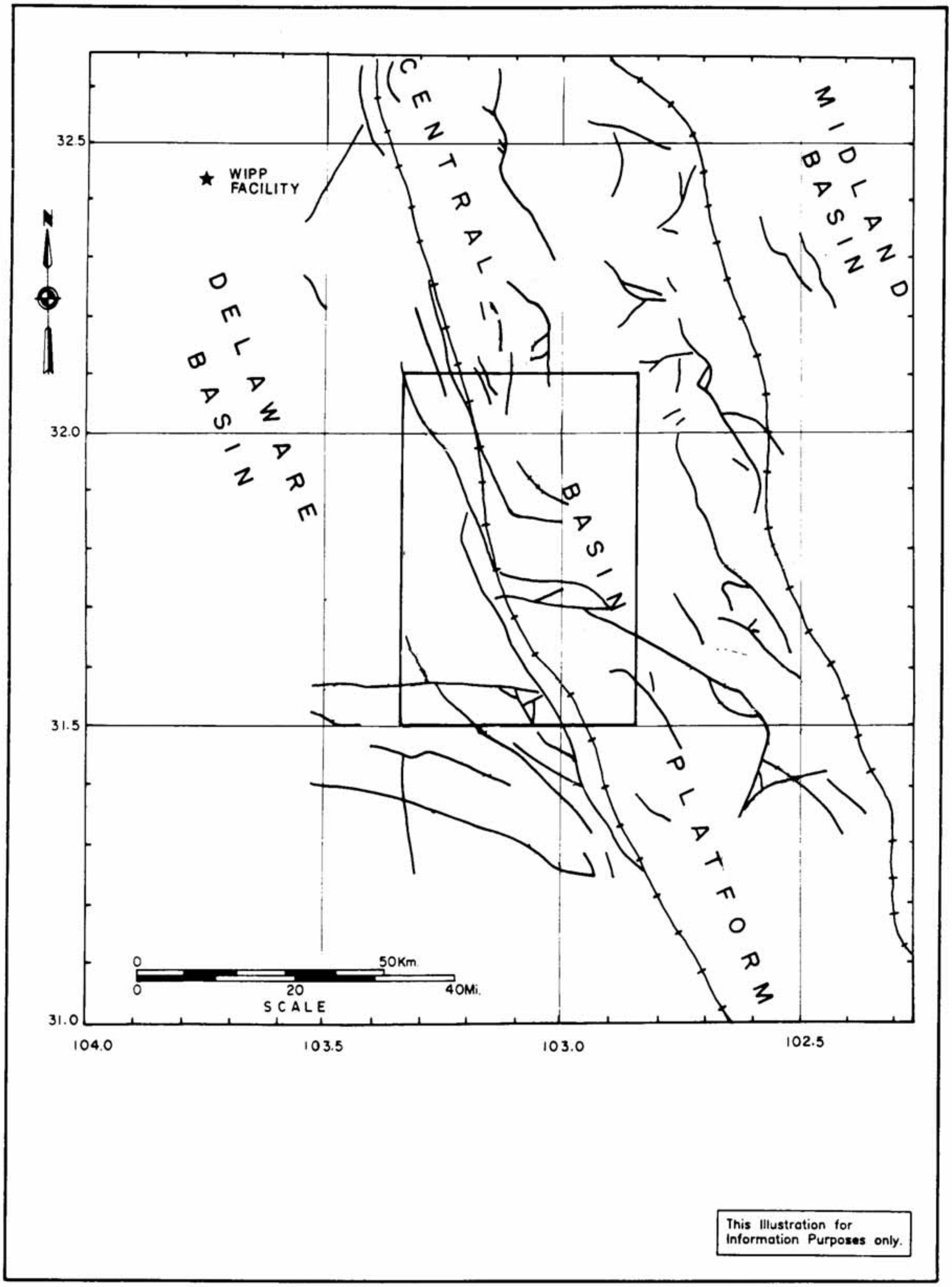

Figure 1.4-2, Geologic Structures of Southeastern New Mexico

1.5 Natural Event Accident Initiators

1.5.1 Earthquakes

Tectonic activity was used as a siting criterion for the WIPP to ensure that faulting and igneous activity do not jeopardize waste isolation over the long term and to avoid areas where earthquakes could impact facility design and operations. The location of the WIPP site met both aspects of the siting criterion. Several seismic studies[27, 28, 29] were conducted to predict ground motions that the site may be subjected to during its operational and long-term disposal phases.

This section discusses earthquake magnitude and intensity, the peak acceleration, and recurrence interval that define the design basis earthquake (DBE) for the WIPP. In this section, earthquake magnitudes are reported in terms of the Richter scale, shown in Table 1.5-1 and intensities are based on the modified Mercalli intensity scale,[30] shown in Table 1.5-2. The results from this section are applied to the seismic design of the WIPP structures and equipment.

1.5.1.1 Seismic History

Seismic history data is divided into two time frames, before and after the time when instrumented seismographic data for the region became available.

Seismic information for New Mexico before 1962 was not instrumented and was derived from chronicles of the effects of earthquakes on people, structures, and surface features. Seismic activity in New Mexico reported prior to 1962 was mostly limited to the Rio Grande Rift between Albuquerque and Socorro. The pre-1962 earthquake data indicates that twenty earthquakes with maximum reported intensities between III and VIII on the Modified Mercalli Scale[30] have occurred within a 186 miles (300 km) radius of the WIPP region from 1923 to 1960, with the strongest being the intensity V Valentine, Texas event of August 16, 1931. With the exception of several weak shocks, reported in 1926, 1936, and 1949, felt in Carlsbad, most known earthquakes before 1962 occurred to the west and southwest of the WIPP site more than 99 miles (160 km) away. A listing of pre-1962 earthquakes can be found in Table 5.2-1 of SAND 78-1596.[8]

Since 1962, seismograph coverage for New Mexico and the WIPP site has become comprehensive enough to locate the epicenters of the earthquakes occurring in the WIPP site region. Seismographs were installed at the WIPP, one on the surface and one in the underground, in 1990. Two seismic events of magnitude 5.0 or greater have occurred in the WIPP site region since 1962. The magnitude 5.0 Rattlesnake Canyon earthquake occurred on January 2, 1992, with its epicenter 37 miles (60 km) east-southeast of the WIPP site. The Marathon, Texas earthquake with a magnitude of 5.7, occurred on April 14, 1995. The Marathon earthquake epicenter was approximately 149 miles (240 km) southwest of the WIPP site. At a distance of 149 miles (240 km), an event of magnitude 5.7 would produce a maximum acceleration at the WIPP site of less than 0.01 g. Neither earthquake had any effect on the WIPP structures and was not detected by the two site seismographs. Facility inspections after the Rattlesnake Canyon earthquake were performed by personnel from the WIPP and the New Mexico Environment Department.

Seismicity within 300 km (186 mi) of the WIPP site is currently monitored by seismographs installed and operated by the New Mexico Institute of Mining and Technology (NMIMT). A network of nine seismograph stations (Figure 1.5-1), continuously monitor the seismographic activity occurring in eastern New Mexico. Data from each station is electronically transmitted to the NMIMT Seismological Observatory in Socorro, New Mexico. The recorded data is then compiled into a quarterly report on the seismicity of the WIPP site by the Geophysical Research Center of NMIMT and sent to Washington TRU Solutions LLC.

Based on the four 2004 quarterly seismic reports, the largest magnitude recorded was 3.9 from an event about 53 miles (86 km) west of the WIPP site. The closest event was a 0.5 magnitude about 32 miles (51 km) west northwest of the site. Neither event produced a ground motion at the WIPP site larger than 0.01g, and neither had any effect on the WIPP structures. A listing of earthquake occurrences including date, time, magnitude, and epicenter location can be found in the earthquake data base maintained by WP 02-PC.02, Delaware Basin Drilling Surveillance Plan.[31]

1.5.1.2 Seismic Risk

The seismic risk analysis for the WIPP siting, completed in 1978, used procedures[32, 33] for the determination of earthquake probabilistic design parameters. In typical seismic risk analyses, the region of study is divided into seismic source areas such as the Cental Basin Platform, Rio Grande Rift, and Delaware Basin. Future seismic events are considered equally likely to occur at any location within those areas. For each seismic source area, the rate of occurrence of events above a chosen threshold is estimated using the frequency of historical events. The sizes of successive events in each source are assumed to be independent and exponentially distributed. The maximum possible size of events for each source is determined using judgment and the historical record. All assumptions underlying a measure of earthquake risk derived from this type of analysis are explicit, and a wide range of assumptions may be employed in the analysis procedure.

Regional studies of earthquakes prior to 1972 in southeastern New Mexico indicate that most of the earthquakes occurred in the Central Basin Platform region near Kermit, Texas, and the area about 124 miles (200 km) or more west and southwest of the WIPP site in the Rio Grande Rift. The strongest earthquake event was near Valentine, Texas, in 1931 and the closest was a 1972 magnitude 2.8 event with its epicenter approximately 25 miles (40 km) northwest of the WIPP site. The record from regional studies of events in the Rio Grande Rift is consistent with the record of Quaternary faulting in that area. Quaternary faults are geologic faults that have occurred within the last three million years or since the end of the Tertiary period.

Seismic instrument studies near the WIPP site since 1974 have recorded additional evidence of the seismic activity for the site and region. The data obtained is similar to that from regional studies; in which half of the events occur on the Central Basin Platform while most of the rest occur to the west and southwest of the site in the Rio Grande Rift, with some events occurring in the general site region not in association with either the Central Basin Platform or the Rio Grande Rift.

The Central Basin Platform data showed that location as the most active seismic area within 186 miles (300 km) of the WIPP site in terms of number of events. The activity is equally likely to occur anywhere along the Central Basin Platform structure without regard to structural details such as pre-Permian buried faults. The lack of known Quaternary faults from the seismically active region of the Central Basin Platform indicates that large magnitude earthquakes have not occurred within the recent geologic past in the area.

Analysis of the regional and local seismic data indicated that the 1,000-year acceleration is less than or equal to 0.06 g and the 10,000-year acceleration is less than or equal to 0.1 gravitational force for all models tried. SAND 78-1596[8] contains the detailed seismic risk analysis performed for the WIPP siting.

1.5.1.3 Design Basis Earthquake

The term DBE is used for the design of surface confinement structures and components and is equivalent to the design earthquake used in NRC Regulatory Guide 3.24, *Guidance on the License Application, Siting, Design, and Plant Protection for an Independent Spent Fuel Storage Installation*.[34] The DBE is such that it produces ground motion at the WIPP site with a recurrence interval of 1,000 years.

From SAND 78-1596,[8] the most conservative calculated estimate of the 1,000 year acceleration at the WIPP is approximately 0.075g. The geologic and seismic assumptions leading to this 1,000-year peak acceleration include the consideration of a Richter magnitude 5.5 earthquake at the site, a 6.0 magnitude earthquake on the Central Basin Platform, and a 7.8 magnitude earthquake in the Basin and Range subregion. These magnitudes correspond roughly to equivalent epicentral intensity events of VII, VIII, and XI on the Modified Mercalli intensity scale.[30] These values, especially the first two, are considered quite conservative, and the other parameters used in the 0.075g derivation are also conservatively chosen. For additional conservatism, a peak design acceleration of 0.1g is selected for the WIPP DBE. The design response spectra for vertical and horizontal motions are taken from NRC Regulatory Guide 1.60, *Design Spectra for Seismic Design of Nuclear Power Plants*,[35] with the high-frequency asymptote scaled to this 0.1g peak acceleration value.

Mine experience and studies on earthquake damage to underground facilities[36] show that tunnels, mines, wells, etc., are not damaged for sites having peak accelerations at the surface below 0.2 g.

The DBE is the most severe credible earthquake that could occur at the WIPP site. DBE structures, systems, and components (SSCs) are designed to withstand a free-field horizontal and vertical ground acceleration of 0.1g, based on a 1,000-year recurrence period, and retain their safety functions.

1.5.2 Design Basis Tornado

From Section 1.4.1.2, New Mexico has an average on nine tornadoes per year with most occurring in May and June. Although tornados have occurred within the 1° square containing the WIPP surface facility, none have touched down at the WIPP site.

H.C.S. Thom developed a method for estimating the probability of a tornado striking a given point.[23] The method uses a mean tornado path length and width and a site-specific frequency. Applying Thom's method to the WIPP yields a point probability of 0.00081 on an annual basis, or a recurrence interval of 1,235 years. An analysis by Fujita yields a point tornado recurrence interval of 2,832 years in the Pecos River Valley.[24] According to Fujita, the WIPP DBT with a million year return period has a maximum wind speed of 183 mph (294.6 km/hr).

The DBT is the most severe credible tornado that could occur at the WIPP site. WIPP DBT SSCs are designed to withstand the 183 mph (293 km/h) winds generated by the DBT, based on a 1,000,000 year recurrence period, and retain their safety function.

Table 1.5-1, Richter Scale

Magnitude	
Less than 2	Very Seldom Ever Felt
2.0 to 3.4	Barely Felt
3.5 to 4.2	Felt as a Rumble
4.3 to 4.9	Shakes Furniture; Can Break Dishes
5.0 to 5.9	Dislodges Heavy Objects; Cracks Walls
6.0 to 6.9	Considerable Damage to Buildings
7.0 to 7.3	Major Damage to Buildings; Breaks Underground Pipes
7.4 to 7.9	Great Damage; Destroys Masonry and Frame Buildings
above 8.0	Complete Destruction; Ground Moves in Waves

Table 1.5-2, Modified Mercalli Intensity Scale[30]

(Abridged)

Intensity	
I.	Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel scale.)
II.	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel scale.)
III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel scale.)
IV.	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rock noticeably. (IV to V Rossi-Forel scale.)
V.	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel scale.)
VI.	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale.)
VII.	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars. (VIII Rossi-Forel scale.)
VIII.	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbs persons driving motor cars. (VIII+ to IX Rossi-Forel scale.)
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX Rossi-Forel scale.)
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel scale.)
XI.	Few, if any, structures (masonry) remain standing. Bridges destroyed, broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII.	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

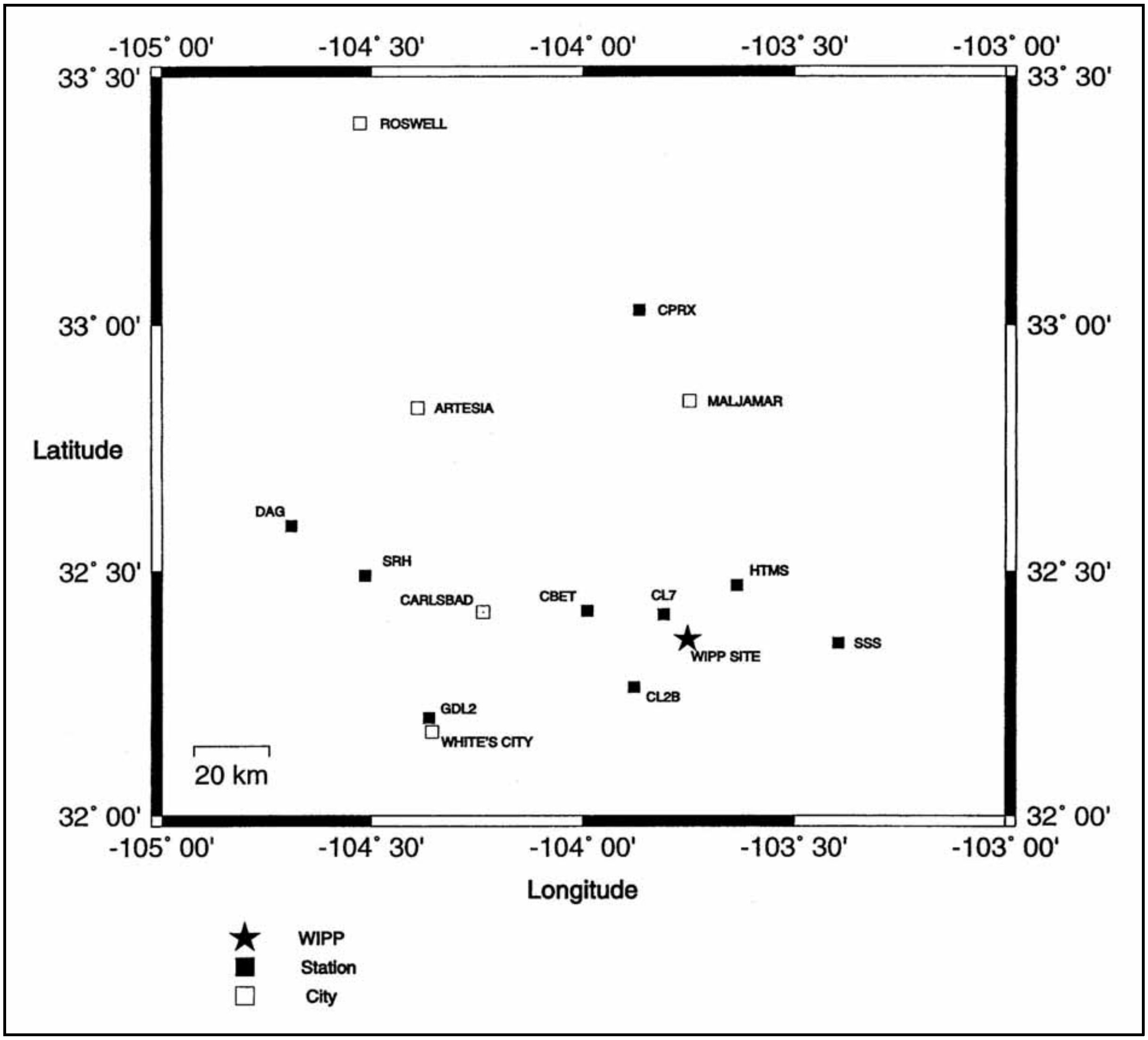

Figure 1.5-1, Seismograph Stations in the WIPP Network

Seismograph Stations

CBET	Carlsbad East Tower	DAG	Dagger Draw
CL7	Carlsbad Station 7	GDL2	Guadalupe Mountains
CL2B	Carlsbad Station 2B	HTMS	Hat Mesa
CPRX	Caprock	SSS	San Simon Swale
SRH	Seven Rivers Hills		

1.6 Man-Made External Accident Initiators

1.6.1 Gas Pipeline Explosion

Oil and gas related activities are the commercial operations within five miles of the WIPP site. There are three potash mines and three chemical processing plants (adjacent to the mines) within five to ten miles (8.0 to 16.1 km) of the WIPP site.

Activities associated with oil and gas exploration, production, and transportation present the most likely man-made external accident initiators to the WIPP because of their proximity to the WIPP site. Figures 1.6-1A and 1.6-1B show the location and related information of each pipeline within five miles (8.0 km) of the site. There are no crude oil pipelines within five miles (8.0 km) of the WIPP site, but. there are four natural gas pipelines in the vicinity of the site. One pipeline is within the WIPP Site Boundary, oriented northeast southwest, and is about 1.2 miles (1.9 km) north of the center of the WIPP surface structures at its closest point.

The three potash mines and three potash chemical processing plants located between five and ten miles (8.0 to 16.1 km) of the WIPP site do not present a hazard to the WIPP operations.

1.6.2 Aircraft Crash

1.6.2.1 Military Facilities

There are no military facilities within a five mile radius (8.0 km) of the WIPP site. Holloman Air Force Base is the nearest military facility to the WIPP site and is located 138 miles (222.1 km) to the northwest.

1.6.2.2 Airports and Aviation Routes

There are no airports within a ten-mile (16.1 km) radius of the WIPP site. The nearest airstrip, now decommissioned, was 12 miles (19.3 km) north of the site. The nearest commercial airport is Cavern City Air Terminal, 28 miles (45.1 km) west of the WIPP site in Carlsbad. Other airports in the area are Eunice (32 miles or 51.5 km east), Carlsbad Caverns Airport (42 miles or 67.6 km southwest), Hobbs Airport (42 miles or 67.6 km northeast), Jal Airport (40 miles or 64.4 km southeast), Lovington Airport (50 miles or 80.5 km northeast), and Artesia Airport (51 miles or 82.1 km northwest). The relationship of these airports to the WIPP site is shown in Figure 1.6-2. The figure also shows the historic airways applicable to the WIPP during the siting and design phase.

A study performed in August 2000[37] documented more current flight information based on input from local Carlsbad airport data, military data, and Federal Aviation Administration (FAA) data. Commercial and general aviation flights into the Carlsbad Airport totaled 3,924 flights per year. Military flights prior to October 2000 were about 965 flights per year and were expected to drop due to changes in U.S. Air Force training plans.

The study summarized FAA information that included sets of air traffic data and flight patterns for military, commercial and private aircraft within a five mile radius of the WIPP site. The data indicated little traffic over the WIPP site with heavier traffic to the south. The proximity of the WIPP site to the southern border of the country limit the north-south traffic. The restricted airspace associated with the White Sands Missile Range to the west of the WIPP site cause east-west traffic to preferentially fly to the north or south of the site. The highest number of flights recorded in the data provided was 35 flights in 26 hours. This would equate to over 11,570 flights per year. While this is an increase over the nominal 30 flights per day during the design phase of the WIPP, the study further calculated the frequency of aircraft impact to the WIPP site to be 3.6×10^{-7}/year, indicating that the WIPP site's remote location protects it from the effects of aircraft accidents.

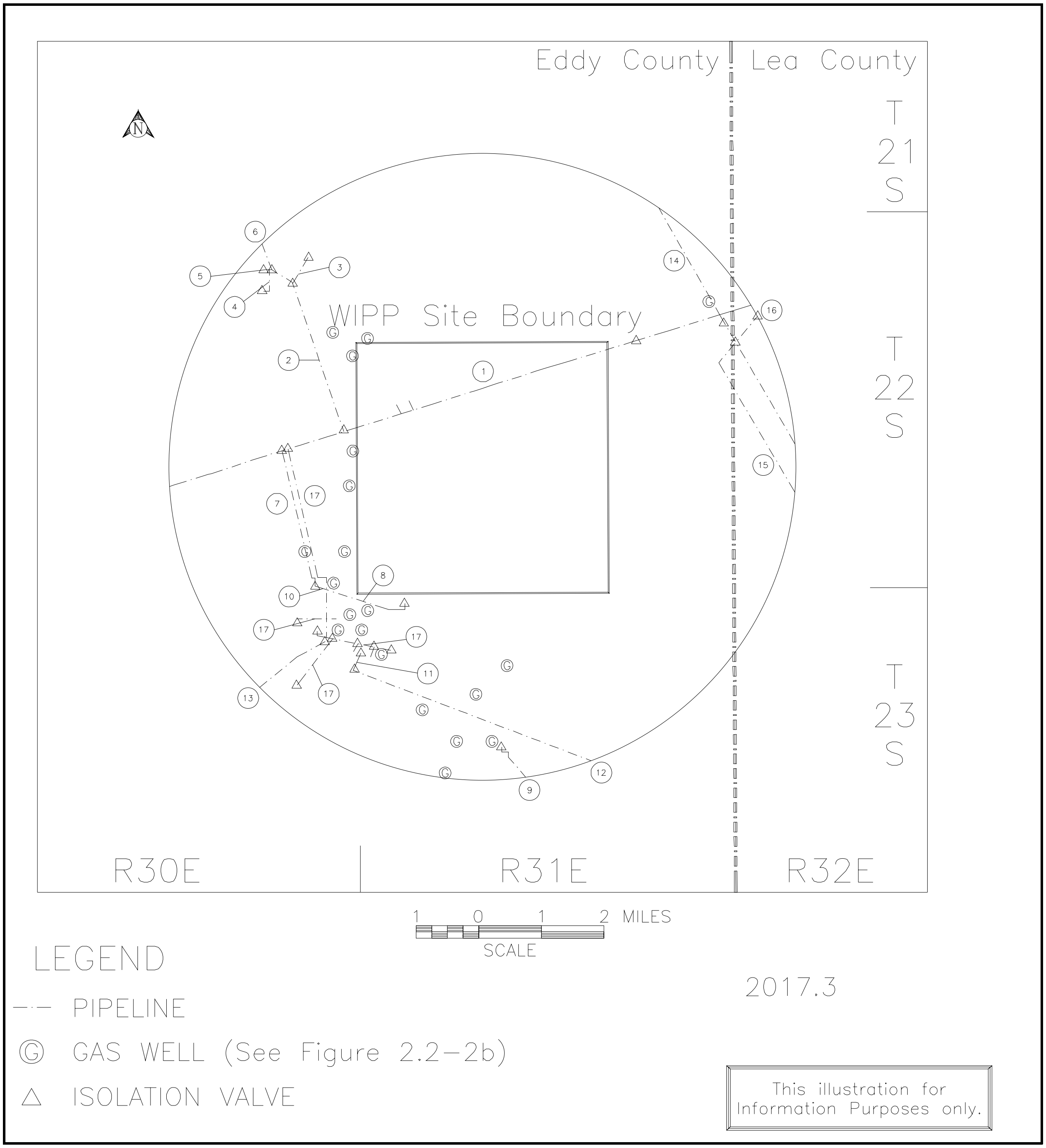

Figure 1.6-1A, Natural Gas Pipelines and Wells Within Five-Mile Radius

Figure 1.6-1B, Explanation to Figure 1.6-1A

1. El Paso Natural Gas Co., Eunice-Carlsbad Line (LC060762) 12.75" Dia Gas Line, Built 1945, Located 1.125 miles NNW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

2. El Paso Natural Gas Co., James "A" No. 1 (NM17321) 4.5"/8.625" Dia Gas Line, Built 1974, Located 2.375 miles WNW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

3. El Paso Natural Gas Co., Cabana No. 1 (NM18432) 4.5" Dia Gas Line, Built 1974, Located 4.25 miles NW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

4. El Paso Natural Gas Co., James "E" No. 1 (NM19974) 4.5" Dia Gas Line, Built 1974, Located 4.25 miles NW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

5. El Paso Natural Gas Co., El Paso "201" Spur Line (NM20125) 4.5" Dia Gas Line, Built 1974, Located 4.625 miles NW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

6. El Paso Natural Gas Co., James "C" No. 1 (RW18344) 6.625" Dia Gas Line, Built 1974, Located 4.625 miles NW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

7. El Paso Natural Gas Co., James Ranch Unit No. 1 (NM046228) (RW14190) 4.5" Dia Gas Line, Built 1958, Located 3.06125 miles WSW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

8. El Paso Natural Gas Co., James Ranch Unit No. 7 (NM26987) 4.5" Dia Gas Line, Built 1976, Located 2.625 miles SW of WIPP. Operating Pressure 721 PSIG, Burial Depth 24".

9. El Paso Natural Gas Co., Arco State No. 1 (RW17822) 6.625" Dia Gas Line, Built 1971, Located 4.625 miles S of WIPP. Operation Pressure 837, Burial Depth 24".

10. El Paso Natural Gas Co., Lateral EE-4 (NM16959/(RW18065) 4.5" Dia Gas Line, Built 1973, Located 3.125 miles SW of WIPP. Operating Pressure 1200 PSIG, Burial Depth 36".

11. Natural Gas Pipeline Co. of America, Lateral EE-6 Built 1974, 4.5" Dia Gas Line, Built 1974, Located 3.2 miles SSW of WIPP. Operating Pressure 1200 PSIG, Burial Depth 36".

12. Natural Gas Pipeline Co. of America, Lateral EE-3 (NM16029) 8.625" Dia Gas Line, Built 1972, Located 3.4 miles SSW of WIPP. Operating Pressure 1200 PSIG, Burial Depth 36".

13. Natural Gas Pipeline Co. of America, Lateral EE-7 (NM22471) 4.5" Dia Gas Line, Built 1974, Located 4.7 miles SW of WIPP. Operating Pressure 1200 PSIG, Burial Depth 36".

14. Transwestern Pipeline Co., West Texas Lateral (NM070224) 24" Dia Gas Line, Built 1960, Located 4.5 miles ENE of WIPP. Operating Pressure 1200 PSIG, Burial Depth 30".

15. Transwestern Pipeline Co., West Texas Lateral (NM8722) 30" Dia Gas Line, Built 1969, Located 4.25 miles ENE of WIPP. Operating Pressure 930 PSIG, Burial Depth 30".

16. Transwestern Pipeline Co., Monument Lateral (NM073482) 10" Dia Gas Line, Built 1960, Located 4.5 miles ENE of WIPP. Operating Pressure 930 PSIG, Burial Depth 30".

1 **(1 kilometer = 0.62 miles)**

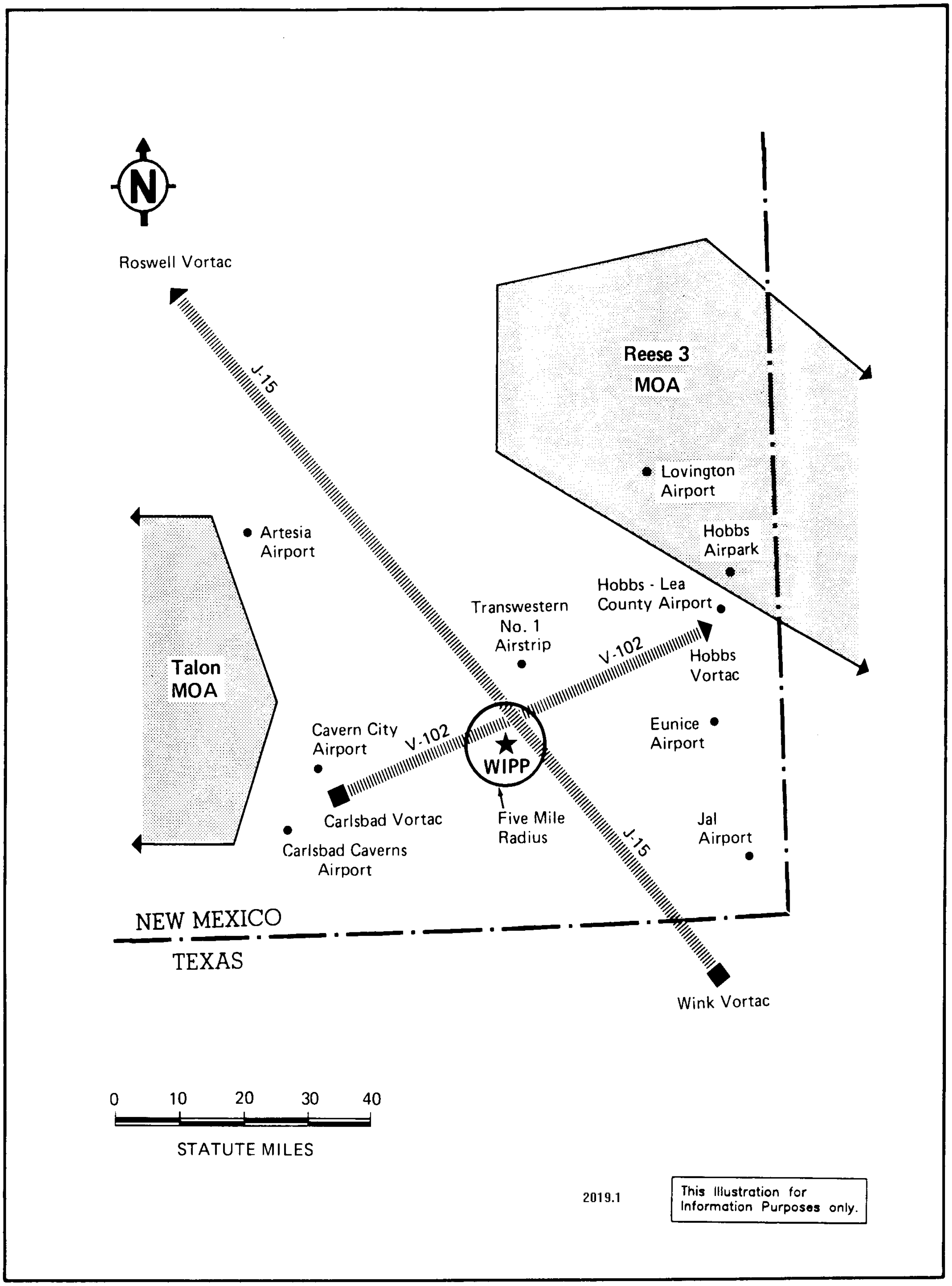

Figure 1.6-2, Airports and Aviation Routes Adjacent to the WIPP Site

1.7 Nearby Facilities

1.7.1 Extractive Activities

Within a five mile (8.0 km) radius from the center of the WIPP LWA, both oil and gas are extracted below the Salado formation. The majority of the newer wells produce oil and gas from the Brushy Canyon formation of the Delaware Mountain Group. Gas wells typically produce from the deeper Pennsylvanian formations (Atoka, Strawn, and Morrow formations). In late 2004, there were 259 oil wells (some which produce both oil and gas), 20 gas wells, and 17 plugged wells within five miles (8.0 km) of the LWA boundary. The completion of these wells is stratigraphically below the repository horizon. There are likewise an additional 661 oil wells, 45 gas wells, and 88 plugged wells within ten miles of the LWA boundary (Figure 1.7-1). The plugged wells include both wells that are considered dry holes and wells that are no longer productive and have been permanently sealed.

Besides the oil and gas extractive activities, there are three active potash mines within ten miles (16.1 km) of the WIPP LWA. Potash is extracted from the McNutt Potash member which is stratigraphically above the WIPP repository horizon.

1.7.2 Ranching

There are approximately 300 ranches with nominally 2.6 million acres in Eddy County and 2.8 million acres in Lea County with a nominal 100,000 to 150,000 head of livestock (New Mexico Agricultural Statistics).[38]

1.7.3 Farming

There are approximately 160,000 acres (64,750 hectares) of farmland in the Carlsbad resource area. The principal crops grown include cotton, alfalfa, sorghum grains and pecans. There are also minor amounts of vegetables grown.

1.7.4 Recreation

Recreational opportunities in the area of the WIPP site include big and small game hunting, camping, horseback riding, hiking, watching wildlife, and sightseeing.

1.7.5 Tourism

There are two national parks (Guadalupe Mountains and Carlsbad Caverns), a national forest (Lincoln), and two state parks (Living Desert Zoo and Gardens, and Brantley) located within or near Carlsbad. Carlsbad Caverns National Park, 36 miles (58 km) southeast of the WIPP site, has approximately one million visitors per year.

1.7.6 Waterways

There are no navigable waterways within a five-mile (8.0 km) radius of the WIPP site. The nearest river is the Pecos River which is 12 miles (19.3 km) west of the WIPP site.

1.7.7 Land Transportation

1.7.7.1 Roads and Highways

Other than the highways that provide north or south access, only one other highway lies within a five-mile (8 km) radius. This is New Mexico Highway 128, which is between four and five miles (6.4 to 8 km) southwest of the WIPP (Figure 1.3-2). It connects Jal with New Mexico 31, which leads into Loving and it provides access to Carlsbad. New Mexico Highway 128 is used by ranchers, school buses, potash miners, and by oil and gas company vehicles. Dirt roads in the area are used for ranching, oil and gas maintenance/production activities.

1.7.7.2 Railroads

Except for the rail spur that serves the WIPP site, there are no railroad lines within the five-mile radius the site. There are rail lines to Mosaic Corporation Main Plant and Nash Draw operation, and the Intrepid Mining, LLC. Each potash mining operation is located between 6 and 10 miles (9.7 to 16.1 km) of the WIPP site. All railroad lines within the general vicinity of the WIPP site are used specifically to transport potash.

1.7.8 Projected Industrial Growth

Oil and gas production is the only significant economic activity forecast for the future within five miles (8 km) of the WIPP site. Active potash mining is occurring within ten miles of the site. Potash expansion is not firm because of market conditions. No extractive activity is allowed within the LWA area with the exception of Section 31 (the southwest corner section of the LWA area). There is currently one gas well, referred to as James Ranch 13, producing from that section below the 6,000 ft (1,828.8 m) LWA designation. This well was slant drilled from section 6 of Township 23 South. Other permit applications for slant drilling into section 31 from outside sections have been denied by the BLM. The other fifteen sections of the LWA area are withdrawn to the center of the earth.

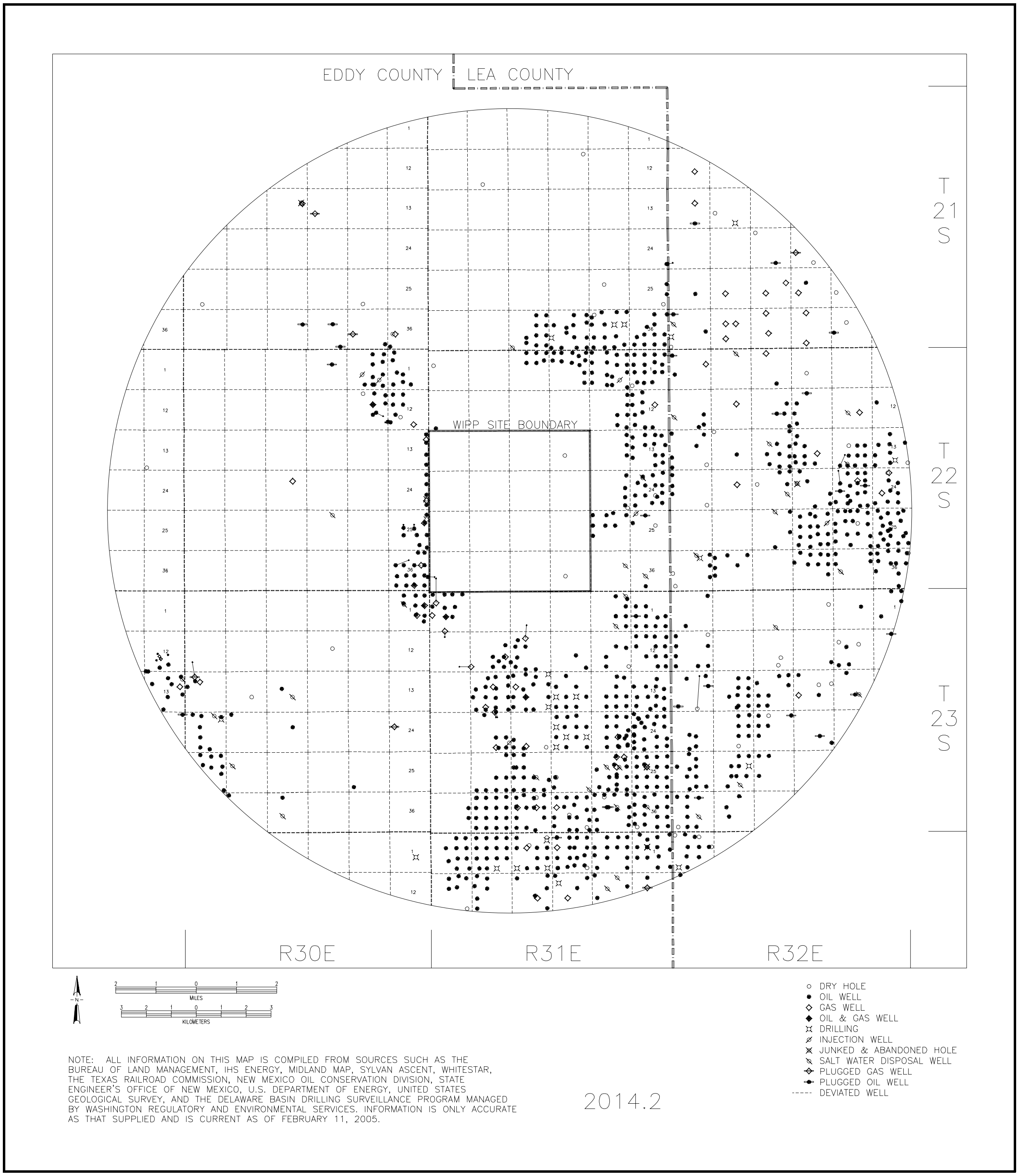

Figure 1.7-1, Natural Gas and Oil Wells Within a Ten-Mile Radius (1 Kilometer = 0.62 Miles)

1.8 Validity of Existing Environmental Analysis

The DOE's *Environmental Protection Program* (DOE Order 450.1)[39] describes the DOE's commitment to environmental protection and pledges to implement sound stewardship practices that are protective of the air, water, land and other natural and cultural resources. The DOE conducts effluent monitoring and environmental surveillance to verify that the public and the environment are protected during WIPP operations, and to ensure operations comply with applicable federal and state requirements.

The WIPP 2004 site environmental report[13] provides a description of the WIPP environmental monitoring program and the results of that monitoring. Based on environmental reports generated since WIPP was constructed, there have been no environmental events that challenge the design basis for the WIPP.

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FACILITY DESCRIPTION

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FACILITY DESCRIPTION

2.1 Introduction

The purpose of this chapter is to provide descriptions of the Waste Isolation Pilot Plant (WIPP) facility and processes to support assumptions used in the hazard and accident analyses. This chapter discusses design and safety criteria for structures, systems, and components (SSCs) that protect the public, workers, and the environment from hazards posed by the WIPP remote-handled (RH) waste handling operations. This chapter also describes the SSCs that support RH waste handling as well as the waste handling process.

2.2 Requirements

The WIPP was designed and constructed according to U.S. Department of Energy (DOE) O 6430, *General Design Criteria Manual for Department of Energy Facilities*, draft, dated June 10, 1981,[1] and codes and standards applicable at the time of construction. Facility modifications designed prior to DOE O 6430 being superceded were designed according to the revision of DOE O 6430 and codes and standards applicable at the time of modification. Future modifications will be designed according to DOE O 420.1B, *Facility Safety*[2]; and DOE O 430.1B, *Real Property Asset Management*[3]; and the codes and standards in DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for use with DOE O 420.1A, Facility Safety*.[4] Codes and standards from DOE G 420.1-1 are summarized in Table 2.2-1.

SSCs for the original WIPP design were classified as Design Class I, II, and III in the WIPP General Plant Design Description (GPDD)[5] and individual system design descriptions (SDDs). Based on DOE G 420.1-1,[4] the WIPP has replaced design class with functional classification. The WIPP SSC functional classifications are as follows:

- **Safety Class (SC)**. SC SSCs are those whose preventive or mitigative function is necessary to keep radiological material exposure to the public below the off-site evaluation guideline, which is 25 rem (roentgen equivalent man) (250 millisieverts) total effective dose equivalent. The dose estimates to be compared to it are those received by a hypothetical maximally exposed off-site individual at the site boundary.

- **Safety Significant (SS)**. SSCs not designated as SC, but whose preventive or mitigative function is a major contributor to defense in depth (DID) and/or worker safety as determined from hazards analysis. SS SSC designations based on worker safety are limited to those whose failure is estimated to result in a prompt worker fatality or serious injuries or significant radiological or chemical exposure to workers.

  Table 2.2-1 provides codes, standards, and standard practices for safety SSCs, and these are considered for the design of the new or modified SSCs.

- **Defense in Depth**. SSCs that are not classified as SC or SS, but fulfill a DID safety function important to accident scenarios evaluated in the WIPP documented safety analyses (DSAs) such as items that are intended to prevent or mitigate radiological consequences.

- **Balance of Plant (BOP)**. This category includes facility SSCs not identified above. SSCs or functions required by the Occupational Safety and Health Administration and mine safety regulations are included in this category.

Table 2.2-1, Safety Class and Safety Significant SSC Design Standards

DOE G 420.1-1	SAFETY SIGNIFICANT	SAFETY CLASS
Concrete	ACI-318	ANSI/ACI-349
Steel	AISC-M011	ANSI/AISC-N690
Pressure Vessels	ASME Section VIII	ASME Section VIII
Piping/Valves	ANSI/ASME B31.3/ ANSI/ASME B16.5, B31.3	ANSI/ASME B31.3; ANSI-N278.1/ ANSI/ASME B16.5, B31.3
Pumps	ANSI/API; ANSI/ASME B73.1M, B73.2M; ASME Section VIII; AWWA; Hydraulic Institute Standards	ANSI/API; ANSI/ASME B73.1M, B73.2M; ASME Section VIII; AWWA; Hydraulic Institute Standards
Tanks (Atmos.)	ANSI/API-650; AWWA-D100; ANSI/ASME-B96.1	ANSI/API-650; AWWA-D100; ANSI/ASME-B96.1
Heat Exchangers	ASHRAE Handbook; ASME Section VIII; TEMA B, C, or R	ASHRAE Handbook; ASME Section VIII; TEMA B, C, or R
Gloveboxes	ANSI/ASTM C852; ANS 11.16	ANSI/ASTM C852; ANS 11.16
Ducts/fans	SMACNA Manual / ASHRAE Handbook	SMACNA Manual/ASHRAE Handbook; ANSI/ANI-59.2
Filtration	ASHRAE-52.1; Mil-F-51068F; ANSI/ASME-N509 and N510; DOE NE STD-F3-45	ASHRAE-52.1; Mil-F-51068F; ANSI/ASME-N509 and N510; DOE NE STD-F3-45
Cranes	CMAA; ANSI/ASME NOG-1; ANSI/ASME B30.2; DOE-STD-1090-96	CMAA Nuclear Sections; ANSI/ASME NOG-1; ANSI/ASME B30.2; DOE-STD-1090-96
Other Equipment	ANSI N 14.6; AISC M011	ANSI N 14.6; AISC M011
Electrical Hardware	NFPA 70, 110, and 780; IES Lighting Handbook; ANSI C2; ANSI/IEEE C37, -80, -141, -142, -242, -399, -493, and -577	NFPA 70, 110, and 780; IES Lighting Handbook; ANSI C2; ANSI/IEEE C37, -80, -141, -142, -242, -308, -338, -379, -384, -399, -493, -577, and -603
As Applicable to Specific Electrical Hardware	ANSI/IEEE-323, -334, -336, -344, -381, -382, -383, -420, -450, -484, -535, -628, -649, -650, -833, -934, -944, and -946	
I & C Hardware	NFPA-70 and -110; ANSI C2; ANSI/ANS-8.3, -N42.18, and -N13.1; ANSI/ASA-Series; ANSI/IEEE-141, -142, -242, -493, and - 1050	NFPA-70 and -110; ANSI C2; ANSI/ANS-8.3, -N42.18, and -N13.1; ANSI-N320 and -N323; ANSI/ASA-Series; ANSI/IEEE-141, -142, -242, -323, -336, -344, -379, -384, -493, and - 1050

Quality Assurance shall be applied in accordance with WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description;[6] and WP 13-QA3005, Graded Approach to Application of QA Controls.[7]

The full list of references in this table may be found in Appendix A of DOE G 420.1-1[4]

SC codes and standards are required and SS codes and standards are recommended.

2.3 Facility Overview

2.3.1 Facility Design

The WIPP site is located in Eddy county in southeastern New Mexico, 26 miles east of Carlsbad as shown in Figure 1.3-1. The land area set aside for the WIPP site is 10,240 acres. The WIPP site is located in an area of low population density with less than thirty permanent residents living within a ten-mile radius. The area surrounding the facility is used primarily for grazing, and development of potash, oil, salt, and gas resources. Development of these resources results in a transient population (nonpermanent) consisting principally of workers at three potash mines that are located within ten miles of the WIPP site. The largest population center nearest the WIPP site is the city of Carlsbad, 26 miles to the west, with approximately 25,000 inhabitants. Two smaller communities, Loving, with a population of approximately 1,300, and Malaga, with a population of approximately 200, are located approximately 20 miles southwest of the facility. As the result of the WIPP Land Withdrawal Act of 1992 (LWA) (Public Law 102-579),[8] no mineral resource development is allowed within the WIPP site boundary, with the exception of existing leases.

The WIPP is designed to receive and handle 500,000 cubic feet per year (ft^3/yr) (14,160 cubic meters per year [m^3/yr]) contact-handled (CH) waste and 10,000 ft^3/yr (283 m^3/yr) RH waste. The RH waste received from the generator sites will be contained in 72-B canisters and 55-gallon drums. The WIPP facility is designed to have a disposal capacity for transuranic (TRU) waste of 6.2 million ft^3 (175,600 m^3). The WIPP facility has sufficient capacity to handle the 250,000 ft^3 (7,080 m^3) of RH waste that was established in the Record of Decision (46 *Federal Register* 9162)[9] as a total volume. In addition, the WIPP LWA of 1992[8] limits the total RH TRU activity to 5.1 million curies. TRU waste with a radiation level between 200 mrem/hr but less than 1000 rem/hr is considered RH waste.

RH wastes are disposed of in the 100-acre disposal area on a horizon located 2,150 ft. beneath the surface in a deep, bedded salt formation. Waste is transferred from the surface to the underground through the waste shaft using a mine hoist. The disposal phase is planned to last for 35 years (DOE/NPT-96-1204, *National Transuranic Waste Management Plan*[10]; DOE/EIS-0026-S-2, *WIPP Disposal Phase Final Supplemental Environmental Impact Statement*[11]).

CH waste disposal began at the WIPP in March 1999 and RH waste disposal is scheduled to start in 2006. Disposal is permanent with no intent to retrieve. If recovery of disposed waste is required in the future, the hazards will be analyzed and designs to protect the worker, the public and the environment will be developed prior to recovery operations.

The WIPP site is divided into surface structures, shafts, and subsurface structures as shown in Figure 2.4-3. The WIPP surface structures accommodate the personnel, equipment, and support services required for the receipt, preparation, and transfer of waste from the surface to the underground. The surface structures are located in an area within a perimeter security fence. The area within the security fence is either paved or graveled with minimal vegetation. There is a gravel road along the perimeter security fence, which acts as a fire break in the event of a wild land fire. Several features outside the perimeter security fence also serve as fire breaks and include the salt pile to the north, pond areas to collect rain runoff to the north, east and south, a paved parking area and access road to the west, and berms and the electrical switch yard to the east.

The primary surface operations at the WIPP are conducted in the waste handling building (WHB), which is divided into the CH waste handling area, the RH waste handling area, and support areas. The RH waste handling area includes the RH bay, the hot cell complex, and support facilities.

Vertical shafts, including the waste shaft, the salt handling shaft, the exhaust shaft, and the air intake shaft, extend from the surface to the underground horizon as shown in Figure 2.4-3. These shafts are lined from the shaft collar to the top of the salt formation, approximately 850 ft. below the surface, and are unlined through the salt formation. The waste shaft is located between the CH and RH areas in the WHB. It is nominally 19 ft. in diameter and is serviced by the waste shaft conveyance and the waste hoist.

The WIPP underground consists of the waste disposal area, construction area, north area, and the waste shaft station area. Underground ventilation is divided into four separate flow paths supporting the waste disposal area, the construction area (includes areas being mined), north area, and the waste shaft station area. The layout allows mining and disposal operations to proceed simultaneously.

A typical disposal panel consists of seven disposal rooms. Each room is 33 ft. wide, 13 ft. high, and 300 ft. long. The disposal rooms are separated by pillars of salt 100 ft. wide and 300 ft. long. Panel entries at the end of each of these disposal rooms are also 33 ft. wide and 13 ft. high and will be used for waste disposal, except for the first 200 ft. from the main entries. The first 200 ft. are used for installation of the panel closure, not disposal. The panel entries are 20 ft. wide by 13 ft. high for the intake and 14 ft. wide by 12 ft. high for the exhaust.

2.3.2 Facility Operations

The principal operations at the WIPP involve the receipt and disposal of TRU mixed waste. A pictorial view of the 72-B RH waste handling process is shown in Figure 2.5-2 with a pictorial view of the 10-160B RH waste handling process is shown in Figure 2.5.3.

RH waste will be shipped to the WIPP site in RH shipping casks that have been certified by the U.S. Nuclear Regulatory Commission (NRC). The RH shipping casks are transported to the WIPP on a trailer hauled by a truck. The waste handling process begins when the truck arrives at the WIPP security gate. Waste containers are further discussed in Section 2.5.2 of this chapter. Upon arrival at the gate of the WIPP, each incoming RH shipping cask is inspected to verify the shipment documentation, perform a security check, and conduct an exterior radiological survey of the shipping cask. If the shipping cask has visible external damage, the waste handling process will likely proceed and the shipping cask will be subsequently repaired.

Following turnover of the shipping documentation, the driver transports and parks the trailer in the parking area for RH shipping cask trailers near the RH entrance to the WHB. The driver unhooks the tractor and is subsequently released. The number of loaded RH trailers in the parking area will be coordinated with CH waste handling to not exceed parking area limits established in the Hazardous Waste Facility Permit.[12]

The RH waste received for disposal in the WIPP facility must conform with DOE/WIPP-22-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant,[13] referred to in this DSA as the RH WAC. Analyses in this DSA address RH waste emplacement operations only. CH waste handling and emplacement operations are included in DOE/WIPP-95-2065, *WIPP Contact-Handled (CH) Waste Documented Safety Analysis* (CH DSA).[14]

2.4 Facility Structure

The WIPP facility is divided into surface structures, shafts, and underground structures as shown in Figures 2.4-1 and 2.4-2. The WIPP surface structures accommodate the personnel, equipment, and support services required for receipt, preparation, and transfer of waste from the surface to the underground. The surface structures are surrounded by a perimeter security fence. The underground structures consist of the waste disposal area, construction area, north area, and the waste shaft station area. A spatial view of the WIPP site is shown in Figure 2.4-3. Waste handling surface operations at the WIPP are conducted in the WHB, which is divided into the CH waste handling area, the RH waste handling area, and support areas.

2.4.1 Waste Handling Building

The WHB and its associated systems provide a structure to unload TRU waste from the incoming RH shipping casks and to transfer that waste to the underground disposal area via the waste shaft. The WHB is divided into the following areas: the CH waste handling area, the RH waste handling area, the WHB support area, Building 412 (TRUPACT maintenance facility [TMF]), and the WHB mechanical equipment room. The general layout of the WHB is shown in Figures 2.4-4 and 2.4-5, with sectional views shown in Figure 2.4-6. The WHB is surrounded by pavement and gravel on all sides and is approximately 200 ft. from the property protection area (PPA) security fence.

The WHB is a steel frame structure with insulated steel siding, and includes portions of the building, such as the hot cell complex, that are constructed of concrete for shielding and structural purposes. The WHB is constructed in accordance with the requirements for NFPA (National Fire Protection Association) 220, *Standard on Types of Building Construction*,[15] Type II construction. The WHB acts as a confinement barrier to control the potential for release of radioactive material. Confinement is provided when the tornado doors are closed. The WHB is designed for the design basis earthquake (DBE) of 0.1 g (gravitational force) peak acceleration with a 1,000-year return interval. The WHB is designed to withstand the design basis tornado (DBT) with 183 mph wind and a translational velocity of 41 mph, a maximum rotational velocity radius of 325 ft, a pressure drop of 0.5 lb/in^2 and a pressure drop rate of 0.09 lb/in^2/s. The roof of the WHB is designed to withstand a 27 lb/ft^2 snow load. The 100-year recurrence maximum snow pack for the WIPP region is 10 lb/ft^2.

The west wall of the CH bay in the WHB is shared with Building 412. Building 412 is designed to withstand the DBE and DBT and a snow load of 27 lb/ft^2. The main lateral force resisting structural members of the Support Building are designed to withstand the DBE and DBT to prevent the Support Building from collapsing on the adjacent WHB. The north wall of the WHB includes masonry construction which provides nominally two hours of fire resistance in the event of a Support Building fire. The design parameters for the WHB are described in SDD CF00-GC00, Plant Buildings, Facilities, and Miscellaneous Equipment.[16] Waste handling areas subject to potential for contamination are provided with coatings that are easy to decontaminate. The ceiling and wall mounted equipment within the WHB is not seismically restrained.

The RH side of the WHB has two areas for handling RH waste: the RH bay and the hot cell complex. The hot cell complex is divided into areas designed for specific functions: the cask unloading room (CUR), the transfer cell, the transfer cell service room, the upper hot cell, the crane maintenance room, and the facility cask loading room (FCLR). The major areas within the RH waste handling area are shown in Figures 2.4-4 and 2.4-5, with sectional views shown in Figure 2.4.6. Waste transport routes in the WHB are shown in Figure 2.4-7. A more detailed view of RH waste handling route is shown in Figure 2.5-2 for the 72-B waste handling process and Figure 2.5-3 for the 10-160B waste handling process. The design parameters for the WHB are described in SDD CF00-GC00.[16]

2.4.1.1 RH Bay

The RH bay is a high-bay area for receipt and handling of the 72-B and 10-160B shipping casks. A trailer carrying a shipping cask enters the RH bay through a set of double doors on the east side of the WHB. The space available in the RH bay accommodates a maximum of two trailers at one time. The RH bay is taller than the CH bay to allow RH shipping casks to be removed from the transportation trailer inside the WHB. The RH bay was originally designed to accommodate unloading of transportation casks from railcars. There are railcar tracks embedded in the RH bay floor although they are currently not in use. Additional rails are provided for moving the road cask transfer cars (RCTC) into the CUR from the RH bay. The RH bay doors are closed when processing a RH shipping cask.

For contamination control, the WHB ventilation system is designed to maintain airflow direction to the areas where postulated accidents could occur. Ventilation airflow is from the RH bay into the CUR and upper hot cell; from the CUR into the transfer cell; from the FCLR into the transfer cell; and from the transfer cell into the upper hot cell. The RH bay and FCLR are protected by an automatic sprinkler system.

2.4.1.2 Hot Cell Complex

The hot cell complex consists of a series of rooms with concrete walls up to 54 inches thick that provide permanent radiation shielding for personnel whenever RH waste canisters and drums are not in either a shipping cask, shielded insert, or the facility cask. The shielding is designed for an internal gamma surface dose rate of 400,000 Rem/hr and for an internal neutron surface dose rate of 45 Rem/hr.[17] The complex is located in the north side of the RH bay (Figure 2.4-8).

The CUR floor is at reference elevation 100'-0" and at the east end of the complex. The upper hot cell floor is 31 ft. wide, 57 ft. long, and located at elevation 123'-6." The ceiling of the upper hot cell is at elevation 156'-10." Above the upper hot cell is the manipulator repair room and above it is the crane maintenance room. The transfer cell which is approximately10 ft. wide and 79 ft. long is below the upper hot cell and has a floor elevation of 76'-0." The FCLR is located west of the upper hot cell between elevations 100'-0" and 124'-6."

2.4.1.2.1 Cask Unloading Room

The CUR has 54 in. thick concrete walls to provide a shielded area for unloading of RH waste drums from the 10-160B shipping cask into the upper hot cell. The CUR is separated from the upper hot cell by a 54 in. thick concrete ceiling and two concentric shield plugs, and is separated from the transfer cell by a 54 in. thick concrete floor and 8 in. thick steel shield valve. The 140-ton concrete-filled steel CUR shield door at the entrance to the CUR provides radiation shielding for personnel outside the CUR during 10-160B shipping cask unloading operations. The CUR shield door remains open during transfer of the 72-B shipping cask from the CUR to the transfer cell. A free-standing control panel for the CUR 25-ton crane is located in the southwest corner of the room. The control panel is used during 72-B waste handling. When a 10-160B shipping cask is being processed in the CUR, the shield door is closed. No one is allowed in the CUR when RH drums are being removed from the 10-160B shipping cask and transferred to the upper hot cell. Additionally, the CUR shield door will be closed during operations that involve transfer of items from the upper hot cell to the CUR when there is RH waste in the upper hot cell.

The CUR shield door is 18.2 ft. long by 22.0 ft. high by 4.0 ft. thick. The CUR shield door is opened and closed, at a rate of approximately 15 ft. per minute, by a pneumatic cylinder/piston and when moving is supported by a cushion of air exhausting from the door bottom. The air cushion is referred to as an air bearing. When closed, an inflatable seal is pressurized forming a partial seal between the inside of the door and the surface around the CUR door opening. When the door is closed, the exhaust air supply is removed, the loss of the air cushion causes the door to settle to the floor. The CUR shield door is opened or closed only with direct visual access to the shield door travel area. The CUR shield door is interlocked to other RH waste handling system components as follows:

- The CUR shield door must be closed before the upper hot cell shield plugs can be removed.
- The CUR shield door cannot be opened with the upper hot cell shield plugs removed
- The CUR shield door must be closed before the upper hot cell crane grapple can be raised when it is positioned over the upper hot cell floor shield valve.

2.4.1.2.2 Upper Hot Cell

The upper hot cell is a 54 in. thick concrete walled room that provides a shielded location for the facilities and equipment necessary to unload the RH waste drums from their 10-160B drum carriage units; provides temporary storage for unloaded drums; provides canister storage locations (floor wells), six canister storage wells in east side, two canister storage wells at the northwest inspection station, and one at the northeast inspection station; provides for inspections of the physical integrity of the drums; provides for the performance of a radiological contamination survey and identification verification of each drum; and provides for loading drums into facility canisters. Details of the upper hot cell area are shown in Figures 2.4-9, 2.4-10, and 2.4-11. The bridge mounted overhead powered manipulator operates in the upper hot cell with rails at elevation 141'-0". The upper hot cell crane operates above the overhead powered manipulator, with its rails at elevation 148'-0". The operating gallery (elevation 122' 1") provides space for operating personnel to monitor and control all operations in the upper hot cell. Six shielded viewing windows between the operating gallery and the upper hot cell allow nearly 100 percent visual observations of all operations within the upper hot cell. A transfer drawer is provided at the radiological inspection station for transferring surface contamination assessment swipes, collected in the upper hot cell, from the upper hot cell to the transfer drawer enclosure in the operating gallery.

Access to the upper hot cell from the CUR is through two shield plugs in the upper hot cell floor. The large plug has a nominal diameter of 8.6 ft. and contains a smaller concentric plug that has a nominal diameter of 2.7 ft. Both plugs must be in place before a shipping cask can enter or exit from the CUR. When installed, the plugs provide shielding corresponding to the level of radiation protection required by the CUR. An interlock is provided between the CUR shield door, CUR shield valve, and the upper hot cell crane, and requires that the CUR shield door and shield valve be closed in order to remove the shield plugs. When the CUR shield door is closed, the CUR functions as an air lock between the upper hot cell and the RH bay. The upper hot cell is maintained at the lowest negative pressure and air leakage is from the RH bay through the CUR into the upper hot cell. The upper hot cell has provisions for maintenance of installed equipment. Access to the upper hot cell is permitted only when RH waste drums or canisters are not present.

2.4.1.2.3 Transfer Cell

The transfer cell, located beneath the CUR, the upper hot cell, and the FCLR and is separated from each by 54 in. thick concrete, contains the shuttle car used to move either the 72-B shipping cask or the shielded insert (used with the facility canister). The transfer cell contains the 72-B shipping cask inner lid bolt detensioning robot, a radiological contamination swipe robot and transport system for the radiological swipe samples, closed circuit television (CCTV) cameras used to monitor the operation activities in the transfer cell, and the transfer cell ceiling shield valve.

2.4.1.2.4 Transfer Cell Service Room

The service room, separated from the transfer cell by a 54 in. thick concrete wall, contains a receive/send station for the radiological swipes from the transfer cell, a vent hood where the swipe samples are removed from transport carrier, the counting equipment that performs the analysis of the radiological swipes, and the continuous air monitor (CAM) that services the transfer cell. The service room also contains the motor for the transfer cell shuttle car and a grapple override tool for the FCLR facility grapple.

2.4.1.2.5 Crane Maintenance Room

The crane maintenance room is located above the manipulator repair room at the west end of the upper hot cell (Figure 2.4-10). The crane maintenance room is located so that the upper hot cell crane can be pulled directly into it for repair. The crane maintenance room is separated from the upper hot cell by a 4 ft. high 54 in. thick concrete shield wall and a ceiling mounted shield door. The shield door is approximately 34 ft wide, 12 ft. tall and is constructed of steel beams with a solid steel cover over 2 in. thick. The shield door weighs approximately 33,000 lbs. and is operated by a 20,000 lbs. capacity floor mounted winch. The door overlaps the opening in the concrete shield wall to prevent radiation streaming into the crane maintenance room from the upper hot cell. Ventilation seal plates seal the gap between the door and its jamb to control air flow from the room into the upper hot cell. The winch is key operated with RH waste handing personnel controlling key access such that the crane maintenance room shield door can not be opened with RH waste in the upper hot cell. The crane maintenance room is fire protected by an automatic sprinkler system.

2.4.1.3 Facility Cask Loading Room

The FCLR has 54 in. thick concrete floor and contains the facility cask transfer car, the facility cask rotating device, the shield bell, telescoping port shield and grapple hoist, equipment needed to transfer RH waste canisters from the transfer cell into the facility cask and for the subsequent transfer of the facility cask to the waste shaft conveyance. An operating console located behind a 2 ft. thick concrete shadow shield with a shield window in the north portion of the room is used to control the FCLR and transfer cell waste handling activities. The FCLR is fire protected by an automatic sprinkler system and functions as an air lock between the waste shaft and the transfer cell and RH bay.

2.4.1.4 Waste Shaft Entry Room

The waste shaft entry room is the location where CH and RH waste is loaded on the waste shaft conveyance. The room has four equipment entry doors that are interlocked such that only one can be open. Pivot rails provided at the waste shaft collar are rotated to the horizontal position when loading the conveyance and are rotated vertically when not in use. The pivot rails are interlocked such that the conveyance cannot be moved until the pivot rails are out of the way. Fencing with gates are provided at the shaft collar and the shaft station in the underground to prevent inadvertent access to the shaft. The gates are interlocked such that if a gate is open, the conveyance cannot be moved, or if the conveyance is moving and a gate is opened, the conveyance emergency stop is actuated. With the FCLR doors open and all other doors to the waste shaft entry room closed, the facility cask transfer car moves from the FCLR into the waste shaft entry room onto the waste shaft conveyance. No personnel or equipment is transported by the waste conveyance when it is transporting CH or RH waste into the underground.

2.4.1.5 WHB Support Areas

WHB support areas, common to both the CH and RH areas of the WHB, include the waste hoist support areas and the main mechanical equipment room containing the heating, ventilation, and air conditioning (HVAC) equipment.

Air locks are located on both the CH and RH sides of the waste hoist collar, including the waste shaft conveyance loading room (CLR) on the CH side of the waste hoist and the FCLR on the RH side of the waste hoist. Access doors to the waste hoist are interlocked, only one can be opened, to control air flow, which is towards the waste hoist from the CLR or from the FCLR.

The waste hoist control room provides space and equipment needed for operation of the waste hoist and controls for operating the waste hoist in either manual or automatic mode.

The main mechanical equipment room of the WHB houses the exhaust fans, high efficiency particulate (HEPA) filters, except for the hot cell HEPA filters which are located adjacent to the hot cell, and the associated ducting that controls ventilation flow within the WHB.

2.4.2 Building 412

Building 412 (the TMF) is located to the west side of the WHB (Figure 2.4-4). Structural portions of the building are designed to withstand the DBE and DBT because of its interface with the WHB. The equipment within the TMF is not seismically restrained. The TMF is also designed to withstand a snow load of 27 lb/ft^2.

2.4.3 Exhaust Filter Building

The Exhaust Filter Building (EFB), containing the HEPA filtration equipment associated with the underground ventilation system, is adjacent to the exhaust shaft. During normal operations, air is pulled from underground areas, up the exhaust shaft, and discharged to the environment without the HEPA filtration units in service. In the event of an underground radiological event, airflow from the underground is diverted through the HEPA filtration units located in the EFB to remove airborne radioactive particulates from the air stream. The EFB layout is shown in Figure 2.4-12.

The major areas within the EFB are the filter room and support area. The filter room houses the underground exhaust HEPA filtration units. The support area includes two mechanical equipment rooms housing the building filtration units, the exhaust fans, the supply air handling units, the motor control centers, and the airlock.

2.4.4 WIPP Shafts

The four shafts, the waste shaft, the salt handling shaft, the exhaust shaft, and the air intake shaft, extend from the surface to the underground horizon as shown in Figure 2.4-3. All shaft construction and mining operations are in accordance with 30 CFR Part 57, "Safety and Health Standards - Underground Metal and Nonmetal Mines."[18] The waste shaft is located between the CH and RH waste handling areas in the WHB. It is nominally 19 feet in diameter and is serviced by a hoist that incorporates a waste shaft conveyance to transport CH and RH wastes from the surface to waste shaft station.

2.4.4.1 Shaft and Hoist General Features

The principal components of each shaft are the liner that extends from the collar to the salt interface approximately 850 ft. below the surface, and the key that provides a transition between the liner and the salt formation. The remainder of each shaft is unlined.

The shaft collars are situated approximately 400 ft. above the historic flood plain of the Pecos River and the collar slab around the shaft, where used, is at a higher elevation than the surrounding ground. The collar areas of the salt, waste, and air intake shafts are surrounded with fencing/barriers to prevent unauthorized entry and minimize the chance for items falling into the shafts.

The waste shaft, the salt handling shaft, and the air intake shaft are equipped with conveyances with head frames constructed of structural steel. The conveyance systems in the shafts and all shaft furnishings are designed to resist the dynamic forces of the hoisting operations, and these forces are greater than the seismic forces on the underground facilities. The conveyances in the waste and air intake shafts are guided by steel cables, guide ropes, and the salt handling shaft conveyance is guided by fixed wooden guides.

The waste, salt handling, and air intake shaft hoists have redundant brake systems designed so that either set of brakes can stop a fully-loaded conveyance under all conditions. In the event of a power failure, the brakes set automatically.

The control system for each hoist can detect malfunctions or abnormal operations, such as overtravel, over-speed, power loss, circuitry failure, or starting in a wrong location, and triggers an alarm for the abnormal operation, and automatically shuts down the hoist.

The salt handling shaft conveyance is used to transport mined salt to the surface and to provide personnel transportation between the surface and the underground. It also acts as a duct for supplying air to the mining and disposal areas, and is one route for the power, control, and communications cables. The salt hoist's maximum rope speed is approximately 1,800 ft. per minute. The salt handling shaft inside diameter is 10 ft. for the steel lined portion, and 11 ft., 10 in., for the unlined portion.

The exhaust shaft is used to exhaust air from the underground areas to the surface. The inside diameter of the lined portion of exhaust shaft is 14 ft. The shaft lining is unreinforced concrete. The exhaust shaft collar does not utilize a building or headframe, and is sealed at the top by a 14 ft. diameter elbow that directs air to the underground ventilation system fans.

The air intake shaft is used primarily to supply the fresh air to the underground areas and is also used for backup egress of personnel between the surface and the underground horizon. The air intake shaft hoist's maximum rope speed is approximately 830 ft. per minute. The inside diameter of the unreinforced concrete lined upper portion of this shaft is 16 ft.

2.4.4.2 Waste Shaft and Hoist Specific Features

The main purpose of the waste hoist system is for moving radioactive waste between the surface and the underground. It is also used to transport personnel, material and equipment. The waste hoist tower, which houses the hoist motor and support equipment is located between the CH and RH portions of the WHB and sits over the waste shaft. The waste hoist tower and headframe is designed to withstand a DBE. The waste shaft and hoist arrangement is shown on Figure 2.4-13. CH and RH waste are transported on the lower portion of the conveyance, below the man cage and the maintenance platform. Waste and personnel are not transported at the same time.

The inside diameter of the unreinforced concrete-lined upper portion of the waste shaft is 19 ft. The waste shaft conveyance (outside dimensions) is approximately 30 ft. high by 11 ft. wide by 15 ft. deep, and carries a maximum payload of 45 tons. A man deck, approximately 15 ft. above the conveyance floor, is provided for personnel transport. The man deck is enclosed with expanded metal fencing with doors provided for access. The man deck can be removed to permit transporting tall and/or heavy loads. A maintenance work platform is bolted to the top of the outside frame of the conveyance, above the man deck. The work platform is used during shaft inspections and shaft maintenance. Due to hoist load limits, the platform and man deck may need to be removed for RH waste transfer. The main deck of the conveyance has embedded rails that are used by the facility cask transfer car. The facility cask transfer car is used to transport the facility cask between the facility cask loading room and the waste shaft conveyance, and between the waste shaft conveyance and the underground Because of the 11 ft. width of the conveyance deck, the facility cask which is over 13 ft. long cannot be placed on the conveyance by a forklift. (The forklift pockets on the facility cask are on the long side [see Figure 2.5-8].) During loading and unloading operations, the waste shaft conveyance is steadied by fixed guides. At the underground waste hoist station, rope stretch is removed by a chairing device that supports the weight of the waste shaft conveyance and payload.

The waste hoist is an electrically driven friction hoist. The 600 hp DC (horsepower direct current) voltage waste hoist motor is designed for a maximum operating speed of 13.5 rpm (revolutions per minute). The motor's field is formed by wound poles, and is supplied with a constant DC current obtained from rectifying a 480-volt, three-phase supply. The DC voltage magnitude and direction controls the speed and direction of the hoist. The maximum rope speed of the waste hoist is approximately 500 ft. per minute. There is one silicon controlled rectifier power supply to power the hoist. An automatic control circuit can detect electrical problems with the drive motor and stop the hoist.

The waste hoist brake system can safely stop and hold the waste shaft conveyance without the drive motor. There are two sets of brakes, mounted approximately 180 degrees apart, on each braking flange of the hoist wheel. Either set of brakes if fully capable of stopping the waste conveyance. The brakes are spring set and are released by hydraulic pressure. Brake switches indicate brake set, release, and wear. A redundant hydraulic power supply exists to supply hydraulic pressure to release the brakes. Each hydraulic unit has its own motor, pump, and oil reservoir. There is an automatic switch over from the primary system to the standby system if the hydraulic pressure decreases below the set point. There is no automatic switch over from the standby system to the primary system. A timed back up pressure relief path exists to set the brakes if for any reason the brake pressure is not released within a few seconds after the application of the brake set signal.

Hoisting, tail, and guide ropes are provided for the safe operation of the waste shaft conveyance and the counterweight. The hoisting ropes are 1-3/8-in.-diameter, fully locked coil bright steel ropes suitable for use with a friction hoist. For the conveyance with the maximum design payload, the factor of safety of the hoisting ropes is at least 5.9 as determined based on American National Standards Institute (ANSI) M 11.1, "*American National Standard for Wire Rope Mines,*[19] and Mine Safety and Health Administration (MSHA) - 30 CFR Part 57.19021, "Minimum Rope Strength,"[20] according to the depth of the waste shaft. Both the hoisting ropes and tail ropes have a minimum endurance limit of 400,000 loading cycles. The tail ropes are 2-1/4-in.-diameter, non-rotating bright steel, with a synthetic fiber core. The three tail ropes approximately balance the weight of the six hoisting ropes. The guide ropes are 1-3/4-in.-diameter, half-lock bright steel with internal and external lubrication and are designed to operate with minimal field lubrication only. There are four guide ropes for the waste shaft conveyance and two guide ropes for the counterweight. Tension in these ropes is maintained by weights on the bottom of the ropes. The size of the weights vary to prevent harmonic vibrations during hoist operation.

A waste shaft conveyance and counterweight over-travel arrester system can stop movement if the normal control system has failed. Four timbers are provided at the tower and the sump regions for both the waste shaft conveyance and the counterweight to assist in absorbing energy to stop an over traveling waste shaft conveyance or counterweight. Retarding frames rest in notches either at the top of the wood arresters, in the sump area, or at the bottom of the wood arresters, the tower area. The retarding frames have knives that cut into the timbers if driven by the waste shaft conveyance or the counterweight.

If the waste shaft conveyance over-travels against the upper crash beams and the hoist ropes fail, safety lugs on the waste shaft conveyance mate with pivoting dogs on the catch gear mounted in the headframe to prevent the waste shaft conveyance from falling if the ropes break. The counterweight catch gear system functions in a similar fashion to stop the counterweight from falling. Each catch gear frame is mounted on a hydraulic shock absorber which absorbs energy from a descending waste shaft conveyance or counterweight. Lever arms are used to raise the pivoting dogs if they are not supporting any weight.

Emergency stop buttons are provided at the master control station and at all control stations to effect an emergency stop of the hoist. These buttons are operable in all modes of hoist operation, and when pressed, open the control power loop and set the hoist brakes. These buttons provide the most rapid means of bringing the hoist to a stop. A controlled stop button which decelerates the waste shaft conveyance before setting the brakes is also located on the control panel. The controlled stop is a slower and softer stopping action than the emergency stop.

Eleven signals, two analog and nine contact, are transmitted to the Central Monitoring Room (CMR) for remote monitoring. The analog signals are hoist motor voltage and amperes. The contact signals are "Hoist Operation, Manual"; "Hoist Operation, Semi-Auto"; "Hoist, Abnormal Condition"; "Emergency Stop"; "Men Working in Shaft"; "Waste on Hoist"; "Personnel on Hoist"; "Hoist, Up"; and "Hoist, Down." The waste hoist signaling system consists of bells and lights activated by the operators at the master control station and the control stations.

At the beginning of each operating day, inspections are made on the shaft conveyance, cable attachments, cage doors, and collar doors. The hoist operator visually inspects the hoist drum assembly, pedestal, bearing housings, brakes and brake operations, and all hydraulic pipes for general condition and possible leaks. Also at the start of each operating day, the various methods of communication between the hoist operator, toplander, bottom lander, and the shaft conveyance are checked and verified to be operating correctly. The proper operation of the emergency stop tripping logic, limit switches, overtravel, deadman control, position indicator, and braking mechanisms are tested at the start of each operating shift.

The conveyance is operated empty through one round trip at the start of each operating shift. The waste shaft is inspected weekly to detect cracking, corrosion, deterioration, and water intrusion. Rope inspections are performed weekly and the entire active length is visually examined for structural damage, corrosion, and proper lubrication. Visual examination for wear and broken wires are made at stress points, attachment points, where the rope rests on sheaves, where the rope leaves the drum, at drum crossovers, and at change-of-layer regions. When any visible condition that results in a reduction of rope strength is present, the affected portion of the rope is examined more frequently. Additional testing and inspections are identified in the Underground Hoisting SDD (SDD UH00).[21]

2.4.5 Underground Facilities

2.4.5.1 General Design

The underground facilities are located 2,150 ft. below the surface and include the waste disposal, construction, north, and waste shaft station areas. The construction and north areas contain the facilities to service and maintain underground equipment for mining and waste disposal operations. The construction and north areas are segregated from the waste shaft station and waste disposal areas by bulkheads, overcasts, and airlocks which are constructed of noncombustible materials except for flexible flashing used to accommodate salt movement. Some mining construction activities may be required within an active disposal panel, however, these activities can be separated from the disposal processes and areas by schedule or time, ventilation controls, and temporary bulkheads. Underground mining procedures and cavity dimensions incorporate the results of the salt creep analysis in DOE/WIPP 86-010, *Waste Isolation Pilot Plant Design Validation Final Report*.[22]

The underground support facilities and their ventilation flows in the shaft pillar area are shown on Figure 2.4-14. The support facilities on the disposal side provide a maintenance area, a vehicle parking area with plug-in battery charging, and a waste transfer station. The support facilities on the construction side consist of a vehicle parking area, electrical substation, welding shop, offices, materials storage area, emergency vehicle parking alcoves, a diesel equipment fueling station, and a mechanical shop.

The north area was initially used for evaluating the interaction of simulated waste and thermal sources on bedded salt under controlled conditions. The north area was deactivated in September 1996. Portions of this area have been reopened for the permanent disposal of salt mined primarily from Panel 2 and ground control activities and are being maintained open to support a limited experimental program and material storage.

The construction area fuel dispensing room is in an alcove off the construction exhaust entry. This fuel dispensing room includes pumping facilities for a portable fuel tank. The portable diesel tank hoisting and lowering is done through the waste shaft or the salt handling shaft. Diesel tank hoisting is not performed at the waste shaft when waste is present and is moved promptly to the storage location. An automatic dry chemical fire suppression system, with main and reserve tanks, is provided in the fuel dispensing room. Any fire generated smoke and fumes would be exhausted directly to the exhaust ventilation system. The underground ventilation system is discussed in Section 2.6.

2.4.5.1.1 Self-Contained Self-Rescuers

WIPP is required by New Mexico State Mining Law 69-8-16 to provide self-contained self-rescuers (SCSRs) in the underground. A SCSR must be available for each person in the underground. SCSRs consist of a compressed oxygen cylinder and a CO_2 scrubber. The oxygen cylinders are pressurized to 3000 psi.

The SCSRs are stored in metal cache enclosures at predetermined locations throughout the underground. Portable skids containing SCSRs cache enclosures are used and relocated as necessary. The remainder of the SCSR cache enclosures are attached to the rib at designated areas and are not portable.

SCSRs are used in addition to the portable self-rescuers carried by underground personnel.

2.4.5.2 Mining Method

Mining is performed by continuous mining machines. One type of continuous mining machine is a road header or boom-type continuous miner operating a milling head. The milling head rotates in line with the axis of the cutter boom, mining the salt from the face. The mined salt is picked up from the floor by the loading apron. The mined salt is pulled through the miner on conveyers and loaded into one of the haul vehicles.

Another type of continuous mining machine is a drum miner operating with a head that rotates perpendicular to the axis of the cutter boom, and cuts the salt away from the working face. The mined salt is pulled through the miner on a chain conveyor and then loaded into a haul vehicle. Prior to mining in new areas, probe holes are drilled to relieve any pressure that may be present. After mining, vertical pressure relief holes are drilled up at the main intersections of drifts and crosscuts.

During and immediately after mining, a sounding survey of the excavation ceilings is made to identify areas of weakness which might represent safety or stability problems. Routine sounding of the roof, especially in unbolted areas, is commonly performed throughout the life of an opening. Inspection and maintenance for the underground is described in procedure WP 04-AU1007, Underground Openings Inspections.[23]

Hand scaling or removal of salt with the continuous miners, or rock bolting, is accomplished after areas are identified as potentially unstable. Specific work packages are developed for mining and ground control. Mine operations personnel are responsible for mining and ground control.

2.4.5.3 Mined Material

The salt removed during underground mining is brought to the surface by the salt handling shaft conveyance. From the surge pocket, salt is loaded into the 8-ton salt handling skip with a skip measuring and loading hopper, the skip is raised to the surface, and dumped through a chute to surface haulage equipment which transports the salt to the surface salt pile.

2.4.5.4 Interface Between Mining and Waste Disposal Activities

Separate mining ventilation and disposal ventilation circuits are maintained by means of bulkheads, overcasts, and airlocks of noncombustible material, except for flexible flashing used to accommodate salt movement, in accordance with 30 CFR Part 57.[18] The use of noncombustible materials minimizes the effects of fires in one area of the underground propagating to another area. Air pressure in the mining side is maintained higher than in the disposal side to ensure that any leakage results in air flow to the disposal side. The underground ventilation system is discussed in Section 2.6. Rooms being mined are within the construction circuit, and rooms with active waste emplacement are within the waste disposal circuit. Any mining necessary in the disposal circuit to address uneven floor or ground control issues is planned such that it is unlikely to be necessary at the active waste face and is not done in the transport path when waste is in transit to the disposal room.

2.4.5.5 Ground Control Program

The ground control program at the WIPP ensures underground safety from any potential unplanned rock fall from the ceiling or walls of openings. From the time an opening is mined and throughout the life of the opening, action is taken to identify and remove or restrain any loose or potentially unsafe ground. Ground control is based on the following:

- Ground stability is maintained as long as access is possible.
- Ground control maintenance efforts increase with the age of the openings.
- Ground control plans are specific but flexible.
- Regular ground control maintenance is required.

The WIPP ground control program uses observational experience and analysis of salt behavior to anticipate future ground support requirements. To provide long-term ground support, the WIPP ground control system must accommodate the continuous creep of salt and retain broken fractured rock in the roof or walls. To aid in ground control activities, the WIPP underground is divided into over 100 zones. A database that documents the current status of each underground excavation zone is maintained and includes the physical state of the zone with respect to geometry, excavation age, ground support, and operational use.

DOE/WIPP 02-3212, *Ground Control Annual Plan for the Waste Isolation Pilot Plant*[24] addresses technical aspects of the underground facility which are concerned with the design, construction, and performance of the subsurface structures and support systems. Each year the Ground Control Annual Plan is updated to reflect developments in the WIPP ground support practices, materials, and any changes in operational requirements. The WIPP ground control plans are living documents that keep ground control practice at the WIPP both current and responsive.

The WIPP ground control includes continuous visual inspections of openings, geotechnical monitoring, installation of ground support components, and analysis of ground support component failures. Ground control support systems may vary as different conditions are encountered. Support system may be subjected to longitudinal and lateral loading due to the rock deformation. The anchorage components may undergo lateral deformation due to offsetting along clay seams or fractures and increasing tensile loading.

Visual examinations are performed by underground operations personnel. Procedure WP 04-AU1007[23] specifies inspections to be performed at the beginning of each shift, weekly, monthly, and annually. Geotechnical field activities include data collection from geotechnical instrumentation, fracture surveys, and observations. Monitoring results are analyzed in comparison with established design criteria, and are utilized in a variety of computer models. Analyses are performed to ensure that rock mass behavior is understood and proper ground control measures are instituted. Ground support is designed and specified to meet the requirements of 30 CFR Part 57.[18] Maintenance activities ensure that ground conditions presenting a potential hazard are rectified.

Ground support at the WIPP includes rock bolts and supplementary systems. The rock bolt systems typically used are mechanically-anchored bolts and resin-anchored threaded rods. The supplementary systems include cables with mesh mats and trusses. During mining, spot bolting is the typical method of ground control to rectify unstable conditions. Pattern bolting was used in Panels 1, 2 and 3 and is anticipated to be used in subsequent panels. Panel 3 through 8 are not anticipated to remain open as long as Panel 1 or 2. The disposal area access drifts will remain open and operational for a much longer period than Panels 1 through 8. Materials installed for spot bolting, and pattern support meet the requirements of 30 CFR Part 57.[18] Proper installation is confirmed by safety and quality assurance audits. MSHA inspectors perform independent inspections, making certain that support construction is performed in accordance with regulations.

Prior to disposing of waste in a panel, the panel has been mined to meet dimensional requirements such that CH waste is stacked the equivalent of three 55-gallon drums high. Ground control measures in an active panel may include removal of rock, bolting, and floor milling. Pattern bolting minimizes the need to remove rock from the ceilings of disposal rooms, however, milling the floor is expected to ensure the proper room dimensions and to ensure a smoother surface over which to transport waste. In the event that ground control measures are not sufficient to ensure safety, rooms may be closed.

The roof beam may be removed by mining if it is a cost-effective alternative to bolting or if the roof is highly fractured and removal will result in a safer working environment. The roof beam is that portion from the roof up to the next competent layer, typically just above the overlying clay and anhydrite layers. This option has been exercised in portions of East-140 south and areas in the north end of the underground.

2.4.5.6 TRU Waste Disposal Area

The disposal area (Figure 2.4-2) provides space for 6.2 million ft.^{3} (176,000 m^3) of TRU waste material in TRU waste containers. This area also includes the four main entries and the crosscuts that provide access and ventilation. Figure 2.4-15 shows a typical waste container disposal configuration. The main entries and crosscuts in the repository provide access and ventilation to the disposal area. The main entries link the shaft pillar/service area with the disposal area and are separated by pillars. Typical entries are 13 ft. high and 14 to 16 ft. wide. The waste disposal area is designed so that each panel contains seven rooms. The locations of the panels are shown in Figure 2.4-2. The rooms have nominal dimensions of 13 ft. high by 33 ft. wide by 300 ft. long, and are separated by 100 ft. wide pillars.

Boreholes are used for disposing of RH waste canisters. Boreholes are drilled into the ribs (walls) of the disposal rooms and entries and are drilled to a length of approximately 17 ft. with a diameter of approximately 30 in. and located a distance away from the corners of salt pillars that separate disposal rooms, nominally 34 ft. from the projected corner along the short axis and 26 ft. along the salt pillars.

The amount of TRU waste in each panel/room is limited by thermal, structural, and physical considerations, and emplacement is designed not to exceed 10 kW/acre. Based on criticality analysis, a spacing of 30 in. or greater between centers for RH waste canisters is allowed.[25] Typical spacing will be 8 ft. center to center for canister emplacement. A shield plug and shield ring provide shielding between the canister in the borehole and the room.

If waste volumes disposed of in the eight panels fail to reach the design capacity, the DOE may choose to use the four main entries and crosscuts adjacent to the waste panels. Drifts East-300, East-140, West-30, and West-170 from South-1600 to South-3650 are nominally 2,050 ft. long. East-west crosscuts in this area are nominally 20 ft. wide by 13 ft. high by 470 ft. long. The layout of these excavations is shown on Figure 2.4-2.

2.4.5.7 Panel Closure System

Upon completion of waste emplacement in each underground panel, the filled panel is closed. Figure 2.4-16 shows two designs for a panel closure system, both of which include a block and mortar explosion-isolation wall. A 12 ft. thick block and mortar wall has been installed in the access drifts of Panel 1and is being installed at Panel 2. An alternative closure system including a 30 ft. thick block and mortar wall in combination with run of mine salt has been recommended to the New Mexico Environment Department and the United States Environmental Protection Agency.

2.4.5.8 Geotechnical Monitoring Program

The safety of the underground excavations has and will continue to be evaluated on the basis of criteria established from actual measurements of rock behavior. The geotechnical monitoring program provides measurement of rock mass performance for design validation, routine evaluation of the safety and stability of the excavations, and provides information necessary to predict the short- and long-term behavior of underground excavations. The criteria are regularly evaluated and modified as more field data are collected from the actual performance of the underground openings. The instrumentation for open panels includes at least one borehole extensometer installed in the roof at the center of each disposal room. The roof extensometers monitor the dilation of the immediate salt roof beam and possible bed separations along clay seams.

Data collection, analyses, and evaluation criteria indicate changes in measured room closure rates over time, and when those measured room closure rates exceed projected values. Areas where observed rates significantly vary from projected values are monitored more closely to determine the cause of the variance. If the cause is not related to mining activity, additional field investigation is undertaken to characterize the conditions. Should the field data indicate that ground conditions are deteriorating, corrective actions are taken. If ground conditions in a disposal room deteriorate and cannot be cost effectively remediated, the room may be closed.

Geologic investigations also include geologic and fracture mapping, and seismic monitoring. Borehole inspections can detect displacements, fractures, and separations occurring within the strata immediately surrounding the excavations. The results of geologic investigations provide continued confidence in the performance and geology of the site with respect to site characterization.

Geotechnical data and the results of the geotechnical investigations are reported annually in the WIPP geotechnical analysis reports (*Geotechnical Analysis Report for July 2002 - June 2003*, DOE/WIPP 04-3177).[26] The report describes monitoring programs, geotechnical data collected during the previous year, and describes the techniques used for data acquisition. The report details the geotechnical performance of the underground excavations including shafts, and provides an evaluation of the geotechnical aspects of performance with respect to relevant design criteria.

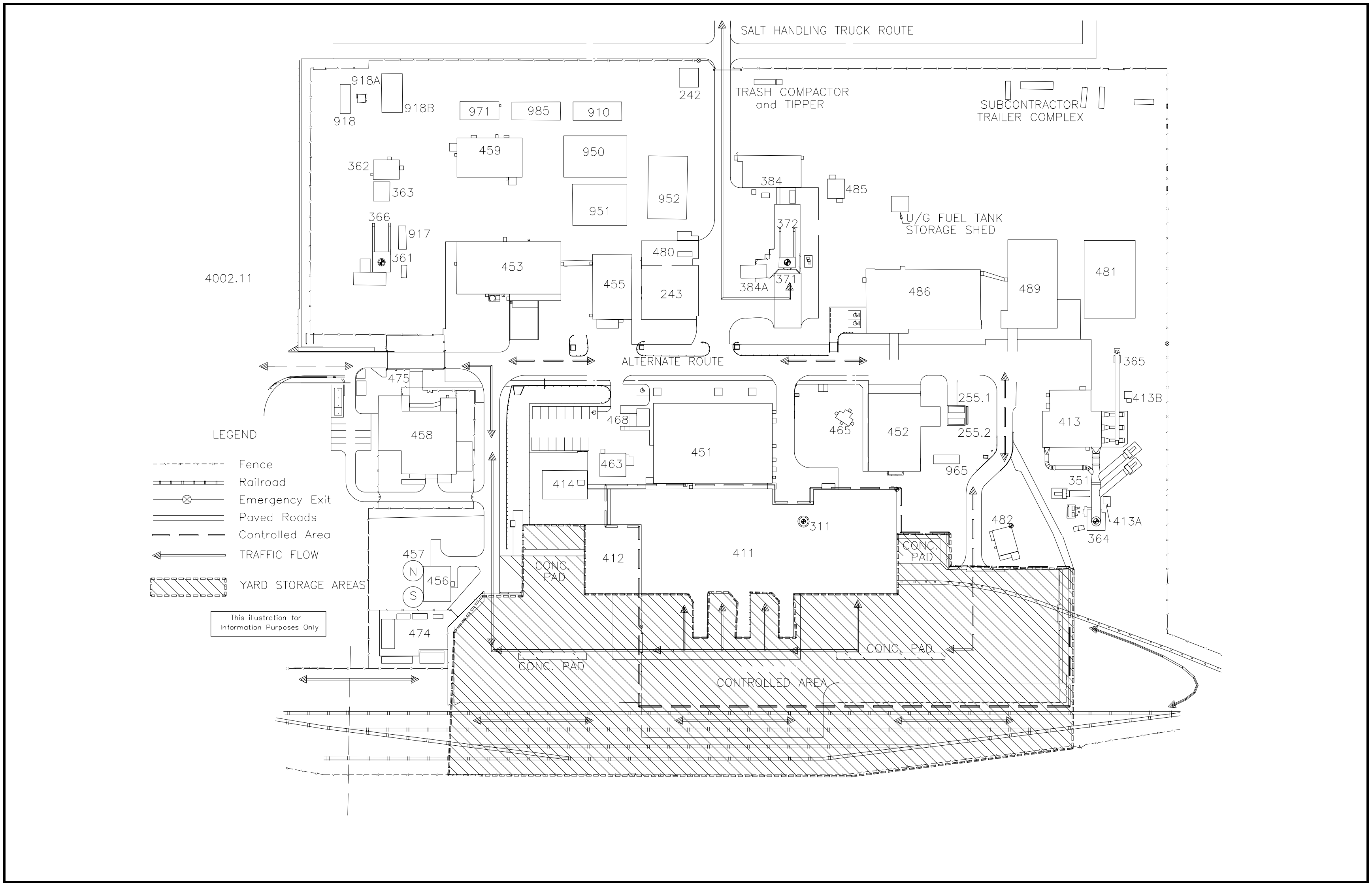

Figure 2.4-1, WIPP Surface Structures

BLDG./ FAC. #	DESCRIPTION
242	NORTH GATEHOUSE
243	SALT HAULING TRUCKS SHELTER
255.1	DIESEL GENERATOR #1 25P-E-503
255.2	DIESEL GENERATOR #2 25P-E-504
311	WASTE SHAFT
351	EXHAUST SHAFT
361	AIR INTAKE SHAFT
362	AIR INTAKE SHAFT/HOIST HOUSE
363	AIR INTAKE SHAFT/WINCH HOUSE
364	EFFLUENT MONITORING INSTRUMENT SHED A
365	EFFLUENT MONITORING INSTRUMENT SHED B
366	AIR INTAKE SHAFT HEADFRAME
371	SALT HANDLING SHAFT
372	SALT HANDLING SHAFT HEADFRAME
384	SALT HANDLING SHAFT HOISTHOUSE
384A	SALT HOIST OPERATIONS
411	WASTE HANDLING BUILDING
412	TRUPACT MAINTENANCE FACILITY
413	EXHAUST FILTER BUILDING
413A	EFFLUENT MONITORING ROOM A
413B	EFFLUENT MONITORING ROOM B
414	WATER CHILLER FACILITY & BLDG
451	SUPPORT BUILDING
452	SAFETY & EMERGENCY SERVICES BUILDING
453	WAREHOUSE/SHOPS BUILDING
455	MAINTENANCE SHOP
456	WATER PUMPHOUSE

BLDG./ FAC. #	DESCRIPTION
457N	WATER TANK 25-D-001B
457S	WATER TANK 25-D-001A
458	GUARD AND SECURITY BUILDING
459	TOOL CRIB
463	COMPRESSOR BUILDING
465	AUXILIARY AIR INTAKE
468	TELEPHONE HUT
474	HAZARDOUS WASTE STORAGE FACILITY
475	GATEHOUSE
480	VEHICLE FUEL STATION
481	AUXILIARY WAREHOUSE
482	EXERCISE ROOM
485	COMPRESSOR BUILDING
486	ENGINEERING BUILDING
489	TRAINING BUILDING

BLDG./ FAC. #	DESCRIPTION
910	ENVIRONMENTAL MONITORING TRAILER
917	AIS TRAILER
918	GEOTECHNICAL ENGINEERING
918A	VOC AIR MONITORING STATION
918B	VOC LAB TRAILER
950	WORK CONTROL TRAILER
951	CONSTRUCTION ENGINEERING
952	INTEGRATED WASTE HANDLING
965	SAMPLE PREPARATION LAB
971	SANDIA NATIONAL LABS
986	CLEANING CONTRACTOR

4003.11

This illustration for Information Purposes Only

Figure 2.4-1a, Legend for Figure 2.4-1

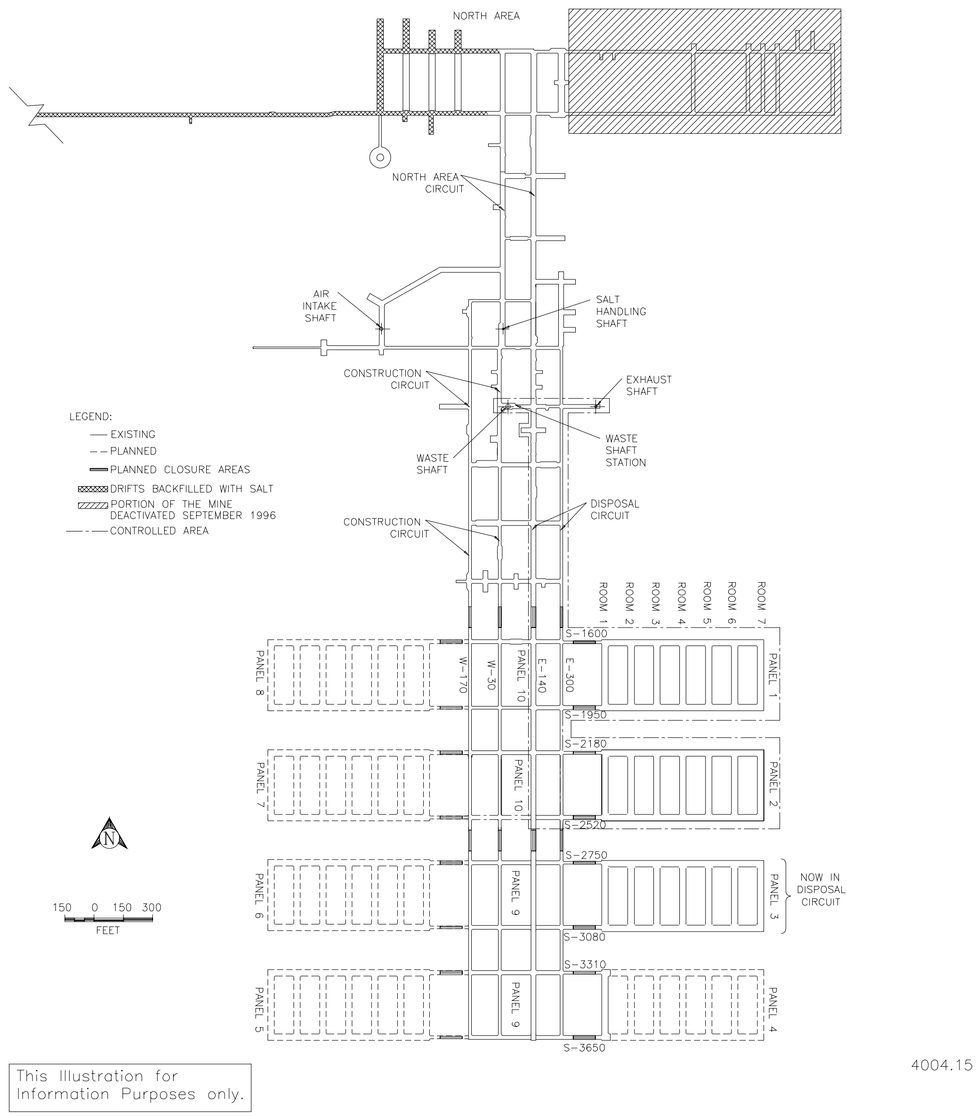

Figure 2.4-2, Underground Structures

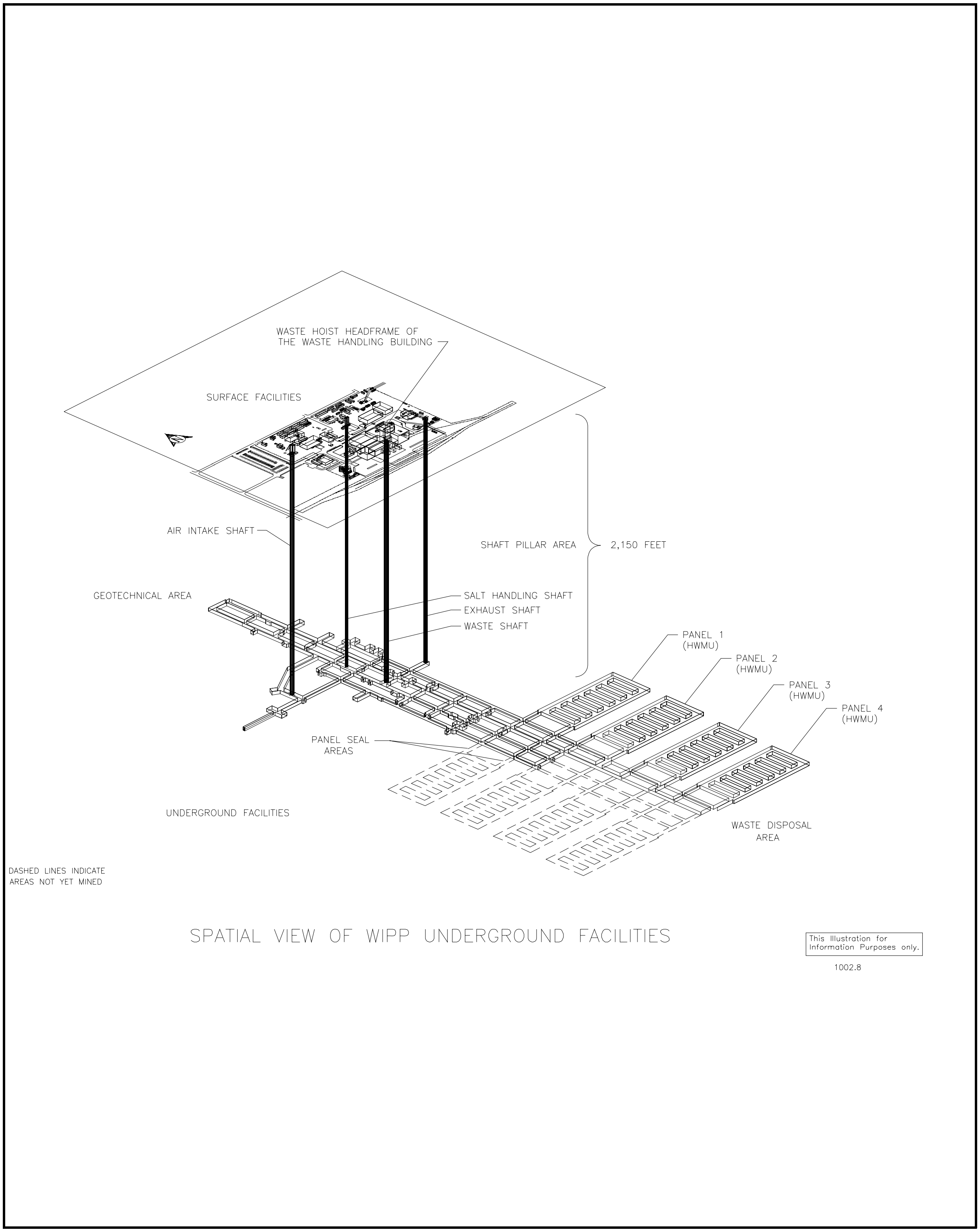

Figure 2.4-3, Spatial View of the WIPP Site

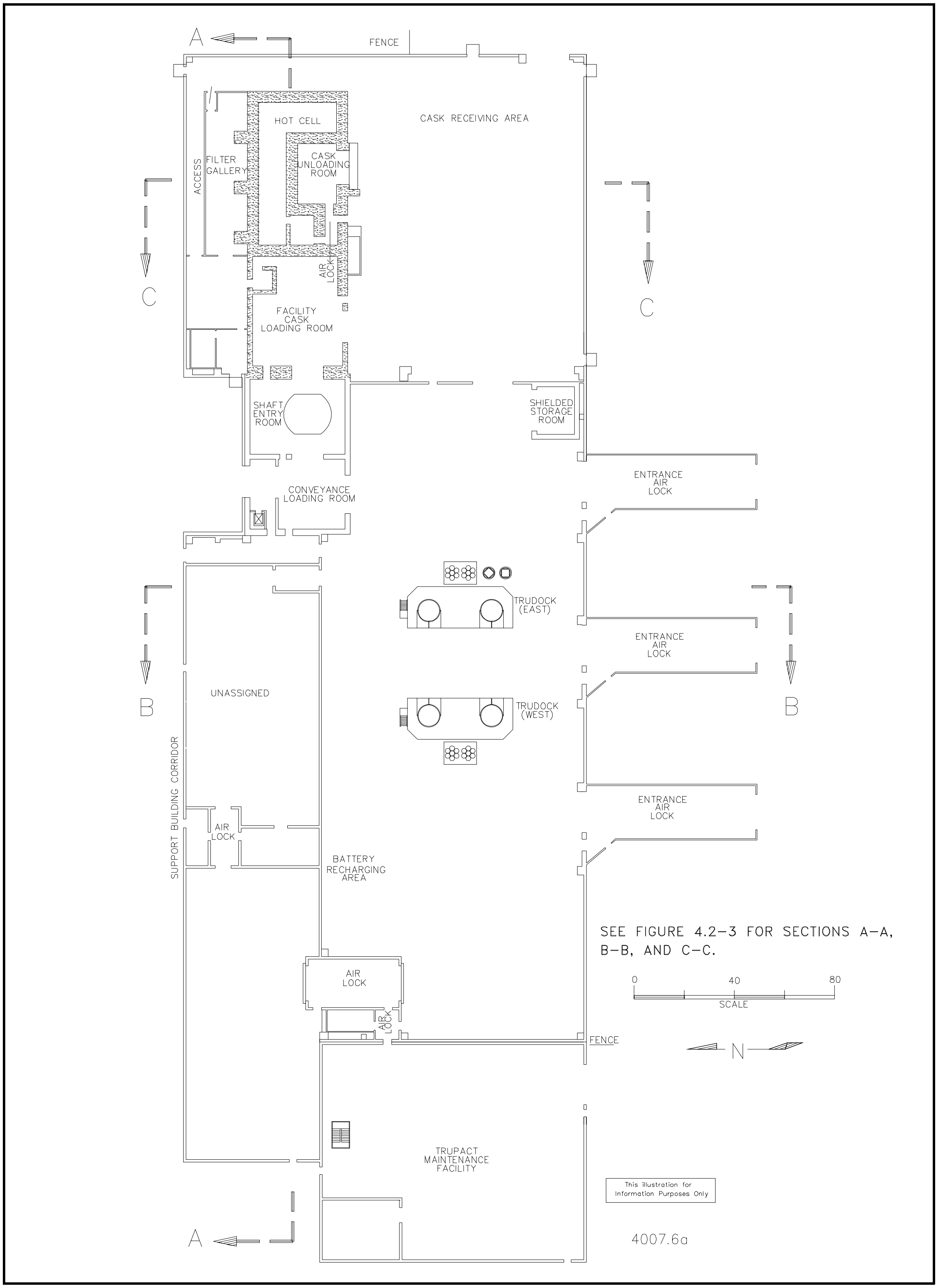

Figure 2.4-4, WHB Plan (Ground Floor)

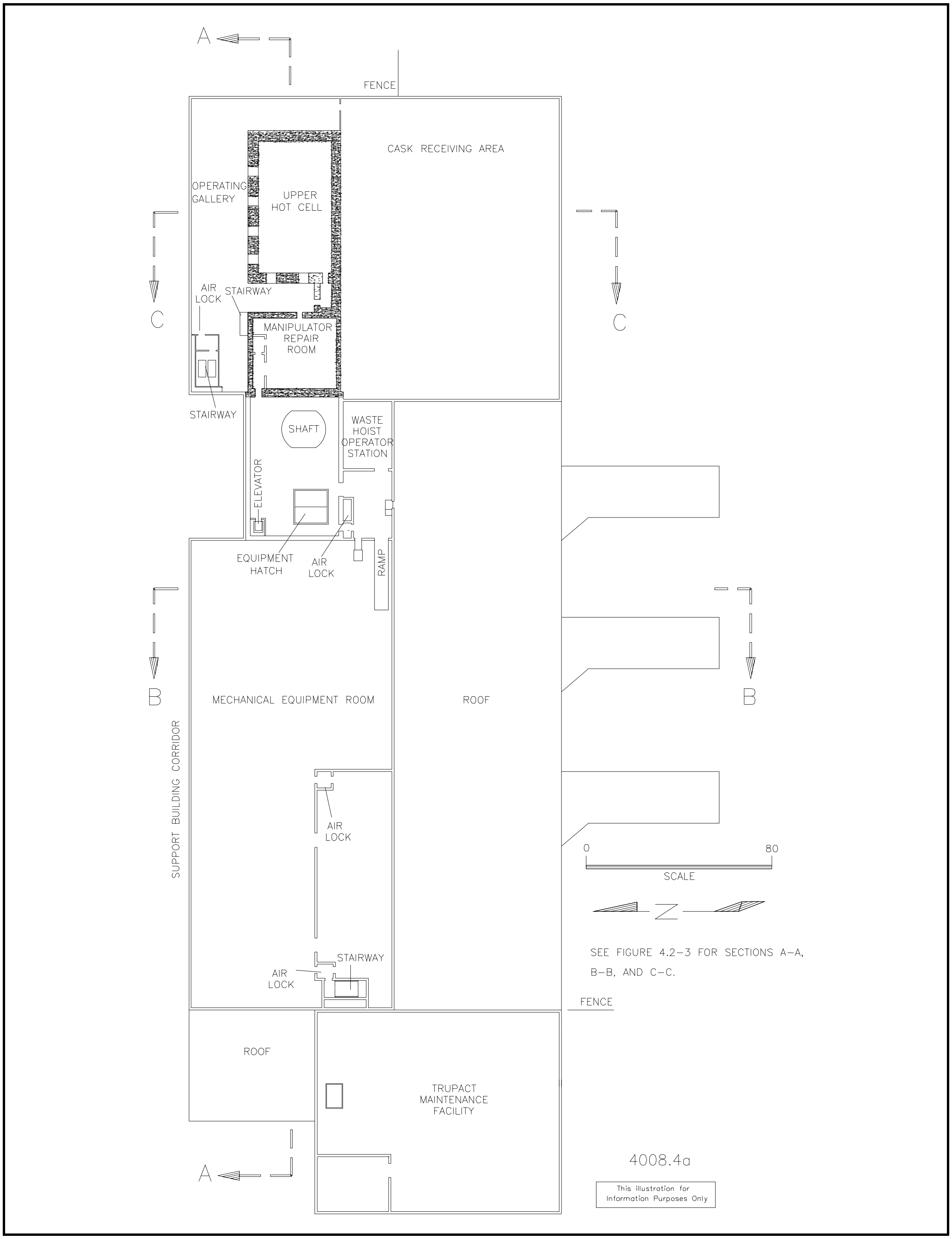

Figure 2.4-5, WHB Plan (Upper Floor)

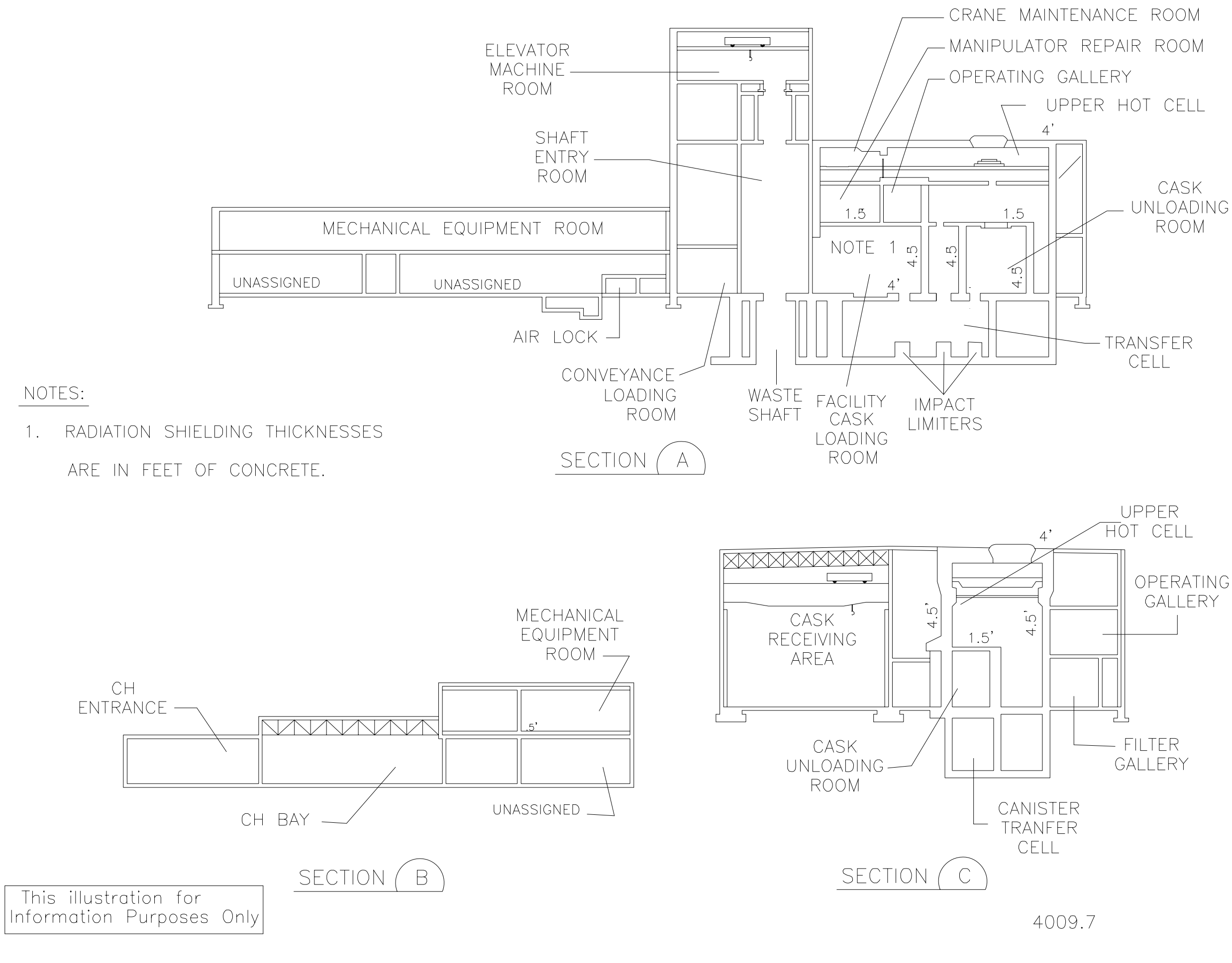

Figure 2.4-6, WHB (Sections)

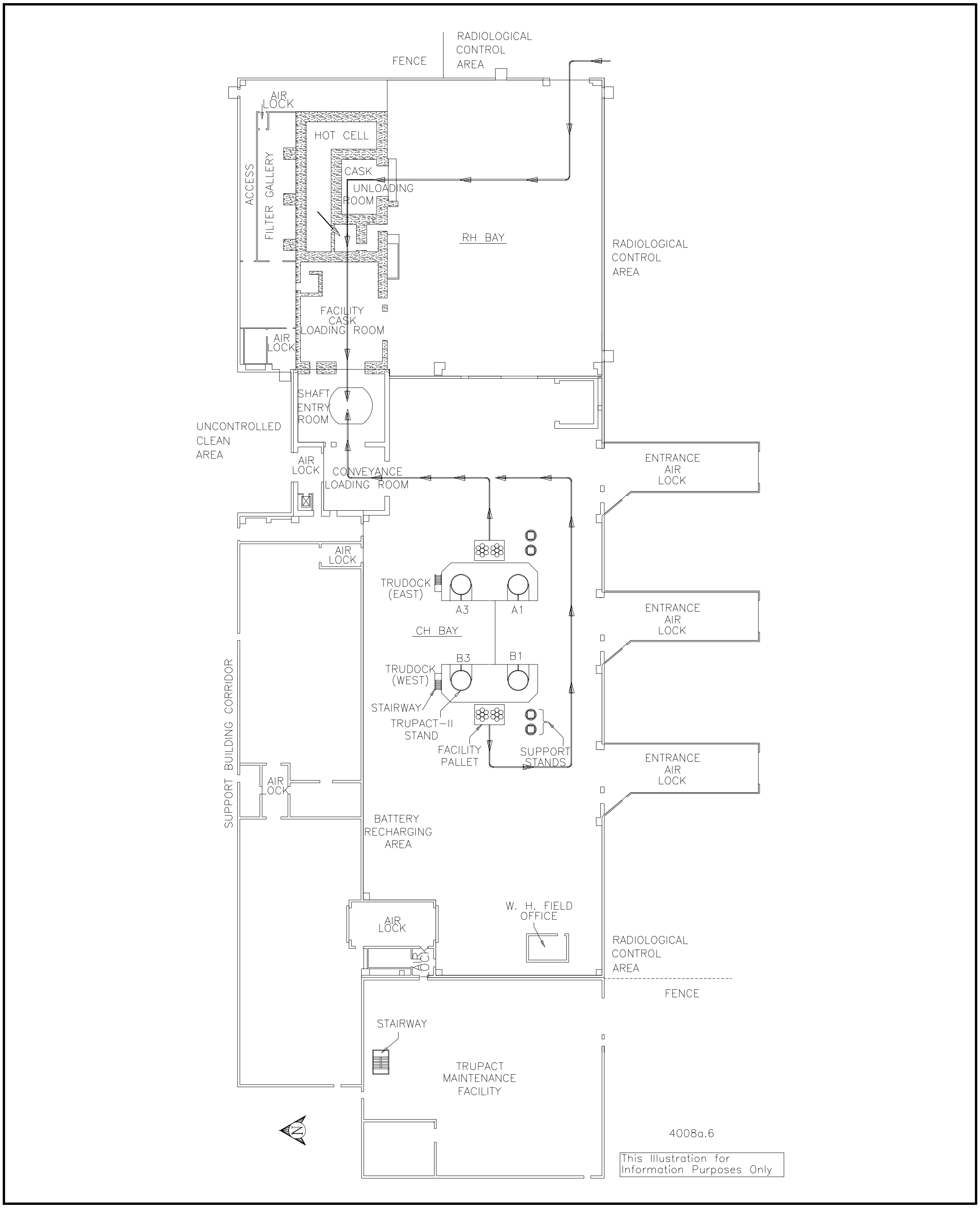

Figure 2.4-7, Waste Transport Routes in the WHB

(More details are shown in Figure 2.5.2 for 72-B waste handling and
Figure 2.5.3 for 10-160B waste handling)

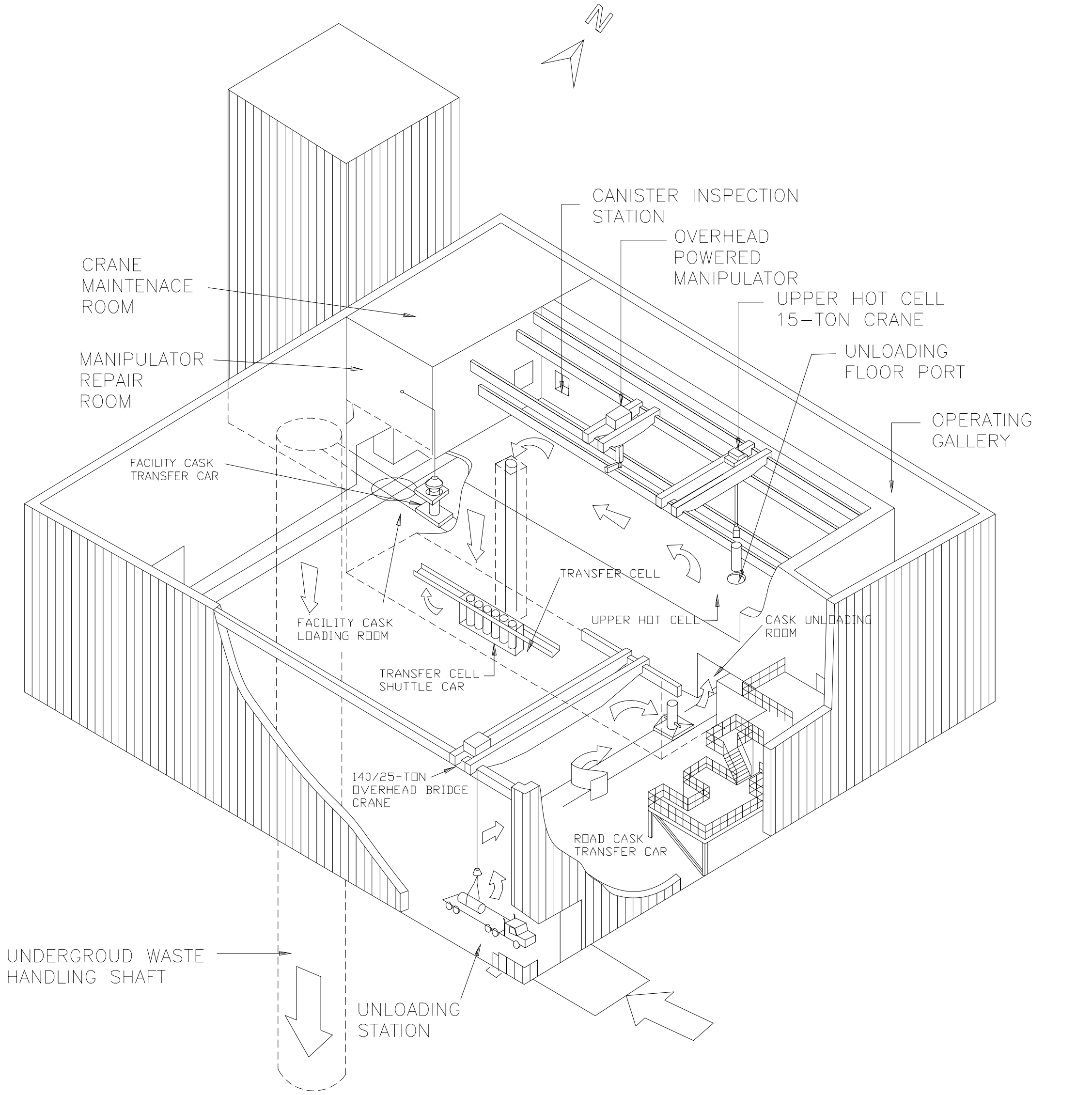

Figure 2.4-8, Pictorial View of the RH Surface Facilities

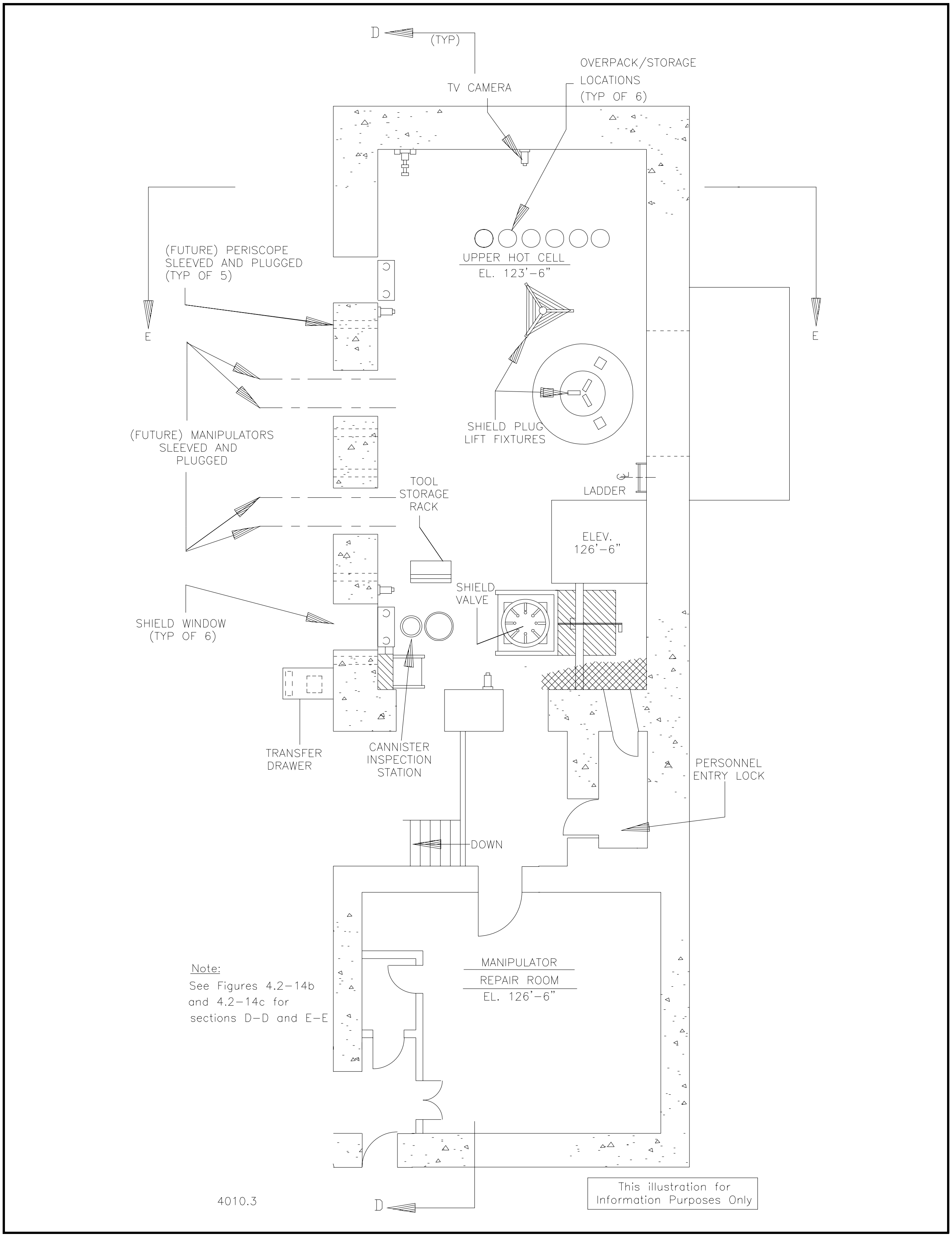

Figure 2.4-9, Details of Upper Hot Cell

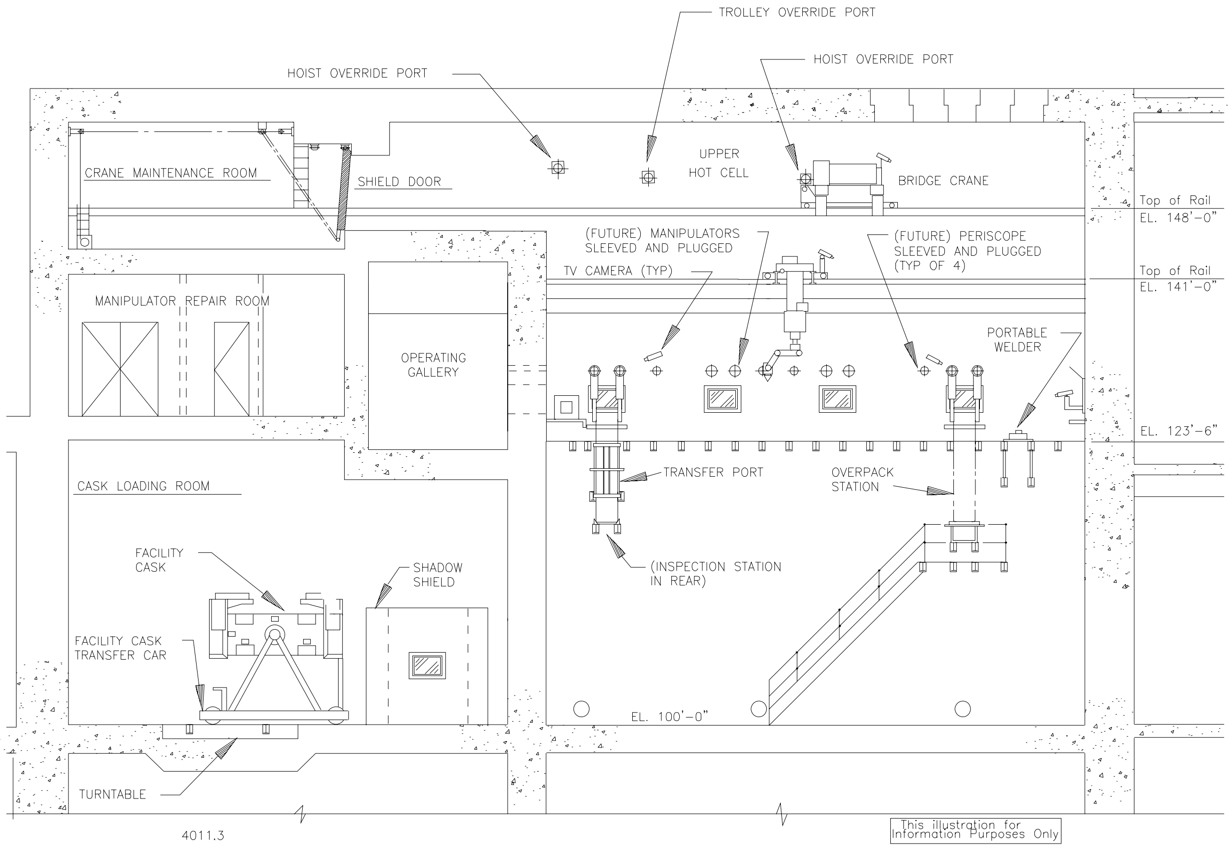

Figure 2.4-10, Details of Hot Cell Complex Cross Section at D-D

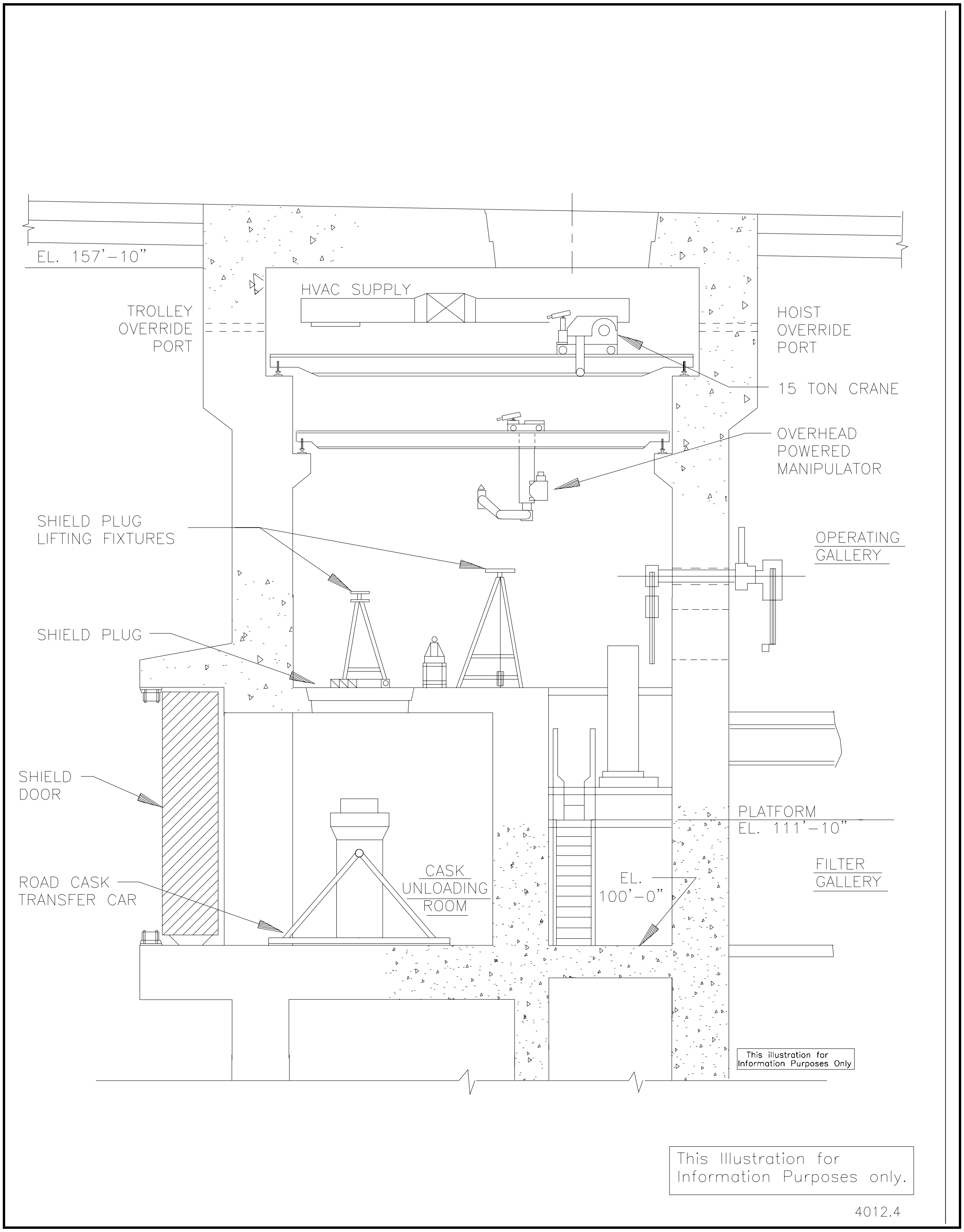

Figure 2.4-11, Details of Upper Hot Cell at Cross Section E-E

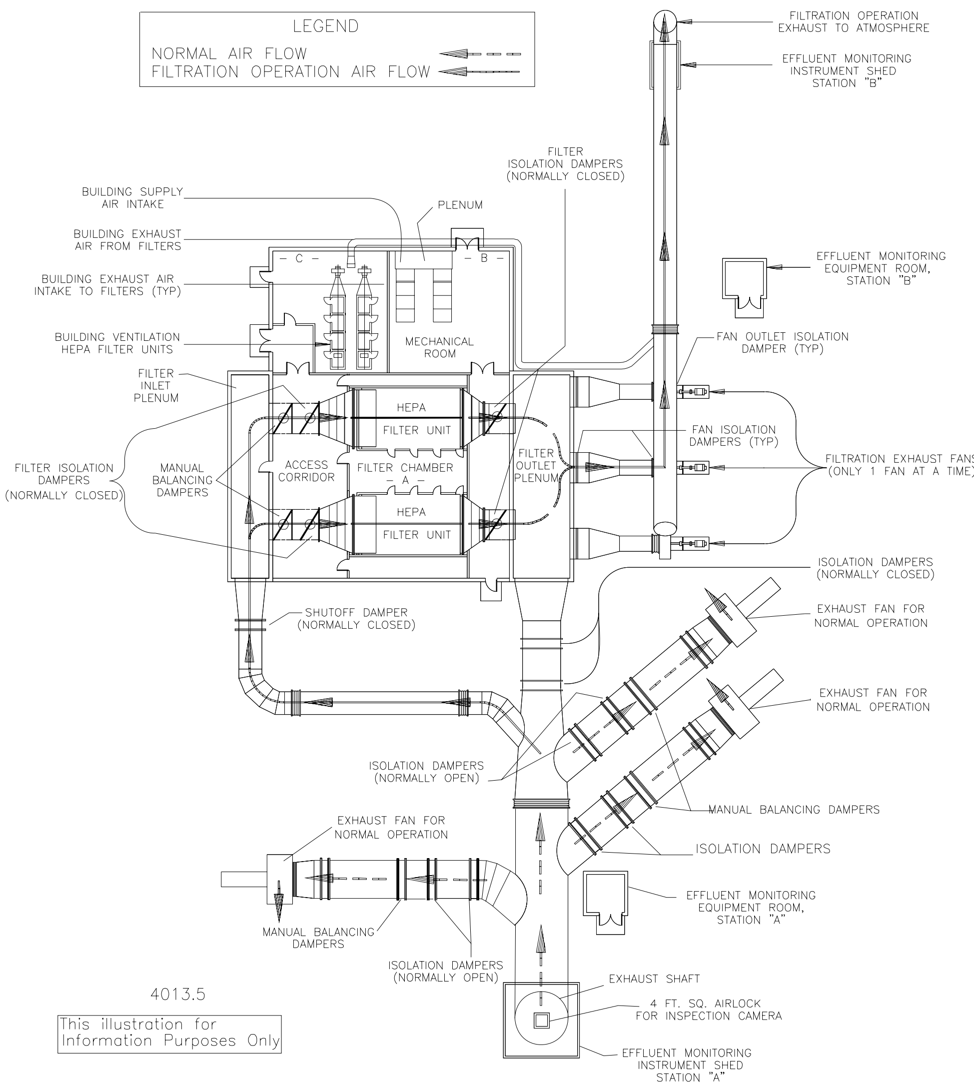

Figure 2.4-12, Exhaust Filter Building

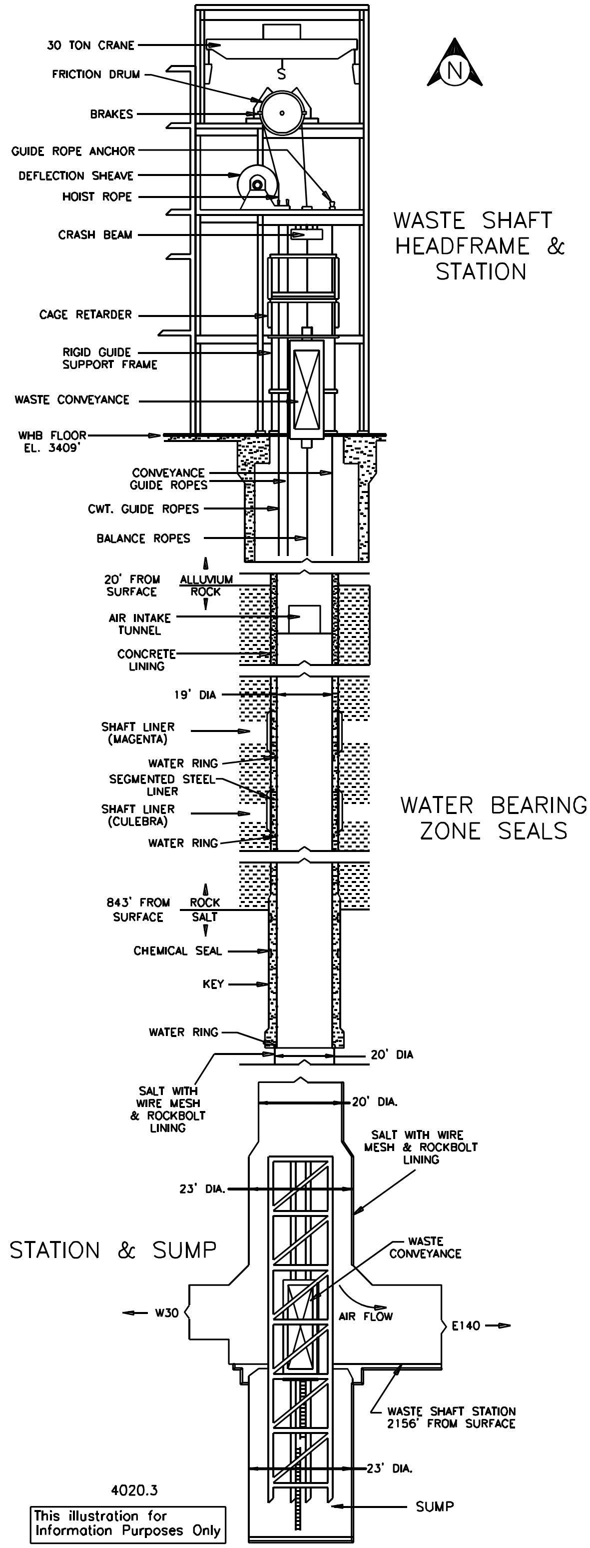

Figure 2.4-13, Waste Shaft and Hoist Arrangement

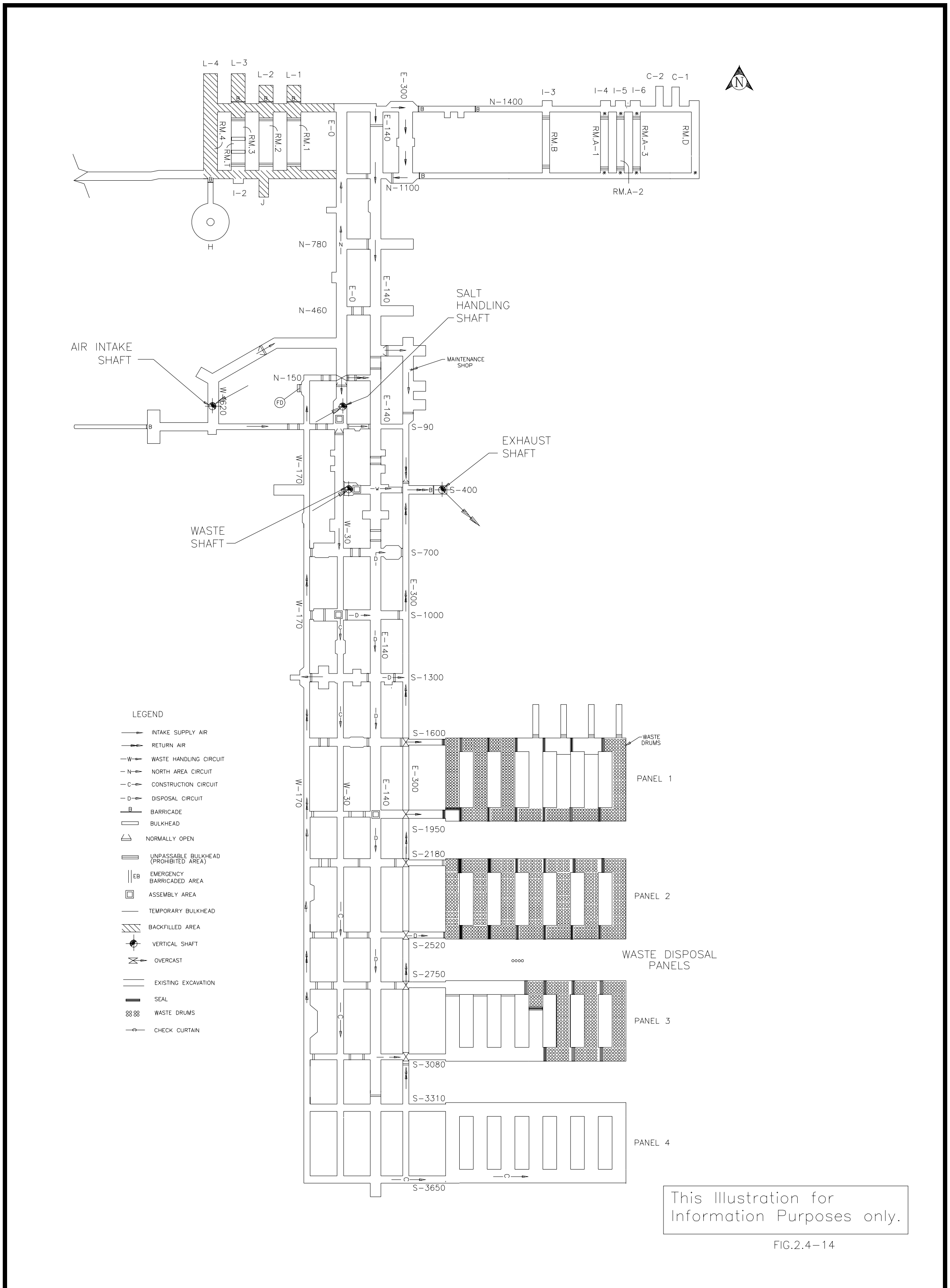

Figure 2.4-14, Underground Layout and Ventilation Flow

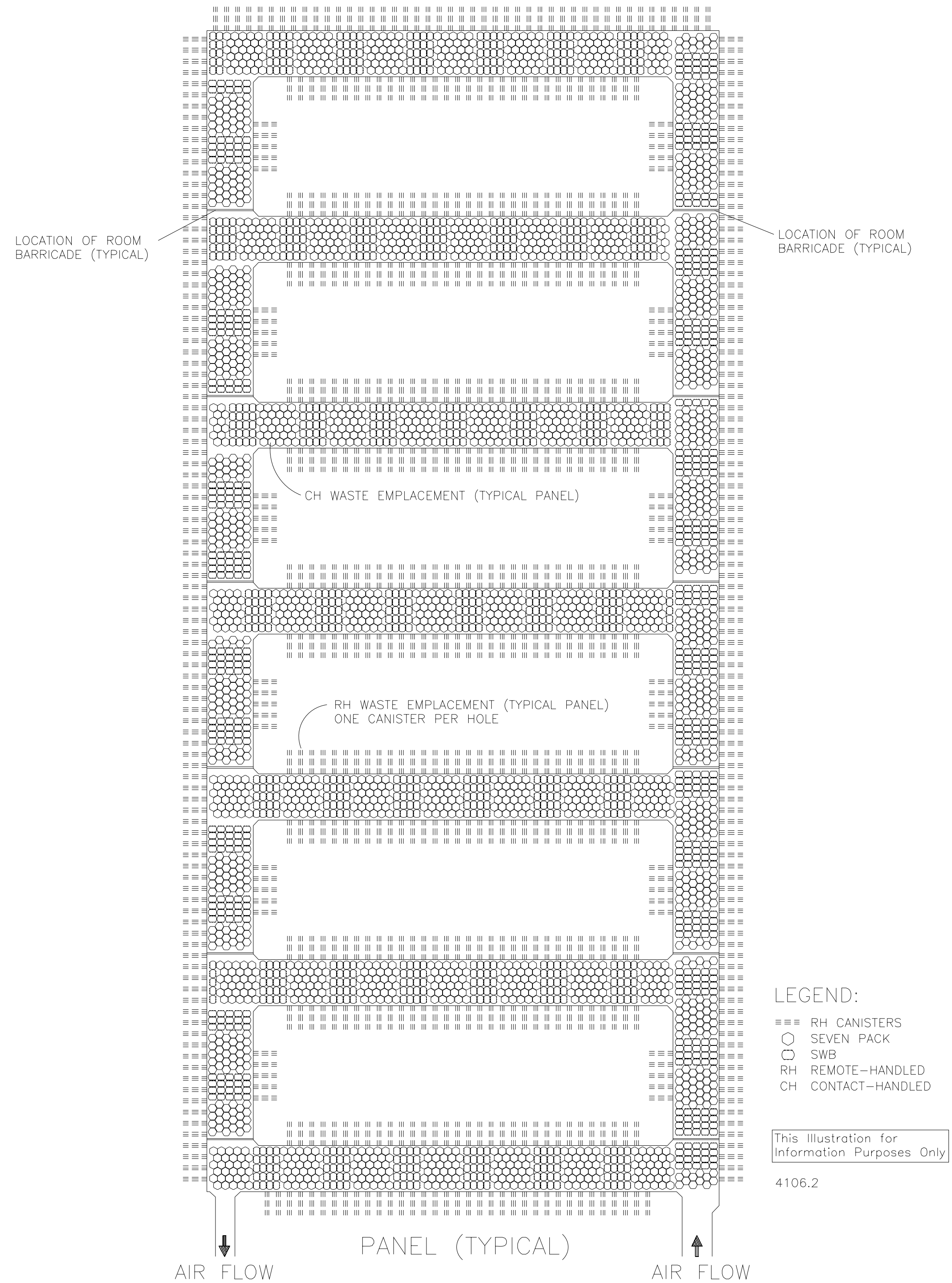

Figure 2.4-15, Typical RH and CH TRU Mixed Waste Disposal Configuration

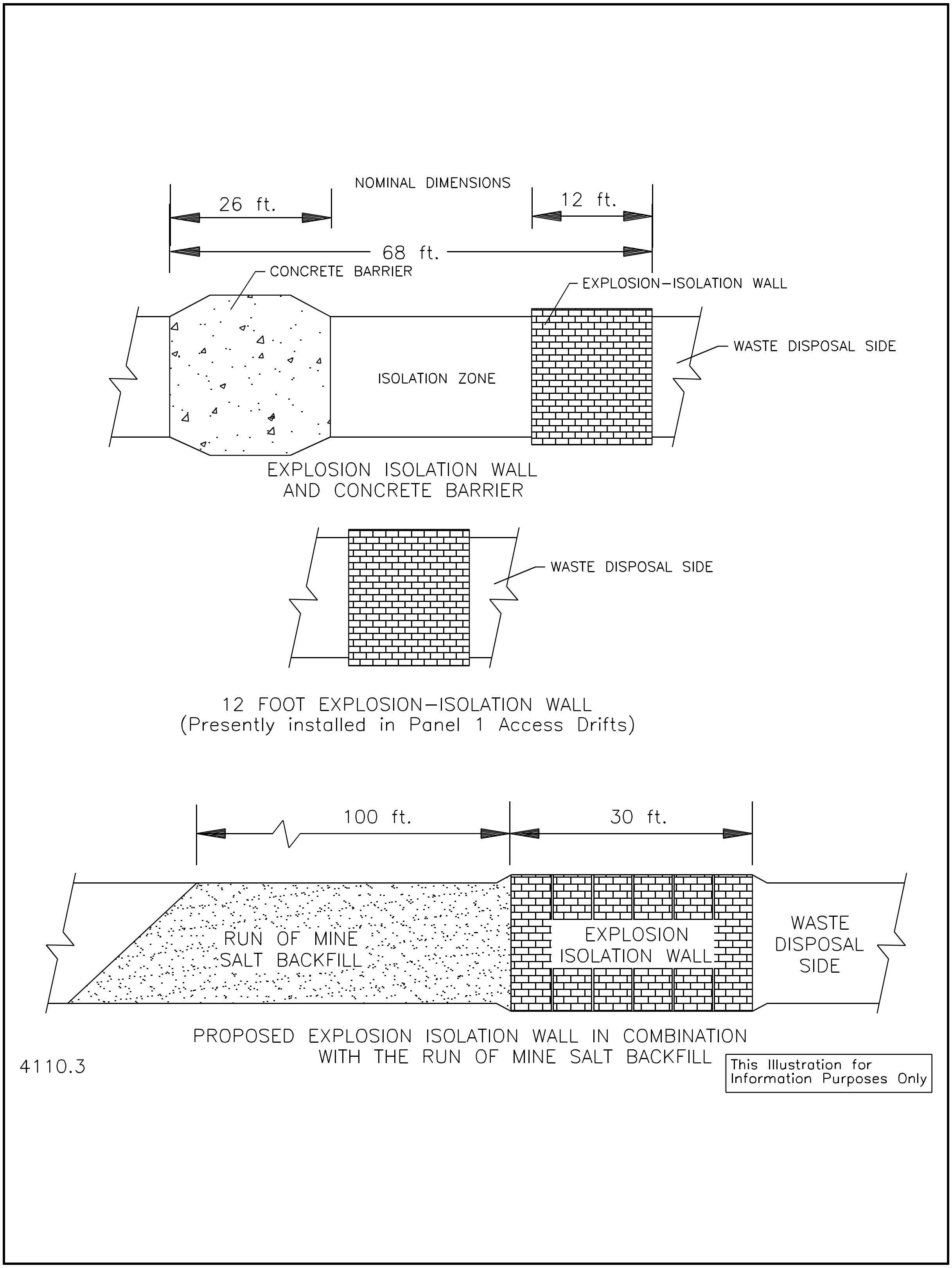

Figure 2.4-16, Panel Closure

2.5 RH Waste Handling Equipment and Process

This section describes the WIPP RH waste handling equipment and process, which begins at the gate of the WIPP facility where RH waste arrives by truck (Figure 2.5-1). Two types of trailers may be used to ship the 72-B shipping cask, one in which the cask is rotated from horizontal to vertical using an overhead crane and one that uses hydraulics to rotate the 72-B cask. The 10-160B shipping cask does not require rotation to remove it from its trailer. Either type of trailer is positioned in the RH bay of the WHB using a trailer jockey or the transport tractor. Diagrams of the RH waste handling processes are shown in Figures 2.5-2 and 2.5-3.

2.5.1 RH Waste Transportation Containers

2.5.1.1 72-B Shipping cask

The RH 72-B shipping cask is a stainless steel, lead-shielded cask designed to provide double containment for shipment of transuranic waste materials. The packaging consists of a cylindrical stainless steel and lead cask body, a separate inner stainless steel vessel, and foam-filled impact limiters at each end of the cask body. The cask is designed to safely transport a single canister of RH waste which can contain three 55-gal. drums or be direct loaded. The maximum payload weight is 8,000 lbs.

The 72-B shipping cask outer cask (OC) body consists of a 1.5 in. thick, 41.1 in. outer diameter stainless steel outer shell, and a 1.0 in. thick, 32.4 in. inside diameter stainless steel inner shell, with 1.9 in. of lead shielding between the two shells. A 5.0 in. thick bottom forging is welded to the OC. The OC is closed by a 6 in thick stainless steel lid with 18 evenly spaced 1.25 in. diameter bolts. The main closure lid has a double bore-type O-ring seal. The containment seal is the inner butyl O-ring seal, which is leak testable. The OC lid has a seal test port and a vent/sampling port sealed with butyl O-rings. The nominal 27,900 lb. OC provides a containment boundary for the payload and also acts as an environmental barrier. The OC lead shielding assures the surface radiation levels are below Department of Transportation (DOT) limits.

The separate inner vessel (IV) is constructed of a 1.5 in. thick bottom forging welded to a 0.4 in. thick, 32 in. outside diameter shell. The 6.5 in. IV lid is secured by eight evenly spaced 7/8 in. bolts and has three test ports, of which one is designated as the vent/sampling port. The IV cavity has a minimum diameter of 26.5 in. and is 121.5 in. long. The nominal 4,000 lbs IV provides a containment boundary for the 72-B waste canister

The RH 72-B shipping cask is certified by the NRC in accordance with 10 CFR 71.63(b).[27, 28] The general shipping cask arrangement, shown in Figure 2.5-4, includes impact limiters, weighing nominal 2,500 lbs. each, at each end of the shipping cask which function to provide protection of the seal areas during the hypothetical transport accident events. Each impact limiter is constructed of polyurethane foam filled stainless steel attached to the OC with six evenly spaced 1.25 in. diameter bolts. The maximum gross weight of a 72-B shipping cask with impact limiters and a fully loaded 72-B waste canister is 45,000 lbs.

The impact limiters are provided with lifting lugs, allowing the use of rigging for handling. Both of the shipping cask lids have bayonet sockets in the outside center for insertion of lifting fixtures. Both lids are also provided with threaded holes for insertion of lifting bolts or eyes. The shielded shipping cask has two transport trunnions, used for support during transport and as a mounting point for the 72-B road cask transfer car. It also has four handling trunnions, located 90° apart at the lid end, used for lifting in the RH bay and CUR, and two trunnions located at the opposite end used for rotating the cask from the horizontal to the vertical position.

2.5.1.2 10-160B Shipping cask

The 10-160B shipping cask is a steel, lead-shielded cask designed to provide single containment for shipment of 55-gallon drums of RH waste. The packaging consists of a cylindrical carbon steel and lead body with an impact limiter at each end. The 10-160B is designed to safely transport ten 55-gallon drums of RH waste in two stacked drum pallet/carriage units holding 5 drums each. The maximum payload weight is 14,500 lbs.

The cask body consists of a 2.0 in. thick, 78.5 in. outer diameter carbon steel outer shell, and a 1.1 in. thick, 68 in. inside diameter carbon steel inner shell, with 1.9 in. of lead shielding between the two shells. A 5.5 in. thick flat circular steel bottom plate is welded to the inner and outer shells. The lead shielding ensures the surface radiation levels are below DOT limits. The internal cavity has a diameter of 68 in. and is 77 in. high. The overall length of the cask without impact limiters is 88 in. An 11 gage stainless steel thermal shield surrounds the cask outer shell in the region between the impact limiters. The cask is closed by a 5.5 in. thick steel primary lid, weighing 5,300 lbs, that is attached to the cask with 24 evenly spaced 1.75 in. diameter bolts. The lid closure is made in a stepped configuration to eliminate radiation streaming at the lid/cask body interface. A double silicone O-ring provides the lid to cask seal.

The primary lid has a 31 in. diameter opening that is equipped with a secondary lid. The 5.5 in. thick 46 in. diameter steel secondary lid, weighing 2,150 lbs., is attached to the center of the primary lid with 12 evenly spaced 1.75 in. diameter bolts. The secondary lid has multiple steps machined in its periphery which match those in the primary lid, eliminating radiation streaming pathways, and is sealed to the primary lid by a double silicone O-ring.

The 10-160B shipping cask is certified by the NRC in accordance with 10 CFR 71.63(b).[27, 29] The 10-160B shipping cask arrangement, shown in Figure 2.5-5, includes impact limiters at each end of the shipping cask. The upper (lid end) impact limiter weighs 5,300 lbs. while the lower weighs 5,200 lbs. Both impact limiters extend about 12 in. beyond the outside wall of the shipping cask and are installed prior to transport so that the shipping cask can meet all transport environment and accident conditions. Each 102 in. outside diameter impact limiter is constructed of polyurethane foam-filled stainless steel. The impact limiters are secured to each other around the cask by eight ratchet binders. The maximum gross weight of a loaded 10-160B shipping cask with impact limiters is 72,000 lbs. and has an overall length of 130 in. The impact limiters are provided with lifting lugs, allowing the use of rigging for handling. The 10-160B shipping cask is equipped with four tie-down lugs welded to the outer shell. The cask also has two lifting lugs and two redundant lifting lugs which are removed during transport and reinstalled for waste handling operations. The secondary lid is equipped with three lifting lugs used to lift both lids. Both lids are covered by the top impact limiter and rain cover during transport.

2.5.2 RH Waste Containers

RH waste containers approved for disposal at the WIPP include DOT Type A, or equivalent, 55-gallon drums shipped in a 10-160B shipping cask and 72-B waste canisters shipped in a 72-B shipping cask. The 72-B waste canisters and 55-gallon drums are equipped with filtered vents which allow aspiration, preventing internal pressurization of the container and minimizing the buildup of flammable gas concentrations, and preventing the escape of any radioactive particulates.

2.5.2.1 72-B Waste Canisters

The 72-B waste canister is a carbon or stainless steel single-shell container with an outside diameter of 26 in., a wall thickness of 0.25 in., and an overall length of 121 in. It has an inside diameter of 25.5 in. with an inside length of 108 in. The 0.375 in. dished head with integral WIPP standard lift pintle is welded to the shell after the canister is filled with waste. The canister is vented using a suitable filter and can be direct loaded or loaded with three 55-gallon drums of radioactive waste, each with a vent filter. It has a maximum weight, including the canister and its waste content, of 5,980 lbs. The 72-B waste canister may have either a welded or mechanical lid.

2.5.2.2 30- and 55-Gallon Drums

The standard 30- or 55-gallon, DOT-17C and DOT-17H metal drums will be used for RH waste. For 30-gallon drums, the 17C drum is approximately .065 in. thick and the 17H drum is approximately .05 in. thick. The overall dimensions for both 17C and 17H 30-gallon drum external s are approximately 29.5 in. tall with a 20.0 in. diameter. A standard 30-gallon drum has a gross internal volume of approximately 113 liters with a maximum gross weight of 500 lbs. For 55-gallon drums, the 17C drum is approximately 0.065 in. thick and the 17H drum is approximately 0.05 in. thick. The overall dimensions for both 17C and 17 H 55-gallon drums are approximately 35 in. tall with a 24.0 in. diameter. A standard 55-gallon drum has a gross internal volume of approximately 208 liters with a maximum gross weight of 1,000 lbs.

2.5.2.3 Facility Canisters

The facility canister is a carbon steel single-shell container weighing approximately 980 lbs., it has an outside diameter of 28.5 in., a wall thickness of 0.25 in., and an overall length of 117.5 in. It has an inside diameter of 28 in. with an inside length of 110.5 in. The lid, with an integral pintle used for lifting, is attached to the shell mechanically after the canister is loaded with three waste drums from a 10-160B shipping cask. The facility canister can hold three 55-gallon drums of radioactive waste. Each drum has a vent filter and can have a maximum weight of 1000 lb. The facility canister is not vented, however, the lid to body connection is not air tight so the canister will not pressurize.

2.5.3 RH Waste Handling Containers

2.5.3.1 Shielded Insert

The shielded insert is specifically designed to be used in the transfer cell to hold and transport loaded facility canisters from the upper hot cell until loaded into the facility cask. The shielded insert, designed and constructed similar to the 72-B shipping cask, has a 29 in. inside diameter with an inside length of 130.5 in. to accommodate the 28.5 in. diameter by 117.5 in. long facility canister. The shielded insert is installed on and removed from the transfer cell shuttle car in the same manner as the 72-B shipping cask.

2.5.3.2 Facility Cask

The facility cask (Figure 2.5-8) is a double end loading shielded container, weighing approximately 67,000 lbs. empty and 75,000 lbs. loaded (with a maximum weight waste canister of 5,980 lbs.). The facility cask is approximately 165 in. long with an approximate height of 98 in. and consists of two concentric steel cylinders with the annulus between them filled with lead. The internal cylinder has a 30 in. diameter and a 0.50 in. wall thickness. The outer cylinder has an external diameter of 41.75 in. with a wall thickness of 0.625 in. The lead annulus is 4.75 in. thick. The robustness of the facility cask serves to prevent any breach of the waste canister. The facility cask is designed such that it maintains its shielding integrity when dropped from a height of 102 in. The equivalent impact load is 1g horizontal and 13g vertical (SDD WH00, Waste Handling System).[17] The facility cask has two support trunnions located approximately mid length at 180° from each other. The trunnions are the support points of the facility cask transfer car. The facility cask has a motor operated gate-type shield valve at each end used for loading and unloading RH waste canisters. Both shield valves are electrically operated with manual overrides and have spring loaded pins that lock the valve gates closed. Compressed air is used to release the locking pins to permit the valves to be opened. The motor operated mechanism opens and closes the shield valves at a nominal rate of 4 ft. per minute. The facility cask shield valves have 8.61 in. thick steel blocks and are designed to support the weight of a fully loaded RH waste canister when they are closed and the cask is vertical. The facility cask has two sets of forklift pockets, the lower set used for transport and placement on the horizontal emplacement and retrieval equipment (HERE).

The facility cask is designed to provide shielding for a RH waste canister such that the cask surface dose rate is less than 200 mrem/hr when the waste canister surface dose rate is 7,000 rem/hr.

The top and bottom facility cask shield valves have eight locking pin limit switches that indicate when the shield valve locking pins are retracted or inserted. The shield valves have four position limit switches to indicate when the shield valves are open or closed. There are two shielding contact switches mounted in the face of each shield valve housing. These switches indicate when the shield bell is in contact with the top shield valve housing and when the telescoping port shield ring is in contact with the bottom shield valve housing.

2.5.4 RH Waste Handling Equipment

2.5.4.1 RH Bay Equipment

140/25 Ton Overhead Bridge Crane

The 140-ton overhead bridge crane with a 25-ton auxiliary hoist is used for shipping cask handling and maintenance operations. The overhead bridge crane is designed to stay on its rails retaining control of the load during a loss of power or DBE.[17] The crane is controlled from a RF handheld control box operated from the floor of the RH bay. The 140-ton main hoist has a lifting height of 41 ft, while the 25-ton auxiliary hoist has a lifting height of 42 ft.

Motorized Man Lifts

Two motorized man lifts are used to provide waste operations personnel elevated work platforms for access to the 72-B and 10-160B shipping casks while the casks are on their transport trailers. Waste operations personnel use the platforms to perform the initial waste handling activities of removing the impact limiters from the shipping casks and performing any work required for readying the casks for lifting from their trailers.

140/25-Ton Crane Cask Lifting Yoke

The 140/25-ton crane cask lifting yoke is a lifting fixture that attaches to either hook of the 140/25-ton overhead bridge crane and is designed to lift and rotate the 72-B shipping cask by engaging its handling trunnions. Figure 2.5-9 shows the 140/25-ton overhead bridge crane with the cask lifting yoke lowering a 72-B shipping cask onto the 72-B RCTC.

72-B Road Cask Transfer Car

The 72-B RCTC is a self-propelled, rail guided structural steel car with two A-frame supports and a bottom positioning fixture designed to hold the 72-B shipping cask in the vertical position. The point of the A-frame is designed to cradle the transport trunnions of the shipping cask (Figure 2.5-10), while the positioning fixture prevents the cask from moving.

The four wheeled car, weighing approximately 3,500 lbs. with a load capacity of 40,000 lbs., is designed to transport the loaded 72-B shipping cask from the transport trailer to the cask preparation station, then to the CUR. It also repeats the route in reverse for empty shipping casks. Each of the two front wheels are powered by an electric motor which moves the car at one of two speeds, 16.5 or 66 ft. per minute. The 72-B RCTC rail tracks are located in the east side of the RH bay, and start in the CUR and run south about 80 ft. ending near the firewater trench by the south wall of the RH bay. Only one RCTC can operate on the rails at a time.

10-160B Road Cask Transfer Car

The 10-160B RCTC (Figure 2.5-11) is a four wheeled, self-propelled, rail guided structural steel car constructed similar to the 72-B RCTC without the A-frame structure. The 10-160B RCTC, weighing approximately 3,000 lbs. with a load capacity of approximately 62,500 lbs., is designed to transport the 10-160B shipping cask, in the vertical position, from the transport trailer to the cask preparation station then to the CUR. Angled guides are bolted on top of the frame to center the beveled bottom of a 10-160B shipping cask on the car and prevent any lateral cask movement. It also repeats the route in reverse for an empty 10-160B shipping cask. Each of the two front wheels is powered by an electric motor which moves the car at one of two speeds, 16.5 or 66 ft. per minute. The 10-160B RCTC can be configured (angled guides removed and A-frames installed) to transport a 72-B shipping cask.

Cask Preparation Station

The cask preparation station is a variable height elevated work platform designed to provide accessability to the shipping cask lid area to allow workers to perform cask unloading preparations and shipment activities such as; bolt detensioning, 72-B cask outer lid removal, lid lift fixture installations, radiological surveys, inspections, and minor maintenance. The preparation station is designed to service both 10-160B and 72-B shipping casks. The cask preparation station work deck is vertically adjustable from a height of approximately 72 in. to 168 in. above the RH bay floor and straddles the RCTC rails. The elevating deck is positioned by electrically operated screw jacks controlled from a push button console. A deck insert is provided to accommodate the different shipping cask diameters. The removal/installation of the 72-B cask outer lid and installation/removal of the 72-B shipping cask inner lid lift fixture (pintle) is performed at this location, as well as installation/removal of the 10-160B lid bolts and installation/removal of the 10-160B lid lift tool.

10-160B Cask Lid Lift Fixture

The 10-160B cask lid lift fixture has a pintle and three one inch ball lock pins (Figure 2.5-12). A ball lock pin is inserted into each of the lid lifting lugs to attach the lift fixture to the 10-160B lid. When the 10-160B is in the CUR, the lid lifting fixture pintle is engaged by a facility grapple connected to the upper hot cell crane, then the lid is lifted into the upper hot cell. The 10-160B cask lid lift fixture is attached to the cask lid by using either the 140/25-ton overhead bridge crane or the cask preparation station jib crane.

72-B Cask Outer Lid Lift Fixture

The 72-B cask outer lid lift fixture is used by the cask preparation station jib crane to remove the outer lid from the 72-B shipping cask while the 72-B cask is in the vertical position on the 72-B RCTC. The 72-B shipping cask outer lift fixture can be lowered by hand or by using the jib crane. The bottom of the fixture is configured to engage the bayonet socket in the lid and rotated 60 degrees to engage the bayonet attachment. Two spring loaded pins on the fixture are released to secure it in the outer cask lid. The pins prevent inadvertent rotation of the fixture and disengagement of the bayonet attachment.

72-B Cask Inner Lid Lift Fixture

The 72-B cask inner lid lift fixture is used by the FCLR facility grapple. It allows remote removal of the inner lid while the cask is in the transfer cell. Operators place the fixture on the inner lid after the outer lid has been removed. The inner lid lift fixture attaches to the inner lid in the same manner as the outer lid lift fixture attaches to the outer lid.

72-B Cask Inner Lid Alignment Tool

The 72-B inner lid alignment tool consists of two parts that are installed at the cask preparation station. The arm is temporarily bolted in the inner lid. It fits in only one orientation and extends out to fit into the guide. The guide is temporarily bolted to the outer vessel after the arm is bolted to the lid. Location of the guide is determined by location of the arm.

After the 72-B cask inner lid is removed in the transfer cell, it may rotate slightly before it is placed back on the cask. The two parts of the tool fit together to center and rotate the lid by the arm on the lid following the guide as the lid is lowered.

10-160B 55-Gallon Drum Lift Device

A drum lift device (Figure 2.5-13) is installed on each 55-gallon drum at the generator site. The drum lift device is similar in construction to the drum lid bolt ring and is installed on the drum just below the first chine below the lid. The lift device has two diametrically opposed wire cable loops that are used to lift the drum from the carriage. When the wire cable loops are engaged by a lifting fixture, the symmetrical construction and placement of the drum lift device allows the drum to be suspended, moved, and inserted into a facility canister.

2.5.4.2 Cask Unloading Room Equipment

25-Ton Crane/Cask Lifting Yoke

The CUR 25-ton crane is fitted with a dedicated cask lifting yoke used to lift the 72-B cask from the 72-B RCTC, lower it through the CUR floor shield valve, and set it in the shuttle car inside the transfer cell. The bridge rails of the CUR 25-ton crane are attached to the walls of the CUR. The crane is designed to stay on its rails retaining control of its load during a DBE. The cask lifting yoke lifts the shipping cask by engaging the shipping cask handling trunnions. The CUR 25-ton crane has a lifting height of 28 ft.

Load cells are located on each hoist cable to provide indication of cable overload and/or load imbalance. In addition to protecting the crane and cask lifting yoke from damage, the load cells are used to prevent inadvertent decoupling of the cask lifting yoke from the cask lifting trunnions.

Closed-Circuit Television Cameras

Two CCTV high resolution cameras are located in the CUR. CCTV cameras are used to provide operators direct viewing of 10-160B cask unloading operations. Each camera system includes a camera head mounted inside the CUR, a control unit located in the upper hot cell operating gallery, and connecting cable. The video output is displayed on monitors located in the upper hot cell operating gallery. Each camera is fitted with a zoom lens and supported on a pan/tilt unit to provide full motion.

CUR Floor Shield Valve

The CUR floor shield valve has a valve body that is a carbon steel plate 6.5 in. thick, 68 in. wide and 67.5 in. long (Figure 2.5-14). It is supported on four rollers which ride on two floor mounted flat tracks. Four guide rollers mounted in the bottom of the shield keep the shield in line. The shield is positioned by a motor driven ball screw actuator mounted such that the shield valve body rolls under the actuator as it moves from the closed to open position. The CUR shield valve is normally maintained in the closed position. The motor actuator includes a brake and limit switch for valve position indication and control interlocks. The CUR shield valve body weighs approximately 8,500 lb. The CUR floor shield valve provides permanent shielding and separates the CUR and the transfer cell. When lowering a 72-B shipping cask or shielded insert into the transfer cell, air pressure in the CUR is maintained higher than in the transfer cell. The CUR floor shield valve is interlocked to other RH waste handling system components as follows:

- The CUR floor shield valve can not be closed unless the CUR 25-ton crane hook is in the high limit position.
- Access to the CUR shield valve control panel is prevented by the closed CUR shield door when the upper hot cell shield plugs are removed. The upper hot cell shield plugs cannot be removed while the CUR shield valve or the CUR shield door is open.
- The CUR floor shield valve can not be opened unless the upper hot cell shield valve and the transfer cell ceiling shield valve are closed.
- The CUR floor shield valve cannot be opened unless the transfer cell shuttle car is positioned under the shield valve (Position W) and the CUR crane is positioned over the shield valve.
- The upper hot cell crane can not remove the upper hot cell shield plugs unless the CUR floor shield valve and shield door are both closed.

2.5.4.3 Upper Hot Cell Equipment

Upper Hot Cell Crane

The remote operated overhead upper hot cell crane (Figure 2.4-11) has a 32 ft. span and can travel about 96 ft. in an east-west direction. It carries a trolley which can move in a north-south direction approximately 23 ft. 10 in. and is load rated at 15-tons The trolley carries a hoist which supports a grapple rotating block and the upper hot cell facility grapple. A hook can be attached to the upper hot cell facility grapple to handle loads including loaded or empty 10-160B drum pallet/carriage units, and 55-gallon drums of RH waste. The hoist has a lifting height of 64 ft. The crane is designed to stay on its tracks, and to hold its load in place in the event of a DBE or electrical failure.[17]

If the upper hot cell crane requires maintenance, the manually operated crane bridge sweep winch or the control console in the upper hot cell operating gallery is used to move the crane into the crane maintenance room. In the event the crane becomes inoperable while moving a load, override tools for the crane and grapple are used to safely lower and release the load, and then raise the grapple to a position that will allow the crane bridge sweep winch to position the crane inside the crane maintenance room.

The operator control console, located in the operating gallery, is hand held to allow the operator to select the optimum upper hot cell viewing window location to visually observe the crane operation.

Upper Hot Cell Facility Grapple Rotating Block Assembly

The upper hot cell facility grapple rotating block assembly is in a fabricated steel housing consisting of four sheaves at the top and a gear drive connected to clevis at the bottom. The grapple rotating block is suspended from the upper hot cell crane by cables passing through the sheaves. The gear drive has a motor driven pinion that rotates the clevis yoke which normally supports a facility grapple.

Upper Hot Cell Facility Grapple

The upper hot cell facility grapple (Figure 2.5-15) is a special lift fixture designed to engage a standard WIPP pintle and has a lift capacity of 21,000 lbs.. The facility grapple has an axially mounted electrically operated actuator that rotates a drive gear that drives three lifting lugs into or out of engagement under the WIPP pintle. In the event of a power failure when the facility grapple was engaged on a lifting pintle, the lifting lugs would automatically lock in place. The grapple is equipped with a proximity switch interlocked with the drive motor that rotates the pivot dogs. The pivot dogs can only rotate when the switch is in contact with a pintle. During lifting, the space between the pintle and the proximity switch prevents the pivot dogs from rotating. The drive shaft has an auxiliary bevel gear which allows the grapple to be manually operated from the service room with a special grapple override tool if the electrical actuator fails to operate. The upper hot cell facility grapple is identical to the FCLR facility grapple described in the FCLR equipment.

A crane hook, rated at 15-tons, is available for use with the facility grapple. The hook is attached to a handling pintle with a flange.

Upper Hot Cell Shield Plug Lift Fixtures

There are two upper hot cell shield plug lift fixtures, one for each size shield plug. Both fixtures, shown in Figure 2.4-11, can be used with the upper hot cell crane to remove their respective upper hot cell shield plug, or both shield plugs can be removed at the same time using only the large upper hot cell shield plug lift fixture. The small upper hot cell shield plug lift fixture resembles a tripod. It is 9 ft. tall with a handling pintle at the top which is engaged by the upper hot cell facility grapple. The legs are fabricated from 3 in. schedule 40 pipe. Each leg has an engagement pin which can engage lifting lugs, on a 13 in radius, on the small shield plug removal adapter. A centering pin is provided near the bottom of the shield plug lift fixture to engage the shield plug removal adapter and align the fixture with the removal adapter. The fixture is lifted by the upper hot cell crane with the facility grapple installed. The fixture is rotated by the rotating block to allow it to engage the shield plug removal adaptor lifting lugs. The upper hot cell small shield plug lift fixture weighing approximately 400 lbs., has a lift capacity of approximately 10,000 lbs.

The shield plug removal adapter is a fabricated steel fixture that is attached to the small shield plug with three bolts through holes in its base plate. It has three arms, each with a lifting lug that can be engaged by the small upper hot cell shield plug lift fixture. The center line of the lifting lugs are each on a 13 in. radius. The adapter has a height of 12 3/8 in. and weighs approximately 160 lbs.

The large upper hot cell shield plug lift fixture, similar in design to the small upper hot cell shield plug lift fixture, is 11 ft. tall and its engagement pins have a 39 in. radius. It is fabricated from 3 in. schedule 80 pipe to accommodate a greater lift weight. Its three engagement pins are designed to engage the three lifting lugs of the large shield plug removal adaptor. The large upper hot cell shield plug lift fixture weighs approximately 800 lbs. and has a lift capacity of 20,000 lbs.

10-160B Drum Carriage Lift Fixture

The 10-160B drum carriage lift fixture is a pentagon with five legs and a centering guide post with a guide pin. Each leg has an engagement pin which engages a lift lug, mounted on a lifting post, on the drum carriage. The guide pin slides into the center of the drum carriage center stanchion. Figure 2.5-16 shows the 10-160B drum carriage lift fixture and a fully loaded (five 55-gallon drums) drum carriage. Figure 2.5-16 shows a cut-away view of a 10-160B shipping cask containing two drum carriages with the lift fixture engaging the upper drum carriage. The 10-160B drum carriage lift fixture has a lift capacity of approximately 6,500 lbs.

Viewing Windows

Six upper hot cell viewing windows are provided in the operating gallery. Four viewing windows are located in the north wall and two in the west wall. The window frames are cast in the 54 in. thick concrete shield wall separating the upper hot cell from the operating gallery. The frames are designed so that any radiation streaming paths parallel to the optical axis are prevented. The oil filled shielding windows are comprised of the frame, leaded shielding glass, cover glasses and trim frames. The cover glasses and gaskets retain the oil within the window housing. The cold side, operating gallery, consists of a tempered cover glass and three 5 in. thick lead shielded glasses. The hot side, upper hot cell, contains a 1 ½ in. thick non-browning cover glass. The oil fill provides radiation shielding and acts as a heat transfer medium. An oil expansion tank is provided as a means of keeping the window full of oil despite the temperature excursions caused primarily by exposure to radiation and the high intensity lighting within the upper hot cell.

Wall Mounted Manipulators

There are four wall mounted heavy duty manipulators in the upper hot cell, located at two inspection stations, that allow operators in the operating gallery to reproduce the natural movements and forces of the human hand. The operator must exert the same force on the master arm that he wishes to exert with the slave arm; however, the tong squeeze motion does have a mechanical force multiplication. The manipulators are used for performing tool handling, radiological surveying and identification of canisters within the upper hot cell. The manipulators are mounted in the wall of the upper hot cell using a thru tube and are equipped with counterweights that limit motion and speed of travel in the event the operator releases the manipulator control.

Overhead Powered Manipulator

The overhead powered manipulator is a crane mounted remote controlled arm with shoulder, elbow, and wrist pivots which can be independently driven (Figure 2.4-11). The wrist can support various adaptor tools including a hook hand and parallel jaw hand. The manipulator is suspended from a rotation drive assembly which permits full rotation of the manipulator about its vertical axis. The manipulator is attached to the rotation drive by two locking pins which allow for remote removal of the manipulator from the rotation drive assembly. The overhead powered manipulator is designed to hold its load in place in the event of a loss of electrical power or a DBE.[17]

The rotation drive is attached to the bottom of a telescoping tube which provides manipulator vertical motion. There are five square nested telescoping sections connected in such a way that movement of any one tube causes all tubes to move. The telescoping tubes have an up-down travel of approximately 15 ft. at a speed of 15 ft. per minute and have a lifting capacity of 5,000 lbs. The telescoping tube assembly is supported by the trolley carriage which travels on a bridge assembly. The bridge can travel east-west for approximately 50 ft. at a speed of up to 22 ft. per minute, while the trolley can travel north-south for approximately 25 ft. at a speed of up to 15 ft. per minute.

The control panel for the overhead powered manipulator includes the controls for bridge, trolley, hoisting, and manipulator operation. The control equipment is located in panels along the north wall of the operating gallery. The operator controls and indicators are mounted on the overhead powered manipulator console. The console is mounted on wheels and can be moved near the viewing window that provides the best viewing of the operation to be performed. The console includes cables that can be plugged into any one of three connection boxes mounted in the operating gallery.

Closed-Circuit Television System

The CCTV high resolution cameras located in the upper hot cell, the CUR, and transfer cell provide direct viewing of specific operations which can be monitored in the upper hot cell operating gallery. Each closed circuit camera includes a camera head, a control unit, and connecting cable. Each upper hot cell and CUR camera is fitted with a zoom lens and is supported on a pan/tilt unit to provide full motion.

Shielded Transfer Drawer

The shielded upper hot cell transfer drawer is used to transfer materials, such as radiological smear samples and small tools, from the upper hot cell to a transfer drawer enclosure in the operating gallery (Figure 2.5-17). A motor driven shield plug blocks the nominal 20 in. opening in the shield wall of the upper hot cell. The shield plug travels nominally 46 in. perpendicular to the opening on rollers that ride on tracks fastened to a steel frame.

The upper hot cell transfer drawer enclosure in the operating gallery side of the shield wall has a viewing window, two glove ports, and a transfer port. A motor driven shield plug in the floor of the transfer drawer enclosure blocks off the upper hot cell transfer port in the same manner as is done inside the upper hot cell. The transfer drawer enclosure shield plug has a travel of nominally 38 in. The motors of the shield plugs are electrically interlocked so that only one shield plug is in the open position at any time. The upper hot cell transfer drawer is moved in and out of the shield wall opening as the upper hot cell shield plug is moved. A light screen machine guard system is installed inside the transfer drawer enclosure to prevent movement of the operating gallery shield plug while hands, gloves, or other obstructions are protruding though the transfer drawer enclosure glove ports or transfer canister port.

A sample tray is used for transferring the assessment swipes between the operating gallery and the upper hot cell. The sample tray is manually moved into the shield wall opening and must be completely inside the shield wall opening before the operating gallery shield plug is closed.

The transfer drawer is a flat tray, roller-mounted on the drawer carriage that rolls on rails on the bottom of the opening of the upper hot cell shield wall. When the upper hot cell shield plug is closed and the transfer drawer enclosure shield plug is retracted, the operator can pull the sample tray into the transfer drawer enclosure.

Upper Hot Cell Shield Valve

The upper hot cell shield valve (Figure 2.5-14) body is a carbon steel plate 6.5 in. thick, 68 in. wide and 67.5 in. long. It is supported on four rollers which ride on two floor-mounted flat tracks. Four guide rollers are mounted in the bottom the shield and ride on the inside edges of the tracks to keep the shield in line. The shield is positioned by a motor driven ball-screw actuator which includes a brake and a rotary limit switch assembly. The shield valve assembly weighs approximately 10,000 lbs. The shield valve provides permanent shielding and separates the upper hot cell and the transfer cell. When moving waste canisters between the upper hot cell and the transfer cell, ventilation air flow is from the transfer cell into the upper hot cell. Guide tubes are provided between the upper hot cell and the transfer cell to ensure proper alignment of a canister being transferred between the two locations. The upper hot cell shield valve is interlocked to other RH waste handling system components as follows:

- upper hot cell shield valve cannot be opened unless the CUR floor shield valve and the transfer cell ceiling shield valve are closed.
- The transfer cell air supply damper is interlocked with the upper hot cell floor shield valve. The damper automatically closes when the upper hot cell shield valve is opened.
- Upper hot cell shield valve cannot be closed unless the upper hot cell facility grapple is in the pre-set high limit position.
- Upper hot cell shield valve and the CUR floor shield valve must be closed before the transfer cell ceiling shield valve can be opened.
- Upper hot cell shield valve and the transfer cell ceiling shield valve must be closed before the CUR floor shield valve can be opened.
- Upper hot cell shield valve can not be opened unless the transfer cell shuttle car is positioned below the upper hot cell shield valve port and the detensioner robot is in the home position.

2.5.4.4 Transfer Cell Equipment

Transfer Cell Shuttle Car

The transfer cell shuttle car (Figure 4.2-18) is a steel frame structure with a single cask basket designed to accommodate a loaded RH 72-B shipping cask or a shielded insert. The car is used to position a cask at four positions: (1) under the CUR floor shield valve (CUR port), position W, (2) under the upper hot cell shield valve (hot cell port), position X, (3) under the transfer cell ceiling shield valve (FCLR port), position Y1, and (4) the 72-B cask lid storage position (Y2). A platform located on the car just west of the cask basket is used to store the inner vessel lid of the RH 72-B cask during canister transfer to the facility cask. The shuttle car, approximately 22 ft. long, 10 ft. deep and 6 ft. wide, has four steel wheels that ride on rails mounted on support trestles, and is designed to support its load and remain on the rails in the event of a DBE.[17]

The shielded insert can also be loaded into the cask basket. This allows for the shielded transport of facility canisters that have a larger diameter than the RH 72-B canister from under the upper hot cell port to under the FCLR port.

Impact limiters are cylindrical containers filled with sand located under each cask/canister handling position. The impact limiters are designed to limit damage to the casks, shielded insert, canisters and the transfer cell floor in the event of an accidental drop of a cask or shielded insert by the CUR 25-ton crane or a drop of a canister by the FCLR grapple hoist or upper hot cell crane. The impact limiters also help ensure the 72-B cask, shielded insert, or canister remain upright after being dropped.

The bottom support beams of the cask basket are connected to the transfer cell shuttle car with shear bolts designed to break away, allowing the cask or shielded insert to fall through the bottom of the basket into the impact limiters. This prevents serious damage to the transfer cell shuttle car structure and aids in accident recovery by maintaining the 72-B cask or shielded insert in a upright position.

The transfer cell shuttle car is driven east and west by a chain drive system at the west end of the transfer cell. The double chain sprockets are driven by a solid shaft which penetrates the transfer cell wall so that the gear reducer and drive motor are located outside the transfer cell. The reducer and drive motor are connected by a triple V-belt. Belt tension can be adjusted by a turnbuckle linkage mounted on the gear reducer. Proper tension in the chain drive is accomplished by two counterweights which hang from the chains near the west end of the transfer cell. A single chain can move the transfer cell shuttle car.

The transfer cell shuttle car position is sensed by an encoder on the chain drive shaft and controlled by the programmable logic controller in the FCLR control panel. Four programmed stops serve the CUR port, position W, the upper hot cell port, position X, the FCLR port, position Y1, and the 72-B cask lid storage position, position Y2. The programmable logic controller also controls the speed, 0 to 31 ft. per minute, of the transfer cell shuttle car through the variable speed drive to allow shifting from high speed to low speed as the programmed stop locations are approached. Three fixed CCTV cameras fitted with laser pointers provide visual backup of the proper positioning of the transfer cell shuttle car. The transfer cell shuttle car has two over travel stop limit switches.

The shuttle car is interlocked with the CUR floor shield valve, the upper hot cell shield valve, and the transfer cell ceiling shield valve such that the shuttle car cannot move unless all three shield valves are closed.

Detension Robot

The detension robot, located in the transfer cell, is used to detension the inner lid bolts of the 72-B shipping cask at the transfer cell shuttle car position X. The robot incorporates a torque wrench end-of-arm tool and is rated at 300 ft. lb. The robot detensioning sequence is initiated by the operator. The robot is normally controlled from the operator console located in the FCLR. It can also be operated by a pendent located outside the transfer cell. The robot is interlocked with the transfer cell shuttle car so that the transfer cell shuttle car is at position X before the robot can be moved and the robot must be at the home position before transfer cell shuttle car can be moved. The robot is also interlocked with the upper hot cell shield valve such that the robot must be in the home position before the shield valve can be opened. Once the detensioning process has started, the process is automatic.

Swipe Robot

The swipe robot is used to take swipes of the 72-B cask inner lid and the 72-B canister to detect the presence of surface contamination before completing the canister transfer from the 72-B shipping cask to the facility cask. The swipe robot interfaces with swipe delivery system. The robot is equipped with a specially designed end-of-arm tool with pneumatically operated finger grippers. The grippers are designed to interface with the swipe holders. The robot is located in the transfer cell at the shuttle car position Y1. The swipe robot is interlocked with the transfer cell shuttle car so that the shuttle car is at position Y1 before the robot can be moved and the swipe robot must be at the home position before the shuttle car can be moved. The swipe robot is normally controlled from the operator console located in the cask loading room. It can also be operated by a pendent located outside the transfer cell.

Swipe Delivery System

The swipe delivery system is used to transport swipes from the transfer cell to the service room for counting and returns clean swipes to the transfer cell. The swipe delivery system send and receive station is located in the service room. The receive station is located in the vent hood that is kept at a slightly negative pressure with respect to the service room pressure. The swipe delivery system interfaces the send and receive station in the service room with an acceptor tube that is mounted adjacent to the swipe robot in the transfer cell. The swipe delivery system operation is initiated by health physics personnel at the send station or automatically when a swipe is placed in a pneumatic swipe carrier at the acceptor tube in the transfer cell. A blower provides the motive force to send the pneumatic swipe carrier between the send and receive station and the acceptor tube. The blower exhausts to the transfer cell and the vent hood exhausts into the RH bay ventilation system.

Transfer Cell Ceiling Shield Valve

The transfer cell ceiling shield valve (Figure 2.5-14) is located under the port connecting the transfer cell to the FCLR. The shield valve has a 12 in. deep steel frame supporting a 42 in. square shield plate 1 in. thick. The approximately 8 ft. long frame is bolted to the transfer cell ceiling. The electric motor-driven-screw actuator is attached to the shield plate with a clevis pin. Valve travel from full-closed to full-open position is nominally 42 in. at a speed of 3 in. per second. The transfer cell ceiling shield valve is normally closed, except during facility cask loading activities. The valve motor is equipped with torque switches that will automatically shut off power if the valve is closed against an object in its path. The transfer cell ceiling shield valve provides permanent shielding and separates the transfer cell and FCLR for differential air pressure control. Air pressure in the transfer cell is maintained at lower pressure than the FCLR. The transfer cell ceiling shield valve is interlocked to other RH waste handling system components as follows:

- Transfer cell ceiling shield valve cannot be opened unless the CUR floor and upper hot cell shield valves are closed.
- Transfer cell ceiling, CUR, and upper hot cell shield valves are interlocked with the transfer cell shuttle car drive so that the transfer cell shuttle car cannot be moved if all shield valves are not closed. This interlock prevents damage to the canister from transfer cell shuttle car movement during canister transfer.
- The transfer cell ceiling shield valve cannot be opened with the facility cask bottom shield valve closed, nor closed with the facility cask bottom shield valve open if the facility cask is present.
- The transfer cell ceiling shield valve cannot be opened if the telescoping port shield is not in contact with facility cask bottom, or if the teleport shield is up and the hoist is at either position E or F so that the bell shield is in contact with the telescoping port shield.

Transfer Cell Cameras

There are six CCTV cameras and four vision cameras located in the transfer cell and are used to provide operators direct viewing of transfer cell operations. The camera output is monitored from the upper hot cell operating gallery, the operator console located in the FCLR and in the transfer cell service room.

Transfer Cell Service Room

The transfer cell service room is located outside the transfer cell and contains a console that can be used to monitor the transfer cell CCTV camera. The transfer cell service room is not occupied when waste is present in the transfer cell.

2.5.4.5 Facility Cask Loading Room Equipment

Facility Cask Transfer Car

The facility cask transfer car (FCTC) (Figure 2.5-19), a rail-mounted car weighing approximately 7900 lbs., is powered by a variable speed electric motor which drives two wheels at speeds up to 30 ft. per minute. The FCTC has two A-frame structures, each with a trunnion saddle to support the facility cask weight and transport the facility cask in the stable horizontal position on four 18 in. diameter wheels. It also allows rotating the facility cask on its trunnions to the vertical position by the facility cask rotating device (FCRD). The FCTC has brackets that engage lock pins on the rotating device to prevent movement of the car while the facility cask is being rotated. The FCTC car is designed to perform the following functions:

- Serve as the platform for the facility cask in the FCLR.
- Transport the facility cask from the FCLR to the waste shaft conveyance.
- Serve as the platform for the facility cask while the facility cask is transported underground by the waste shaft conveyance.
- Transport the facility cask from the waste shaft conveyance to an underground area accessible by the 41-ton diesel forklift.

A FCTC position limit switch is provided to stop the car in its load position over the telescoping port shield. The limit switch is an infrared transmitter and receiver mounted on the car that actuates when its transmitted signal is reflected by reflective tape on the floor.

Facility Cask Turntable

The facility cask turntable is a circular platform containing tracks to guide the FCTC to the RH bay or to the waste hoist collar from the FCLR. The turntable is supported by air bearings recessed into the FCLR floor. Compressed air is manually supplied to the turntable. The turntable can be rotated 360 degrees by hand to change the direction of FCTC travel.

Facility Cask Rotating Device

The FCRD, a floor mounted hydraulically operated structure, is designed to rotate the facility cask from the horizontal position to the vertical position for waste canister loading and then back to the horizontal position after the waste canister has been loaded into the facility cask (Figure 2.5-20). The FCRD is equipped with a 40 gallon hydraulic tank and uses hydraulic fluid that has a flash point of 302 degrees F. Hydraulic rams are attached to the center of the connecting beams of two rotating arms. One end of each rotating arm is attached to a pivot point on the floor mounted structure, while the other end latches to a pivot pin on the facility cask top shield valve enclosure. Hydraulic rams extend to rotate the facility cask to the vertical position and retract to rotate the facility cask to the horizontal position.

6.25-Ton Facility Cask Loading Room Grapple Hoist

The 6.25-ton FCLR grapple hoist, mounted to the ceiling of the FCLR, is designed to maintain control of its load during a DBE. The hoist is gear driven by a two speed induction motor for operation at 8 and 24 ft. per minute. The hoist has a position transmitter that sends a position signal to the control console programmable logic controller. A torque monitoring control system is provided to indicate output torque of the motor and to furnish a signal to shut the hoist down if the load is excessive. In the event of a power failure, the 6.25-ton FCLR grapple hoist brakes are automatically set.[17] Figure 2.5-21 shows the 6.25-ton FCLR grapple hoist, the shield bell, and the stationary alignment sheave.

Stationary Alignment Sheave

The stationary alignment sheave, a single cable pulley, is anchored to the FCLR ceiling above the cask loading station. The stationary alignment sheave is used to convert the horizontal travel of the hoist cable to vertical travel of the facility grapple. The cable passes over the pulley and down to the block in the top of the shield bell. The cable then extends back to the ceiling where it is attached to the ceiling anchored tension load cell assembly. This arrangement provides an accurately positioned vertical lift for the facility grapple even though there is a lateral shift of the cable on the hoist drum. A limit switch, also part of the stationary alignment sheave, is mounted on a bracket attached to the pulley housing is used to sense the upper travel limit of the shield bell and prevents the facility grapple from being raised too high.

Facility Cask Loading Room Facility Grapple

The FCLR facility grapple (Figure 2.5-15) is a special lift fixture designed to engage a standard WIPP pintle. The facility grapple has an axially mounted electrically operated actuator that rotates a drive gear that drives three lifting lugs into or out of engagement under the WIPP pintle. In the event of a power failure when the facility grapple is engaged on a lifting pintle, the lifting lugs will automatically lock in place. The grapple is equipped with a proximity switch interlocked with the drive motor that rotates the pivot dogs. The pivot dogs can only rotate when the switch is in contact with a pintle. During lifting, the space between the pintle and the proximity switch prevents the pivot dogs from rotating.

Telescoping Port Shield

The telescoping port shield (Figure 2.5-22) is mounted in the floor of the FCLR, centered directly over the transfer cell ceiling shield valve opening. An electrical motor driven jacking system is used to raise the telescoping port shield to mate with the facility cask lower shield valve housing during RH waste canister transfer. Two shielding contact switches mounted in the face of the facility cask's bottom shield valve housing are actuated when the telescoping port shield is in contact with the shield valve housing. The telescoping port shield must be in contact with the facility cask before the bottom shield valve can be opened. The telescoping port shield has four basic components:

- An upper ring with an outside diameter of 95 in.
- A lower ring which has an outside diameter of 72 in. and suspended from the upper ring
- The motor driven ball screw jacking system which raises and lowers the traveling shield ring
- A traveling shield ring which is 27 in. deep has an outside diameter of 54 in. and an inside diameter of 36 in. through which the waste canister passes.

Limit switches mounted above and under the FCLR floor are actuated by the shield ring and indicate when the telescoping port shield is fully up and fully down. The telescoping port shield provides radiation shielding when the transfer cell ceiling shield valve and the facility cask bottom shield valve are open during transfer of a waste canister into the facility cask.

Shield Bell and Block

The shield bell (Figure 2.5-23) is a heavy walled steel casting that provides radiation shielding from the waste canister when the facility cask top shield valve is open. The shield bell has internal cavities to house the facility grapple and the grapple support block. The facility grapple cavity has a nominal 18.25 in. diameter. The grapple support block cavity is a modified tee-shaped, nominally 6 in. wide, in order to house the single pulley block and provide a path for the facility grapple electrical cable to pass through to the grapple. There are three penetrations with bronze bushings through the top of the shield bell, two for the wire rope that moves the facility grapple, and one for the electrical cable that controls the opening and closing of the facility grapple. When not in use, the shield bell rests on the top of the facility grapple support block which is suspended from the grapple hoist. The shield bell is supported by the facility cask when the facility grapple is in use.

Two shielding contact switches mounted in the face of the facility cask's top shield valve housing are actuated when the shield bell is resting on the facility cask. The shield bell must be in contact with the facility cask before the top shield valve can be opened.

Control Console

The FCLR control console is located within a 24 in. thick concrete wall shadow shield area with a dry shield window in the north side of the FCLR. The floor mounted control console has a programmable logic controller, control switches, indicators, and a TV monitor that displays the transfer cell operations. The operator can perform the following using the FCLR control console:

- Position the transfer cell shuttle car under the telescopic shield port in preparation to removing a waste canister
- Lower the shield bell onto the top of the facility cask
- Raise or lower the shield ring on the telescoping port shield assembly
- Open and close the facility cask top and bottom shield valves
- Raise or lower the facility grapple and open and close the grapple
- Raise or lower the facility cask rotating device
- Select robot modes and initiated robot activation
- Monitor transfer cell activities via CCTV cameras
- Monitor swipe delivery interface with radiation technician
- Open or close the transfer cell ceiling shield valve
- Engage or disengage a waste canister pintle with the FCLR facility grapple

The programmable logic controller calculates the grapple hoist position based on the signal it receives from the hoist position transmitter. Each position corresponds to a physical grapple position as indicated below:

Grapple Position	Location
A	Grapple in its maximum up position
B	Shield bell in contact with the top of facility cask
C	Grapple slightly above pintle of canister in the facility cask or canister is slightly above the facility cask bottom shield valve

D	Canister resting on facility cask bottom shield valve
E	Shield bell resting on top of raised telescoping port shield or canister in position for a side swipe
F	72-B cask inner lid above transfer cell shield valve or canister in position for a side swipe
G	Grapple in contact with 72-B cask inner lid in both the normal and storage positions
H	Grapple in contact with pintle of canister inside 72-B cask or shielded insert
EE	Canister in position for bottom swipe
FF	72-B cask inner lid in position for lid bottom swipe and canister top swipe
GG	Canister in position for top swipe.

Grapple hoist positions are indicated on the digital data display unit on the upper portion of the control panel.

FCLR Shielding Interlocks

The following interlocks are provided to ensure shielding is in place when transferring a waste canister from the transfer cell into the facility cask in the FCLR:

- The upper shield valve on the facility cask cannot be opened unless the shield bell is in contact with the upper part of the facility cask.
- The transfer cell ceiling shield valve cannot be opened unless the telescoping port shield is in the raised position and the facility cask lower shield valve is closed if the cask is present. If the cask is not present the transfer cell ceiling shield valve cannot be opened unless the grapple is at position E or F.
- The facility cask lower shield valve cannot be opened unless the grapple hoist is at position D inside the facility cask and the transfer cell ceiling shield valve is opened
- The grapple hoist cannot be raised when loaded with a RH WASTE canister at position F unless the facility cask is vertical and the telescoping port shield is raised.
- The facility cask rotating device cannot rotate the facility cask from vertical to horizontal unless the grapple hoist is in the highest position and the telescoping port shield is retracted.
- The facility cask transfer car cannot move away from the facility cask rotating device unless the facility cask rotating device latches are retracted, the FCRD lock pins are retracted, and the FCRD is in the full down position (facility cask horizontal).

2.5.4.6 Underground Equipment

The underground handling and emplacement equipment consists of diesel-powered forklifts and the HERE. Since the RH waste handling equipment is the largest equipment transporting waste in the waste disposal area, its size is used to define the minimum operating sized opening of 11 ft. vertical and 14 ft. horizontal for waste handling transport.

Horizontal Emplacement and Retrieval Equipment

The HERE is used in the underground to transfer a RH waste canister from the facility cask into a horizontal disposal borehole. The HERE includes the following equipment:

Waste Transfer Equipment		Borehole Related Components
• Alignment fixture	• Portable power cable	• Shield plug
• Shield collar	• Control console	• Shield plug carriage
• Leveling platform	• Transfer carriage	• Shield plug rings
• Staging platform	• Transport equipment	
• Facility cask		

Alignment Fixture

The alignment fixture (Figure 2.5-24) provides a reference plane for aligning the waste transfer machine with respect to the borehole to allow waste canister and shield plug installation. It is a welded carbon steel structure consisting of a base plate with three hydraulic jacks and a vertical face plate with holes for attaching and bolting the shield collar. It has two forklift pockets to facilitate its moving. The horizontal base of the fixture serves to support the front end of the waste transfer machine. It has two alignment pins located to ensure that the waste transfer machine and shield collar line-up.

The three hydraulic jacks are used to align the alignment fixture with the borehole. The hydraulic system is powered by a hydraulic pump with a custom built 30 gallon hydraulic tank located on the alignment fixture assembly. Each of the jacks have a maximum stroke of 10 in. The alignment fixture has three tilt sensors and three proximity switches. The tilt sensors provide tilt information to permit the operator to level the alignment fixture. The proximity switches sense the gap between the shield collar and the facility cask.

The alignment fixture has four hydraulic locking clamps, rated at 3,600 psi, to rotate and lock the shield collar to the facility cask. The locking clamps are controlled by a selector switch located on the control console. The alignment fixture also has a passive fire suppression system with four discharge nozzles aimed at the hydraulic power unit and the leveling jacks. The interlocks between the HERE transfer mechanism, facility cask, and alignment fixture/shield collar are interlocked as follows:

- The front shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism must detect the facility cask.
- The rear shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism must detect the facility cask.
- The facility cask shield valves cannot be closed if the HERE transfer mechanism is extended beyond either shield valve.

Shield Collar

The shield collar, shown in Figure 2.5-24, is a carbon steel shield device used when emplacing a waste canister and shield plug into a borehole. It is attached to the alignment fixture and inserted into the counterbore in the borehole to provide shielding during emplacement operations.

The shield collar is 29 in. long with an outside diameter of 44 in. and a 7 in. wall thickness. A one inch thick, 62 in. diameter mounting ring is welded to the outside of the collar. The mounting ring has twelve holes to bolt the shield collar to the alignment fixture. The shield collar weighs approximately 6,800 lb. The shield collar is functionally classified as SS because of the shielding it provides during transfer of a waste canister from the facility cask to the disposal borehole.

Leveling Platform

The leveling platform is a steel frame approximately 300 in. long, 113 in. wide, and 24 in. high where the components to operate and interface with the alignment fixture and staging platform are located (Figure 2.5-24).

The front end of the leveling platform has two holes that sit on the alignment fixture alignment pins. A motor driven hydraulic pump operates a hydraulic jack, which is located at the rear of the leveling platform. The jack is used to align the waste transfer machine, consisting of the leveling platform, staging platform, and transfer carriage axis with the axis of alignment fixture shield collar.

Three sets of rails are mounted on each side of the leveling platform. The rails support the staging platform and interface with roller bearings on the staging platform to permit the staging platform to travel on the rails. A staging platform drive system is mounted on the leveling platform. The drive system moves the staging platform in the forward and reverse direction to position the front face of the facility cask against the shield collar. The drive system motor positions the facility cask against the shield collar at a speed of approximately 6.7. in. per minute.

Staging Platform

The staging platform is a steel frame 288.5 in. long that rests on roller bearings which engage and ride on the rails of the leveling platform. The staging platform supports the facility cask and transfer carriage, and has a hydraulic ram providing linear motion to the transfer carriage. The transfer carriage rides on two 123.5 in. long rails bolted to the top of both sides of staging platform. The staging platform requires a regulated compressed air supply to operate the facility cask lock pins. Figure 2.5-24 shows the staging platform.

The following control devices are mounted on the staging platform: a tilt sensor used to monitor the longitudinal tilt of the waste transfer machine for alignment with the alignment fixture, a rotary limit switch used to stop the transfer carriage forward and reverse travel motion before the travel limits have been reached, and a two position detection limit switch is activated when the shield plug carriage is seated on the staging platform rails.

Transfer Carriage

The transfer carriage (Figure 2.5-24) is a large steel cylinder with its own hydraulic system that is used to push either the waste canister from the facility cask into the borehole or the shield plug from the shield plug carriage into the borehole.

The rear end of the transfer carriage houses the transfer mechanism and includes heavy wall shielding to prevent exceeding radiation dose rate limits when the facility cask top shield valve is opened. The transfer carriage housing is a steel cylinder approximately 91.25 in. long with an inside diameter of approximately 30 in. The hydraulic drive system components which operate the transfer mechanism are mounted in or on the transfer carriage housing. The transfer mechanism is used to emplace waste canister and shield plug into the borehole.

The transfer carriage has roller bearings which ride on the staging platform rails. The staging platform based drive system moves the transfer carriage forward and reverse to emplace a waste canister. The transfer carriage is positioned with the front of the housing against the facility cask during waste canister emplacement. During shield plug emplacement, the transfer carriage is retracted to provide room for installing the shield plug carriage on the staging platform.

The transfer mechanism consists of a double acting five stage, telescopic, hydraulic cylinder attached at the plunger end of the transfer carriage housing end plate. The front end of the cylinder is supported by two rollers attached to a 2.75 in. thick steel plate which provides shielding and supports the transfer mechanism grapple. The transfer mechanism grapple is similar to the facility grapples used with the upper hot cell crane and in the FCLR, except the grapple is not closed when emplacing either the RH waste canister or the shield plug into the bore hole. Two grapple mounted proximity detection switches detect when the grapple comes in contact with the pintle of the waste canister or shield plug. Two position limit switches indicate when the two grapple jaws are open or closed. The drive motor is stopped when the limit switches reach the open or closed limits. The hydraulic cylinder has a 10,000 lbs. minimum load capacity, a 24 ft. stroke, and a retracted length of 70 in. If a power failure occurs, manual means are provided to retract the transfer mechanism from a partial or fully extended position and to release the grapple if closed.

The transfer carriage is equipped with four locking clamps to clamp the carriage to both the facility cask and shield plug carriage. Two spring-loaded reel type mechanisms attached to multi-turn rotary potentiometers to monitor the linear travel distance of the transfer carriage for position indication. Three proximity metal detecting position switches activate and indicate when the transfer carriage is within 0.50 in. of the facility cask to stop the carriage drive.

Shield Plug Carriage

The shield plug carriage (Figure 2.5-25) is approximately 74 in. long. It holds the shield plug in a horizontal position during emplacement and aligns the bottom of the shield plug with the bottom of the facility cask cavity. The shield plug carriage is placed on and supported by the rails of the staging platform which also supports the transfer carriage. The shield plug carriage has two forklift pads to facilitate handling by a forklift and has four roller bearing supports that ride on the staging platform rails.

Control Console

The control console for the HERE provides all the controls and information displays necessary to operate the waste transfer equipment. The console is mounted on a moveable platform truck to facilitate relocation. The console can be located at a sufficient distance from the HERE to ensure radiation doses to the console operator are kept as low as reasonably achievable.

Each step in the operational sequence is initiated or controlled by the operator through a programmable controller mounted within the control console. The programmable controller incorporates the interlock functions to ensure proper sequence of operations.

Portable Power Cable

The portable power cable is used to electrically connect the HERE to a 480 volt, 3 phase, 60 Hz power source.

Transport Equipment

The transport equipment consists of wheel assemblies that convert the leveling platform to a trailer-like configuration used to move the waste transfer machine assembly from one location to another. The assembly can be towed by a forklift or tractor.

Borehole Shield Plugs

The shield plug is inserted into the borehole after emplacement of the waste canister. It provides shielding for the exposed end of the borehole. The shield plug is a cylinder approximately 69 in. long with a 29 in. diameter is made of concrete shielding material inside a 0.24 in. thick steel shell with a removable pintle at one end. The shield plug is inserted with the pintle end closest to the HERE. Each shield plug has integral forklift pockets and weighs approximately 3,900 lbs.

Steel shielding rings can be used with canisters having a surface dose rate of more than 85 R/hr for radiological control purposes. When used, shielding rings are installed after the shield plug to cover the gap between the shield plug and borehole walls. The rings are made from 0.25 or 0.125 in. thick carbon steel plate and are configured with an opening in the center that fits over a shield plug center assembly. Areas of the shielding rings that do not contribute to the shielding function have cut outs to minimize weight to allow operators to install them quickly.

Shield plugs are transported by a forklift using either the shield plug carriage or the forklift pockets provided in the shield plugs. Figure 2.5-26 shows the waste canister and shield plug inside a disposal borehole.

41-Ton Diesel Forklift

The 41-ton diesel forklift has a lift capacity of 82,000 lbs. and a maximum lift height of 99 in. The forklift is provided with a two range (high or low) travel selector, but does not have a speed indicator. It is used to lift the facility cask from the facility cask transfer car and transport it at a speed of approximately 3 to 4 miles per hour to the active RH waste emplacement room and to place it on the waste transfer machine assembly. It is also used to transport the waste transfer machine assembly. The forklift has a 50 gallon diesel fuel tank and a 125 gallon hydraulic fluid tank. The forklift is equipped with an automatic/manual fire suppression system and has a portable fire extinguisher. The hydraulic fluid is a water/glycol based fluid that will not flash or support combustion.

20-Ton Diesel Forklift

The 20-ton diesel forklift has a lift capacity of 40,000 lbs. and a maximum lift height of 84 in. The forklift has a 50 gallon diesel fuel tank and a 64 gallon hydraulic fluid tank It is used to lift and handle the alignment fixture assembly consisting of the alignment fixture and shield collar. The forklift is equipped with an automatic/manual fire suppression system and has a portable fire extinguisher.

6-Ton Diesel Forklift

The 6-ton diesel forklift has a lift capacity of 12,000 lbs. and a maximum lift height of 72 in. The forklift has a 37 gallon diesel fuel tank and a 24 gallon hydraulic fluid tank It is used to lift and handle the shield plug carriage and the shield plug. The forklift is equipped with an automatic/manual fire suppression system and has a portable fire extinguisher.

2.5.5 RH Waste Handling Process

2.5.5.1 RH Waste Receiving

Upon arrival at the gate of the WIPP, each incoming RH shipping cask shipment is inspected to verify the shipment documentation, perform a security check, and conduct an exterior radiological survey of the shipping cask. If radiation or contamination levels exceed the criteria in WP 12-5, WIPP Radiation Safety Manual,[30] subsequent activities include posting or decontamination or both. If the shipping cask has visible external damage, the waste handling process will likely proceed and the shipping cask will be subsequently repaired.

Following turnover of the shipping documentation, the driver transports and parks the trailer in the parking area for RH shipping cask trailers near the RH entrance to the WHB. The driver unhooks the tractor and is subsequently released. The number of loaded RH trailers in the parking area will be coordinated with CH waste handling to not exceed parking area limits established in the Hazardous Waste Facility Permit.[12] Typically there will be 14 or fewer loaded RH trailers in the parking area. Two types of trailers may be used to ship the 72-B shipping cask, one in which the cask is rotated from horizontal to vertical using an overhead crane and one that uses hydraulics to rotate the 72-B cask. The 10-160B shipping cask does not require rotation to remove it from its trailer. Either type of trailer is positioned in the RH bay of the WHB using a trailer jockey or the transport tractor.

2.5.5.2 72-B RH Waste Handling Process

2.5.5.2.1 Cask Preparation

When space becomes available, a trailer with a loaded 72-B shipping cask attached to transport or a facility tractor is brought into the RH bay. Due to space limitations, only two loaded shipping casks are administratively allowed in the RH bay at a time. After the trailer is spotted inside the RH bay, operators use a motorized man lift work platform to unbolt the two impact limiters from the shipping cask while the cask is still on the trailer. The 140/25-ton overhead bridge crane is used to lift the impact limiters and place them on support stands. The 72-B cask lifting yoke is connected to the 140/25-ton overhead bridge crane. The cask lifting yoke engages the handling trunnions of the 72-B shipping cask, rotates the cask to the vertical position, and then lifts the cask clear of the trailer as sets it on the 72-B RCTC. If the 72-B shipping cask arrives on a trailer provided with hydraulics to rotate the cask, the cask is rotated after the impact limiters are remove. The cask is removed from the trailer using the cask lifting yoke. The A-frame of the 72-B RCTC supports the shipping cask at the transporter trunnions. The 72-B shipping cask is then moved to the cask preparation station in the RH bay. From this point in the process, the 72-B RH waste handling process is controlled by procedure WP 05-WH1710, 72-B RH Processing,[31] and associated operating procedures. The cask preparation station, which straddles the 72-B RCTC rails, allows personnel to have access to the top area of the shipping cask for conducting radiological surveys, performing physical inspections or minor maintenance, cask unloading preparation activities, and performing decontamination, if necessary.

After surveys for surface contamination and radiation levels are performed, the test port tool, with a radiological assessment filter and an industrial grade HEPA roughing filter attached, and vent adapter is installed on the OC lid gas sampling port. The OC lid gas sampling port is opened, using the test port tool, venting the atmosphere between the inner (IC) lid and OC lid through the HEPA roughing filters. The radiological assessment filter is checked for radioactive contamination. The test port tool and vent adapter are removed from OC lid sampling port and the OC lid is unbolted, using the OC lid bolt detensioner, and lifted to allow the underside of the OC lid and top of the IV lid to be surveyed for contamination. The 72-B cask outer lid lift fixture is attached to the OC lid using the 2.5-ton jib crane at the cask preparation station. The OC lid is lifted by the jib crane from the 72-B cask and placed on its storage stand. The test port tool and vent adapter is installed on the IV lid gas sampling port. The IV lid gas sampling port is opened venting the shipping cask cavity atmosphere through the assessment filter and the HEPA roughing filters. The radiological assessment filter is checked for radioactive contamination. The test port tool and vent adapter are removed from IV lid sampling port The inner lid vent is opened to equalize the pressure between the shipping cask cavity and atmosphere. Then the inner lid pintle is attached to the inner lid. The pintle is used as a lift fixture for the inner lid and interfaces with the facility grapple used to ultimately transfer a waste canister into the facility cask.

2.5.5.2.2 Cask Unloading Room

The 72-B shipping cask is moved from the cask preparation station into the CUR. The CUR 25-ton crane with the 72-B cask lift fixture engages the two opposing lifting trunnions of the cask. The 25-ton crane lifts the cask from the 72-B RCTC and positions it over the CUR shield valve. Interlocks require the CUR 25-ton crane to be positioned over the floor shield valve, the transfer cell shuttle car cask receiver in the transfer cell to be positioned under the floor shield valve (position W), the transfer cell ceiling shield valve to be closed, the upper hot cell shield valve to be closed, and the upper hot cell floor shield plugs installed before the CUR floor shield valve can be opened. When all interlocks are satisfied, the floor shield valve is opened. The process is reversed when a 72-B shipping cask is removed from the transfer cell.

Ventilation flow is from the CUR to the transfer cell to provide confinement and protect the workers in the case of an off-normal event.

2.5.5.2.3 Transfer Cell

The loaded 72-B shipping cask is lowered through the open CUR floor shield valve port into the transfer cell and into the shuttle car road cask receiver. The design of the transfer cell shuttle car road cask receiver prevents lateral movement once it is inside the receiver. Vertical movement is prevented by the weight of the cask itself. The 72-B cask lift fixture is disengaged from the lifting trunnions. CCTV cameras and load cells on the lift fixture are used to verify lift fixture disengagement. The CUR 25-ton crane lift fixture is lifted into the CUR. When the open port of the CUR floor shield valve is clear and the hook is at the high limit position, the floor shield valve is closed.

The transfer cell shuttle car is designed to transfer the 72-B cask and shielded insert from below the CUR floor shield valve to programmed work stations in the transfer cell. Remote controlled CCTV cameras are used to monitor waste handling operations in the transfer cell.

The transfer cell shuttle car is moved and positions the 72-B cask next to the robotic inner lid bolt detensioner (position X). The detensioner loosens the IV lid retaining bolts, which are spring loaded so that they remain in the lid. The transfer cell shuttle car then positions the 72-B cask directly below the transfer cell ceiling shield valve (position Y1).

2.5.5.2.4 Facility Cask Loading Room

In the FCLR, the empty facility cask on the FCTC, has been positioned over the port to the transfer cell. The FCLR doors are closed. The facility cask is rotated to the vertical position by the FCRD to align it with the port to the transfer cell, the transfer cell ceiling shield valve, and the telescoping port shield.

When the facility cask has been rotated to the vertical position, the telescoping port shield, mounted in the floor of the FCLR, is raised to mate with the facility cask bottom shield valve body. The 6.25-ton FCLR grapple hoist is lowered so that the shield bell is in contact with the facility cask top shield valve body. With the shield bell and the telescoping port shield in contact with the facility cask, a totally shielded volume is formed to allow the safe transfer of a RH waste canister from the 72-B cask into the facility cask.

The top facility cask shield valve is opened, the transfer cell ceiling shield valve is opened, then the bottom facility cask shield valve is opened and the facility grapple, attached to the 6.25-ton FCLR grapple hoist, is lowered through the facility cask into the transfer cell. The transfer cell ceiling shield valve and both facility cask shield valves are interlocked so that the facility cask bottom shield valve cannot be opened unless the transfer cell ceiling shield valve is opened. The transfer cell ceiling shield valve cannot be closed unless the facility cask bottom shield valve is closed. The facility grapple engages the inner lid pintle and lifts the inner lid clear of the 72-B cask. When the lid is clear of the cask, radiological contamination swipes are taken robotically and transferred through the swipe delivery system to the service room for analysis. The lid is lifted above the transfer cell ceiling shield valve, the shield valve is closed, and the transfer cell shuttle car repositioned so that the inner lid storage platform is aligned under the transfer cell ceiling shield valve (position Y2). The transfer cell ceiling shield valve is opened and the facility grapple positions the inner lid on its storage platform and releases the pintle. The facility grapple is lifted so that the transfer cell ceiling shield valve can be closed. The transfer cell shuttle car is then positioned so that the 72-B cask is in alignment with the transfer cell ceiling shield valve (position Y1) and a radiological smear is taken of the canister pintle. After the contamination check, the facility grapple is lowered until it engages the pintle of the waste canister.

As the waste canister is lifted from the 72-B shipping cask and before it passes through the transfer cell ceiling shield valve, radiological contamination swipes on the waste canister are taken robotically and transferred through the swipe delivery system to the service room for analysis. Also the waste canister identification is observed by CCTV cameras and verified against the hazardous waste manifest and the WIPP Waste Information System (WWIS). During the lift, the CCTV cameras provide a visual inspection to verify the mechanical integrity of the waste canister.

If any discrepancy in a waste canister's identity, integrity, or radiological surveys is detected, the waste canister will be re-inserted inside the shipping cask and the inner lid placed on the shipping cask. When the surveys have been satisfactorily completed and identification verified, the transfer cell shuttle car will position the shipping cask under the FCLR transfer path opening in the ceiling of the transfer cell and the canister will then be lifted inside the facility cask. The bottom shield valve of the facility cask is closed, the transfer cell ceiling shield valve is closed, and the facility grapple lowers the waste canister so that it is resting on the gate of the bottom shield valve. When the waste canister is cleared for disposal, the facility grapple disengages from the waste canister pintle and is lifted into the shield bell, then the facility cask top shield valve is closed. The shield bell is then lifted away from the facility cask and the telescoping port shield is lowered. The facility cask is rotated to the horizontal position. The facility cask is ready to be loaded onto the waste shaft conveyance.

Two sets of doors are provided in the FCLR, one set separates the room from the RH bay and the other set separates the room from the waste shaft collar. The doors are interlocked such that only one set may be opened at a time. Prior to moving a loaded facility cask to the waste shaft conveyance the waste shaft entry room doors must be opened.

Go to Section 2.5.5.4 for completion of the 72-B emplacement process.

2.5.5.3 10-160B RH Waste Handling Process

2.5.5.3.1 Cask Preparation

A loaded 10-160B shipping cask is brought into the RH bay. After the trailer is spotted inside the RH bay, operators, using a motorized man lift as a work platform, remove the top impact limiter from the shipping cask while still on the trailer. The 140/25-ton overhead bridge crane is used to lift the impact limiter and place it at a designated location. Operators install the lifting lugs on the sides of the shipping cask. The 140/25-ton overhead bridge crane is used to lift the 10-160B shipping cask from the trailer by engaging the lifting lugs and place it on the 10-160B RCTC. From this point in the process, the 10-160B waste handling process is controlled by procedure WP 05-WH1722, 10-160B RH Processing,[32] and associated operating procedures. The vent port cap, located on the shipping cask lid is removed and the vent fixture with an integral radiological assessment filter and HEPA filter is placed over the vent port plug secured in place using electro-magnets. The vent port plug is removed with the vent port tool and a sample of the shipping cask atmosphere is pulled through assessment filter using a vacuum pump integral to the vent tool controls. The assessment filter is analyzed for any contamination. Contamination smear of the following areas is performed, vent port plug, vent port plug tools and the surface area inside vent fixture. The filter will be surveyed for contamination after the pressure is equalized and before the 10-160B waste handling process starts. Operations then removes the cask lid bolts. The 10-160B cask lid lift fixture with an integral pintle is attached to the cask lid. The lid lift fixture is installed by using either the 140/25-ton overhead bridge crane or the cask preparation station jib crane.

2.5.5.3.2 Cask Unloading Room

Two activities occur in the CUR related to the 10-160B process. The activities are independent of one another and cannot occur at the same time. One activity positions the 10-160B cask in the CUR so that the drums can be transferred to the upper hot cell. The other activity involves the positioning of the shielded insert into the transfer cell shuttle car to eventually receive a loaded facility canister from the upper hot cell. Placement of the shielded insert into the transfer cell shuttle car requires that the 72-B cask has been removed from the transfer cell.

The transfer car transports the 10-160B cask to the CUR and positions it under the upper hot cell floor shield plugs. Waste Handling personnel leave the CUR and close the shield door. Interlocks require the CUR shield door and floor shield valve and the upper hot cell shield valve to be closed before the upper hot cell shield plugs can be removed. When all interlocks are satisfied, the shield plugs are removed.

When a loaded facility canister is ready for processing out of the upper hot cell, a shielded insert (used to transport a facility canister in the transfer cell) will be positioned inside the CUR using the 72-B RCTC. The interlocks for the CUR floor shield valve function in same manner as the 72-B cask processing. The CUR 25-ton crane will be used to lower the shielded insert into the transfer cell shuttle car cask receiver.

2.5.5.3.3 Upper Hot Cell

Re-packaging of the RH waste drums shipped in the 10-160B cask occurs in the upper hot cell. Access is restricted to the upper hot cell when drums or canisters of RH waste are present. Any reentry after RH waste handling requires a radiological survey of the upper hot cell area. The upper hot cell equipment including the upper hot cell crane and its attachments, the overhead powered manipulator and attachments, master-slave manipulators and CCTV system are used for waste handling operations inside the upper hot cell.

Operators in the operating gallery use the upper hot cell crane and the upper hot cell shield plug lift fixtures, while monitoring the CCTVs, to remove the upper hot cell shield plugs and set them aside in the upper hot cell. The crane with a facility grapple is lowered into the CUR and engages the lid lifting fixture pintle on the 10-160B cask lid. The cask lid is raised into the upper hot cell where radiological contamination surveys are performed on its inside surfaces before it is set aside. The facility grapple on the upper hot cell crane engages the pintle on the 10-160B drum carriage lift fixture and lowers it into the CUR where it engages the lifting elements of the upper drum carriage unit. The crane raises the drum carriage unit into the upper hot cell and moves it to the inspection station. At the inspection station radiological contamination swipes on the drums and carriage are taken. The swipes are placed in the upper hot cell transfer drawer and transferred into the transfer drawer enclosure in the operating gallery for radiological counting. While waiting for radiological counting results, the identification of each drum is verified and compared against the hazardous waste manifest and the WWIS. Once the identification of each of the five drums is verified and all are determined to be free of contamination, the carriage is placed at the designated storage location on the upper hot cell floor. The process is repeated for the second drum carriage unit. If any discrepancy in a waste drum’s identity or radiological survey is detected, carriages will be re-inserted into the 10-160B cask and 10-160B cask unloading process will be reversed. If any empty drum carriage units are in the upper hot cell, a maximum of two will be placed into the empty 10-160B cask. The crane picks up the 10-160B cask lid and lowers it into the CUR and places it on the empty 10-160B cask. The upper hot cell shield plugs are re-installed.

Facility canister(s) have been previously staged in the inspection station of the upper hot cell. The inspection station accommodates two canisters. Typically, the location closest to the upper hot cell viewing window will be used. A facility grapple installed on the upper hot cell crane is used to remove the lid of the canister in the inspection station. The bridge mounted overhead powered manipulator or the upper hot cell crane is used to lift a drum from the carriage and place it into an empty facility canister. A CCTV camera is used to monitor the process. This process is repeated two more times until the maximum load of three drums are in a facility canister. The overhead powered manipulator or the upper hot cell crane is used to install and secure the lid to the filled facility canister. The canister is ready to be moved to either the transfer cell or to a storage location until the transfer cell is available to receive a facility canister. This canister loading process is repeated until all drums have been removed from the two carriages.

2.5.5.3.4 Transfer Cell

Remote controlled CCTV cameras are used to monitor waste handling operations in the transfer cell. The transfer cell shuttle car with a shielded insert, similar to but has a larger inside diameter than a 72-B cask, is positioned so that the shielded insert is directly below the upper hot cell shield valve. The upper hot cell shield valve, which is interlocked with the transfer cell ceiling shield valve, the CUR floor shield valve, and the upper hot cell shield plugs in such a manner that it can only be opened when the shield plugs are installed and the transfer cell and CUR shield valves are closed and the detension robot is at its home position. A filled facility canister is position over the upper hot cell shield valve. Once the valve is opened, the facility canister is lowered through the open upper hot cell shield valve port into the shielded insert. The guide tubes ensure that a facility canister is properly positioned during the lowering process. The upper hot cell crane facility grapple is disengaged from the facility canister pintle and lifted back inside the upper hot cell. CCTV cameras and load cells on the crane are used to verify disengagement. When the open port of the upper hot cell shield valve is clear and the hoist is at its pre-set high limit, the shield valve is closed. The transfer cell shuttle car transfers one facility canister in a shielded insert at a time from below the upper hot cell shield valve to below the transfer cell ceiling shield valve.

2.5.5.3.5 Facility Cask Loading Room

The processing of a facility canister is the same as processing a 72-B waste canister with the following exceptions: the shielded insert does not have an inner lid to remove, identity verification is not performed on a facility canister because it will have already been performed in the upper hot cell, and a facility canister does not have to undergo radiological surveying because it was previously completed in the upper hot cell.

2.5.5.4 Waste Shaft Entry Room

Rails are provided on the waste shaft conveyance to receive the RH FCTC. Pivot rails are provided at the waste shaft collar and rotate horizontally into place when loading the waste shaft conveyance. The pivot rails are rotated vertically when not in use. The pivot rails are interlocked such that the waste shaft conveyance cannot be moved until the pivot rails are out of the way. Fencing with gates are located at the shaft collar and the waste shaft station to prevent inadvertent access to the shaft. The gates are interlocked such that the conveyance cannot move with a gate open, and if the conveyance is in motion when a gate is opened, the emergency stop is actuated.

In the waste shaft entry room with the waste shaft conveyance properly positioned, the shaft station gates are opened, the pivot rails are positioned, and the FCTC transports the facility cask onto the waste shaft conveyance. The FCLR shield doors are closed. The waste shaft conveyance is lowered to the disposal horizon. The FCTC moves the facility cask from the waste shaft conveyance into the underground transfer area as shown in Figure 2.5-28.

2.5.5.5 Waste Shaft Station

When the waste shaft conveyance has stopped at the disposal horizon, the shaft station gates are opened, the pivot rails are positioned, power cable connected, and the FCTC moves from the waste shaft conveyance (Figure 2.5-28) into the East 140 transfer area. The 41-ton diesel forklift positions its tines so that they are inserted into the lower set of forklift pockets of the facility cask and lifts the facility cask from the FCTC. The 41-ton forklift transports the facility cask to the disposal location at a speed of approximately 3 to 4 miles per hour.

2.5.5.6 Underground RH Waste Disposal Process

At the RH waste disposal location, the 41-ton diesel forklift places the facility cask on the waste transfer machine, which will have been previously aligned with the horizontal borehole. The facility cask is moved forward to mate with the shield collar and the transfer carriage is advanced to mate with the rear facility cask shield valve. Both facility cask shield valves are opened and the transfer mechanism extends to push the canister into the borehole (Figure 2.5-29). After retracting the transfer mechanism into the facility cask, the forward shield valve is closed, and the transfer mechanism is further retracted into its housing. A forklift positions a shield plug on the shield plug carriage. The transfer carriage is retracted about 6.5 ft and a 6-ton diesel forklift places the shield plug carriage on the staging platform. The transfer mechanism pushes the shield plug into the facility cask. The front shield valve is opened and the shield plug is pushed into the borehole (Figure 2.5-30).

The transfer mechanism is retracted, the facility cask shield valves are closed, the transfer carriage retracted, and the facility cask removed from the emplacement machine. The emplacement machine is now available for transfer to another location.

When combined CH and RH operations take place in a panel, RH emplacement boreholes are typically drilled into the ribs of rooms in advance of disposal operations. A ventilation control point consisting of a bulkhead with a ventilation regulator is also installed in each room. The ventilation control point may also include man doors or vehicle doors. For CH waste emplacement the ventilation control point is typically installed on the exhaust side room. The ventilation control point may be located as necessary to allow RH equipment or RH waste movement to access boreholes in intake and exhaust portions of a room. Typically RH waste emplacement preceeds CH waste emplacement to preclude CH waste from blocking RH borehole access.

CH waste emplacement starts at the exhaust side of an active disposal room and proceeds through the room to the intake. The sequence of RH emplacement varies in order to minimize RH equipment moves due to its size. When the room is full, brattice cloth and chainlink barricades are installed to isolate a filled room from the ventilation system. This process is repeated for the remaining rooms until the panel is filled

When a panel is filled, the panel closure system or substantial and isolation barriers are constructed in the entries to the filled panels. Based on previous panels to-date, it is anticipated it will take approximately 2 to 2.5 years to complete waste emplacement in a panel. Panel closure, in accordance with the Closure Plan in the HWFP[12], is typically completed within 180 days from the last waste emplacement in a panel.

2.5.6 Process Interruptions

The RH waste handling process interruptions fall into two categories, routine and emergency/abnormal.

2.5.6.1 Routine Interruptions

Routine process interruptions include scheduled maintenance, unscheduled maintenance, and plant inspections. Actions taken during routine process interruptions are conducted in accordance with established procedures. Plant parameters are monitored to ensure that radiological or hazardous material releases do not occur.

2.5.6.2 Emergency/Abnormal Interruptions

Emergency interruptions are those process interruptions due to operational accidents, man-made external events, or natural events that include earthquakes, severe weather, and fires.

Normal plant operations may be suspended following an earthquake. If the earthquake is of sufficient magnitude (i.e., seismic event of 0.015 g or greater acceleration), inspection of structures and equipment is required prior to resuming normal operations. The length of the interruption will depend upon the results of the inspection.

Normal plant operations may be suspended during a tornado or a high wind condition warning. A tornado or high wind condition warning is based on information provided by the National Weather Service or local observation. If a severe weather emergency condition occurs at the WIPP site, inspections of structures and equipment may be required prior to resuming normal operations. The length of the interruption depends on the results of the inspection.

Normal plant operations may be suspended in the event of a fire. The occurrence of a fire may require evacuation of personnel and response by appropriate emergency personnel. After extinguishing the fire, the area will be surveyed, controls will be established to mitigate any problems, and the area returned to normal operations.

Abnormal interruptions include unplanned and unexpected change in a process condition or variable adversely affecting safety, security, environment, or health sufficient to require stopping waste handling or putting waste handling on hold for greater than four hours.

In the event of abnormal interruptions, waste handling or any other site activity is stopped and placed in a safe condition. For example, the loss of off-site power affects all site electrical equipment. Any suspended load is maintained as-is until power is returned. When power returns, loads are lowered. All cranes and hoists hold their loads on loss of power. A manually started backup power supply diesel supplies selected loads as described in Section 2.8.1.2. Some equipment has uninterruptible or battery backup for loss of power such as the central monitoring system (CMS) and the underground CAMs.

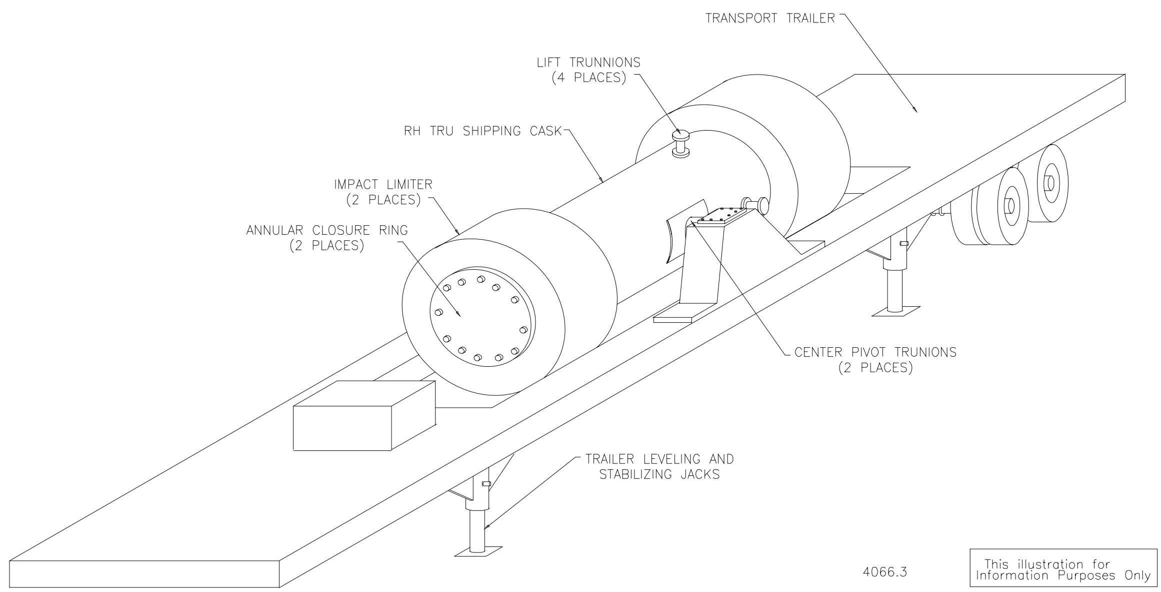

Figure 2.5-1, RH 72-B Shipping Cask on Trailer

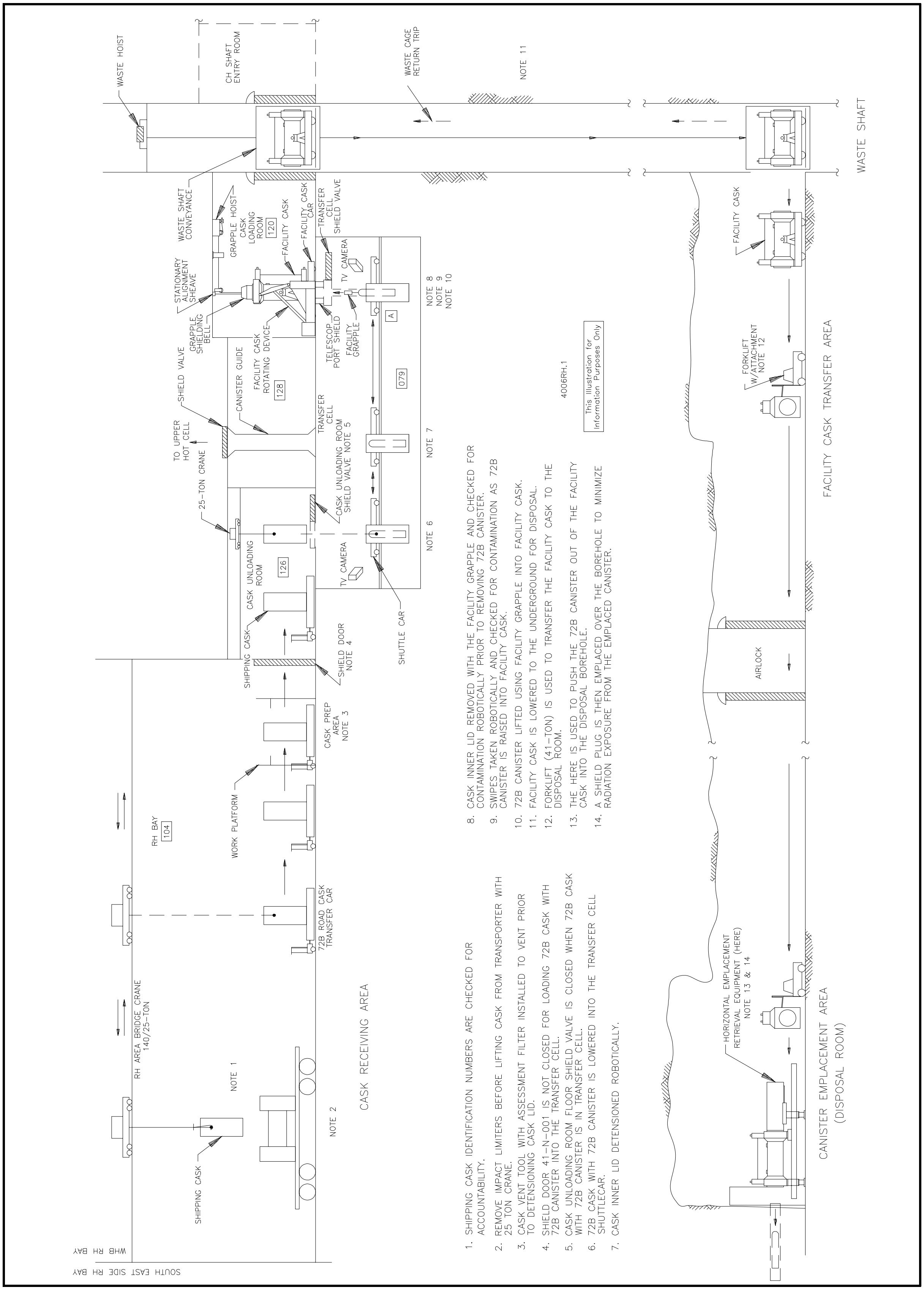

Figure 2.5-2, 72-B RH Waste Handling Process

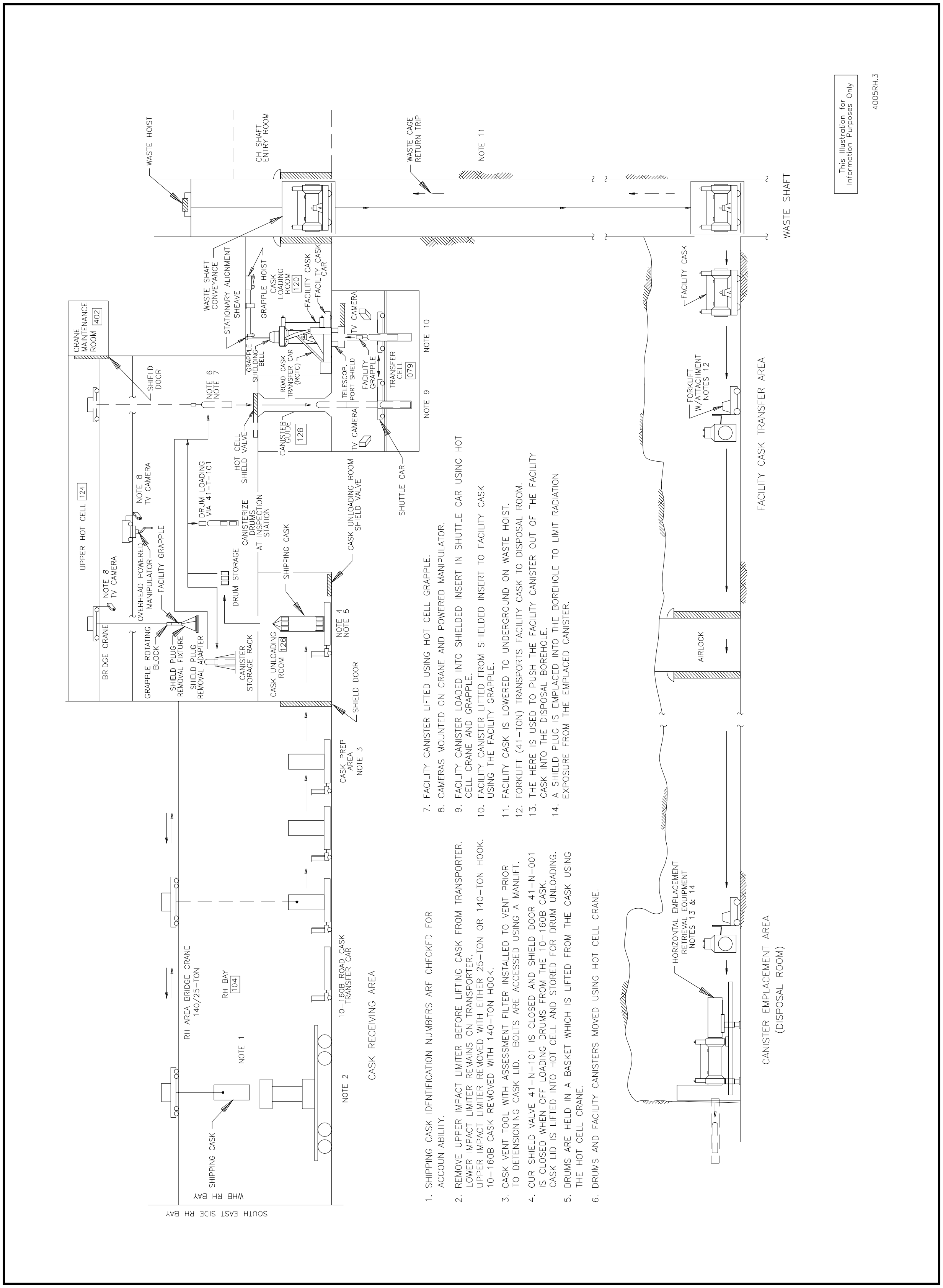

Figure 2.5-3, 10-160B RH Waste Handling Process

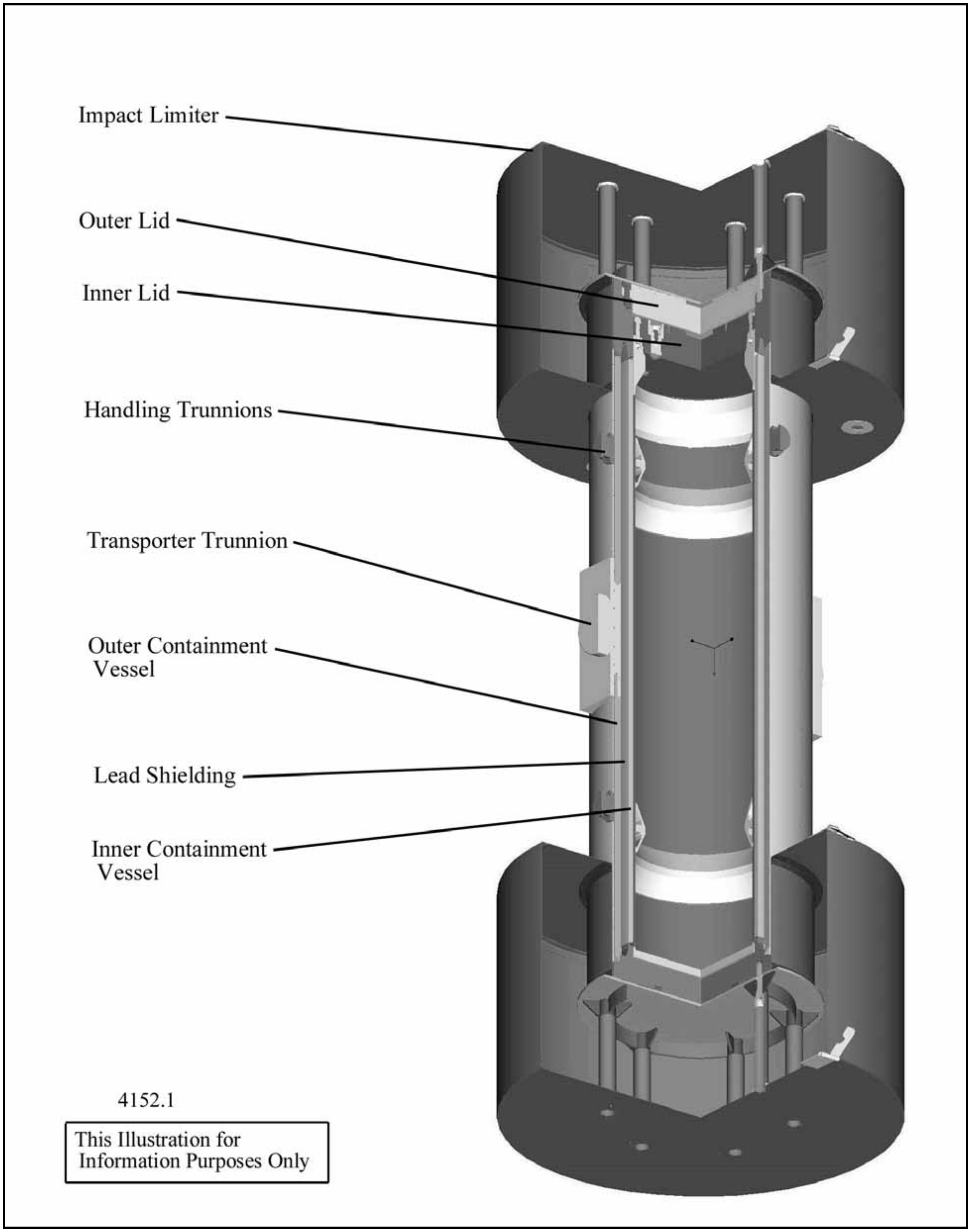

Figure 2.5-4, RH 72-B Shipping Cask

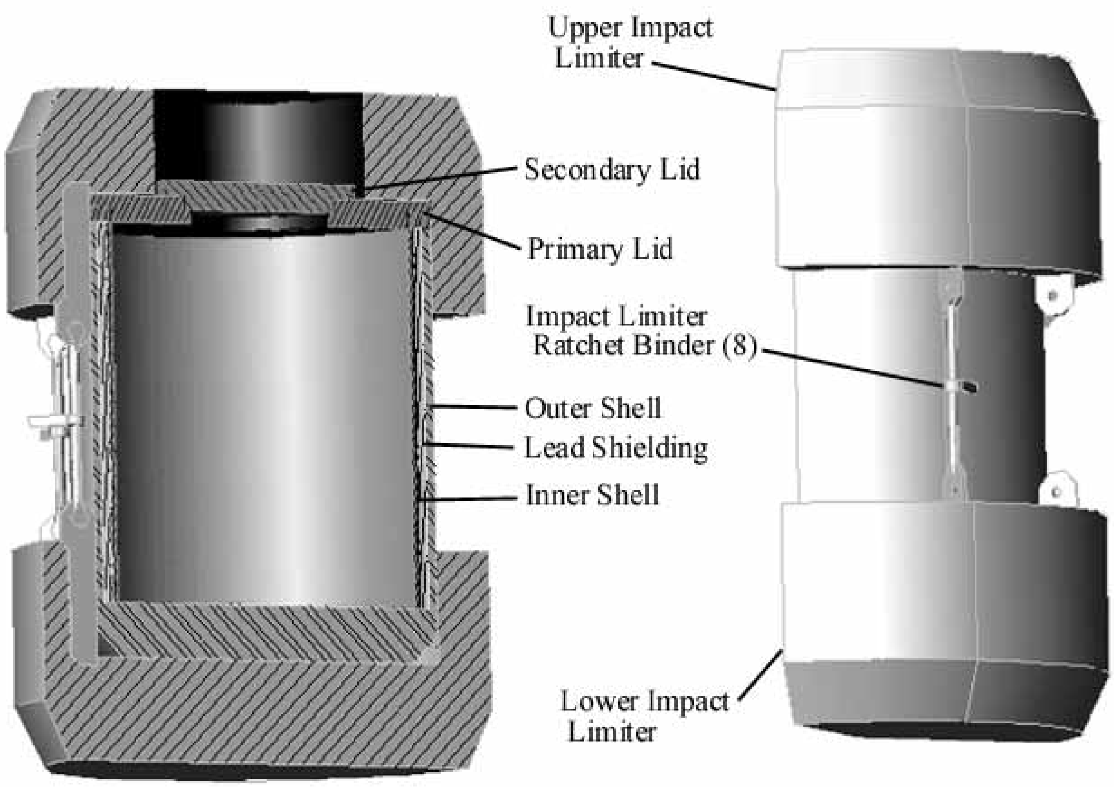

Figure 2.5-5, RH 10-160B Shipping Cask

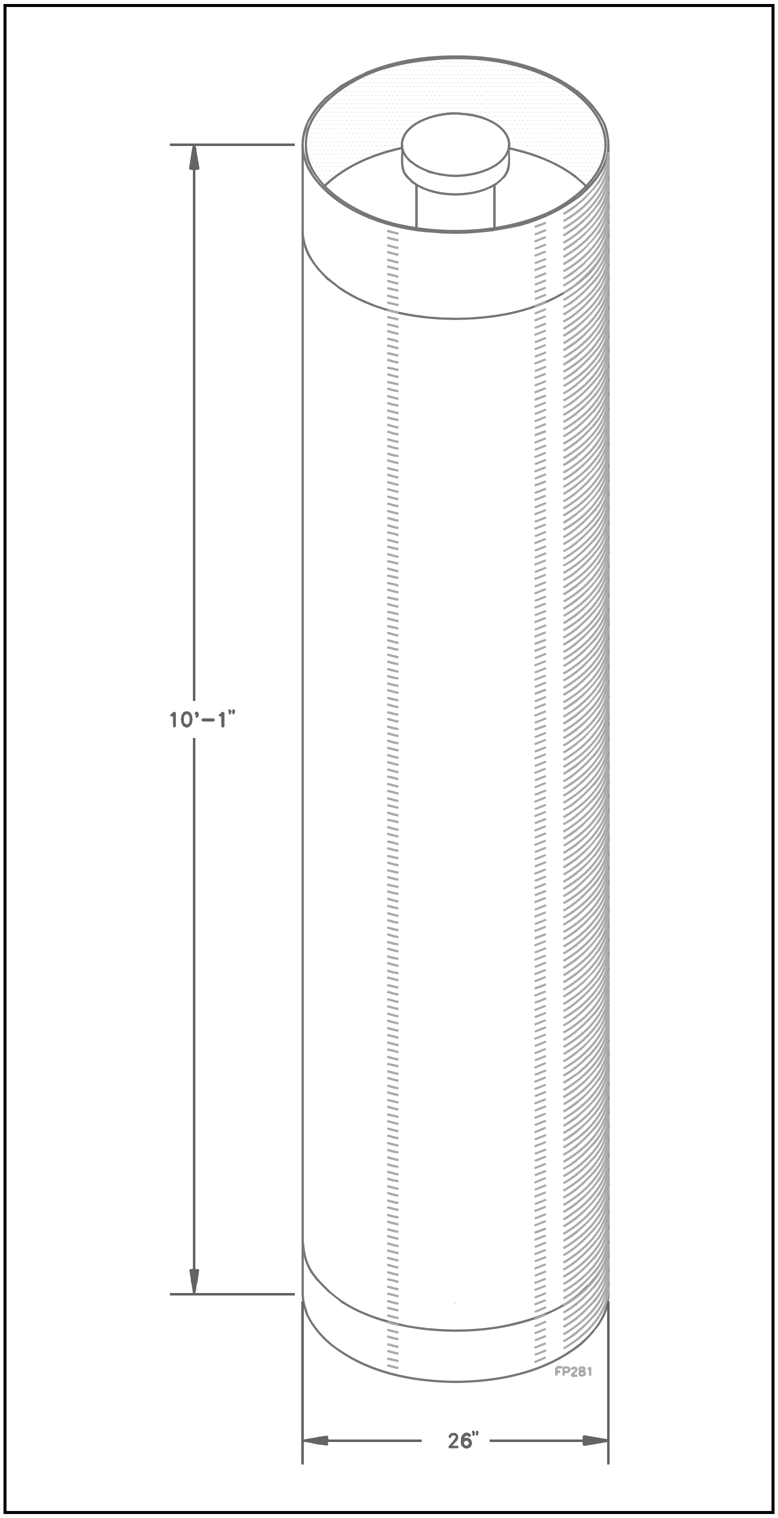

Figure 2.5-6, RH 72-B Waste Canister

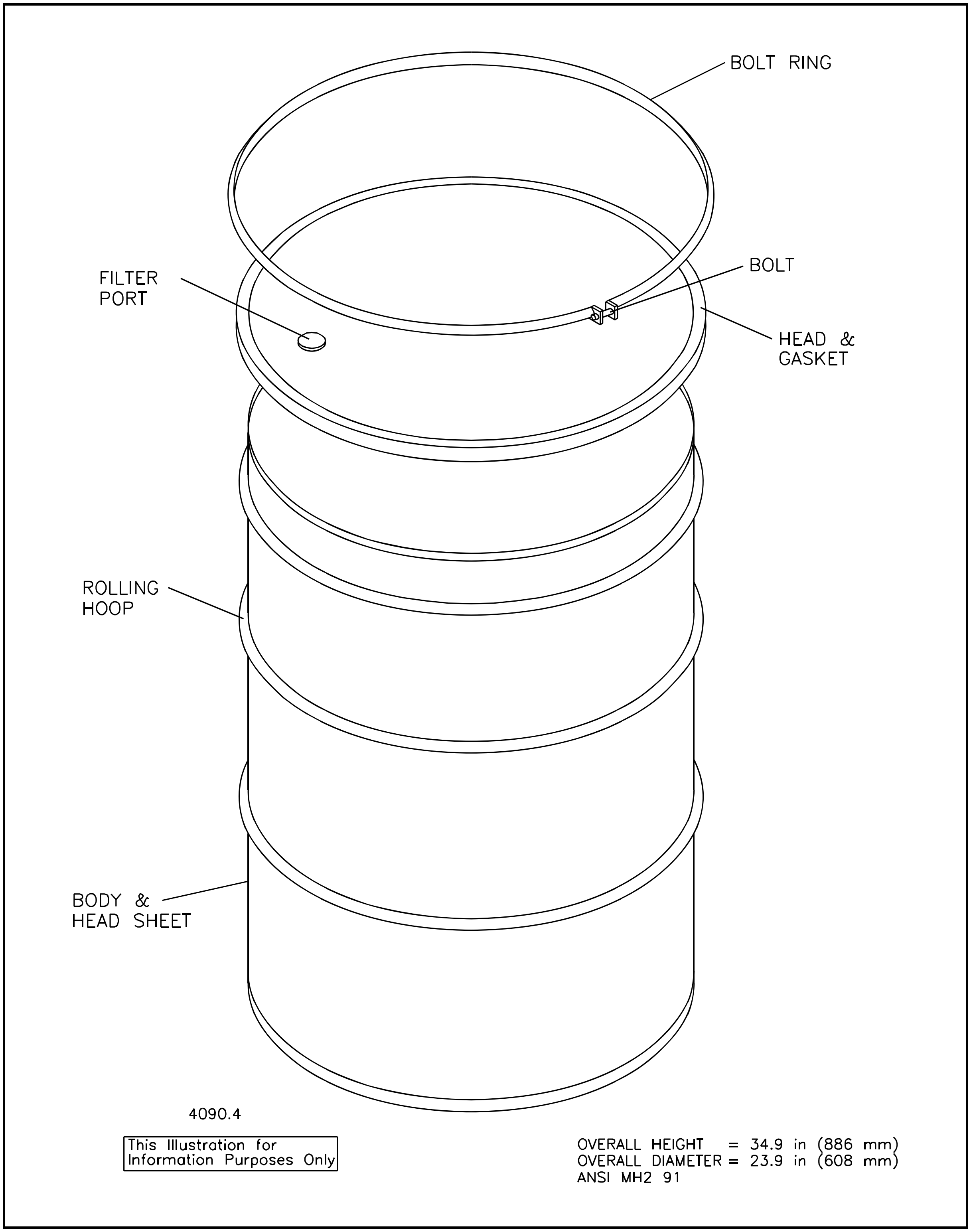

Figure 2.5-7, Standard 55-Gallon Drum

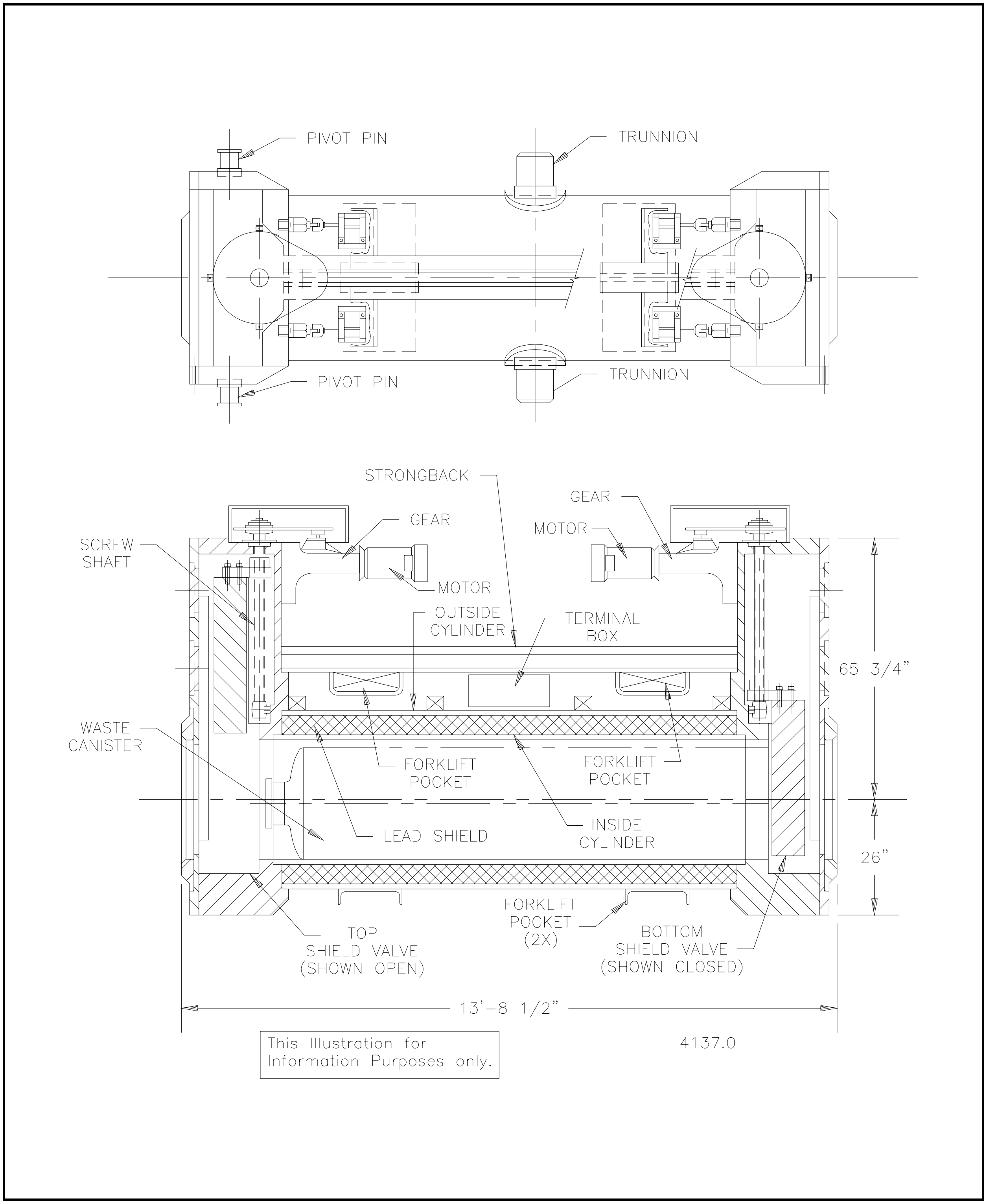

Figure 2.5-8, Facility Cask

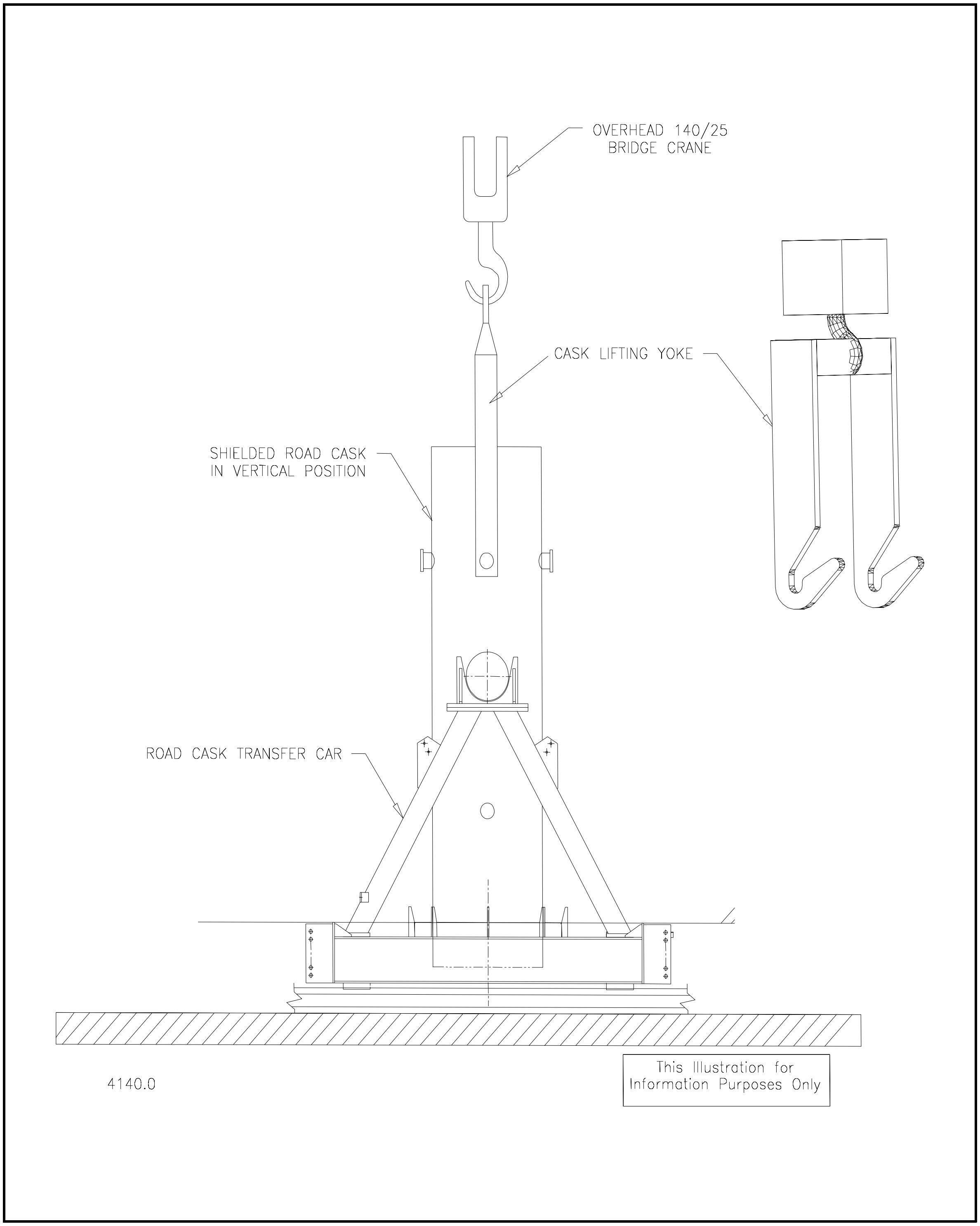

Figure 2.5-9, 140-Ton Crane Cask Lifting Yoke In Use

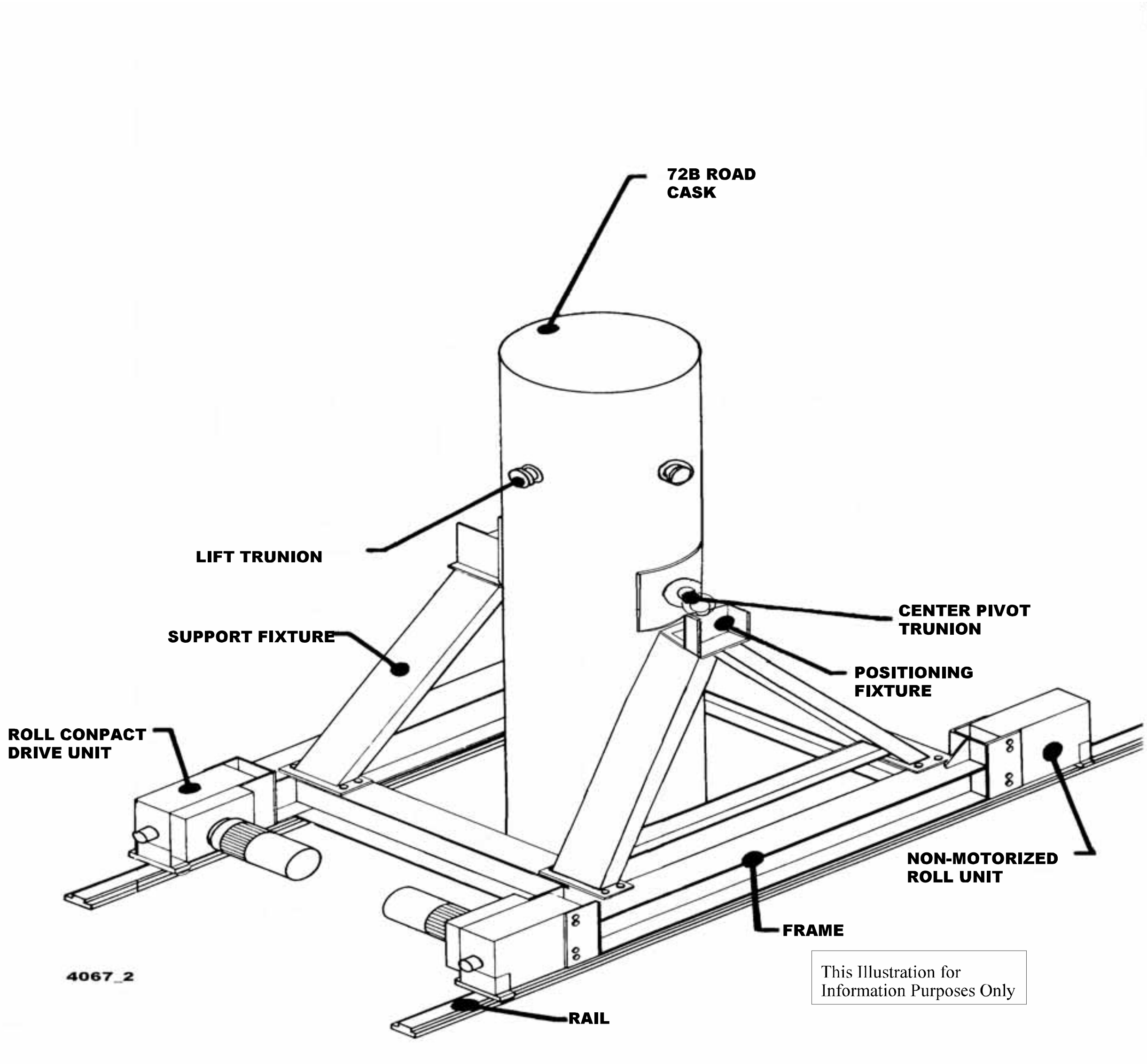

Figure 2.5-10, 72-B Shipping Cask on Transfer Car

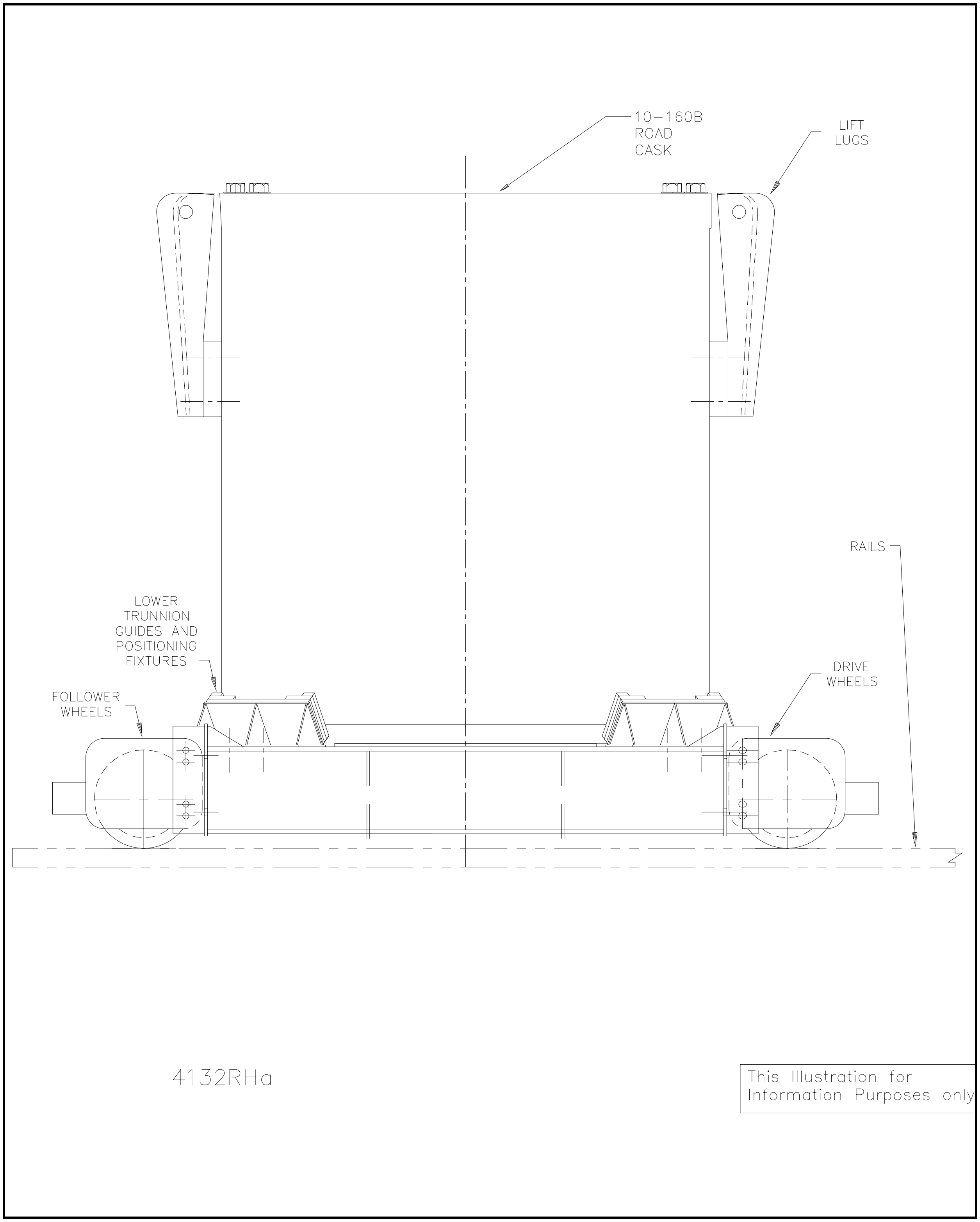

Figure 2.5-11, 10-160B Road Cask Transfer Car

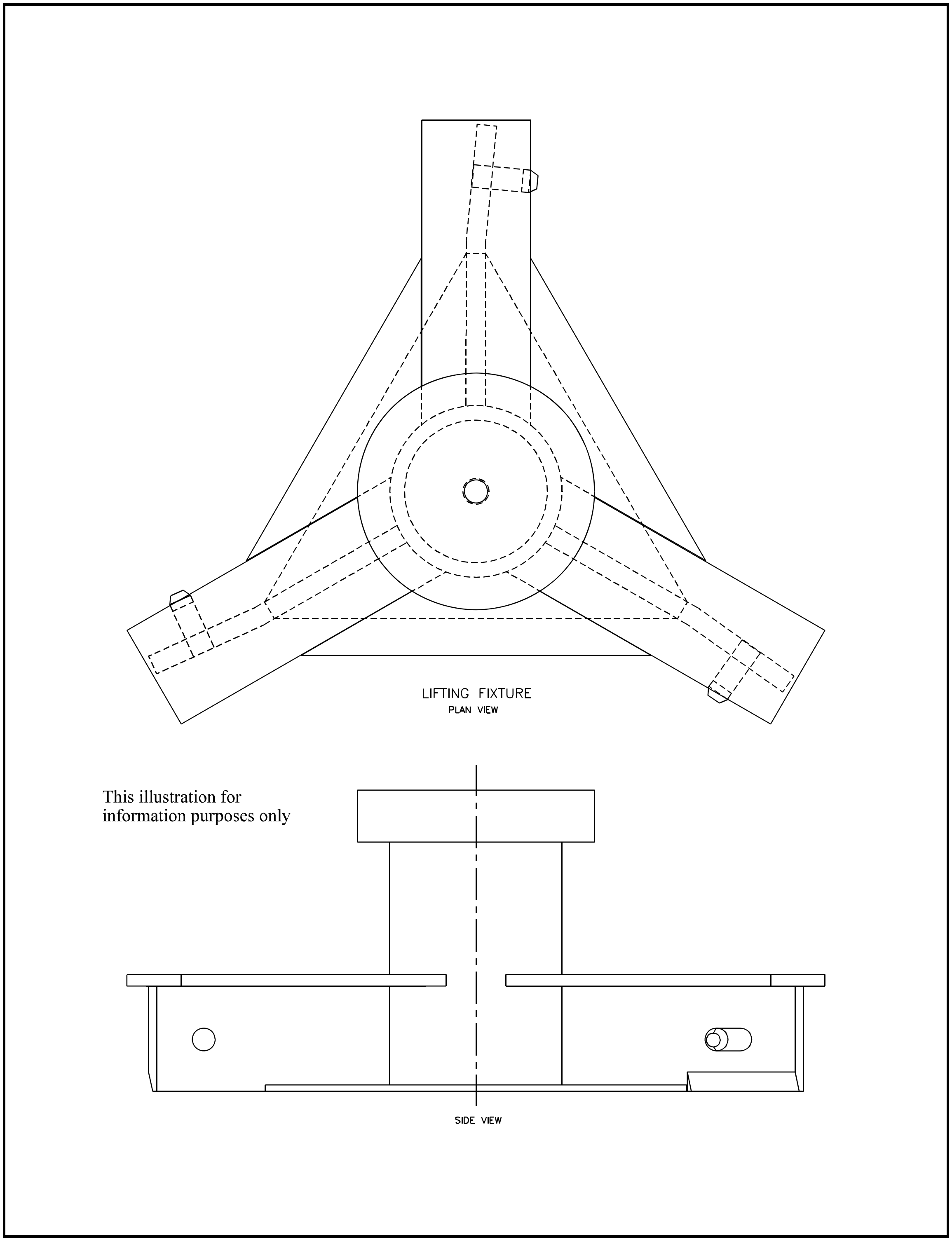

Figure 2.5-12, 10-160B Shipping Cask Lid Lifting Fixture

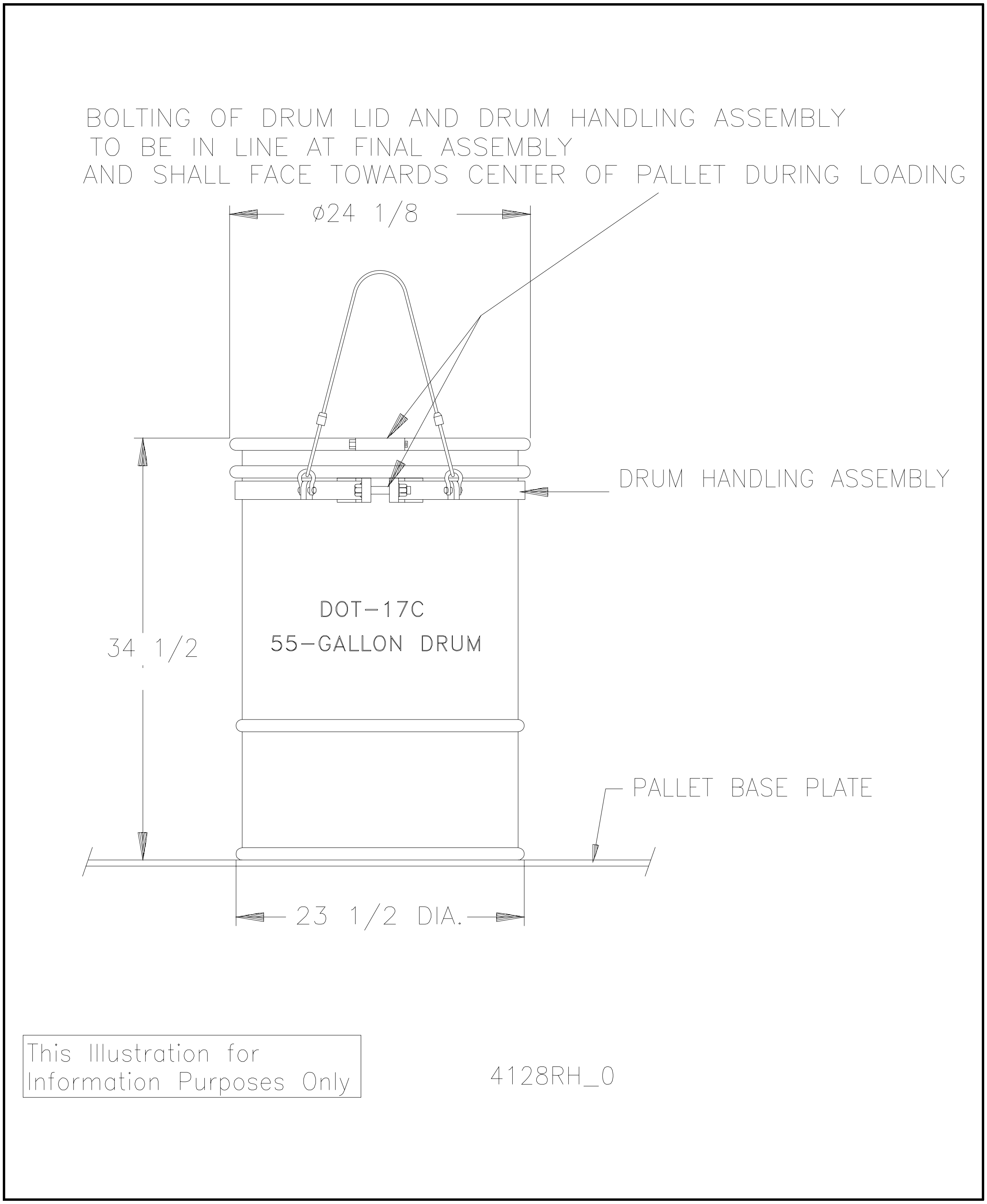

Figure 2.5-13, 10-160B 55-Gallon Drum Lift Device

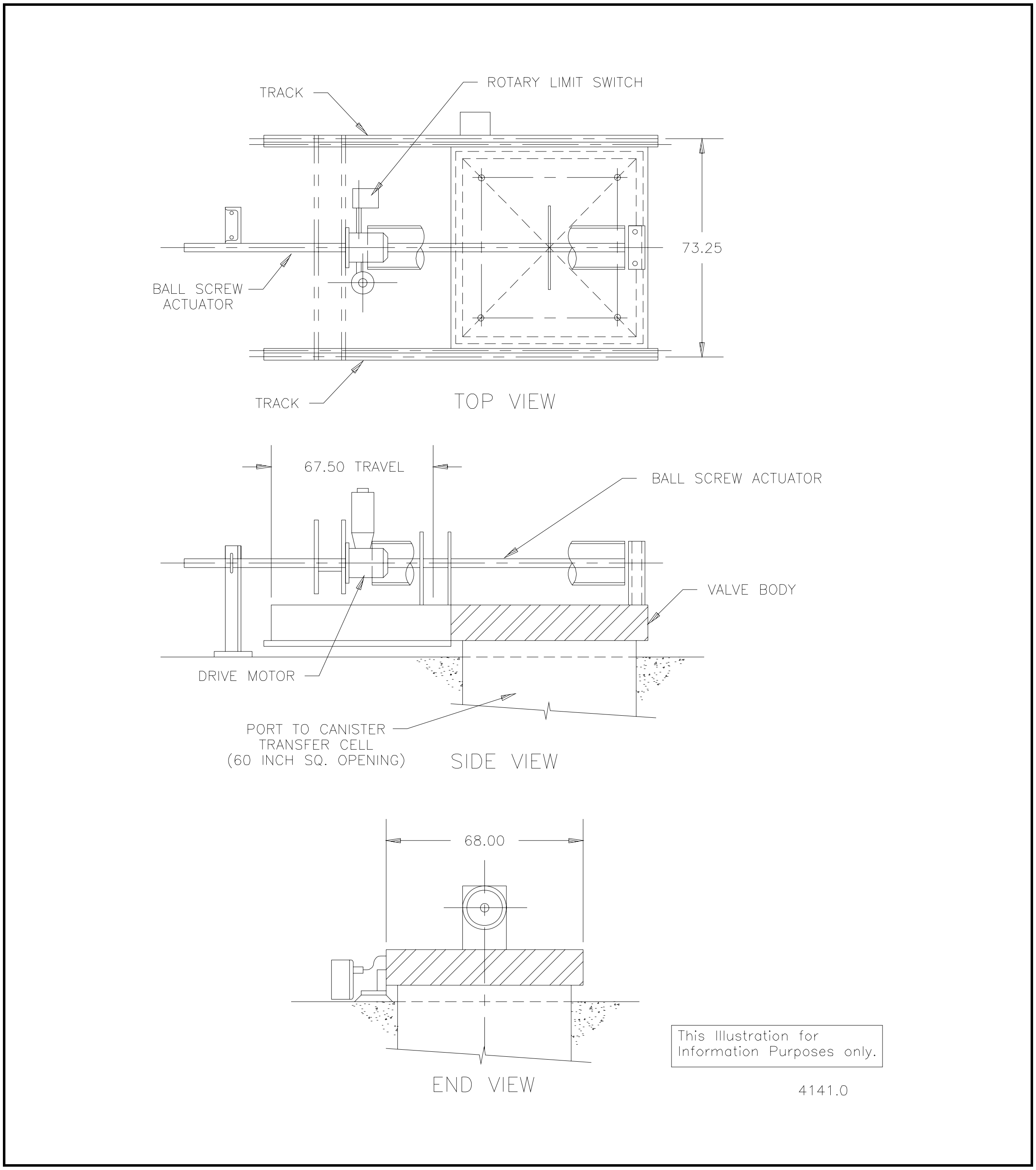

Figure 2.5-14, Shield Valve

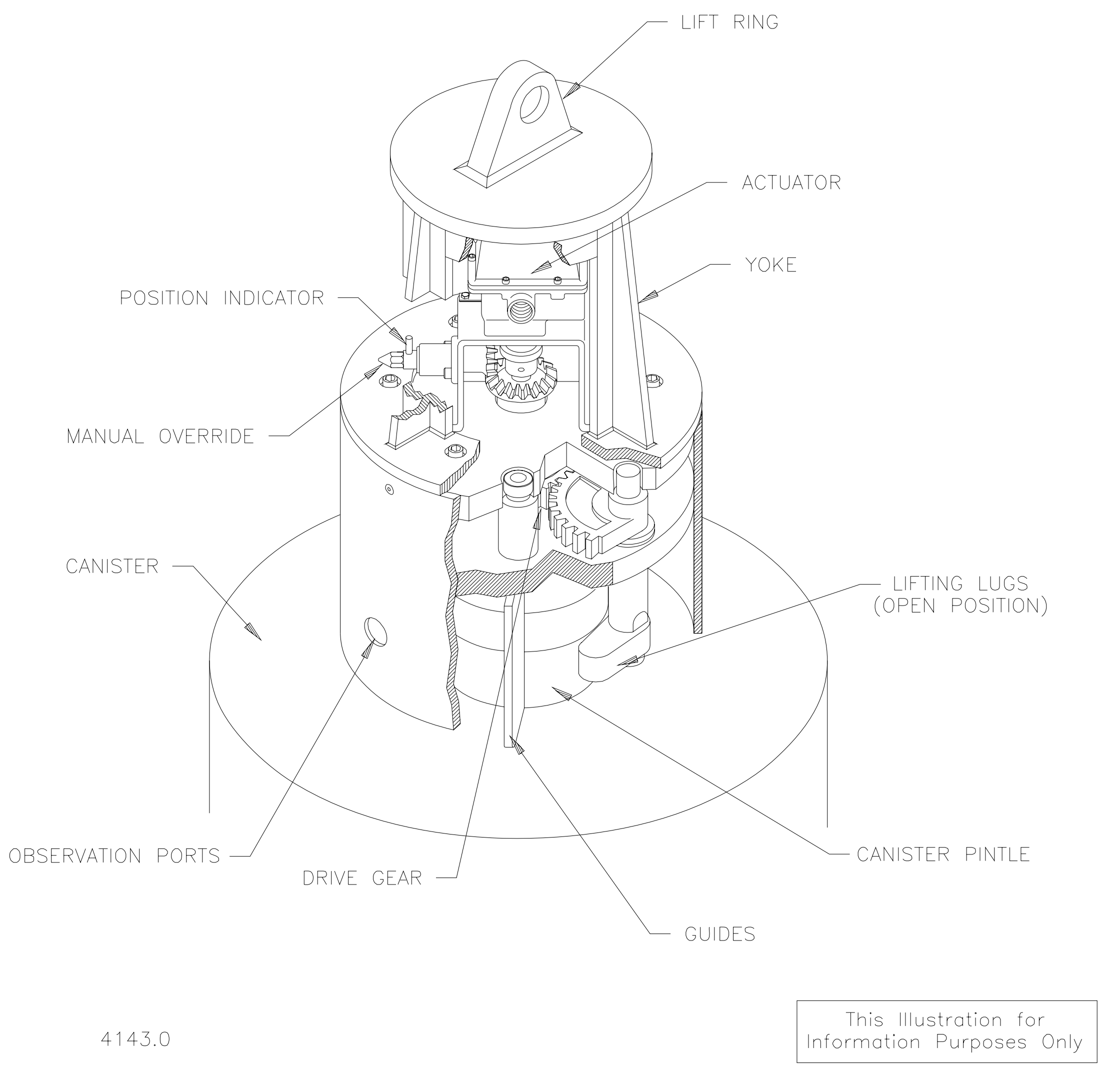

Figure 2.5-15, Facility Grapple

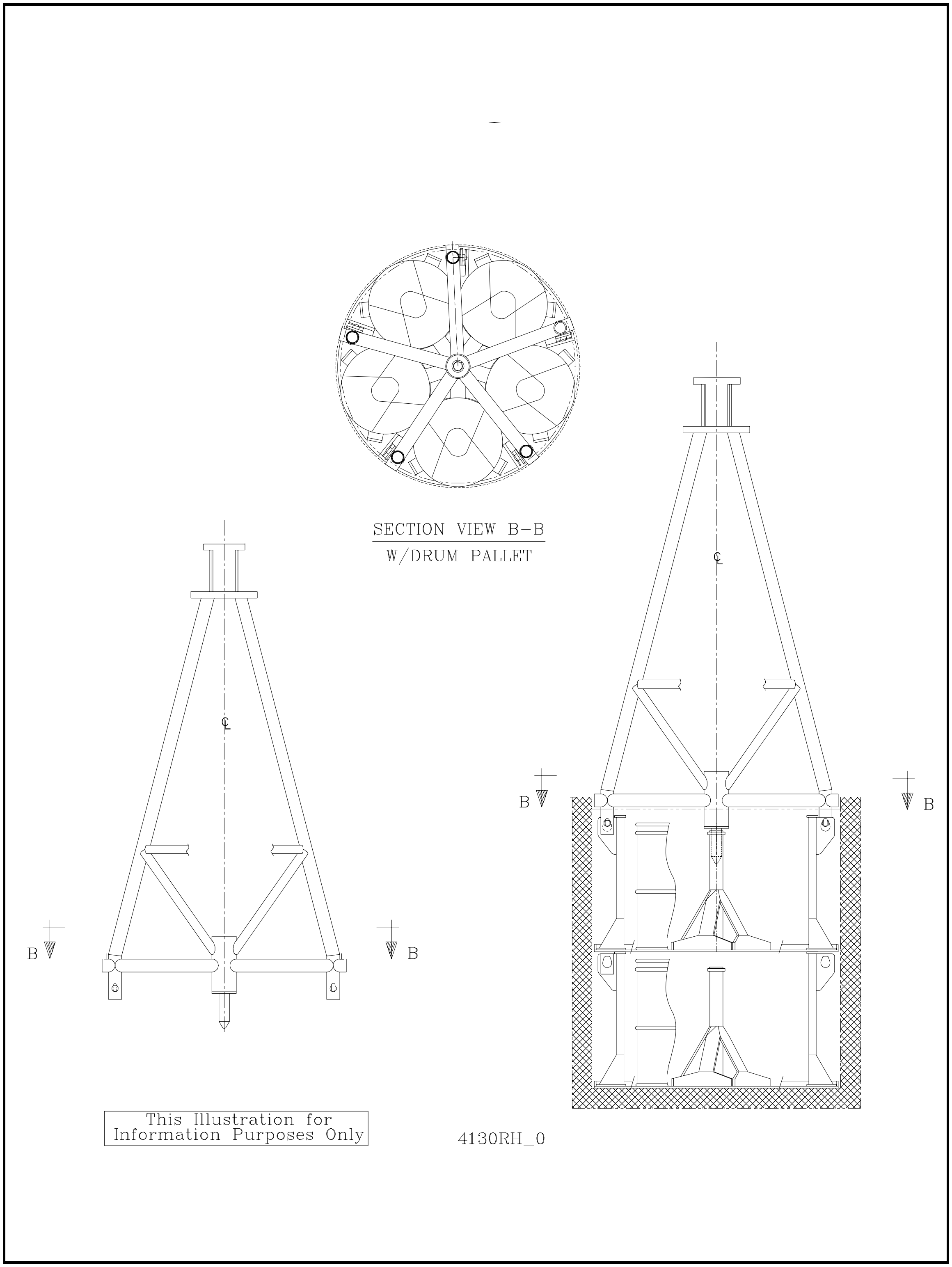

Figure 2.5-16, 10-160B Drum Carriage Lift Fixture

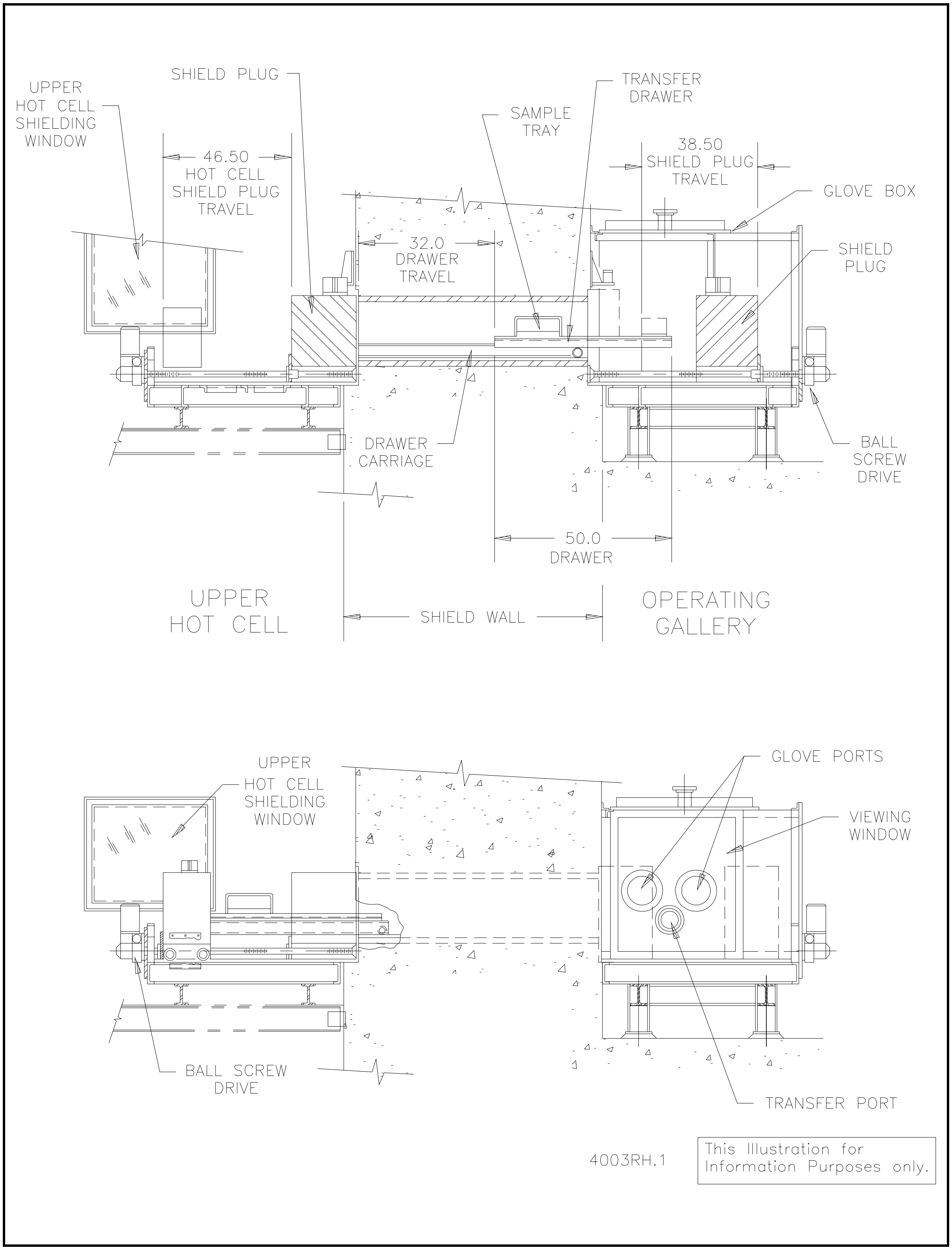

Figure 2.5-17, Upper Hot Cell Transfer Drawer

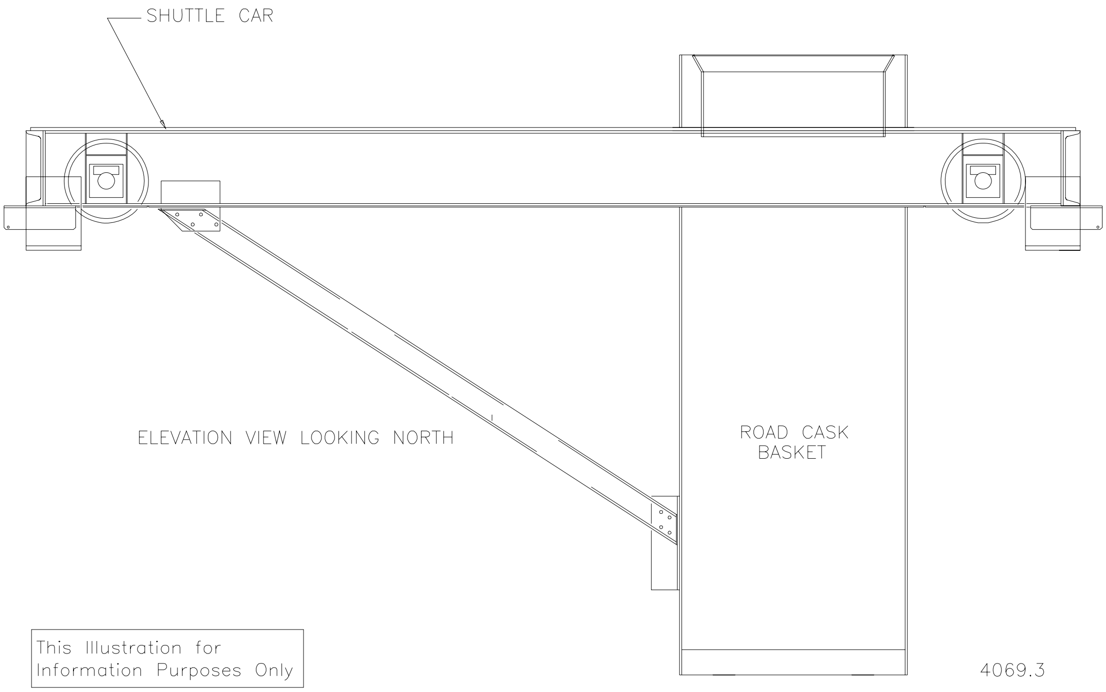

Figure 2.5-18, Transfer Cell Shuttle Car

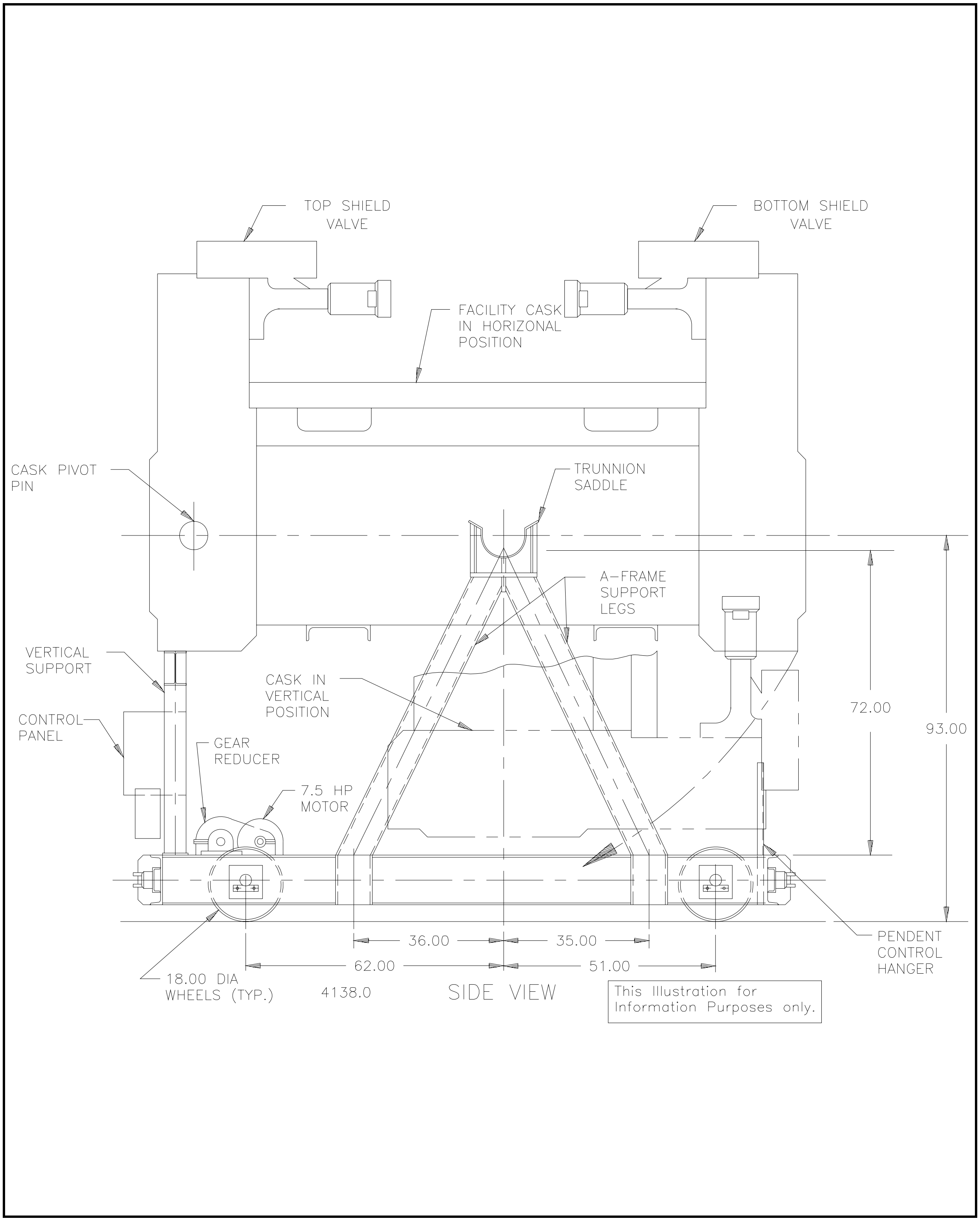

Figure 2.5-19, Facility Cask Transfer Car

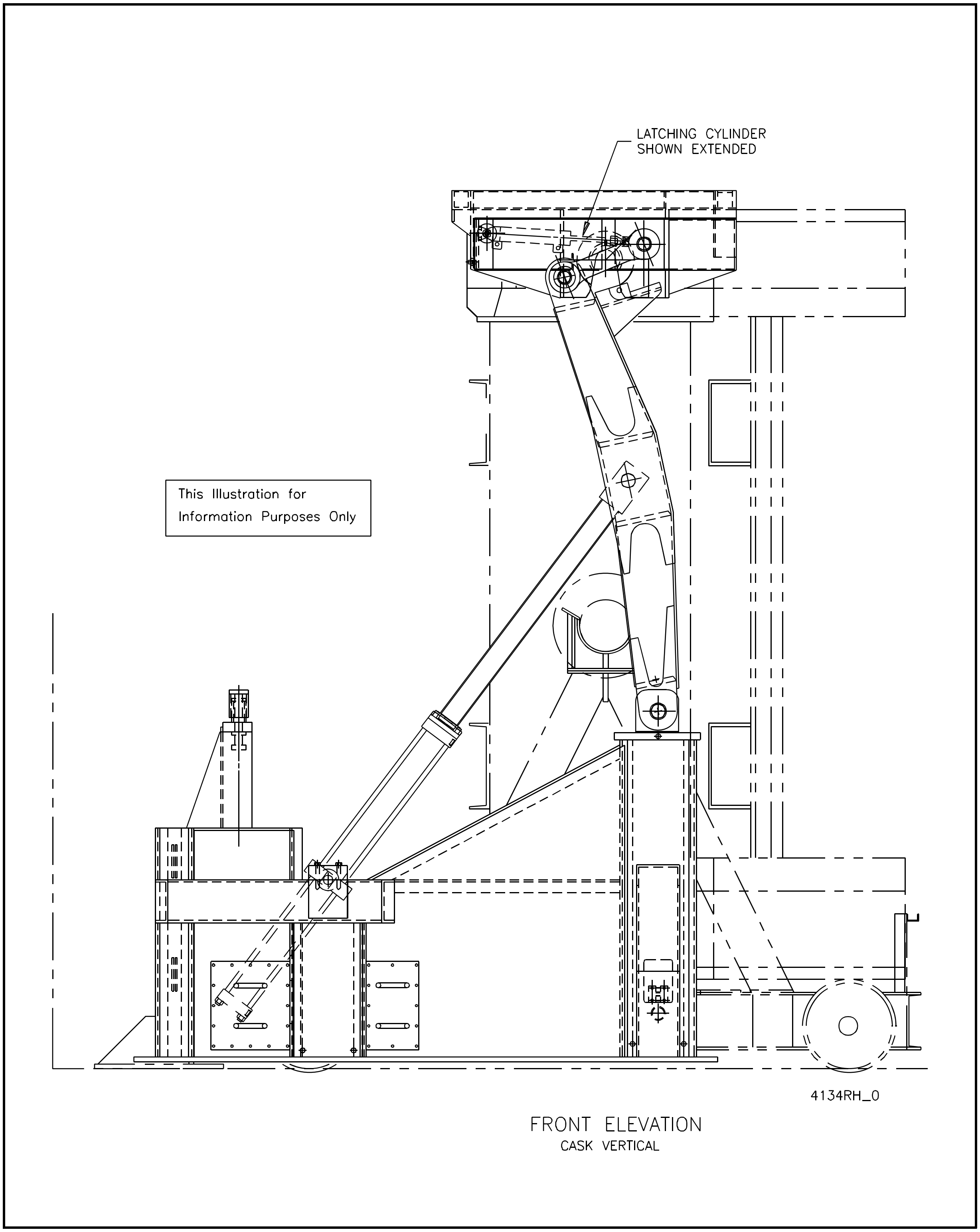

Figure 2.5-20, Facility Cask Rotating Device

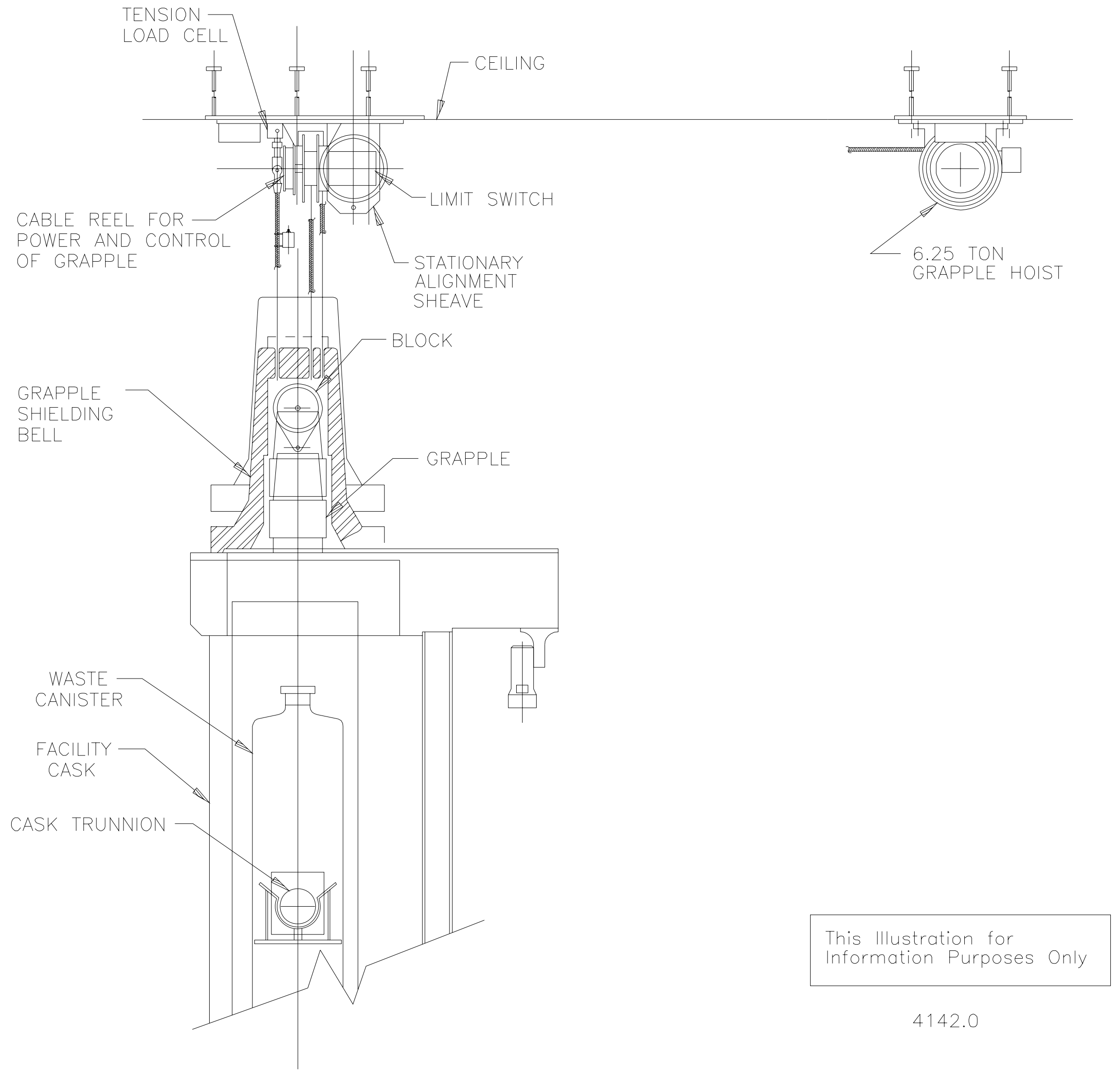

Figure 2.5-21, 6.25-Ton Facility Cask Loading Room Grapple Hoist

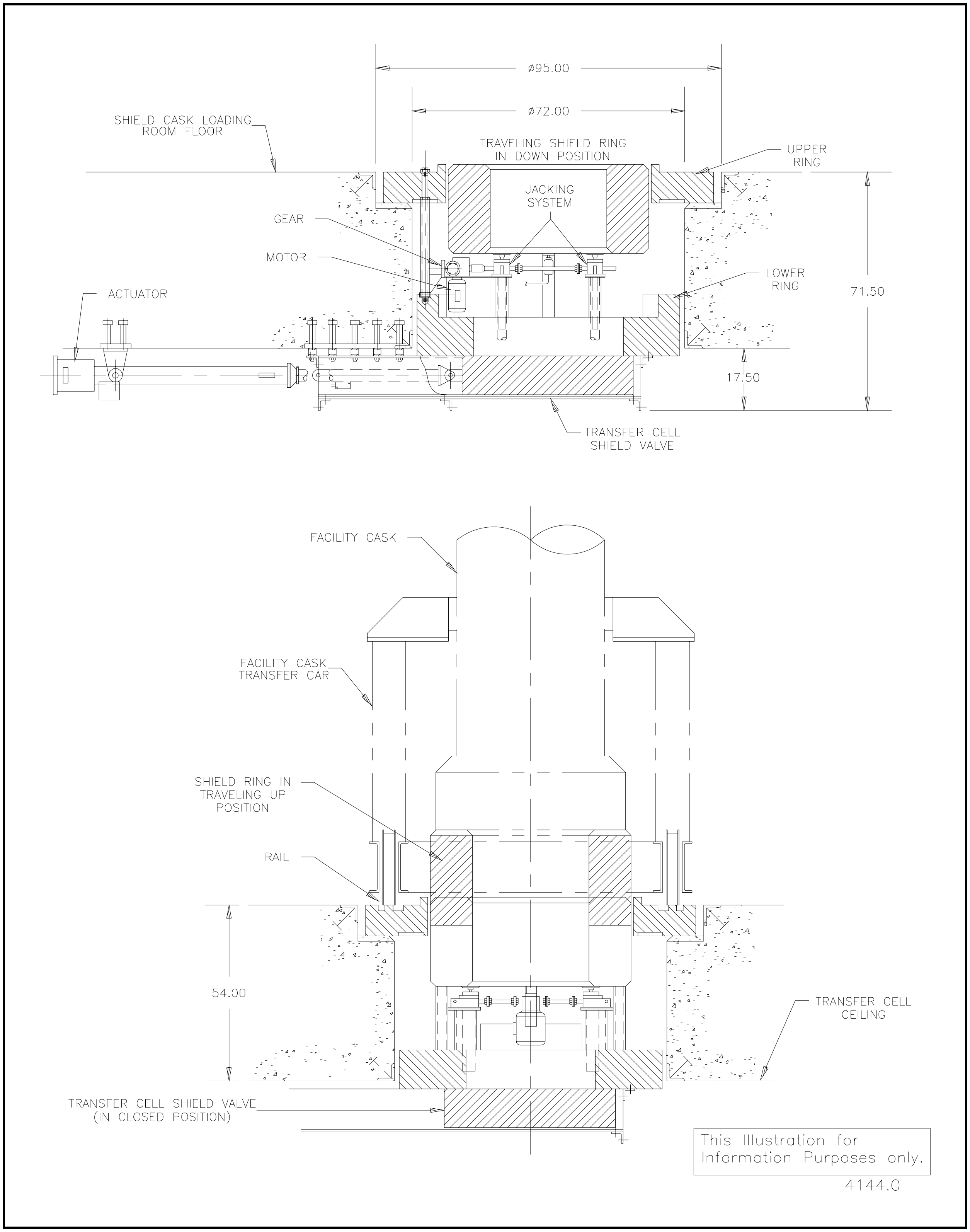

Figure 2.5-22, Telescoping Port Shield

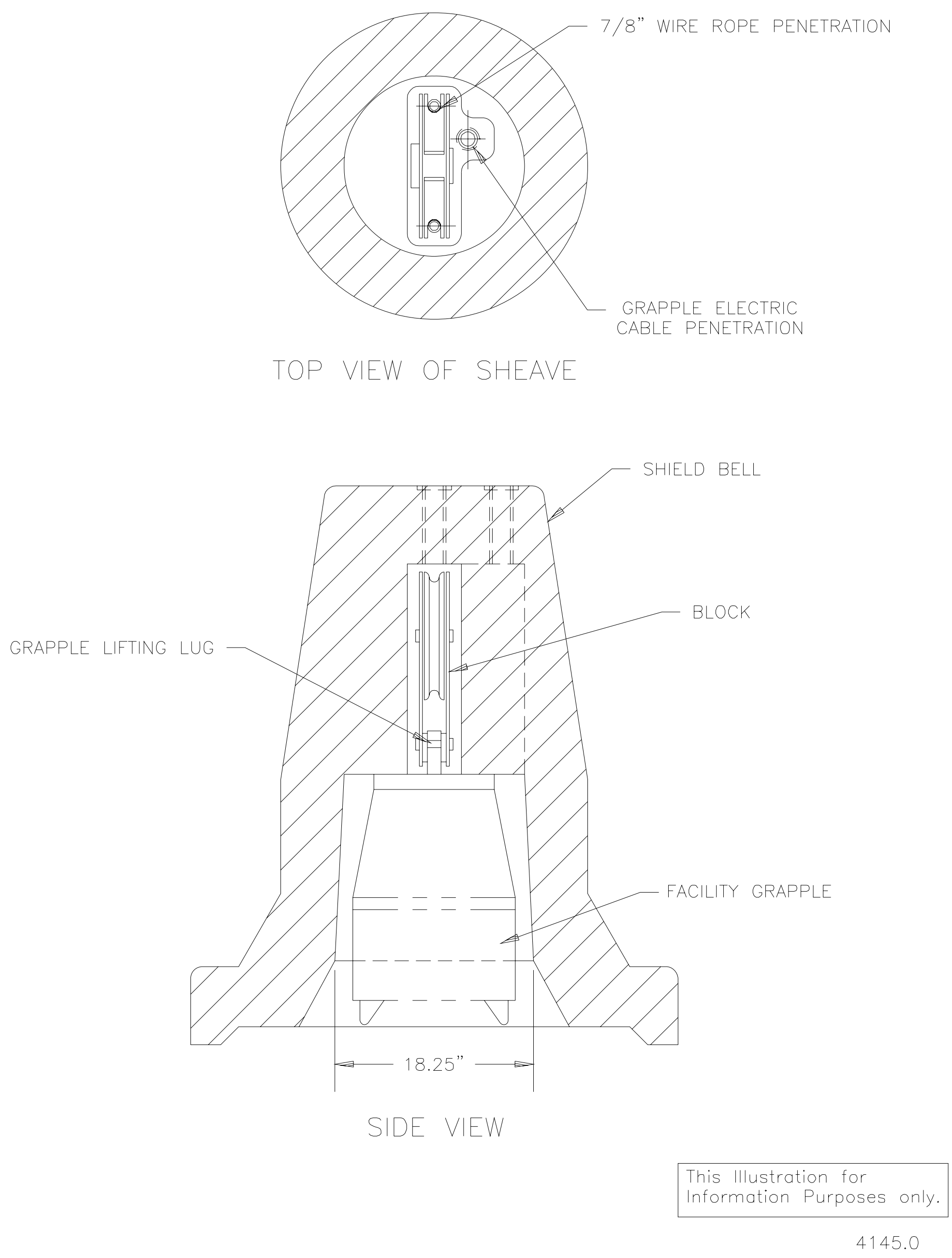

Figure 2.5-23, Bell Shield and Block

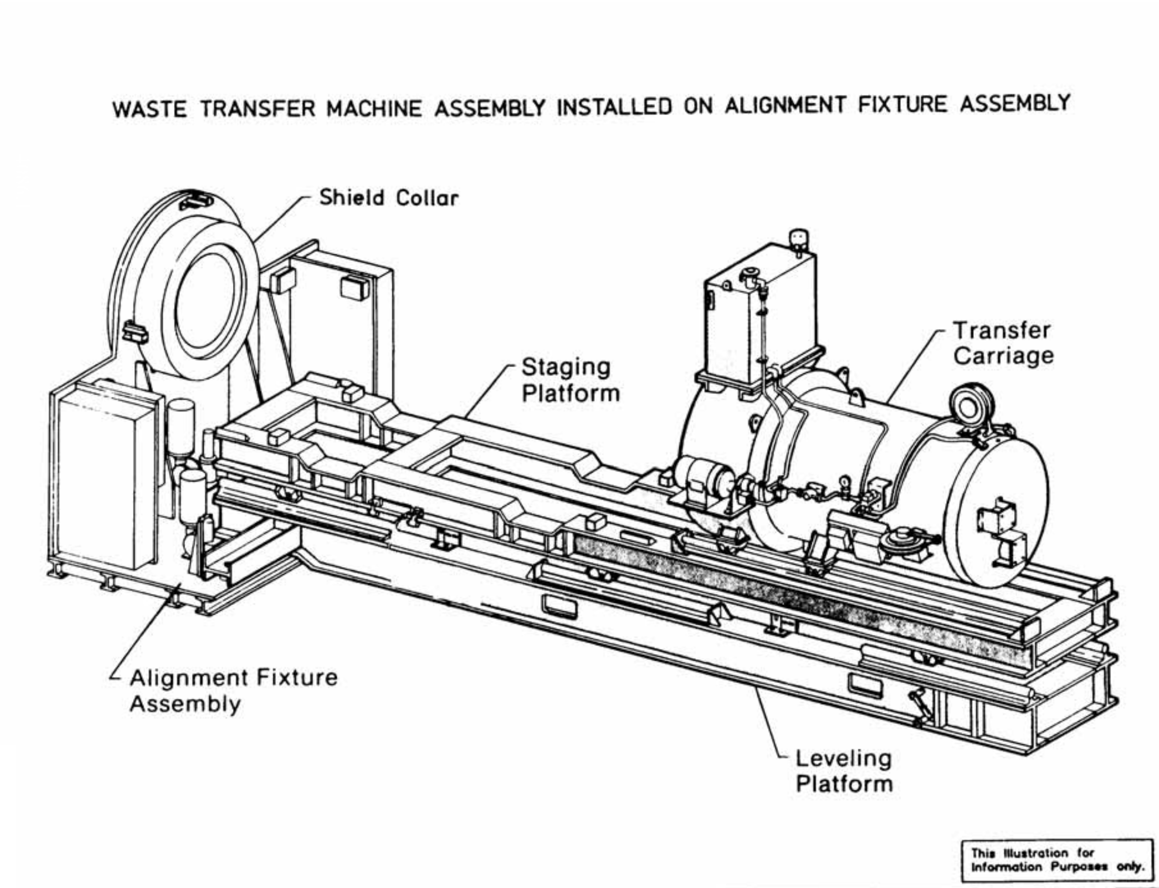

Figure 2.5-24, Waste Transfer Machine Assembly Installed on the Alignment Fixture

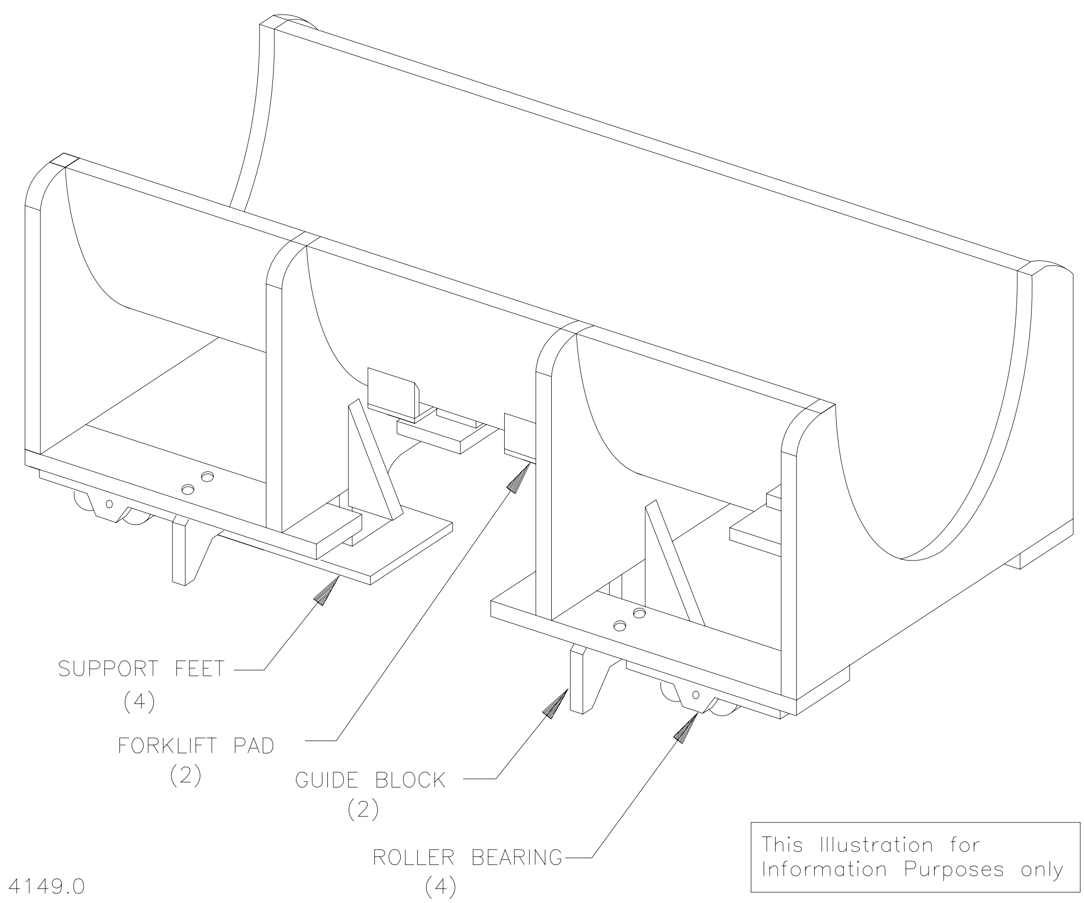

Figure 2.5-25, Shield Plug Carriage

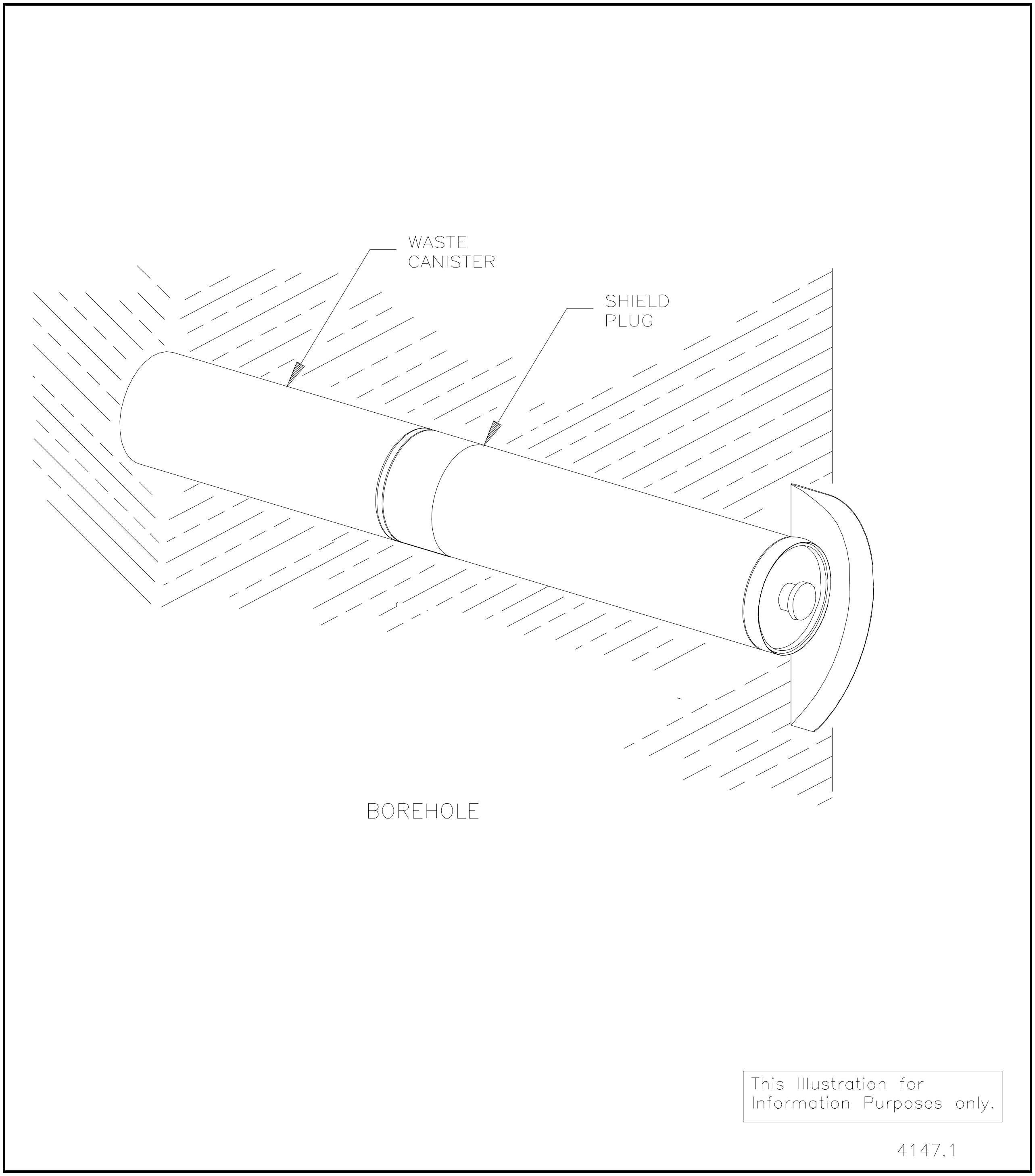

Figure 2.5-26, RH Emplacement Configuration

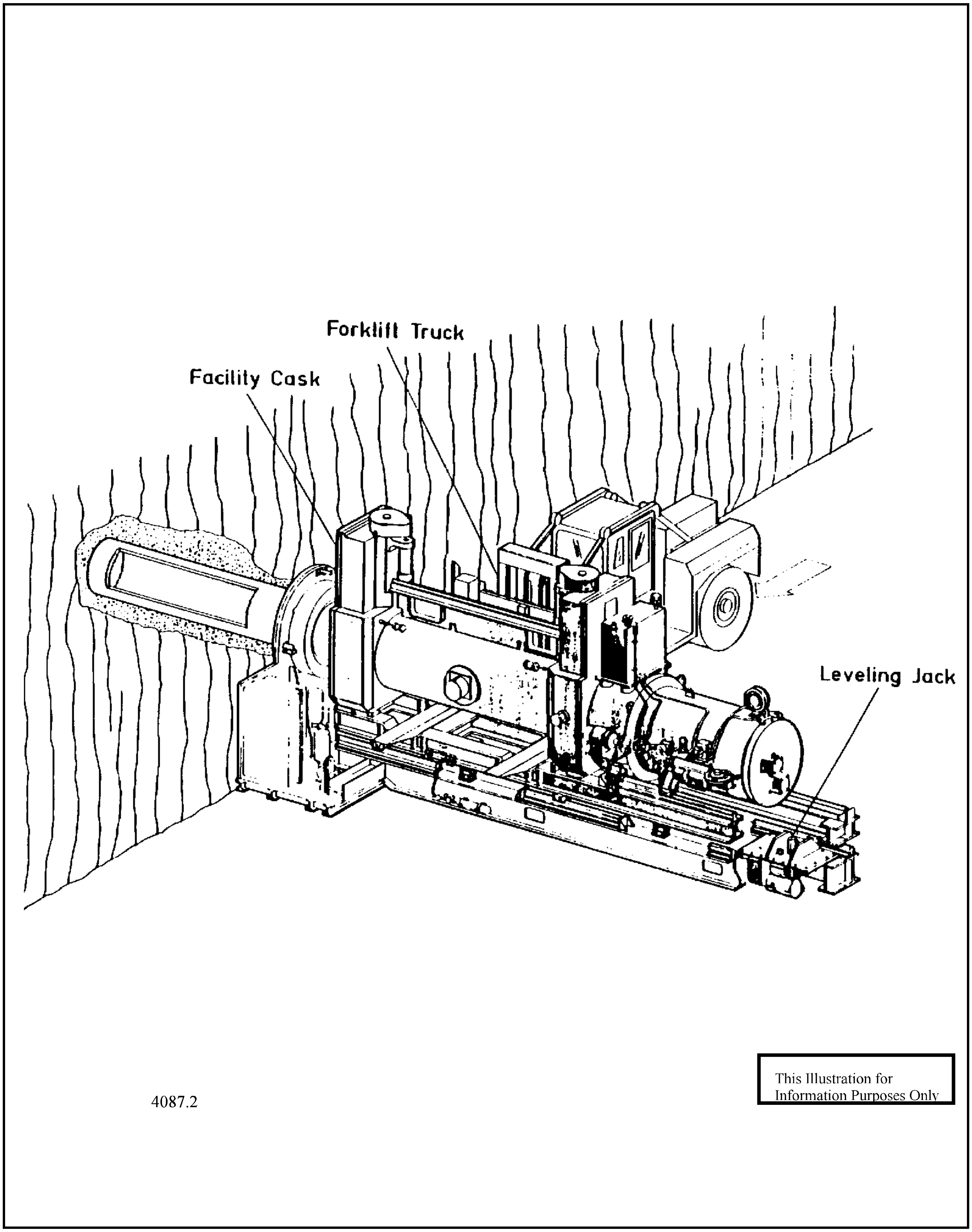

Figure 2.5-27, Facility Cask Installed on the Waste Transfer Machine Assembly

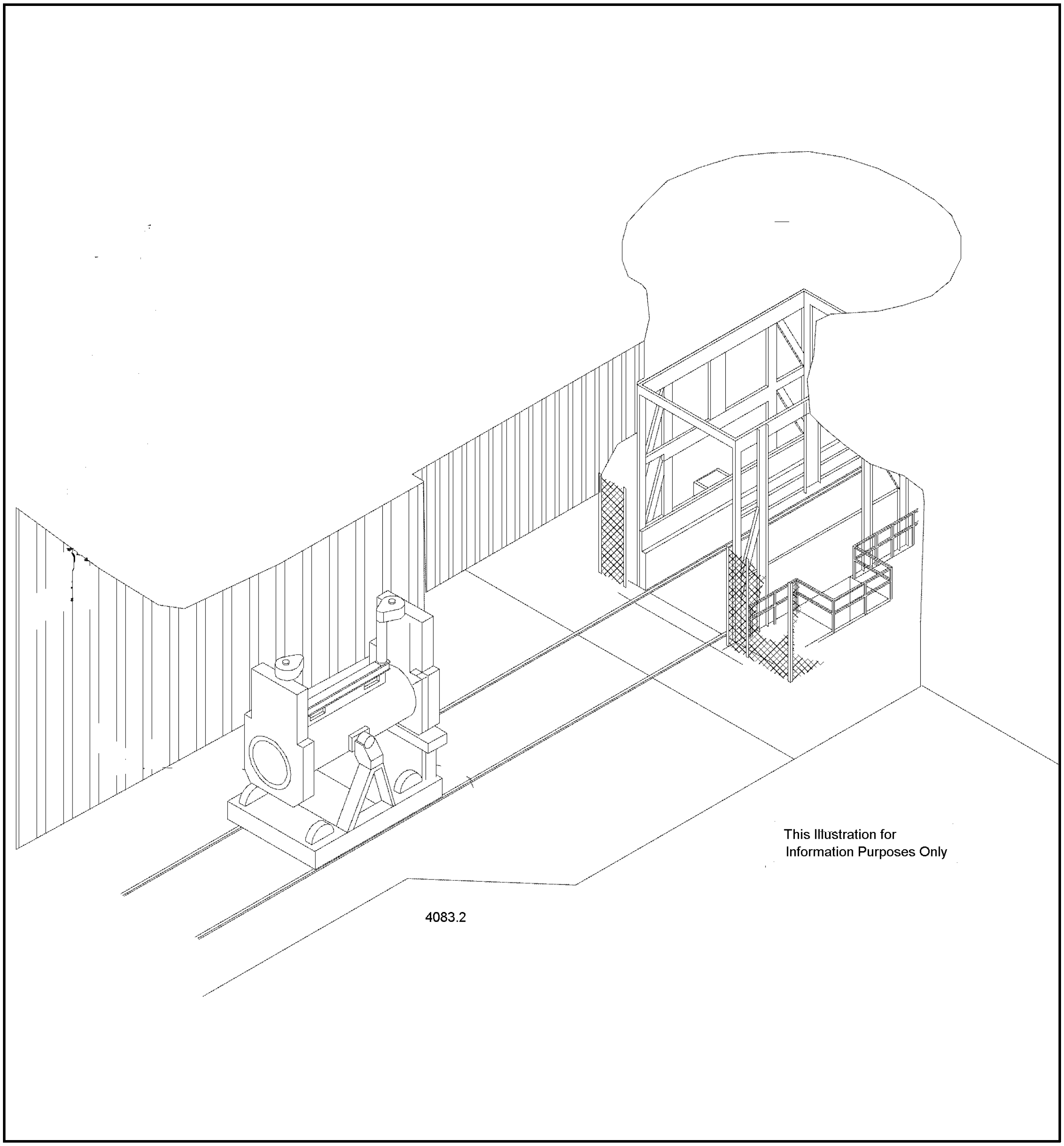

Figure 2.5-28, RH Waste Handling Facility Cask Unloading from Conveyance

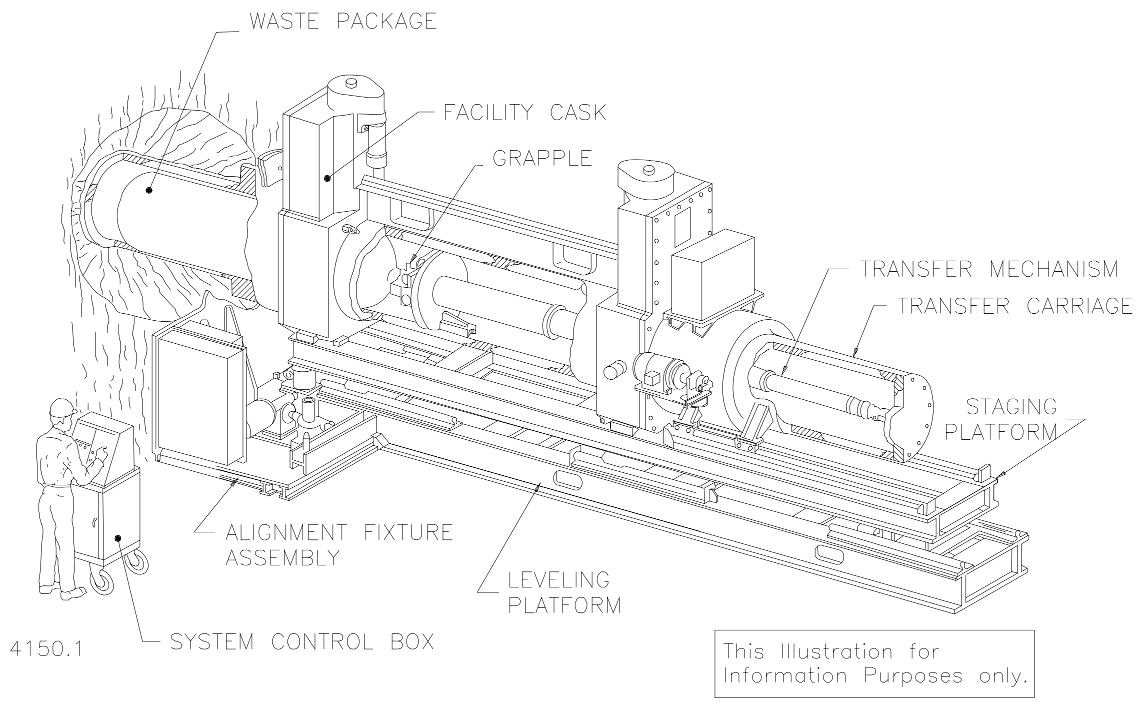

Figure 2.5-29, RH Waste Canister Emplacement

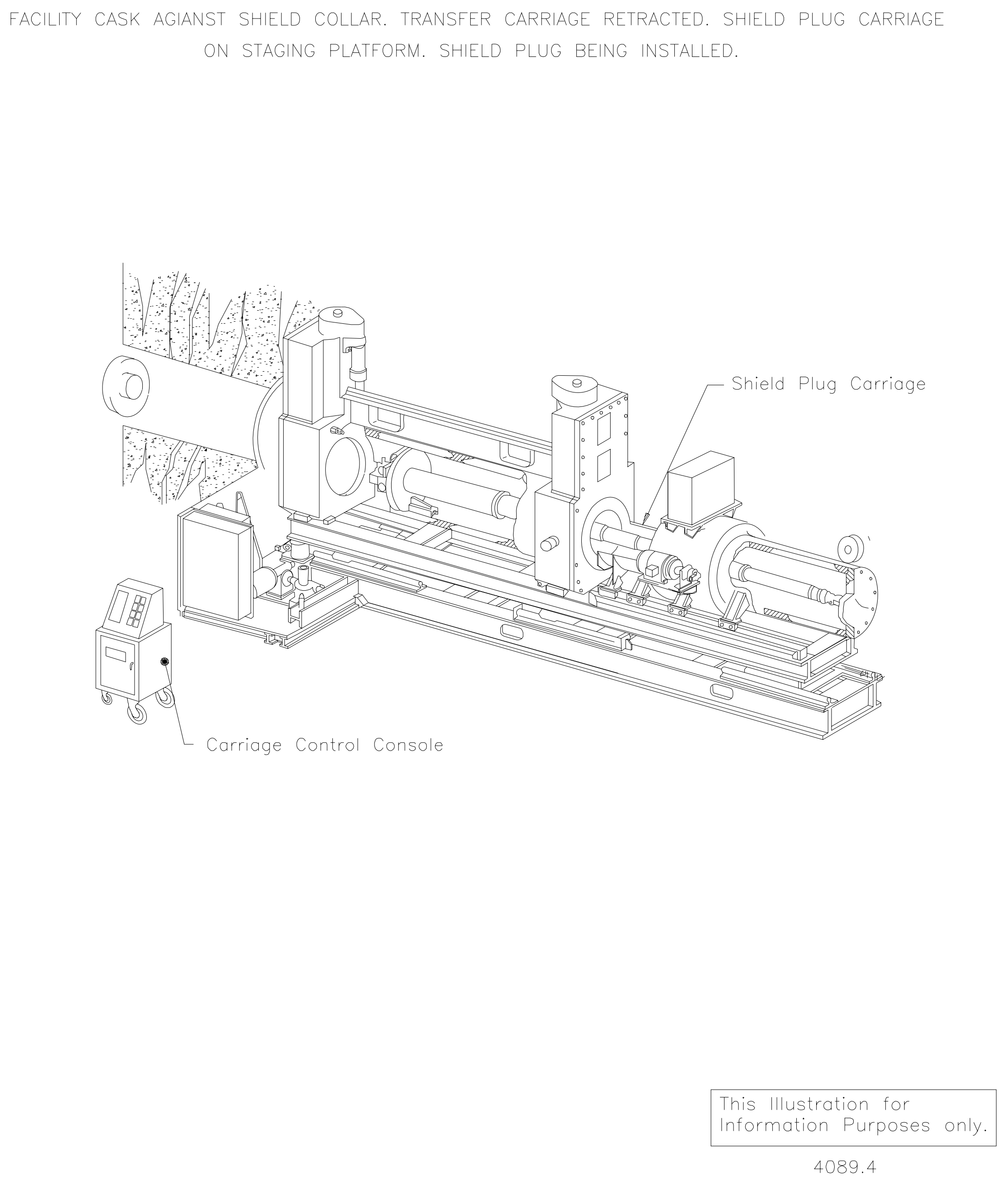

Figure 2.5-30, Installing Shield Plug

2.6 Confinement Systems

The WIPP confinement systems consist of static and dynamic barriers that prevent or minimize:

- The spread of radioactive and hazardous materials within occupied and unoccupied process areas.
- The release of radioactive and hazardous materials in facility effluents during normal operation and process interruptions.
- The release of radioactive and hazardous materials resulting from design basis accidents including severe natural events and man-made events.

Static barriers are structures that confine contamination by their physical presence, and dynamic barriers that control the airborne radioactive material. For the WIPP, static barriers include waste containers, building structures, the underground repository, and HEPA filtration systems. For RH waste handling, static barriers consist of waste drums and canisters, the shipping casks, the WHB, the hot cell complex, the facility cask, HEPA filters in the WHB, and the geological strata. Dynamic barriers consist of the surface and underground ventilation systems that maintain pressure differentials ensuring air flow is from areas of lower to higher contamination potential. The WHB is designed to withstand the effects of tornados, high winds, and earthquake, and the underground is unaffected by these events. The WIPP confinement systems meet the requirements of DOE O 420.1A.[2]

2.6.1 Waste Handling Building

Static and dynamic barriers to ensure confinement are incorporated into the design of the WHB. The WHB is designed to maintain its integrity following a DBT or DBE. The hot cell complex is constructed with thick concrete walls and also incorporates air locks to further ensure that contamination or airborne radioactive material is not easily transported from the immediate area. There are HEPA filters installed in the exhaust of the RH ventilation systems. The ventilation system for the RH portion of the WHB maintains pressure differential between areas of low potential for contamination or airborne radioactive material and those of higher potential. The hot cell ventilation system ensures that the upper hot cell remains at a lower static pressure than other RH areas of the WHB. The air locks further assist the ventilation systems to maintain differential pressure between separate areas.

2.6.2 Underground

The primary confinement for TRU waste in the underground is the waste container itself. Secondary confinement is either the facility cask during waste transport or the disposal borehole and shield plug after the waste canister has been placed inside the disposal borehole. Additional confinement includes the underground bulkheads, overcasts, and airlock that separate the disposal and waste shaft ventilation circuits from the other ventilated areas of the underground. The bulkheads, overcasts, and airlocks are constructed of noncombustible material, except for the flexible flashing used to accommodate salt movement, in accordance with 30 CFR Part 57.[18] The underground ventilation system includes differential pressure control such that air leakage is from non-waste to the disposal area. The effluent from the underground can be directed through HEPA filters located on the surface, near the top of the exhaust shaft, to mitigate any accidental radiological releases from the underground.

2.6.3 Ventilation Systems

The WIPP ventilation systems are designed to provide a suitable environment for personnel and equipment during plant operations, and to provide radiological control during postulated waste handling accidents and process interruptions. Ventilation systems are used for space heating and cooling. The WIPP ventilation systems serve surface and underground facilities and are designed to meet the emissions limitations in DOE O 5400.5, *Radiation Protection of the Public and the Environment,*[33] using the following guidelines:

- Transfer and leakage air flow is from areas of lower to areas of higher potential for contamination.

- In building areas that have a potential for contamination, a negative pressure is maintained to minimize the spread of contaminants.

- Consideration is given to the temporary disruption of normal air flow patterns due to scheduled and unscheduled maintenance operations by providing dual trains of supply and exhaust equipment. Ventilation systems are provided with features to reestablish designed airflow patterns in the event of a temporary disruption. Ducts that carry potentially contaminated air are routed away from occupied areas.

Systems are designed so that some components can be taken out of service for maintenance while the system continues to operate as designed.

2.6.3.1 Surface Ventilation Systems in Controlled Areas

There are independent ventilation systems for each of the following areas:

- Waste hoist tower including the hoist maintenance room
- CH waste handling area
- RH waste handling area
- Upper hot cell
- WHB mechanical equipment room
- EFB

The waste hoist maintenance room is located in the second floor of the waste hoist tower. The ventilation system that serves this area is not expected to contain or become contaminated with radioactive material as the air is ultimately exhausted down the waste shaft to the combined underground exhaust.

The WHB and EFB ventilation systems have fresh air supply intakes located away from the exhaust vents and are designed to provide confinement barriers with the capability to limit releases of airborne radioactive contaminants. These ventilation systems provide pressure differentials that are maintained between building interior zones and the outside environment which controls potentially contaminated air. The WHB ventilation system continuously filters the exhaust air from waste handling areas to reduce the potential for release of radioactive effluents to the environment.

Airlocks for ventilation differential pressure control are electrically interlocked and are provided in the following locations:

- At entrances to potentially contaminated areas to maintain a static barrier
- Between areas of large pressure differences to provide a pressure transition and to eliminate high air velocity
- Between areas where pressure differentials must be maintained
- To minimize air movement from the WHB to the waste shaft

The ventilation systems include instrumentation to the following operating parameters:

- Pressure drop across each prefilter and HEPA filter bank
- Air flow rates at selected points
- Pressure differentials surrounding areas of high potential for contamination levels

The operation of the supply and exhaust fans is controlled by interlocks to maintain differential pressures between rooms. The WHB exhaust fans and controls can be supplied by backup power in the event that normal power is interrupted.

2.6.3.2 WHB CH and RH Waste Handling Area Ventilation Systems

The CH and RH waste handling areas are supplied by separate, independent ventilation systems, shown on schematic flow diagrams, Figures 2.6-1 through 2.6-3. The ventilation supply and exhaust systems for each WHB subsystem supply air to the rooms of the areas served. Each supply air handling unit consists of filters, cooling coils, heating elements, fans with associated duct work, and controls to condition the supply air maintaining the design temperature during winter and summer. Fan operating status, filter bank pressure drops, and static pressure differentials are monitored in the CMR. Excess filter pressure drop and loss of flow alarm in the CMR. The filtration system consists of prefilters and HEPA filters sized in accordance with design air flows utilizing industry standards for maximum efficiency.

The WHB supply and exhaust fans are designed and interlocked to maintain building pressure negative with respect to atmospheric pressure and maintain the design air flow pattern. During normal operation, if the operating exhaust/supply fan fail, the corresponding supply/exhaust fan is stopped. The standby train is started automatically and can also be started manually.

The internal cavity of each RH shipping cask is vented into a vacuum system that collects any airborne particulate contamination on a swipe medium. The sample system exhausts headspace gas and potential airborne-particulate contamination through an industrial grade HEPA filter prior to exhausting air into the RH bay ventilation system.

The Station C effluent sampling system continuously samples the air discharged from the WHB exhaust vent downstream of HEPA filtration.

Tornado dampers, constructed to withstand the DBE and DBT, are installed in all HVAC inlet and exhaust openings in the WHB. Dampers installed in the air intakes open in the same direction as the normal airflow and close automatically to prevent reversal of flow. Dampers in exhaust air openings open against the direction of normal airflow and are held open by springs. When tornado pressure on the open damper blades overcomes the spring tension, the blades close. In the event of a tornado, the WHB tornado dampers will automatically close to prevent the outward rush of air caused by a rapid drop in atmospheric pressure. Damper closure mitigates damage to HEPA filters from a potential high differential pressure.

In case of an off-site power failure, the capability exists to selectively switch one exhaust fan to the backup power system in order to continue to exhaust air in the designed flow pattern.

Sufficient remote instrumentation is provided enabling the operator to monitor equipment from the CMR. The monitored parameters include fan operating status, filter bank pressure drop, and static pressure differential in areas of the WHB. Filter differential pressure is displayed locally as well as in the CMR via the CMS. An alarm for a pressure drop indicating filter replacement is needed actuates at a predetermined level across the HEPA filters. For those HEPA filters which are on-line continuously in the WHB, the CMS monitors prefilter and HEPA filter pressure differential.

Instruments and system components are accessible for, and will be subject to, periodic testing and inspection during normal plant operation.

All nuclear grade HEPA filter banks are tested for conformance with ANSI N510, *Standard for Testing of Nuclear Air Cleaning Systems*,[34] and have a 99.97 percent removal efficiency (SDD HV00, Heating, Ventilation and Air Conditioning System).[35]

2.6.3.3 WHB Mechanical Equipment Room Ventilation System

The mechanical equipment room is maintained at a pressure slightly below atmospheric to minimize leakage of room air, which may contain airborne radioactive contaminants. Negative pressure is maintained by the same exhaust fan systems that exhaust air from the CH and RH waste handling areas.

2.6.3.4 WHB Waste Shaft Hoist Tower Ventilation System

The ventilation system provides filtration of supply air, unit heaters to prevent equipment from freezing, and a unit cooler to provide supplementary cooling of equipment in summer. Exhaust air flow is down through the tower and into the waste shaft, where it combines with incoming air from the waste shaft auxiliary air intake tunnel as shown in Figure 2.6-3.

A pressurization system serves the airlock to the crane maintenance room at 142 ft-1 in. elevation and pressurizes the airlock preventing the release of potentially contaminated air from the crane maintenance room to the 142 ft-1 in. elevation access corridor.

2.6.3.5 Exhaust Filter Building Ventilation System

A schematic flow diagram of the EFB ventilation system is shown in Figure 2.6-4. The EFB supports the operation of the underground ventilation system and contains the underground ventilation system HEPA filters. The function of the ventilation system in the EFB, major components, operating characteristics, safety considerations, and controls, are similar to the CH waste handling area in the WHB. Each supply air handling unit in the EFB consists of prefilters, an electric heating coil, and a fan to condition the air, as required to maintain the design temperature. The EFB ventilation system exhausts air from all potentially contaminated areas of the building through two filter housings, each containing a bank of prefilters and two stages of HEPA filters, and two exhaust fans before discharging to the atmosphere. The EFB exhaust air is discharged to the underground exhaust duct so that it can be monitored for airborne radioactive contaminants.

2.6.3.6 Central Monitoring Room Ventilation System

The CMR is located in the Support Building. The CMR ventilation system provides a suitable environment for personnel occupancy under normal and HEPA filtration operation and maintains a slightly positive pressure in the CMR. The CMR has features to allow its use during both normal and emergency conditions including two-hour fire walls, redundant ventilation systems, supply and exhaust systems capable of being manually connected to the backup electrical power system, and a manual shift to HEPA filtration of intake air. Major components of the CMR HVAC system include supply air handling units that contain fans, cooling coils, filters, air cooled condensing units, and duct heaters, and exhaust-return fans, booster fans, HEPA filter units, instrumentation, and controls. The CMR is served by two 100 percent capacity air handling units. One is in service and one is in standby status. The standby unit will automatically start in the event the operating unit fails. The schematic air flow diagram for the CMR HVAC system is shown in Figure 2.6-5.

2.6.3.7 Underground Ventilation System

The underground ventilation system serves the WIPP underground to provide acceptable working conditions and a life-sustaining environment during normal operations and off normal events including waste handling accidents. In the event of a breach of waste containers the underground ventilation system provides confinement of radioactivity. The underground ventilation system is designed as an exhausting system that maintains the working environment below atmospheric pressure (Figures 2.6-6 and 2.6-7). The design and operation of the underground ventilation system meets or exceeds the criteria specified by 30 CFR Part 57[18] and the New Mexico Mine Safety Code for All Mines.[36] The underground mine ventilation is designed to supply sufficient quantities of air to all areas of the repository. Operation of diesel equipment in the underground is subject to minimum air flow requirements for each piece of equipment operated.

Underground ventilation is divided into four separate flow paths supporting the waste disposal area, the construction area, north area, and the waste shaft station. The waste disposal, construction and north areas receive their air supply from common sources, the air intake shaft and the salt handling shaft. The waste disposal area receives its supply air from the construction supply air at West-30 and South-1000 as shown in Figure 2.4-14. The waste shaft station receives its air supply from the waste shaft and associated auxiliary air intake and is separated from the other three circuits by bulkheads, overcasts, and airlocks. The bulkheads, overcasts, and airlocks are of noncombustible construction except for flexible flashing used to accommodate salt movement. All four air circuits combine near the exhaust shaft, which acts as the common discharge from the underground.

A pressure differential is maintained between the construction circuit and the waste disposal circuit to ensure that any leakage is towards the disposal circuit. The pressure differential is produced by the surface fans in conjunction with the underground air regulators. Pressure differentials across the bulkheads between ventilation circuits are monitored from the CMR.

The underground ventilation system consists of six centrifugal exhaust fans, three main fans in the normal flow path and three smaller fans in the filtration flow path, two identical HEPA filter assemblies arranged in parallel, isolation and back draft dampers, filter bypass arrangement, and associated ductwork.

The main fans are used during normal operation to provide a nominal underground flow of 425,000 scfm (standard cubic feet of air per minute). One main fan can be operated to provide a nominal flow of 260,000 scfm. The main fans are located near the exhaust shaft. The smaller filtrations fans are rated at 60,000 scfm each and are located at the EFB. During filtration operations only one filtration fan is in service and all other main and filtration fans are stopped and isolated. Any one of the three filtration fans is capable of delivering 100 percent of the design 60,000 scfm flow rate with the HEPA filters at their maximum pressure drop. Two of the three filtration fans can also be operated, with the HEPA system bypassed, to provide other underground ventilation requirements, when needed.

The underground ventilation system is operated as follows:

Normal Mode - During normal operation, five different levels of ventilation can be established to provide five different air flow quantities.

- Normal Ventilation: Two main exhaust fans operating to provide a nominal flow of 425,000 scfm unfiltered
- Alternate Ventilation: One main exhaust fan operating to provide a nominal flow of 260,000 scfm unfiltered
- Reduced Ventilation: Two filtration fans operating as ventilation fans to provide a nominal flow of 60,000 scfm each unfiltered
- Minimum Ventilation: One filtration fan operating as a ventilation fan to provide a nominal flow of 60,000 scfm unfiltered
- Maintenance Ventilation: Simultaneous operation of one or two main ventilation fans with one or two of the filtration fans in support of flow calibration and maintenance activities

Filtration Mode - This mode mitigates the consequences of an underground waste handling accident by directing the underground effluent through HEPA filters located on the surface near the top of the exhaust shaft. This mode also reduces the airflow in the underground. Filtration is activated automatically on a high radiation signal from one of the CAMs in the exhaust of the active disposal room, or manually by the CMR operator, through the CMS, when notified of a waste handling event underground. During shift to filtration the main exhaust fans are shut down and their associated isolation dampers close slowly, between 60 and 90 seconds, to minimize the effects of any pressure pulse back through the system.

In the filtration mode, the underground exhaust air passes through two identical filter assemblies located in the EFB on the surface. Each filter assembly consists of two banks of prefilters and two banks of HEPA filters arranged in series; and, each assembly will handle 50 percent of the filtered mode air flow, 30,000 cfm (cubic feet per minute) nominal each. The filters remove airborne radioactive particulates that may result from a breach of waste containers before the air is discharged to the atmosphere.

The operating status of the exhaust fans are displayed in the CMR and provisions to switch to filtration are provided. An alarm for excessive pressure drop across the filters is actuated at a predetermined level. Filter differential pressure is displayed locally and in the CMR. Instruments and system components are accessible for periodic testing and inspection during normal plant operation. Under normal operating conditions, the ventilation system functions continuously. Operation of the underground ventilation system is detailed in the WP 04-VU series facility operations procedures.[37]

If the normal flow of 425,000 scfm is not available, underground operations may proceed, but the number of activities that can be performed in parallel may be limited depending on the quantity of air available. The underground ventilation system filtration fans can be connected to the backup power supply, one at a time, in the event that normal power is lost. Changeover to backup power is manual, although, the fan isolation dampers fail to the filtration position on loss of power.

The bulkheads, overcasts, and airlocks and ventilation controllers within bulkheads used to segregate the underground ventilation circuits are made of noncombustible material, except for flexible flashing used to accommodate salt movement, in accordance with 30 CFR Part 57,[18] and can support the maximum pressure differential that could occur under normal operating conditions. These structures are designed, installed, and maintained in such a manner to accommodate ground deformation due to salt creep. Bulkheads and airlocks are constructed by erecting framing of rectangular steel tubing and screwing galvanized sheet metal to the framing. Figure 2.6-8 shows a typical bulkhead with an air flow regulator installed. To accommodate salt creep, bulkheads and airlocks use metal frames with telescoping extensions attached to the roof to keep the structure in place, and flexible flashing attached to the structure framing and to salt surface of the opening to provide the ventilation seal.

Approximately 140,000 actual cfm is normally supplied to the disposal area and is adequate to supply three active rooms in a panel during operations.

Approximately 35,000 cfm is required in each active room in a panel. This quantity of air supports the personnel and diesel equipment expected to be operating in the area, and meets or exceeds the minimum air velocity of 60 fpm (ft per minute) per disposal room as specified in the WIPP Mine Ventilation Plan (00CD-0001).[38] Disposal rooms that are filled and isolated, or rooms that are not in use do not require a specific airflow.

Air is routed through the individual disposal rooms within a panel using underground bulkheads and air regulators. Ventilation is maintained only in active rooms within a disposal panel. Once a disposal room is filled, it is closed against entry and isolated from the mine ventilation system by constructing barricades at each end, as shown in Figure 2.6.-9. Barricades typically consist of chainlink that is bolted to the salt and covered with brattice cloth. There is no requirement to ventilate filled rooms. After all rooms within a panel are filled, the panel will be closed, using a closure system described in Section 2.5.5.4.

The ventilation path for the waste disposal circuit is separated from the construction side by means of bulkheads, overcasts, and airlocks constructed of noncombustible material except for the flexible flashing used to accommodate salt movement. ~~In E-300 there is an overcast that allows the disposal circuit ventilation to be directed towards the waste face. To the south of the overcast a metal bulkhead segregates leakage from the construction circuit to the disposal exhaust. Hot work or work involving the use of flammable compressed gas cylinders is not performed when waste is in transit through the overcast.~~

<u>As panels are filled and closed, and new panels are added to the waste disposal ventilation circuit, airlocks, bulkheads, and overcasts are installed and removed as necessary to supply appropriate ventilation, while separating the disposal and construction ventilation circuits.</u>

2.6.3.8 Natural Ventilation Pressure

The air flow in the underground is normally driven by the negative pressure induced by the main fans. There can be a second pressure resulting from the difference in density between the air entering and leaving the repository which can influence air flow. This phenomenon is called the natural ventilation pressure (NVP). It is experienced on days when outside temperatures are either very hot or very cold.

Hot Weather NVP - During hot weather, the air going down to the underground is warmer and less dense than the air returning from the underground. This lighter air has a natural tendency to resist being drawn down into the repository. Hence in hot weather there is negative NVP which opposes the fan pressure. This reduces the flow down the air intake shaft and salt handling shaft. It also reduces the differential pressures between the waste shaft station, waste disposal area, and the other areas. The air in the waste shaft will be cooler than that in the air intake shaft and salt handling shaft, which further reduces the waste shaft station to West-30 differential pressure.

Under ordinary operating conditions, the pressure in West-30 is higher (less negative) than that in the waste shaft station in South-400. On very hot days, exceeding 100°F, the reduction of this differential pressure caused by the negative NVP can result in the pressure in South-400 being higher than in West-30. Without corrective actions, this would allow air flow from the controlled area into a non-controlled area.

Cold Weather NVP - During cold weather, the air going down to the underground is colder and denser, heavier, than the air returning from the underground. This denser air, colder air, has a natural tendency to sink down the air intake shaft and salt handling shaft. In cold weather there is a positive NVP which augments the fan pressure. This increases the air flow down the intake shafts, reduces the fan suction pressure, constant flow control, and increases the differential pressure between the waste shaft station, waste disposal area, and the other areas. On extremely cold weather days, a portion of the air entering the underground through the air intake shaft and salt handling shaft may be the result of a positive NVP. This air is entering the repository without the aid of the mechanical fans. The fans in turn reduce their operating pressure because they are receiving a sufficient and constant volume of air. Up-casting of the air in the waste shaft can occur if the situation is not corrected.

The air feeding the waste shaft comes primarily from the auxiliary air intake tunnel, partly from leakage into the waste hoist tower, and partly from the WHB. The result is that the air feeding the waste shaft tends to be warmer than the surface air feeding the air intake shaft. The reduction in fan pressure, coupled with the warmer air in the waste shaft is only under alternate, reduced, and minimum ventilation modes.

Administrative action is required to adjust the underground ventilation configuration to avoid reverse flow in the waste shaft. They include:

- Start second main exhaust fan (normal ventilation)
- Open the regulator to the waste shaft station
- Cover the air intake shaft and/or the salt handling shaft on the surface
- Close the regulators to the construction, waste disposal and north circuits

A pressure chamber has been constructed at bulkhead 74-B-309 on the west side of the waste shaft station to ensure that leakage from the waste shaft station to the construction ventilation circuit does not occur. The pressure chamber is manually activated whenever waste handling is occurring in the waste shaft and/or waste shaft station, and differential pressure between South-400 and West-30 is low. The chamber is pressurized by six high-pressure fans. The fans are operated in various combinations to provide the air flow necessary to maintain the pressure buffer. As a secondary backup system, pressure will be supplied by an actuated valve on a plant air pressurized line. The valve will be controlled to regulate the flow of air into the chamber and maintain pressure differentials. The pressure inside the chamber is monitored to ensure that it is sufficient to prevent air flow reversal even if the differential pressure from South-400 to West-30, which is also monitored, is in the wrong direction or positive NVP is sufficient to cause waste shaft air flow reversal. Bulkhead 74-B-309 is constructed of metal.

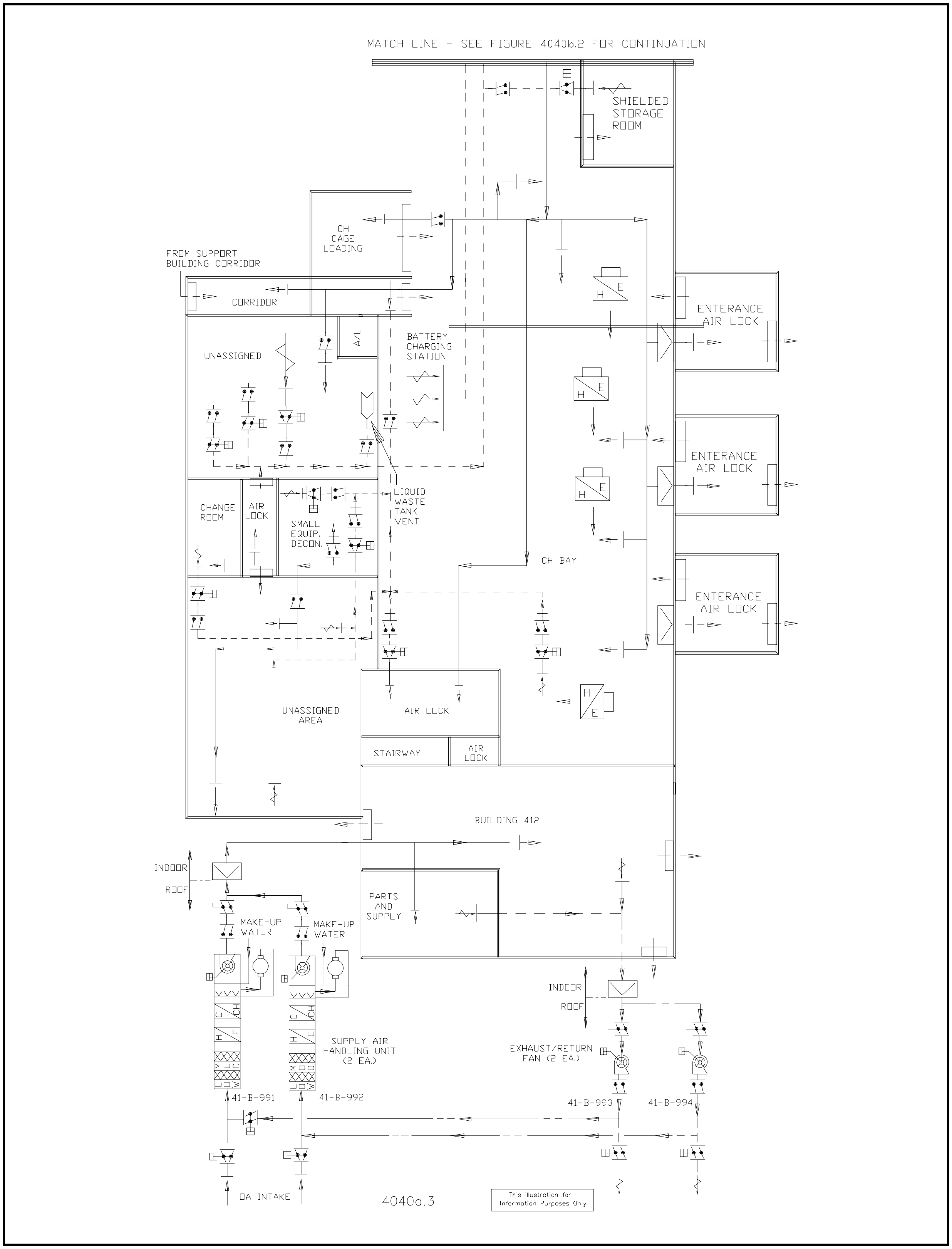

Figure 2.6-1, WHB and TRUPACT Maintenance Facility

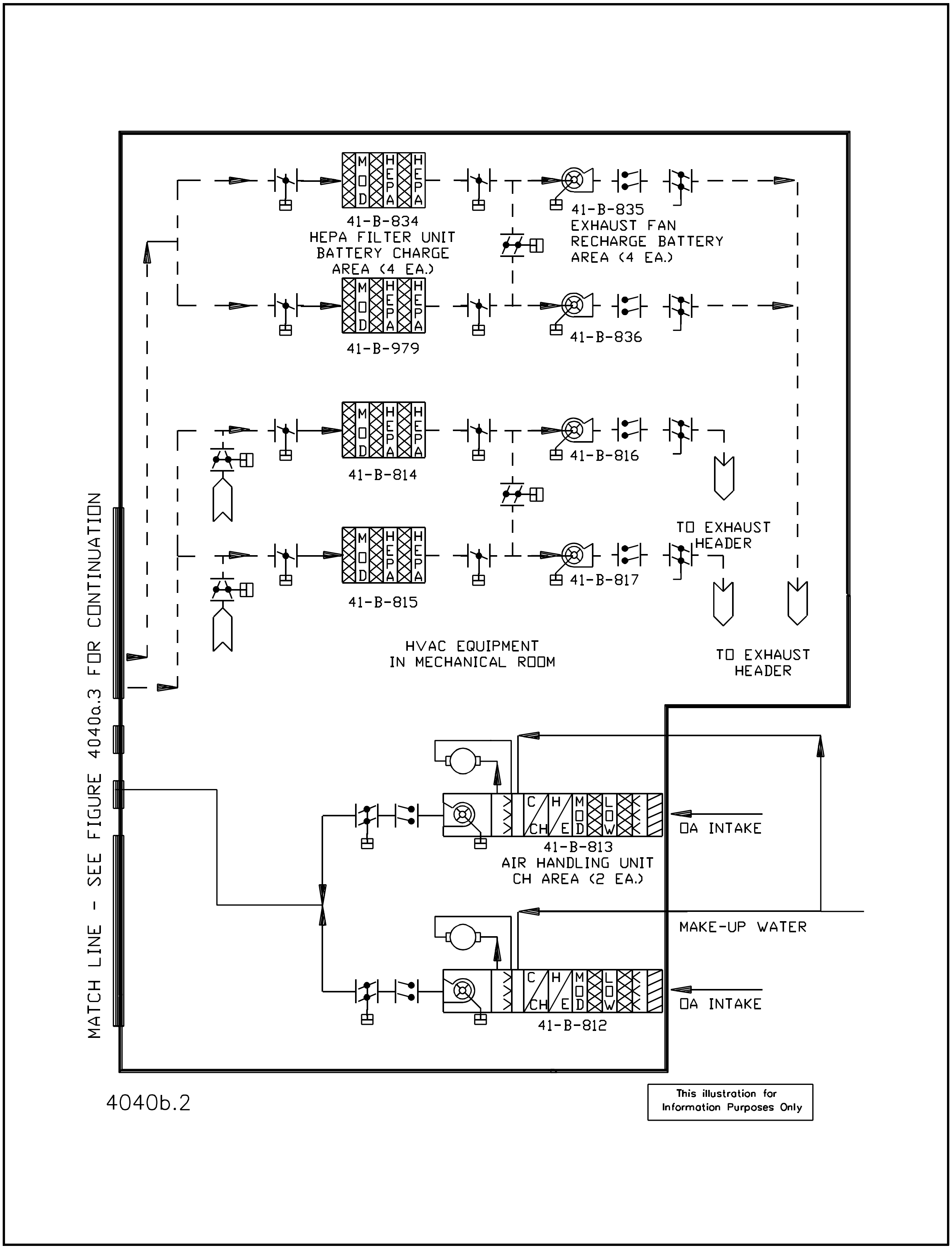

Figure 2.6-1a, WHB CH HVAC Flow Diagram

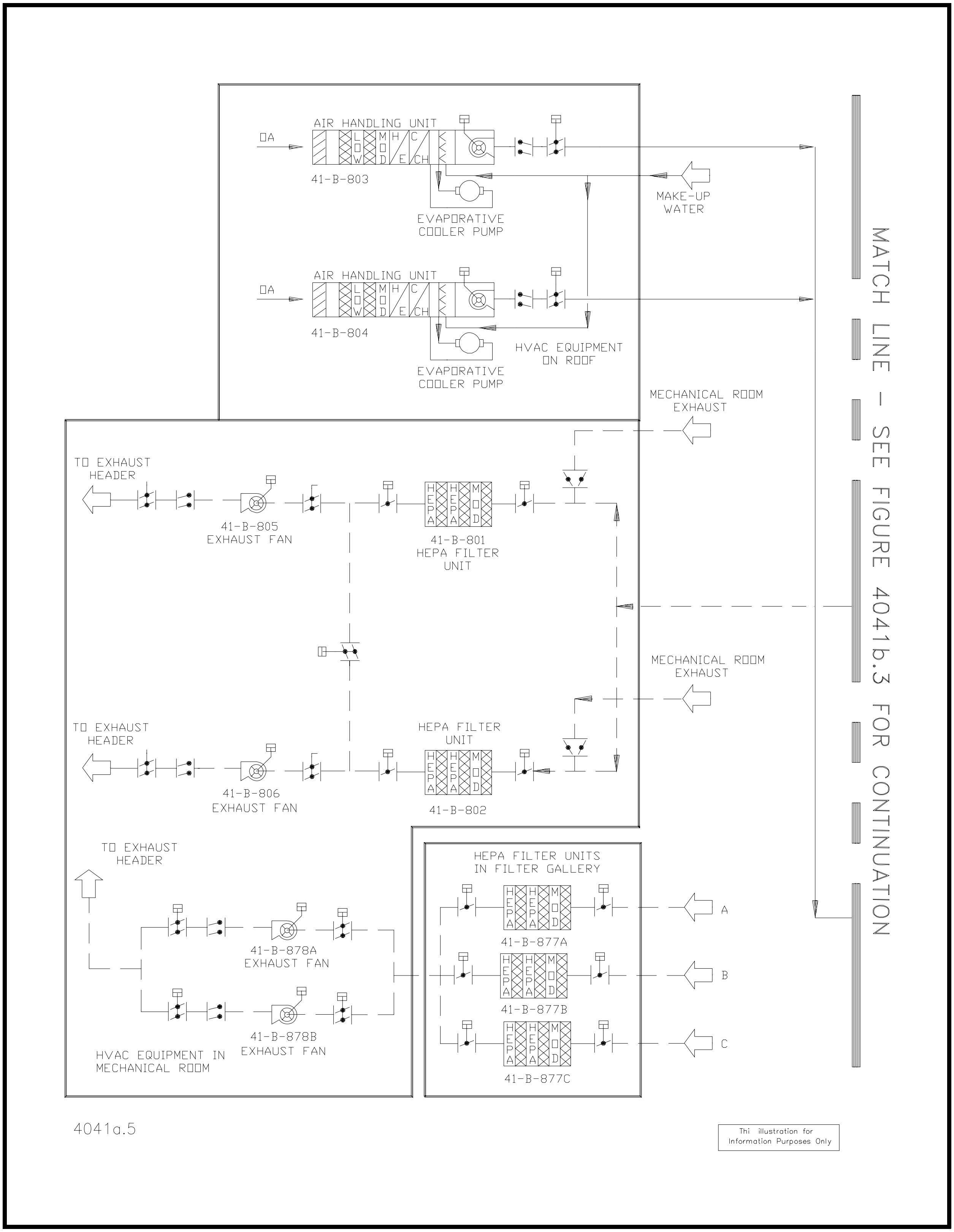

Figure 2.6-2, WHB RH HVAC Flow Diagram

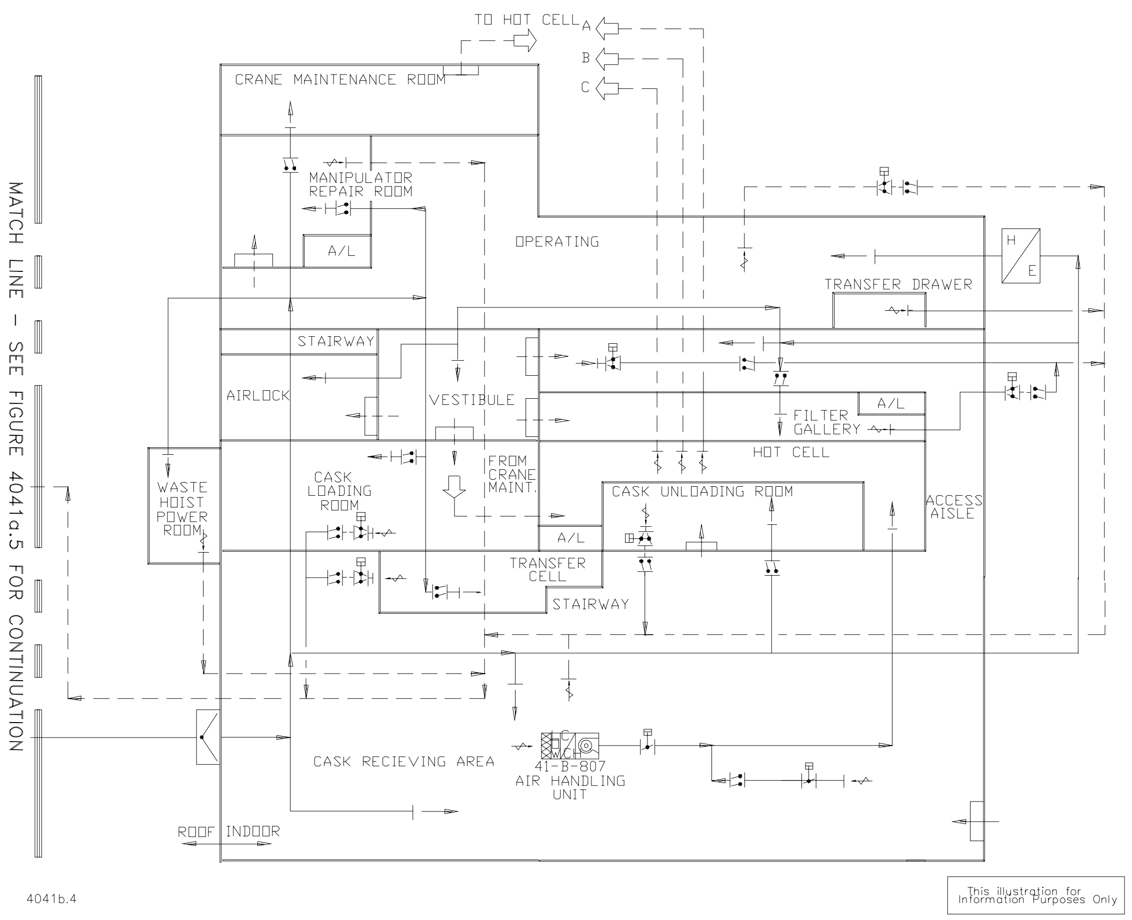

Figure 2.6-2a, WHB RH HVAC Flow Diagram

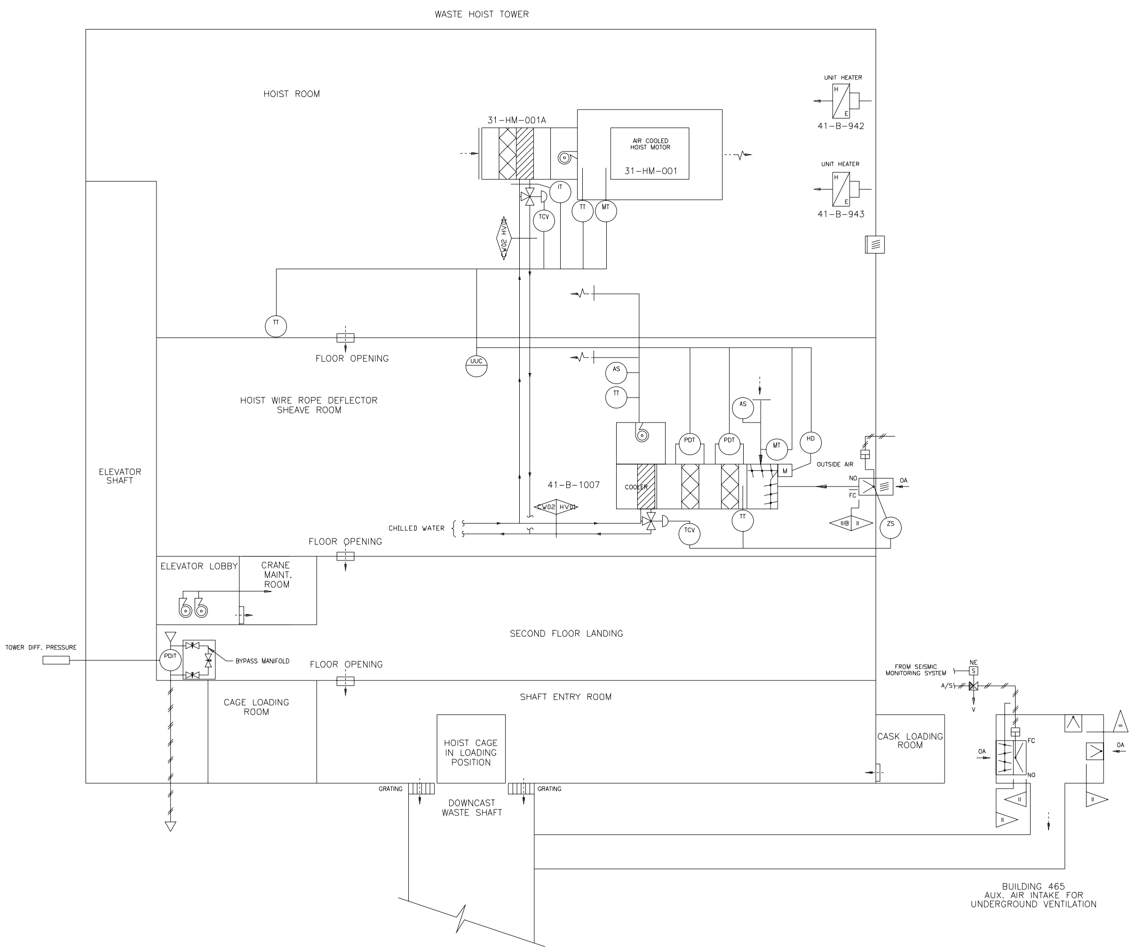

Figure 2.6-3, Waste Shaft/Hoist Tower HVAC Flow Diagram

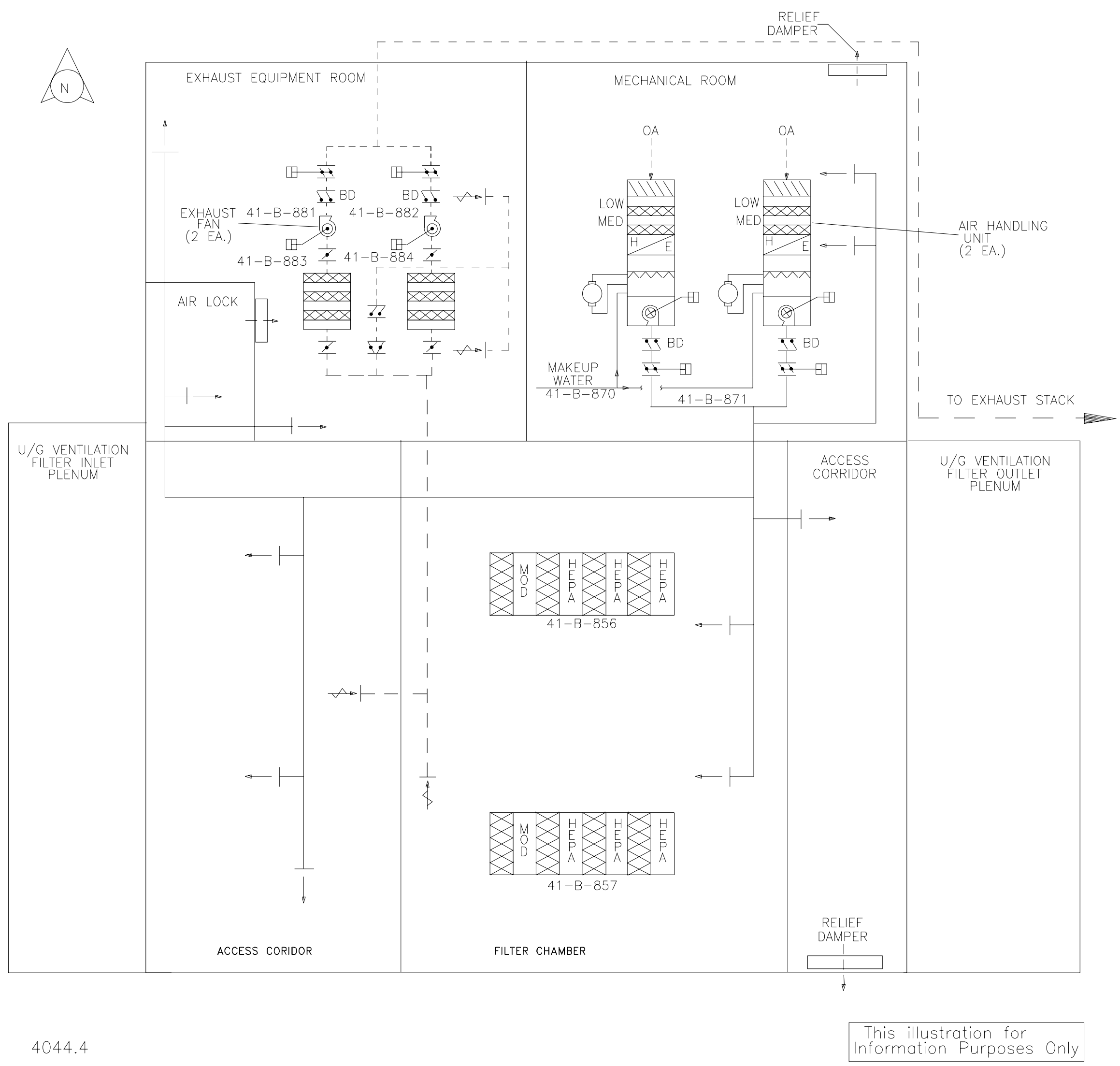

Figure 2.6-4, EFB HVAC Flow Diagram

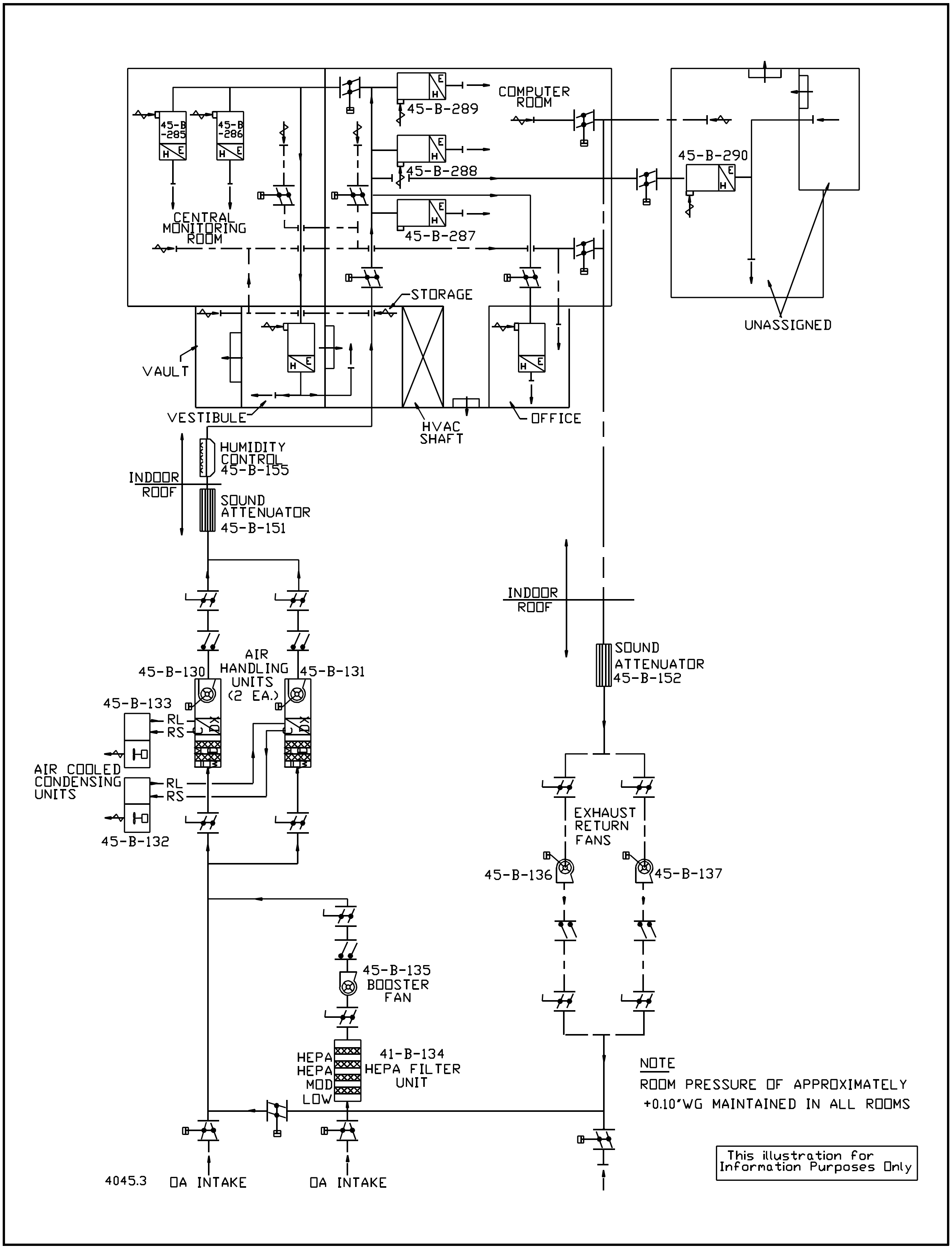

Figure 2.6-5, Support Building CMR HVAC Flow Diagram

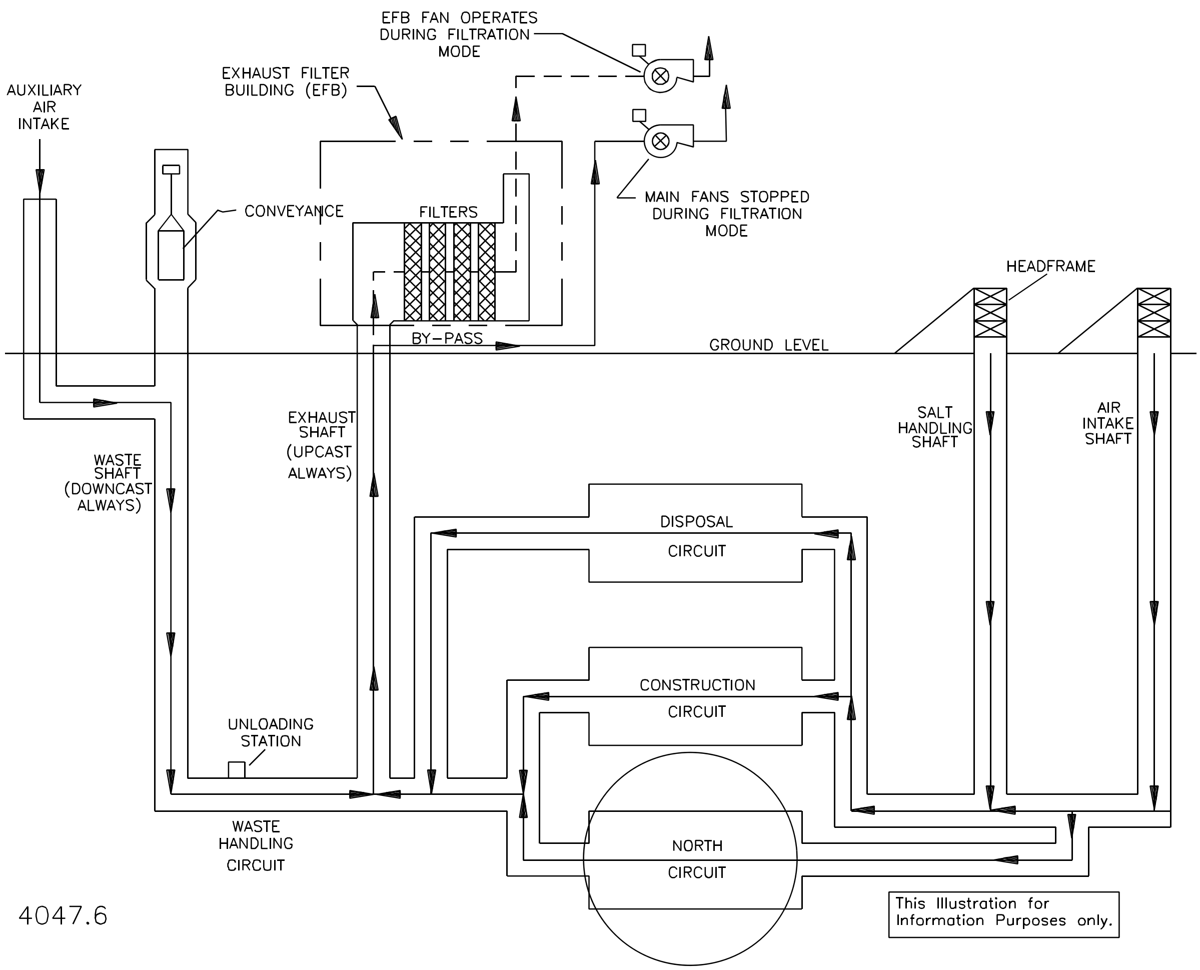

Figure 2.6-6, Underground Ventilation Air Flow Diagram

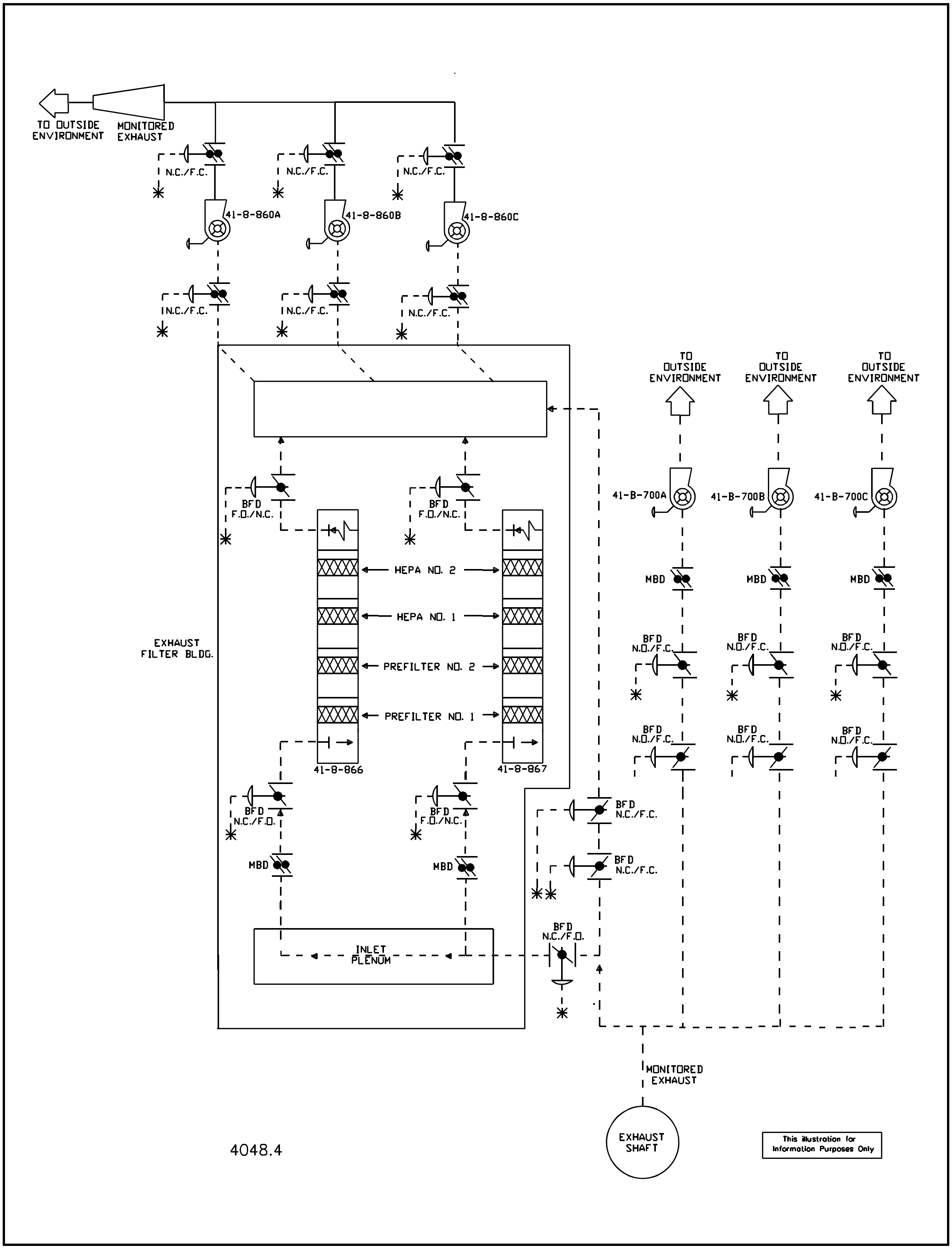

Figure 2.6-7, Main Fan and Exhaust Filter System Schematic

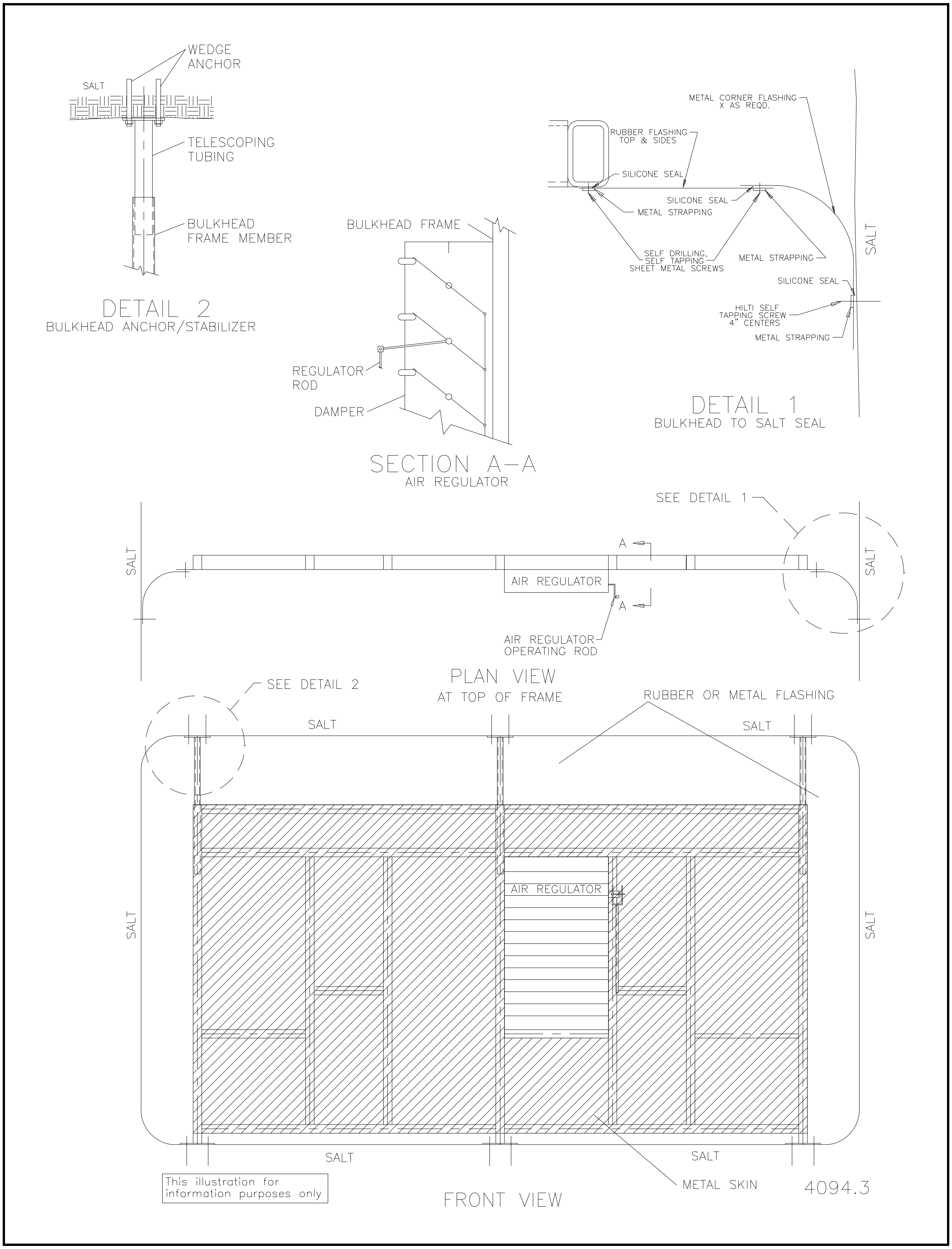

Figure 2.6-8, Typical Bulkhead Design and Components

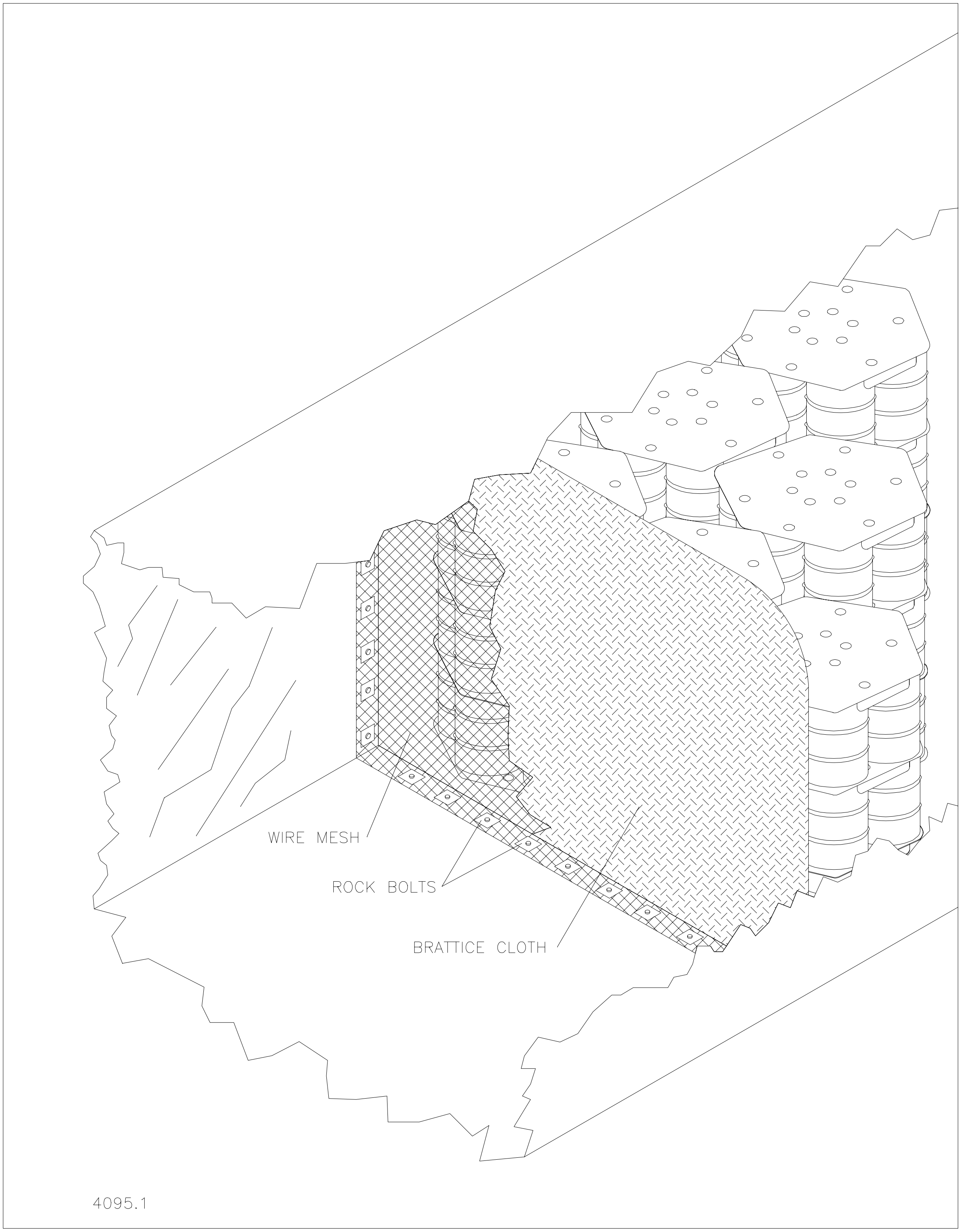

Figure 2.6-9, Typical Disposal Room Barricade

2.7 Support Systems

2.7.1 Radiation Monitoring System

The radiation monitoring system includes five subsystems to ensure radiation protection of plant personnel and the surrounding environment under normal operation, off-normal events, and recovery from off-normal events. The subsystems are: CAM System, Fixed Air Sampling (FAS) Systems, Area Radiation Monitoring (ARM) Systems, Radioactive Effluent Air Monitoring System (REMS), and the Plant Vacuum.

Signals are provided to the CMR to provide continuous surveillance and display or log alarm status for selected CAM, Radioactive Effluent Air Monitoring Systems, ARMs, and the Plant Vacuum system.

During RH waste handling activities in the WHB, ARMs and area CAMs are in operation. ARMs detect direct radiation and changes in shielding. ARMs are located in the RH bay at the cask preparation station, in the CUR, in the FCLR, the transfer cell service room, and two in the upper hot cell. The ARM in the CUR actuates a caution light to notify personnel that RH waste is unshielded inside the CUR. The CUR ARM also enables an alarm at the CUR personnel door that will actuate if the door is opened, while RH waste is unshielded, and sound an alarm locally and in the CMR. The ARM in the FCLR alerts the operator should the telescoping port shield or shield bell be improperly positioned or change positions during transfer of a waste canister from the transfer cell to the facility cask.

CAMs are provided at the cask preparation station, CUR, the service room (monitors the transfer cell), the FCLR and in the exhaust of the active disposal panel. CAMs have both alpha and beta detection capability. CAMs detect airborne radioactive material.

REMS are installed on the WHB ventilation exhaust downstream of the HEPA filters (Station C), and on the underground ventilation system exhaust both upstream (Station A) and downstream (Station B) of the HEPA filters. The REMs consist of sampling equipment including a pump, flow controller, sample holder, and delivery piping.

The plant vacuum system provides a centrally located vacuum source that is used to draw air through filters that collect potentially radioactive particulates. The system supplies the vacuum source for CAMs and FASs located in the CH and RH waste handling areas of the WHB (SDD RM00, Radiation Monitoring)[39] and Support Building. The CAM and FAS units not connected to the plant vacuum system are equipped with their own vacuum pumps. The value of the vacuum and the identity of the operating vacuum pump are displayed in the CMR.

2.7.2 Radiation Effluent Air Monitoring System

2.7.2.1 WHB Exhaust Effluent Air Monitoring System

The WHB exhaust effluent monitoring system, referred to a s Station C, is located on the second floor of the WHB. Station C samples the WHB exhaust downstream of the HEPA filters associated with both the RH and CH portions of the building.

2.7.2.2 Underground Exhaust Effluent Air Monitoring System

The underground exhaust effluent monitoring system is composed of Station A and Station B. Station A is located over the underground ventilation system exhaust elbow at the surface and samples using probes that extend 21 ft below the elbow in the exhaust shaft. Station B samples from a point downstream from the underground ventilation system main fans and HEPA filters. Figure 2.4-12 shows the location of both Station A and Station B. Station A contains three sampling skids each splitting the sample and directing the air into three air samplers per skid. Station B contains two sampling skids each splitting the sample and directing the air into three air samplers per skid.

2.7.3 Fire Protection System

The WIPP fire protection system is designed to ensure personnel safety, mission continuity, and property conservation. Building designs incorporate features for fire prevention. The plant design meets the improved risk level of protection defined in DOE O 420.1A[2] and satisfies applicable sections of the NFPA codes, DOE Orders, and federal codes described in DOE/WIPP-3217, *Waste Isolation Pilot Plant Fire Hazard Analysis Report*.[40]

The WIPP fire protection system design, as described in SDD FP00, Fire Protection System,[41] incorporates the following features:

- Most buildings and their support structures are protected by fixed, automatic fire suppression systems designed to the individual hazards of each area. The WHB, support building, and TMF have wet pipe sprinkler systems. The TMF sprinklers are supplied by the WHB sprinkler system.

- Noncombustible construction, fireproof masonry construction, and fire resistant materials are used whenever possible.

- Fire separations are installed where required because of different occupancies per the Uniform Building Code.

- In multistory buildings, vertical openings are protected by enclosing stairways, elevators, pipeways, electrical penetrations, etc., to prevent fire from spreading to upper floors. The waste hoist tower is an exception and has an open path from the hoist tower to the bottom of the waste shaft to accommodate the hoist ropes.

- A combustible loading control program is in place to minimize the accumulation of combustibles within the WHB and area between the support building and WHB.

- The area within the PPA security fence is either paved or graveled with minimal vegetation. A gravel road parallels the PPA perimeter security fence, which acts as a fire break in the event of a wild land fire. Several features outside the perimeter security fence also serve as fire breaks and include the salt pile to the north, pond areas to collect rain runoff to the north, east and south, a paved parking area and access road to the west, and berms and the electrical switch yard to the east.

The WHB and underground exhaust ventilation systems which remove hot fire gases, toxic contaminants, explosive gases, and smoke are designed with a high fire integrity.

The components of the electrical service and distribution system are listed by Underwriters Laboratories (UL), or approved by the Factory Mutual Engineering Corporation (FMEC), and are installed to minimize possible ignition of combustible material and maximize safety.

Adequate provisions for the safe exit of personnel are available for all potential fire occurrences with evacuation alarm signals provided throughout occupied areas. Building evacuation plans help ensure the safe evacuation of building occupants during emergency conditions. The WIPP emergency management program, as set out in WP 12-9, WIPP Emergency Management Program,[42] contains the underground emergency procedures, the underground evacuation routes, and the designated assembly areas. Additionally, firefighting support is available from the Hobbs and Carlsbad, New Mexico, fire departments.

The WIPP fire protection system consists of four subsystems:

- Fire water supply and distribution system
- Fire suppression system
- Fire detection and alarm system
- Radio fire alarm reporter system

2.7.3.1 Fire Water Supply and Distribution System

The fire water supply and distribution system consists of two fire pumps and a pressure maintenance (jockey) pump located in the water pump house shown on Figure 2.4-1, and a compound loop yard distribution system. One fire pump is electric motor driven and the other pump is diesel engine driven. Both pumps are rated for 1,500 gallons per minute at 125 psi (pounds per square inch). The system is required to provide fire water at a rate of 1,500 gallons per minute for two hours for a total of 180,000 gallons. All major components of the fire water supply and distribution system are UL-listed and FMEC-approved.

The fire water supply system receives its normal water supply from one of two on-site 180,000 gallons ground-level storage tanks, which are part of the water distribution system. The second tank supplies water to the domestic/utility water system, which is a separate system from the fire water supply system. The domestic/utility water tank reserves approximately 100,000 gallons of water for use as fire water if the need arises. Utilization of the domestic/utility tank water by the fire water supply system is achieved by the installation of a suction piping spool piece.

Operation of the two fire pumps and the jockey pump is controlled by distribution system pressure changes. The pumps are arranged for sequential operation. Under normal conditions, the jockey pump operates to maintain the designed system static pressure. Should there be a demand for fire water which exceeds the capacity of the jockey pump, the fire water demand should cause the system pressure to drop which automatically starts the electric fire pump. If the jockey and electric fire pumps cannot maintain system pressure, the diesel pump automatically starts.

The yard compound loop distribution system serves all areas of the site by suppling fire water to all facilities containing a sprinkler system and to the fire hydrants, located at approximately 300-ft intervals, throughout the site. The system contains numerous sectionalizing and control valves, which are locked, and visually checked monthly.

2.7.3.2 Fire Detection and Alarm System

The fire detection and alarm system consists of multiple systems, each utilizing most or all of the following components: heat sensing fire detectors, smoke detectors, sprinkler system water flow alarm devices, manual fire alarm systems, control panels, and audible and visual warning devices. A complete description of the type of fire suppression system provided at each of the WIPP surface structures and the underground is provided in the WIPP Fire Hazard Analysis Report[40] and the SDD-FP00.[41]

2.7.3.3 Radio Fire Alarm Reporter System

The radio fire alarm reporter system provides fire alarm and system trouble annunciations in the CMR for structures not connected to the CMS local processing units. This system consists of radio transmitters that transmit alarm and trouble signals via an FMEC signal to a central base station/receiver.

2.7.3.4 Fire Suppression System

The fire suppression system consists of several different fire extinguishing systems or equipment that service the surface buildings and facilities and the underground areas. These may include any one or more of the following fire extinguishing capabilities: automatic wet pipe sprinkler system, fire hose connections, automatic dry and wet chemical extinguishing systems, and portable fire extinguishers. The automatic wet pipe sprinkler system is the primary suppression system for fire protection at the WIPP site.

The availability of fire-protection water at each sprinkler system is routinely checked as part of the surveillance requirement for each system. Should the fire-protection water distribution system become unavailable, adequate measures (e.g., stopping all potential fire-initiating activities at the affected buildings and implementing fire watches) are taken to provide a reduced risk of a large fire. The suppression system is operable in the absence of electric power due to the heat-rated fusible-link actuation of the sprinkler heads in the facilities and the diesel driven pump that is part of the fire water supply and distribution system. The fire suppression system and the fire water supply and distribution system are not designed to withstand the effects of a DBE or DBT. The WHB is supplied by three risers, one in the overpack and repair room, one in the RH bay and one in the CH bay. The TMF receives its fire water supply from the suppression portion of the WHB.

The fire suppression systems inside the WHB and the Support Building includes the main drain, instrumentation, an alarm valve, a water flow detection device, a water motor gong, an isolation valve, and a fire department connection, distribution piping with installed fusible sprinklers, valving, and an inspectors test connection. A portion of the CH bay is supplied from the portion of the suppression system in the overpack and repair room. The TMF, supplied from the suppression system in the WHB, is equipped with distribution piping with installed fusible sprinklers, valving, a flow switch, an inspectors test connection, and an isolation valve and associated drain.

Sprinkler systems are maintained full of water and pressurized by the fire water distribution system. When a fire occurs, the heat produced will cause one or more sprinklers in the area to actuate causing water to flow. The sprinkler system will continue to flow until it is shut off manually.

2.7.3.5 Fire Protection System Design, Installation, Testing and Maintenance

The following NFPA standards apply at the WIPP:

- The fire water supply and distribution system is designed, installed, tested, and maintained according to NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*[43]; NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*[44]; and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.[45]

- The automatic wet pipe sprinkler systems are designed, installed, tested, and maintained in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,*[46] and NFPA 25.[45]

- The dry and wet chemical fire suppression systems are designed, installed, tested and maintained in accordance with NFPA 17, *Standard for Dry Chemical Extinguishing Systems*,[47] and 17A, *Standard for Wet Chemical Extinguishing Systems*,[48] respectively.

- The fire detection and alarm systems are designed, installed, tested, and maintained in accordance with NFPA 70, *National Electrical Code*,[49] and NFPA 72, *National Fire Alarm Code Handbook*.[50]

- The radio fire alarm reporter system is designed, installed, tested, and maintained in accordance with NFPA 72[50] and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*.[51]

2.8 Utility Distribution Systems

2.8.1 Electrical System

The WIPP electrical system is designed to provide normal and backup power, grounding for electrically energized equipment and other plant structures, lightning protection for the plant, and illumination for the WIPP surface and underground.

The WIPP has standard industrial electrical distribution equipment including medium voltage switchgear and buses; medium voltage to low voltage step-down unit substations; motor control centers; small distribution transformers and panels; relay and protection circuitry; station batteries along with associated synchronous inverters; diesel generators; and the cabling, enclosures, and other structures required to locate and interconnect these items.

The electrical system is designed to supply power at the following nominal bus voltages:

- 13.8 kVAC (kilovolt alternating current), three-phase, three-wire, 60-Hz (hertz) - Power supply for the main plant substation, underground switching stations, and surface and underground unit substation transformers.

- 4.16 kVAC, three-phase, three-wire, 60 Hz - Power supply for the main exhaust fan drive motors.

- 2.4 kVAC, three-phase, three-wire, 60 Hz - Power supply for the drive motor for the motor-generator set, which provides the backup supply for the SH shaft drive motor.

- 480/277 VAC, three-phase, four-wire, 60 Hz - Power supply for motor control centers, the AIS drive motor, solid state direct current converter systems for the SH and waste hoists, underground filtration fans, lighting and power distribution transformers.

- 120/208 VAC, three-phase, four-wire, 60 Hz - Power supply for lighting, utilization equipment, instrumentation, communications, control systems, and small motor-driven equipment.

- 120/208 VAC, three-phase, four wire, 60 Hz - Uninterruptible power supply (UPS) for control and instrumentation which must be continuously energized under all plant operating modes.

2.8.1.1 Normal Power Source

The WIPP normal power is from a public utility company which supplies electrical power from their 115 kV Potash/Kerrmac Junction open wire transmission line from the north and Whitten/Jal substation open wire line from the south. The north line is approximately 9 miles long, while the south line is approximately 19 miles long. The Potash Junction and Whitten Substations each have two feeders from multiple generating stations and loss of one generating source does not interrupt power to the WIPP site.

The utility substation at the WIPP site is located east of the PPA. Area substations are located at the various surface facilities. Underground conduits, cable duct banks, and buried cables connect the plant substation with the area substations.

2.8.1.2 Backup Power Source

In case of a loss of utility power, backup power to selected loads can be supplied by either of the two on-site 1,100 kW (kilowatt) diesel generators. The generators provide reliable 480-VAC power to the loads listed in Table 2.8-1. Backup power is fed through buses A and B (Figure 2.8-1). Each of the diesel generators can furnish power for preselected CMS loads, to operate the air intake shaft hoist for underground personnel evacuation, and other selected backup loads in accordance with procedures in the WP 04-ED series facility operations procedures.[52] The on-site total fuel storage capacity is sufficient for the operation of one diesel generator at full load for one day, and additional fuel supplies are readily available within a few hours by tank truck allowing on-line refueling and continued operation.

Facility Operations personnel manually start the diesel generators within 30 minutes of loss of normal power. The diesel generators can be started from either the control panel on each diesel or from the CMR. Only one diesel may be loaded at a time (Air Quality Permit No. 310-M-2).[53] Monitoring of the diesel generators and associated breakers is possible at the CMR, thus providing the ability to energize selected loads from the backup power source, in sequence, without exceeding generator capacity.

The diesel generators and their load center are located outside between the Safety and Emergency Services Building and EFB. A backup 480-VAC indoor switchgear is located in the main electrical room in the Support Building. Area substations are located at various surface facilities.

Operation of backup power supplies and the selection of loads is addressed in the WP 04-ED series facility operations procedures.[52]

2.8.1.3 Uninterruptible Power Supply

The central UPS, located in the Support Building, provides transient-free, reliable 120/208-VAC power to the essential loads, listed in Table 2.8-2, in the Support Building and WHB. This ensures continuous power to the radiation detection system for airborne contamination, local processing units (LPUs), computer room, and CMR even during the interval between the loss of off-site power and initiation of backup diesel generator power. Additional UPSs provide transient-free power to strategically located LPUs for the radiation monitoring system on the surface, in selected areas in the exhaust shaft, and underground passages and waste disposal areas. In case of loss of AC power input to the UPSs, the dedicated batteries can supply power to a fully loaded UPS for 30 minutes.

2.8.1.4 Lightning Protection and Grounding

The WIPP lightning protection system uses the plant ground system and consists of lightning arresters located at select substations and a lightning dissipation system. The lightning dissipation system uses pole mounted arrays, which encircle the WIPP fenced area and umbrella arrays, which are mounted on top or select facilities and hoist headframes. Dissipation arrays are installed over the hoist head frames and WHB. Hemisphere arrays are installed over the EFB and also over the salt shaft and air intake shaft headframes. A conical array is installed over the waste hoist tower. Roof arrays are located along the outer rim of the WHB and between supports on the site perimeter lamp poles. The arrays between site perimeter lamp poles provide protection to the transportation packages in the parking area prior to being moved into WHB for further waste handling activities. The arrays associated with the WHB and waste hoist tower not only protect personnel but protect the waste containers from damage due to a lightning strike.

The WIPP grounding system uses a resistive grounded electrical system and consists of grounding resistors, a direct buried surface site ground grid, bare copper underground facility ground, facility ground rings, facility ground conductors, ground buses, equipment grounding conductors, bonding and grounding electrodes. The grounding associated with the utility switch yard is separate from the WIPP site plant grounding. The lightning protection and grounding systems are discussed in further detail in the Electrical System (ED00) SDD.[54]

2.8.1.5 Safety Considerations and Controls

Failure of the normal distribution system or any of its components will not affect safe conditions of the WIPP facilities. Upon loss of normal off-site power, the EFB isolation valves fail to the filtration mode. The simplified single-line diagram for the normal and manually switched backup loads is shown in Figure 2.8-1.

2.8.2 Compressed Air

The compressed air system is considered BOP. The system is diverse in the types and sizes of compressors used, and redundancy is provided for the main plant air compressors, salt hoist house, and the underground. All are electrically driven except for the diesel powered backup compressor in the underground.

The WHB and EFB have air dryers. The plant air system ends at these dryers and the instrument air system begins. Instrument air is supplied to selected doors in the WHB. Instrument air is used to operate dampers and control systems for the underground ventilation system and HVAC systems in the EFB.

2.8.3 Plant Monitoring and Communications Systems

The plant monitoring and communications systems include on-site and plant-to-off-site coverage and are designed to provide immediate instructions to ensure personnel safety, facility safety and security, and efficient operations under normal and emergency conditions. Plant monitoring and communications systems include the following:

- CMS
- Plant communications
  - Touch tone phones
  - Mine pager phones

- Plant public address (PA) system including alarms and the site notification system
- Radio
- Underground Evacuation Signal System

2.8.3.1 Central Monitoring System

The CMS collects and monitors real time site data, automatically and manually, during normal and emergency conditions. The underground and surface data monitored by the CMS is gathered, processed, stored, logged, and displayed. The data is collected continuously from approximately 1,500 remote sensors.

The CMS is a computer-based monitoring and control system. It is used for real time site data acquisition, display, storage, alarm and logging and for the control of site components. The CMS monitors selected components from the following systems:

- Radiation monitoring equipment and effluent sampling stations.
- Electrical power distribution status, including backup diesel operation.
- Fire detection and alarm system.
- Ventilation system, including damper position, fan status, flow measurement, and filter
- Meteorological data, including wind speed and direction, temperature, and barometric pressure.
- Facility systems, including air compressors, vacuum pumps, and water storage tank levels.

The CMS has five operator work stations, including an engineer's work station, which display: alarms, status, trends, graphics, and interactive operations. There are two operator work stations and an engineer's work station located in the CMR, two operator work stations in the computer room, and the CMS backup operator work station is located in the security control room. The CMS electronic data storage devices are located in the computer room adjacent to the CMR. The CMS sources of AC electrical power include an UPS, with a minimum of 30 minutes' backup power, and the diesel generator used to power priority loads (including the CMR).

2.8.3.2 Plant Communications

The touch-tone phone system includes a private automatic branch exchange network providing conventional on-site and off-site telephone services. Major uses of this subsystem include the reporting of occurrences (DOE O 231.1A, *Environment, Safety and Health Reporting*)[55] and communications between the CMR and other plant or security personnel or the Emergency Operations Center (EOC).

The mine pager phones are an independent, hard-wired, battery-operated system for communications throughout the underground and between the surface and underground. Mine pager phones are located throughout the underground and in surface structures to support daily operations and emergencies. Surface locations include, but are not limited to the hoists, the CMR and the facility shift manager's desk in the Support Building, and the EOC and the mine rescue room of the Safety Building.

The plant PA and alarm systems provide for the initiation of surface and underground evacuation alarms and PA announcements from the CMR and local stations. The plant PA and alarm systems includes the site-wide PA and intercom installations and the site notification system for remote locations. These alarms are supplied with backup power if the off-site power supply fails. The PA system master control console is located in the CMR, with paging stations located in the Support Building, WHB, water pump house, Guard and Security Building, salt shaft hoist house and headframe, EFB, Safety Building, Engineering Building, warehouse, shops, and underground.

The underground evacuation signal is separate from the public address system and includes electric horns and strobe lights. An underground evacuation signal is initiated automatically by an underground fire alarm signal via the CMS or manually by the CMR operator or from pushbuttons in the salt handling shaft hoist house and waste shaft hoist control room. The underground evacuation signal is reset from any of the three manual pushbutton stations.

Radio includes two-way and paging on-site and off-site radio systems. These systems include base stations in the CMR, security control room, emergency operations center, and mobile and portable units.

The plant communication equipment is not designed to withstand the effects of a DBE or DBT.

Table 2.8-1, Diesel Generator Loads

Manually Switched Backup		
Loads	**kW**	**Remarks**
Uninterruptible power system CMS WHB CAMs	72	Priority backup loads.
CMR HVAC system utilities	20	Priority backup loads.
Fire protection systems in the WHB and Support Building	30	Battery power is provided in fire protection system until the diesel generator is started and loaded.
Fire pump	160	
Communications systems	16	
Guard & Security Building	35	
Air intake shaft hoist (if necessary for underground evacuation)	330	The diesel generators load is reduced to 900 kW prior to operating the air intake shaft hoist.
WHB lighting	45	
WHB cranes	80	After the diesel generator is started cranes are energized as required to land their loads.
WHB vacuum pumps	50	
Main air compressors (1-200 hp)	160	
Underground exhaust fans (1-235 hp)	188	Priority backup loads.
WHB fans	100	Priority backup loads.
Underground Sandia other experimental loads	400	
Safety & Emergency Services Building	10	Priority backup load.

Table 2.8-2, UPS Loads

LOAD ON CENTRAL UPS	
• Radiological monitoring system (ARM and CAM) • Central monitoring system - CMS equipment in the Support Building and WHB • Communication system in WHB and Support Building • Seismic trip in WHB • Network computers and equipment in the Support Building computer room	
Total connected load	88 kW
Running load	30 kW
Loads on Individual UPS Units	
• CMS equipment in facilities other than WHB and Support Building • Selected surface and underground radiological monitoring units • EOC, Safety and Emergency Services Facility, Guard and Security Building • Safety communication and alarm system in facilities other than WHB and Support Building	
Total independent backup system load	66 kVAC

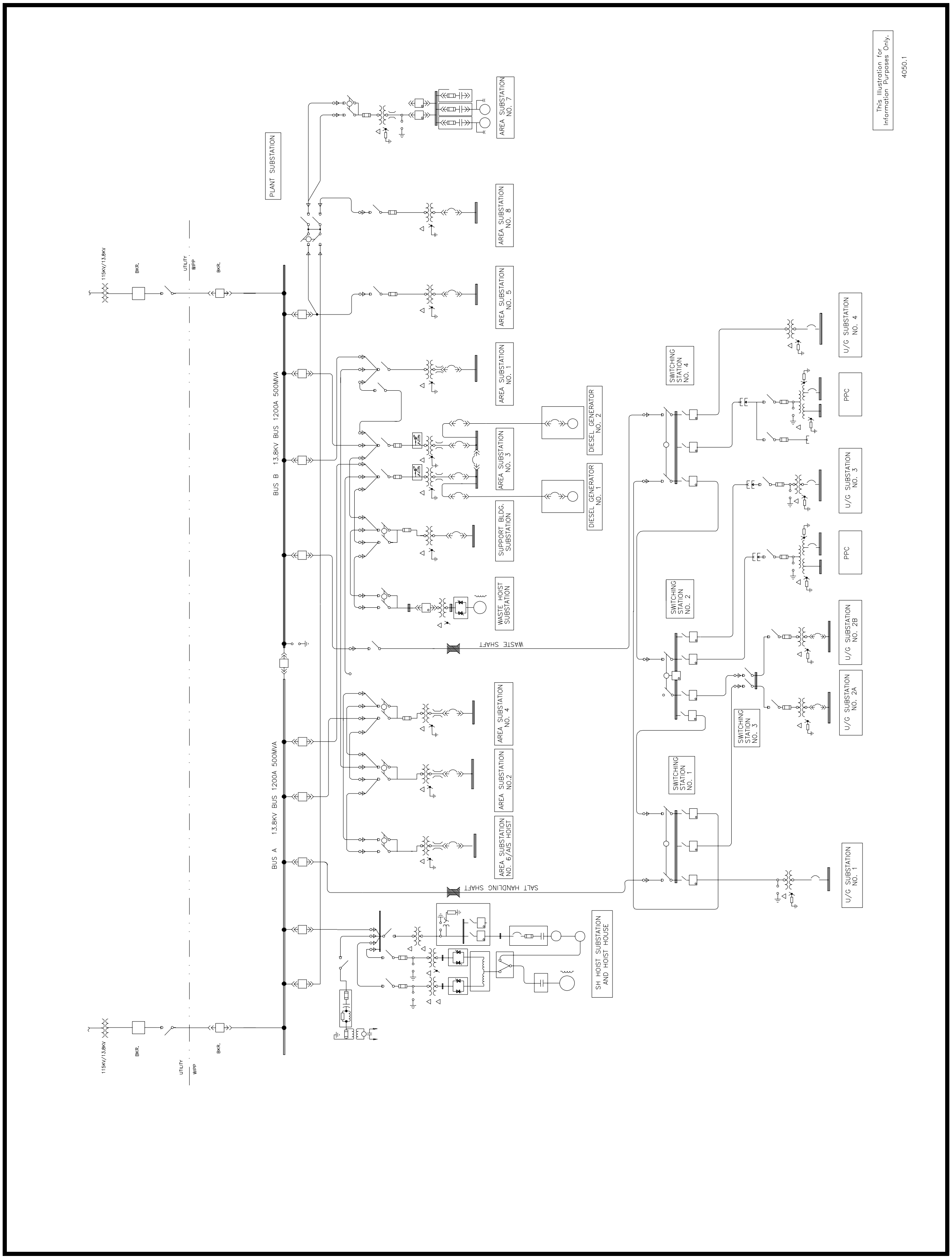

Figure 2.8-1, Electrical Distribution System

2.9 Auxiliary Systems and Support Facilities

2.9.1 Water Distribution System

The water distribution system is designed to receive water from a commercial water department, transport the water to the WIPP site, provide storage for the required reserve of fire water, chlorinate and store domestic water, and distribute domestic water for use by site personnel and processes. The water pump house contains the fire water pumps, the domestic water pumps, and the water chlorination equipment.

2.9.2 Sewage Treatment System

The sewage treatment facility is a zero-discharge facility consisting of two primary settling lagoons, two polishing lagoons, and three evaporation basins. The entire facility is lined with synthetic liners and is designed to dispose of domestic sewage as well as site generated brine waters from observation wells and from dewatering of site shafts.

References for Chapter 2

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44. NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

45. NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

46. NFPA 13, *Standard for the Installation of Sprinkler Systems*.

47. NFPA 17, *Standard for Dry Chemical Extinguishing Systems.*

48. NFPA 17A, *Standard for Wet Chemical Extinguishing Systems.*

49. NFPA 70, *National Electrical Code.*

50. NFPA 72, *National Fire Alarm Code Handbook*.

51. NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*.

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HAZARD AND ACCIDENT ANALYSIS

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HAZARD AND ACCIDENT ANALYSIS

3.1 Introduction

This chapter (1) identifies the potential hazards resulting from remote-handled (RH) transuranic (TRU) waste handling and disposal normal operations at the Waste Isolation Pilot Plant (WIPP), and (2) assesses those hazards to evaluate abnormal, internal operational, external, and natural events that could develop into accidents. The hazard analysis (HA) (1) considers the complete spectrum of accidents that may occur and qualitatively analyzes the accident annual occurrence frequency, and the resultant potential consequences to the public, workers, WIPP operations, and the environment; (2) identifies and assesses associated preventive and mitigative features for defense in depth (DID); and (3) identifies a subset of accidents to be quantitatively evaluated in the accident analysis (AA). The AA evaluates these accidents against the Evaluation Guideline (EG) of 25 rem for the off-site public to verify the adequacy of the preventive and mitigative systems to protect the public.

The methodology and requirements of Title 10 *Code of Federal Regulations* (CFR) Part 830,[1] and its implementing standards U.S. Department of Energy (DOE) Standard (STD), DOE-STD-1027-92[2] and DOE-STD-3009-94[3] were used in the development of this chapter. Items discussed in this chapter include:

- Description of the methodology for and approach to hazard and AA.
- Identification of hazardous materials and energy sources present by type, quantity, form, and location.
- Facility hazard categorization in accordance with DOE-STD-1027-92.[2]
- Identification in the HA of the spectrum of potential accidents in terms of qualitative consequence and frequency estimates.
- AA of design basis accidents (DBAs) identified in the hazards analysis.

Title 10 CFR Part 830[1] prescribes the use of a graded approach for the effort expended in preparing safety analysis and the level of detail presented. The graded approach requires a more rigorous and more thoroughly documented assessment for complex, higher-hazard facilities than for simpler, lower-hazard facilities since grading is a function of both hazard potential and complexity. The WIPP is a disposal facility of low complexity but has a high hazard category due to the radionuclide inventory of the waste containers processed for disposal. Quantitative analysis was used to evaluate risk to the public as compared to the EG of 25 rem from DOE-STD-3009-94.[3] Quantitative and qualitative methods were used in evaluating risk to workers. The WIPP analysis complies with DOE requirements and provides sufficient detail to demonstrate adequate protection of the public, workers and the environment.

3.2 Requirements

The standards, regulations, and DOE Orders used to develop this documented safety analysis (DSA) are listed below. Only portions of the listed documents are relevant to the development of this DSA namely, those that cover hazard identification and evaluation, safety analysis, risk classification, and operational controls.

- 10 CFR Part 830, "Nuclear Safety Management"[1]

  This rule governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities (including providing items and services) that affect, or may affect, the safety of DOE nuclear facilities. This rule specifies the requirement for a DSA for nuclear facilities.

- DOE Order 420.1A, *Facility Safety*[4]

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

- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses Reports*.[3]

  This standard addresses hazard identification/evaluation and safety analysis by providing guidance on the analysis techniques, level of detail, and criteria.

- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*.[2]

  This standard provides a uniform method for facility hazard categorization and insight into the graded approach for DSA development, especially in hazard assessment and AA techniques.

- DOE-STD-1186-2004, *Specific Administrative Controls.*[5]

  This standard provides guidance applicable to Administrative Controls (AC) that are selected to provide preventive and/or mitigative functions for specific accident scenarios, and which, also have safety importance equivalent to engineered controls that would be classified as Safety Class (SC) or Safety Significant (SS) if the engineered controls were available and selected.

- DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830.*[6]

  This guide provides guidance in meeting the provisions for documented safety analyses (DSAs) defined in that subpart. The guidance describes the analytical methods, documentation requirements, and safety commitments that go into the development of a comprehensive safety basis and DSA.

- DOE G 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*[7]

This guide provides guidance in identifying important safety parameters and developing the content for the technical safety requirements (TSRs) that are required by 10 CFR §830.205.[17]

3.3 Hazard Analysis

Hazards associated with normal WIPP operations include mining dangers, rotating machinery, high voltage, compressed gases, confined spaces, radiological and nonradiological hazardous materials, ionizing and non-ionizing radiation, high noise levels, mechanical and moving equipment dangers, working at heights, construction, and material handling dangers. Waste handling operations at the WIPP do not involve high temperature and pressure systems, or electromagnetic fields. Routine occupational hazards are regulated by DOE-prescribed Occupational Safety and Health Administration (OSHA) and by Mine Safety and Health Administration (MSHA) standards. Programs for protecting the WIPP workers from hazardous materials are discussed in Chapter 8.

HA provides a comprehensive assessment of facility hazards and accident scenarios that could produce undesirable consequences for workers and the public. Hazards analysis is divided into three main parts: (1) Hazard identification (ID) of the potential hazards associated with RH waste handling operations; (2) an unmitigated hazard evaluation (UHE) for the RH waste handling process; and (3) mitigated hazard evaluation (MHE). Hazard ID and UHE for the WIPP RH waste handling process, presents a comprehensive evaluation of potential process related, natural events, and man-made external hazards that can affect the public, workers, and the environment. Personnel participating in the hazard ID and HE included personnel from the WIPP waste handling and facility operations organization, the radiological control organization, nuclear safety, system engineers, and consultants with experience in the process. As part of the UHE, events requiring further quantitative AA are identified, as well as identification of potential preventive and mitigative features that are candidates for control selection. In the MHE, those events requiring further analysis are quantitatively analyzed for the public and site workers and qualitatively analyzed for facility workers. Ultimately the controls are selected for protection of the public and workers.

This chapter also provides the hazard categorization of the WIPP.

3.3.1 Methodology

This section presents methodology used to identify and characterize hazards and to perform a systematic evaluation of accidents. A flowchart representing the HA methodology described below is provided on Figure 3.3-1. Hazards existing at the WIPP were identified and Standard Industrial Hazards (SIHs) were screened out in accordance with the Hazard ID methodology described in Section 3.3.1.1. The results of the hazard ID process are presented in Appendix A, Tables A-1 through A-3.

The HE, as described in Section 3.3.1.2, consists of the UHE and the MHE. The scope of the UHE includes events involving hazards identified in, but not screened out as SIH, in the hazard ID process. The UHE uses results from hazard ID to create the UHE tables. The WIPP specific UHE is presented in Appendix A, Tables A-9 through A-12, sorted by event category (e.g., fire, explosion, impact) and facility section in accordance with criteria provided in Appendix A, Tables A-4 and A-5. Assumptions, initial conditions (ICs), material at risk (MAR), and potential causes for each event are specified, then a qualitative evaluation of each event is performed in which the frequency and consequence are assessed in accordance with criteria provided in Appendix A, Tables A-6 and A-7. The combination of the frequency and consequence assessment results in identifying the degree of risk the event posed to the public, on-site worker, and facility worker by identifying a risk bin in accordance with guidance provided in Appendix A, Table A-8. Additionally, potential features available to prevent or mitigate the event are documented on the UHE tables. The final task associated with the UHE is identifying the events that require further evaluation in the MHE for events posing a significant risk to workers and in AA (see Section 3.4 of this chapter) for events posing a significant risk to the public. A significant risk to a receptor group is identified as an event whose frequency and consequence results in it being assigned to Risk Bins I or II on the HE table. Events with high consequence but characterized as being in Risk Bin III are also considered to pose a significant risk and are also carried forward for further evaluation in MHE and AA (Section 3.4) as applicable.

The MHE was used for identifying and verifying the effectiveness of the controls selected to prevent or mitigate events posing significant risk to the on-site and facility workers. The scope of the MHE included all events identified in the UHE that required further evaluation. Though not required for HE, quantitative analysis was performed for events requiring further evaluation to compute the radiological dose to the on-site worker located 100 meters or greater from the release point. For the facility worker the MHE was done on a qualitative basis. If event consequences indicated that functional classification for structures, systems, and components (SSCs) that either prevented or mitigated consequences were warranted, those SSCs were selected and documented on MHE summary tables for the site worker and facility worker, Appendix A, Tables A-13 and A-14, respectively. WIPP procedure WP 09-CN3023, WIPP Functional Classification for Design,[8] identifies 100 rem to the worker as the consequence for requiring consideration for functionally classifying an SSC as SS. Any event in the UHE with a risk of I or II to the worker resulted in the identification of SS SSCs and/or ACs, as appropriate, for worker protection. Any event in the UHE with a risk of III but with high consequence was also evaluated and any controls necessary for worker protection were included in Tables A-13 and A-14. A qualitative assessment of the effectiveness of these controls is documented on the site worker and facility worker MHE summary tables.

3.3.1.1 Hazard Identification

Hazard ID is a comprehensive, systematic process by which facility hazards (hazardous materials and energy) are identified, recorded, and screened. Hazard ID is divided into three steps: (1) division of the facility into "facility sections," (2) information gathering, and (3) screening for SIHs. The term facility "section" is used in the assessment process to distinguish from facility "segments" as defined in DOE-STD-1027-92.[2]

3.3.1.1.1 Facility Sections

For the purposes of hazard ID and evaluation, the RH waste handling process was addressed in sections based on waste handling areas and the activities performed in those areas. The sections established are as follows:

Outside Area (OA)	This section includes the waste on-site transportation route from the security entry gate to the WIPP to the parking area on the south side of the waste handling building (WHB). Two transport routes from the security gate to the parking area are included, one that accesses the parking area from the east side of the WHB and one from the west side of the WHB.
Waste Handling Building (WHB)	This section includes the RH bay, the hot cell complex (cask unloading room [CUR], upper hot cell, transfer cell, and facility cask loading room [FCLR]), and the waste shaft conveyance loading room at the top of the waste shaft, and waste hoist tower. The section also includes the CH bay for events impacting both RH and CH.

Underground Area (UG)	This section includes the waste shaft, the waste shaft conveyance, and all areas of the underground at the waste disposal level.
Building General (BG)	An additional "section" to address those events that have the potential to affect all three sections described above.

3.3.1.1.2 Information Gathering

The information gathering process included physical walk-downs, information walk-downs, and discussions with subject matter experts (SMEs). The physical walk-down, guided by WIPP facility experts, consisted of a comprehensive tour of the RH waste handling areas, and included detailed discussions of the layout and activities conducted in those areas. Information walk-downs included a review of the available facility description and inventory information, supporting operational safety studies, and consultations with system engineers and process experts. The radiological inventory available to contribute to event consequences for the UHE is based on the WHB storage limits imposed by the Hazardous Waste Facility Permit (HWFP),[9] and the 72-B waste canister curie content based on 80 Plutonium-239 Equivalent Curies (PE-Ci) per drum (three of which may be in a 72-B canister). While waste shipped in a 10-160B shipping cask is limited to 20 plutonium curies based on the transportation analysis for the cask, a value of 80 PE-Ci per drum was used in the UHE for events involving 10-160B drums. The main hazardous constituent of concern in RH waste is beryllium in the form of fines or shavings. Waste containers are not deliberately opened at the WIPP. Using the principles of co-detection, any hazardous material release from breached waste containers will be accompanied with a radiological release. The potential preventive and mitigative features identified in the HE to prevent or mitigate radiological consequences from accidents also prevent or mitigate consequences from a release of beryllium fines and shavings.

Hazard ID methodology assigns a unique item number for each facility hazard, the hazard energy source or material, whether the hazard exists at the facility or in a particular facility section, a description to characterize each hazard, and finally a screening as to whether the hazard is or is not considered a SIH. The results of the WIPP hazard ID activities are documented in Appendix A, Tables A-1 through A-3.

Using the results of the information gathering process, including walk-downs and interviews with knowledgeable personnel, the assessment team created a comprehensive list of all expected hazards. Use of hazard ID tables provides a comprehensive listing of generic facility hazards. A hazard ID table has five columns that include the following information:

Item – A specific number provided for each facility hazard.

Hazard Energy Source or Material – This is a checklist of potential hazards that may be in the facility. A large general list is provided to allow the table to be used for a variety of facilities and to help ensure completeness in the identification process.

Exists – This is used to document whether the hazard exists in the particular facility section. Each item in the list requires either a "Yes" or a "No" response.

Description – This column is used to characterize each hazard for the purposes of providing the assessment team and reviewers an understanding of the hazard. The location of the hazard in sufficient detail to locate the hazard within the facility section, quantities, and any other clarifying information may be included in this column.

Standard Industrial Hazard Screening – This column is used to identify those items that are screened as SIH, as discussed below, and those that are not.

3.3.1.1.3 Screening of Standard Industrial Hazards

SIHs are defined as hazard sources (material or energy) or events involving hazards routinely encountered by the general public or in general industry and construction, and for which national consensus codes and/or standards exist to govern handling or use without the need for special analysis to define safety design and/or operational parameters. SIHs are evaluated to the extent that they act as initiators and contributors to events that result in a radiological or hazardous material release. Each identified hazard is screened based on material/energy types and quantities. Hazards that are screened as SIHs are documented as such in the "SIH Screening" column of Appendix A, Tables A-1 through A-3.

The following characteristics are used to determine hazards that are considered SIHs and routinely accepted hazards:

- The hazard is controlled by OSHA regulations or national consensus standards (e.g., American Society of Mechanical Engineers, American National Standards Institute, National Fire Protection Association, Institute of Electrical and Electronic Engineers, National Electric Code), where these standards are adequate to define special safety requirements, unless in quantities or situations that initiate events with serious impact to the public or workers.

- Hazards such as noise, electricity, flammable materials, welding operations, small quantities of chemicals that would likely be found in homes or general retail outlets, and hazardous materials transported on the open road in Department of Transportation (DOT) specified containers are considered to be common hazards encountered in everyday life.

Examples of common hazards/SIHs include:

- Specific materials (e.g., lead and asbestos) that have their own control program
- Thermal energy sources (potential for burns [e.g., welding equipment])
- Electrical shock hazards
- Gas cylinders transported and stored in DOT configuration
- Personnel pinches, trips, falls, slips, etc.
- Confined space hazards
- Hazards typically found in office areas.
- Routine industrial or construction noise

These hazards are evaluated only to the extent that they act as initiators and contributors to events that result in a radiological or chemical release. Each identified hazard is screened based on material/energy types and quantities.

Hazards that do not meet the appropriate screening criteria for identification as an SIH are carried forward to the HE process and are so noted in the hazard ID tables. Hazards that are screened as SIHs are documented as such in the "SIH Screening" column of the hazard ID table. No further consideration is given to these screened hazards.

3.3.1.2 Hazard Evaluation

The UHE follows hazard ID. The purpose of the UHE is to ensure a comprehensive assessment of facility hazards and focus attention on those events that pose the greatest risk to the public and the workers. Event categorization, identification of event cause(s), assignment of event frequency and unmitigated consequence level, and identification of potential mitigative and preventive features are tasks performed during UHE.

Selection of UHE Method

The flowchart in Figure 5.3 of "Guidelines for Hazard Evaluation Procedures"[10] provides a method for selecting a specific assessment technique. Using the flowchart, the technique used in the UHE for RH waste handling at WIPP was selected with the following criteria:

- The study is for regulatory purposes
- No specific hazard evaluation method is required
- This is not a recurrent review
- Expected results are a list of specific accident situations
- The results will not be part of a quantitative risk assessment
- The process is operating
- Human errors are a concern but not the greatest concern
- Accidents are most likely to be single failure events

Application of these criteria to the figure results in various potential analysis methods for performing the UHE including: what-if, what-if/checklist, preliminary hazard analysis, failure modes and effects analysis, and hazard and operability study. The failure modes and effects analysis method was removed from consideration since it is primarily used for analyzing mechanical systems and active components in an electrical system. The hazards evaluation team selected a hybrid approach that incorporated elements of the what-if/checklist and preliminary hazard analysis methods. This method was selected based on its widespread use and DOE acceptance at other TRU waste handling/storage facilities in the DOE complex. The what-if/checklist method uses brainstorming to identify a broad spectrum of accidents in combination with the detailed and comprehensive structure provided by using a systematic hazard ID and event category checklist. Additionally, the use of a tabular accident recording form (adapted from the preliminary hazard analysis technique) provides for the effective listing and presentation of accidents along with their causes, hazard category, risk assessment and potential preventive and mitigative features.

Scope of the RH Waste Handling Assessment

The scope of the RH waste handling UHE examined:

- All aspects of the WIPP RH waste handling operations including waste receipt, handling (including removing waste containers from the 72-B and 10-160 shipping cask), transporting waste containers to the underground disposal area, waste emplacement, and support activities (e.g., equipment maintenance, and mining and ground control activities in the underground). Those aspects of RH waste handling that have the potential to impact CH waste were also examined.

- Natural phenomena (e.g., earthquakes, tornadoes, straight-winds).

- External events (e.g., aircraft).
- Consideration of the spectrum of possible operational events for a given hazard in terms of both frequency and consequence levels.

The assessment does not address:

- Hazards screened as SIHs.
- Willful acts, such as sabotage.

Assumptions and Initial Conditions

Prior to and while performing the UHE, assumptions and ICs are identified to form the basis for the event evaluation. Some assumptions are statements of fact and some are features or conditions that must be true for the UHE to be valid. Assumptions are general statements that govern boundaries of the analysis, but do not necessarily require protection to ensure the validity of the analysis. Initial conditions (ICs) identify those features or conditions that are used as an analysis reference baseline during an evolving design or to clarify a point of analysis that might otherwise be unstated. ICs may often delineate specific conditions that are part of normal facility operations and which have an impact on the HA. As such, ICs are normally established and documented prior to, or during the hazard evaluation process, when events are postulated and evaluated.

In general, ICs may inherently credit specific inventory information or passive design features such as the facility construction in the prevention of or reduction in the frequency of certain accidents. ICs require protection to ensure the validity of the analysis. The specific ICs used for the WIPP UHE are presented in Section 3.3.2.3.

Unmitigated Hazard Evaluation

The UHE is performed to determine the risks (frequencies and consequences) involved with the facility and its associated operations without regard for preventive or mitigative design features or programs. Figure 3.3-1 shows a flow chart for hazard evaluation and AA. Unmitigated refers to the determination of the frequency and consequences without taking credit for preventive or mitigative features other than the specified ICs. While no credit is taken for any controls, the laws of physics are obeyed. The UHE was performed as a qualitative evaluation of facility hazards to identify those events of greatest concern to public and worker safety. The qualitative evaluation results that posed the greatest risk to the public or workers were quantitatively (for public and site workers) evaluated and documented in NS-05-004, WIPP RH DSA Revision 0 Source Term, Dose Consequence and Supporting Information.[11] The quantitative analysis results were used to select the controls to ensure protection of the public and site workers. Controls for facility workers (workers inside 100 meters) were determined from a qualitative evaluation.

Information related to the UHE is collected and organized in hazard evaluation tables. A separate table is developed for each facility section. Hazard evaluation tables then serve as input for a subsequent MHE in a complete HA. Information in the hazard evaluation table includes:

- Event number and category
- Event description including location of the event, hazardous material release mechanism, amount of hazardous MAR, ICs, and hazard source.

- Causes
- Unmitigated Risk
  - Frequency Level
  - Consequence Level
  - Risk Bin
- Preventive Features
  - Design Features
  - Administrative Controls
- Mitigative Features
  - Design Features
  - Administrative Controls

Additional detail and pertinent methodology information regarding each of the hazard evaluation table headings for the UHE is as follows:

Event Number and Category

In the hazard evaluation tables, events are identified by a unique sequential reference consisting of a combination of letters and numbers. The first two (or three) letters represent the facility section (such as "WHB" for Waste Handling Building), the first number represents the event category as described below, and the second number (following the hyphen) represents the event sequential number.

Events are categorized according to the nature of the event. A standard list of event categories is given in Appendix A, Table A-4, along with a general description of the consequence mechanism. The first five categories are for internally initiated events, which are typically process-related events. The final two categories are externally initiated events (i.e., events whose initiators are beyond the facility's direct control). The categories are as follows:

1. Fire
2. Explosion
3. Loss of containment/confinement
4. Direct radiological/chemical exposure
5. Nuclear criticality
6. External hazards
7. Natural phenomena

Event Description

A brief description of a postulated event is provided in this column and includes a description of the event (including event progression information), location, the release mechanism (e.g., thermal release, pressurized release, impact) or other consequence mechanism (e.g., direct exposure), and the MAR. Additionally, ICs applicable to the event and hazard source (e.g., type of hazardous material released) are identified here.

Using the hazard ID tables as a basis, event scenarios are developed for each facility section where a potential exists for a release of hazardous energy and/or material. Appendix A, Table A-5, provides a link between the hazard groups in the hazard ID table with potential events that may be caused by the hazard. This table is used as an aid in identifying potential events and is not meant to be comprehensive or to limit the scenario development. The full character of the hazard is considered when developing event descriptions.

The scenarios cover the spectrum of possible events for a given hazard, from small consequence, high frequency events to reasonable worst-case, low frequency events. Unlike "worst-case," "reasonable worst-case" does not necessarily consider every parameter in its most unfavorable state. Follow-on events, such as a fire following a seismic event or aircraft impact, are identified and evaluated to ensure the entire spectrum of possible events is addressed. Events typically progress to and result in a release of radiological and hazardous material.

Causes

A cause specifically states the failure, error, operational, and/or environmental condition that initiates the progression of occurrences that leads to a release of hazardous material. Causes need to be clearly identified to support event frequency evaluation. The hazard ID tables are used as a guide in developing specific causes for release events.

Unmitigated Risk

This portion of the table documents the determination of the frequency, consequences, and resultant risk with no credit given for preventive or mitigative features other than ICs.

Frequency Level Event frequency evaluation is a predominantly qualitative process (although some semiquantitative estimates may be used) that involves assigning a frequency level to each event in the HE tables. An event is defined as the progression of occurrences necessary to release hazardous material (i.e., from initiator, through to the point of release). The term "unprevented" is used to designate a release event frequency derived during the unmitigated UHE before preventive features are credited to reduce the event frequency. Frequency levels, based on Table 3-4 in DOE STD 3009,[3] are summarized in Appendix A, Table A-6.

Frequency information is derived from generic initiator database documents, existing safety documentation, facility expert opinion, or historical accident data. The frequency level is recorded in the UHE tables according to the lettering scheme given in Appendix A, Table A-6. Considering the sources, methods, and uncertainty associated with a frequency estimate, erring in the conservative direction from best-estimate values accommodates uncertainties in frequency levels. When evaluating event frequency, credit is taken only for items identified as ICs.

Consequence Level Event consequences are documented by specifying the impact on the receptors. For UHE purposes, consequences are defined as the doses or exposures, at receptor locations, that have been determined without taking credit for barriers or controls that could reduce those consequences. Consequences are a function of the type and characteristics of the hazard, the quantity of hazardous material released, the release mechanism, relative location of the release, and relevant transport characteristics. Consequences are determined from (1) engineering judgment, (2) existing safety documentation, and/or (3) qualitative assessment. Much like frequency evaluation, erring in the conservative direction from best-estimate values accommodates uncertainties. During unmitigated consequence determination, SSCs or ACs are not credited for mitigation. The only exception is where an IC prevents consequences (i.e., 72-B and 10-160B shipping cask design).

UHE consequences are evaluated at various receptor locations to assess health effects associated with the postulated event. Appendix A, Table A-7, provides the radiological and chemical consequence levels for the receptor locations specified below, using the maximally exposed individual at each receptor location. Receptors and their locations are as follows:

Facility Worker Workers in the immediate area of the hazard and those workers in the same area who may not be aware of the hazardous condition. Radiological or chemical exposures for the worker are estimated qualitatively to be high in most cases for breached RH waste containers or loss of shielding.

On-Site Worker Individuals outside the structure or immediate area of the hazard but within the site boundary. For evaluation purposes, these workers are located outside the last possible barrier from the hazard and at the worst possible location. Doses or chemical exposures are estimated qualitatively for the receptor at a distance of 100 meters.

Public Everyone outside the site boundary. (See Section 3.4 for a discussion on public access to WIPP)

The UHE is concerned with the maximally exposed individual at each of the receptor locations. When evaluating event consequences in the UHE, credit is taken only for items identified as ICs.

Risk Bin

The objective of risk binning is to focus attention on those events that pose the greatest risk to the public, on-site workers and facility workers. Higher risk events are candidates for additional analysis. Using event frequency and consequence levels, events are "binned" according to the matrix given in Appendix A, Table A-8, to assess relative risk for each of the receptor locations.

Potential or Available Controls

Preventive Features

Potential or existing preventive features are identified as part of the UHE. Preventive features are those expected to reduce the frequency of a hazardous event (up to the point of release). The identification of such features is made without regard to any possible pedigree of the feature. These include engineered features of SSCs, ACs operating individually or in combination.

Preventive features are listed in the HE tables, and are subdivided into administrative and design features for each event. This list of potential controls is a starting point for final selection of controls that could be relied on to prevent the event or consequences from the postulated event.

Mitigative Features

Mitigative features are those expected to reduce the consequences of a hazardous event. The identification of such features is made without regard to any possible pedigree of the feature such as procurement level or current classification. Mitigative features must be capable of withstanding the environment of the event. These include engineered features (e.g., structures, systems, components), ACs (e.g., procedures, policies, programs), or inherent features (e.g., physical or chemical properties, location, elevation) operating individually or in combination.

Mitigative features are listed in the HE tables, and are sub-divided into administrative and design features for each event. This list of potential controls is a starting point for final selection of controls that could be relied on to mitigate the event or consequences from the postulated event.

Event Selection

Event selection is the process of identifying the events that require further evaluation in MHE and AA. Events are identified for further evaluation based on the risk for each of the receptors. A significant risk to a receptor group was identified as an event whose frequency and consequence resulted in it being assigned to Risk Bins I or II on the HE table. Events with high consequence (i.e., challenge to EG or worker criteria) but characterized as being in Risk Bin III were also considered to pose a significant risk and were also carried forward for further evaluation in MHE and AA as applicable. Any events with risk that falls in Risk Bin IV do not require safety features and are not carried forward to AA or to the MHE. Using the principles of co-detection, any hazardous material release from breached waste containers will be accompanied with a radiological release. Hence the risk binning for radiological consequence will encompass any hazardous material consequences.

Mitigated Hazard Evaluation

An MHE was performed to demonstrate that adequate prevention and mitigation features are selected to reduce the unmitigated event risk to the on-site and facility worker groups (See Figure 3.3-1). For events that pose significant risk for the on-site worker, quantitative analysis is documented in NS-05-004.[11] Events that pose significant risk or consequences for the facility worker were qualitatively identified. For each of these events, controls that protect the on-site and facility worker groups by preventing (i.e., reducing the frequency of) the event or mitigating the consequences of the event were selected. The controls selected were generally taken from the list of potential controls identified in the UHE, but in some cases new controls were identified and selected during the MHE process. After control selection, another qualitative assessment was performed to determine the effectiveness of the controls in preventing or reducing the consequence of the event. The results of MHE for the on-site and facility workers are documented in Appendix A, Tables A-13 and A-14, respectively. The selection of controls for on-site and facility worker protection include SS SSCs, specific ACs, and programmatic ACs.

3.3.2 Hazard Analysis Results

As discussed in Section 3.3.1, the HA consists of hazard ID and HE. This section provides an in-depth discussion and summarizes the results of the work performed specific to the RH waste handling process at WIPP to ensure completeness and compliance with the methodology presented in Section 3.3.1. Input used in the development of this HA was derived from physical walk-downs, information walk-downs, discussions with SMEs, facility inventories, and existing safety analyses and operational safety studies.

3.3.2.1 Hazard Identification

WIPP has been in operation receiving CH waste since March 1999 and has experienced no operational events, external events, or natural events that have resulted in a breach of waste containers. A general summary of hazards, by type, and the hazards identified for WIPP are included in the Hazard ID tables in Appendix A, Table A-1 through A-3.

Division of the WIPP Facility—For the purposes of hazard ID and HE, surface and underground waste handling areas are grouped into sections based on the activities conducted in each section. The sections established are as follows:

- OA — Outside Area - includes waste transportation path from the security gate to the south side of the WHB from either the east or west.
- WHB — Waste Handling Building
- UG — Underground
- BG — Building General - includes the OA, WHB, and UG for hazards that could be common to all three sections.

Facility Walk-Downs - Facility walk-downs performed for hazard ID included both physical walk-downs and informational walk-downs. The physical walk-downs consisted of a tour of the waste handling areas. The informational walk-downs included a review of the available facility description and inventory information and consultations with facility experts. The hazard ID Tables A-1 through A-3 document the results of the facility walk-downs. The tables identify the hazardous material and energy sources applicable to the facility section including clarifying information. A summary of the hazards is presented below:

<u>Electrical Hazards</u>

Electrical hazards present throughout the waste handling areas including the transportation route from the security gate to the parking area on the south side of the WHB. General electrical hazards include switchgear, transformers, transmission lines or cable runs, wiring, electrical equipment, motors, battery banks, light fixtures, and service outlets. Other electrical hazards that may be found in specific sections include portable generators, heaters, and power tools. Electrical hazards may be initiators for fire and explosion events.

Thermal Hazards

Thermal hazards are present in the facility sections and typically include electrical equipment, wiring, welding, and engine exhaust. Heaters may be found in specific facility sections. Thermal hazards may be initiators for fire and explosion events.

Pyrophoric Material

The facility sections for the WIPP do not contain any known pyrophoric materials. RH waste containing pyrophoric materials are prohibited through the DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for Waste Isolation Pilot Plant*[12], referred to in this DSA as the RH WAC. For the purpose of hazard ID and HE, it is initially assumed that there are no controls on RH waste content and that pyrophoric material could be present and initiate spontaneous combustion within a waste container or be contributors to fires and explosions.

Open Flame

Welding or cutting torches are used in conjunction with maintenance activities.

Flammables

The WIPP facility sections contain fuel and grease associated with equipment operated in the section, paint, paint cleaning and decontamination solvents, and satellite waste accumulation areas that may contain materials susceptible to spontaneous combustion. Flammable hazards are contributors for fire events.

Combustibles

The WIPP facility sections contain wood pallets, crates, plywood, paper associated with work activities, plastic signs, plastic containers, tarps, and personal protective equipment, and petroleum based combustibles (e.g., grease, hydraulic fluid, diesel fuel). These combustible materials may be contributors for fire events.

Chemical Reactions

There are no chemical reaction sources identified for WIPP operations. For the purpose of hazard ID and UHE, it is assumed that there are no controls on RH waste content and that chemical reactions could occur that result in spontaneous combustion within a waste container or be contributors to fires and explosions.

Explosive Materials

In addition to gases that may be generated by chemical reactions, WIPP facility sections contain explosive materials in the form of hydrogen associated with facility equipment batteries and generation of hydrogen associated with battery charging stations. Small explosive charges are also used in the underground to set anchor bolts for supporting piping or cables. For the purpose of hazard ID and UHE, it is assumed that there are no controls on RH waste content and that chemical reactions could occur that result in explosive materials being generated. Explosive materials are contributors to explosion events.

Kinetic Energy

As part of normal operation and maintenance, the WIPP facility sections contain sources of kinetic energy including vehicles, motors, power tools, moving parts associated with equipment (e.g., belts, bearings), and movement of material via forklift or crane. Other kinetic energy hazards identified include gears, grinders, fans, drills, presses, shears, and saws. Kinetic energy hazards can be initiators for loss of confinement events.

Potential Energy (Pressure)

The WIPP facility sections contain sources of potential energy in the form of pressure including pressurized gas bottles, pressure vessels such as a nitrogen accumulator, and compressed air and pressurized water piping systems. For the purpose of hazard ID and UHE, it is assumed that there are no controls on RH waste content and that RH waste containers could be pressurized as the result of gas generation inside the container. Pressurized containers or systems can be an initiator for loss of confinement events.

Potential Energy (Height/Mass)

The WIPP facility sections include hazards related to elevated equipment that could contribute to accidents involving drops or falls. These include cranes/hoists, elevated doors, elevated work surfaces, man-lifts, scaffolds, and ladders. These hazards may be initiators for loss of confinement events.

Flooding Sources

The WIPP facility sections include water sources that could result in internal flooding. Sources include fire water, domestic water, water tanks used for dust control, barrels of water awaiting sample results, and periodic load testing that may involve the use of water weights. These hazards were considered as potential contributors to events involving flooding.

Physical Hazards

The WIPP facility sections include sources of physical hazards, such as sharp edges, pinch points, tripping hazards, confined spaces, and temperature extremes. These physical hazards may result in an injury to the worker.

Radiological Material

The WIPP facility sections include radiological material associated with RH waste and sources used in the calibration of radiation monitoring equipment. Radiological material is part of the MAR for events that result in a breach of waste containers.

Hazardous Material

The WIPP facility sections include hazardous materials including lead associated with batteries, oxygen cylinders, and other hazardous materials associated with maintenance and poisons such as insecticides. Hazardous material is also associated with the RH waste (e.g., beryllium, lead, mercury, polychlorinated Biphenyls). Hazardous material in the waste is included in the MAR for events that result in a breach of waste containers. Using the principles of co-detection, any hazardous material release from breached waste containers will be accompanied with a radiological release. Radiological consequence will encompass any hazardous material consequences.

Ionizing Radiation Sources

The WIPP facility sections include potential ionizing radiation sources. The primary ionizing radiation source is the radiological material in the RH waste. Ionizing radiation sources are potential initiators for direct exposure events.

Non-Ionizing Radiation Sources

Non-ionizing radiation sources identified in the WIPP facility sections are the bar code readers used to record/identify waste containers, lasers used to detect RH waste handling equipment position, and lasers also used for mining or surveying.

Criticality

Nuclear criticality safety evaluations (NCSEs) for the WIPP have documented that it is not credible for an inadvertent criticality to occur at the WIPP in either the 72-B, 10-160B, or in the waste handling, storage, and disposal configurations because of fissile and special moderator/reflector mass limits imposed by the RH WAC[12] and implemented at generator sites through waste characterization programs. For the purposes of hazard ID and UHE, it is assumed that there are no controls on RH waste content and that a criticality could occur.

Non Facility Events

There is a potential for the WIPP facility sections to be impacted by events that are initiated at a location external to the facility. The events of concern include aircraft crashes, explosions, and fires. These may involve transportation accidents or events that occur in other WIPP structures and propagate to the areas used for handling RH waste. These non-facility events are identified and addressed in the hazard ID and UHE tables.

Vehicles in Motion

The WIPP facility sections where RH waste handling activities occur have the potential to be affected by various vehicles in motion. These include aircraft, cranes being used for maintenance, forklifts, vehicles other than those used for waste handling and transport, and heavy construction equipment. These vehicle-in-motion events are potential initiators for external events that result in loss of confinement, fire, or explosion.

Natural Phenomena

The WIPP facility sections where RH waste handling activities occur have the potential to be adversely affected by natural phenomena hazards (NPH) including earthquakes, heavy rain that results in localized flooding, lightning, hail, snow, straight winds, tornadoes, and seasonal temperature extremes. NPHs are assumed to be potential initiators for events resulting in a breach of waste containers.

Screening of Standard Industrial Hazards - SIHs screened during the hazard ID typically include electrical, thermal, kinetic energy, potential energy (pressure and height/mass), physical, and non-ionizing radiation. The thermal and electrical hazards were present due to equipment found in the facility, but are commonly accepted hazards. The screening eliminated consideration for burns and electrical shock to the worker. However, these thermal and electrical hazards were carried forward to the HE as potential initiators for events that could release hazardous material.

The kinetic energy concern is focused on linear or rotational motion, and acceleration or deceleration. This includes mobile equipment such as cranes, forklifts, and other vehicles, and fans, motors, and electric or pneumatic tools. The potential energy hazard involves sources of pressure, and height/mass. Sources of pressure include coiled springs, gas bottles, pressurized systems (e.g., air), and pressure vessels. Hazards related to height and mass include cranes and hoists, elevated doors, lifts, elevated work surfaces, scaffolds and ladders, floor pits, and facility structure. Potential energy hazards were carried forward to the HE as potential initiators for hazardous material release. The physical hazards are pinch points during material movement, tripping hazards, and temperature extremes in summer and winter. These were screened as SIHs since they are addressed by OSHA standards and site safety requirements. Hazardous materials screened out were dusts, insecticides and carbon monoxide buildup from diesel equipment used in the underground. These materials are of types and quantities in everyday use experienced by the general public, or are addressed by OSHA and MSHA standards, and site safety requirements, and do not represent unique hazards.

Radiological Parameters for Consequence Analysis - The curie content of RH waste to be used in consequence analysis for potential accidents that could result from the RH waste handling process at the WIPP is consistent with that used for drums in the DOE/WIPP-95-2065, Rev. 9, *Waste Isolation Pilot Plant Contact Handled (CH) Waste Documented Safety Analysis* (CH DSA),[14] which was determined from DOE/CAO-95-1121, *U.S. Department of Energy Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* [TWBIR].[15]

Using the mass limit of 200 fissile gram equivalent (FGE) for 55-gallon drums and scaled to PE-Ci for 55-gallon drums, an 80 PE-Ci limit for a 55-gallon drum was established by enveloping most waste streams identified in the TWBIR by a factor of five. A 72-B waste canister can hold three 30- or 55-gallon drums such that a 240 PE-Ci limit is established for a 72-B RH waste canister. Accidents involving 30- or 55-gallon drums shipped in a 10-160B shipping cask are assumed to have no more than 80 PE-Ci in an individual drum with a maximum of ten 30- or 55-gallon drums in the cask. A facility canister will hold three 30- or 55-gallon drums. For accidents involving RH and CH waste, the CH waste MAR was taken from the CH DSA.[14] The following RH MAR values, based on Pu-239 and including any contribution from gamma radiation, are used in the UHE consequence assessment:

• 72-B canister (direct loaded or loaded with three 30- or 55-gallon drums)	240 PE-Ci
• 10-160B shipping cask loaded with ten 30- or 55-gallon drums	800 PE-Ci
• Each 30- or 55-gallon drums from a 10-160B shipping cask	80 PE-Ci
• One facility canister loaded with three 30- or 55-gallon drums from a 10-160B shipping cask	240 PE-Ci
• Solidified/vitrified waste container	1800 PE-Ci.

Hazardous Constituents

Similar to the UHE documented in Revision 9 of the CH DSA,[14] the RH UHE is performed assuming no control on waste characteristics other than the curie content. The waste restrictions of the WIPP HWFP[9] are ultimately credited as controls for worker protection in Tables A-13 and A-14. The HWFP[9] lists the hazardous waste as defined in 40 CFR Part, Subparts C and D, Identification and Listing of Hazardous Waste,[16] that may be present with TRU waste from defense-related operations, resulting in TRU mixed waste. The most common hazardous constituents in the TRU mixed waste consist of metals (e.g., cadmium, chromium, lead, mercury, selenium, silver, and lead), solidified sludges, cemented laboratory liquids, waste from decontamination and decommissioning activities, and halogenated and non-halogenated volatile organic compounds (e.g., from solvents used to clean metal surfaces prior to plating, polishing, or fabrication, to dissolve other compounds, or as coolants). Concentrations of 29 volatile organic compounds (VOCs) in the headspace gases have been calculated and is summarized in the HWFP.[9] The most prevalent VOCs observed in the headspace gases are methylene chloride and carbon tetrachloride. Other hazardous constituents which appear as co-contaminants in TRU waste, and which are of interest in fire scenarios, include asbestos, beryllium, and polychlorinated biphenyls (PCBs).

There are no EGs for chemical consequence during accidents. Using the principles of co-detection, any hazardous material release from breached waste containers will be accompanied with a radiological release. Hence the risk binning for radiological consequence will encompass any hazardous material consequences.

RH Waste Acceptance Criteria

To ensure that waste accepted for disposal at the WIPP meets criteria imposed by the HWFP, the U.S. Environmental Protection Agency Compliance Certification Decision, the Land Withdrawal Act[13] and the Certificates of Compliance for the 72-B and 10-160B, the contents of every container of RH waste shipped to the WIPP must meet the requirements contained in the RH WAC.[12] The RH WAC[12] specifies the fissile limits, waste content restrictions, and acceptable container types to be transported to and disposed of at the WIPP. The RH WAC[12] requires the generator sites to prepare a waste certification program that lists the methods and techniques used for determining compliance with the RH WAC[12] and associated quality criteria. The generator site programs must meet the requirements found in the WIPP Waste Analysis Plan (Attachment 1 to the HWFP).[9] The HWFP and the RH WAC[12] prohibit liquid waste, explosives, compressed gases, oxidizers, and pyrophorics. The following RH waste is unacceptable based on the HE for shipment to the WIPP:

- Waste that exceeds 1000 rem/hr[13]
- Ignitable, reactive, and corrosive waste
- Liquid wastes - limits residual liquid to less than one percent by volume of the external container.
- Compressed gases

The absence of these wastes is confirmed by real time radiography, visual examination, and headspace gas analysis. Waste streams identified to contain incompatible materials or materials incompatible with waste containers cannot be shipped to the WIPP unless they are treated to remove the incompatibility. If new hazardous waste codes are identified during the characterization process, those wastes cannot be accepted for disposal at the WIPP until an HWFP modification has been submitted to and approved by the New Mexico Environmental Department.

Waste containers are limited to 72-B metal canisters (direct loaded or loaded with three 30- or 55-gallon drums) that meet Type A or equivalent transportation requirements, and 30- or 55-gallon drums (also Type A or equivalent) loaded in a 10-160B shipping cask. Waste containers are also discussed in Chapter 2 of this DSA. The RH WAC[12] also requires that each waste container be vented through an individual particulate filter to allow any gases that are generated within a waste container to escape and prevent over-pressurization. The facility canister is similar to a 72-B canister but has not been tested to meet Type 7A requirements. The facility canister is sized to accommodate drums (that do meet Type 7A requirements) shipped in a 10-160B shipping cask.

3.3.2.2 Hazard Categorization

The hazard categorization for the WIPP, based on the CH waste handling process was developed in accordance with DOE-STD-1027-92.[2] The inventory of 80 PE-Ci in a single 55-gallon waste drum is assumed for CH. The inventory of 80 PE-Ci is also assumed for a single 30- or 55-gallon drum of RH waste. Since this inventory exceeds the Hazard Category 2 minimum threshold of 56 Ci for Pu-239, the WIPP is categorized as a Hazard Category 2 facility. The WIPP hazard categorization does not assume segmentation.

3.3.2.3 Hazard Evaluation

Before beginning the UHE for the RH waste handling process at the WIPP, the basic assumptions and ICs were established to define the facility and the areas of the facility being evaluated. Assumptions are general statements that govern boundaries of the analysis and for the WIPP are generally driven by the overall DOE TRU waste program. Initial conditions (ICs) identify those features or conditions that are used as an analysis reference baseline to clarify a point of analysis that might otherwise be unstated. ICs delineate specific conditions that are part of normal facility operations and which have an impact on the HA and for the WIPP are taken from the design basis, and the limitations imposed by transportation of waste to the WIPP and the HWFP. The ICs require protection to ensure the validity of the analysis. The assumption for the RH UHE is:

- RH waste is to be disposed of at the WIPP facility.

The ICs for the RH waste handling UHE include:

- RH waste arrives at the WIPP packaged in 72-B or 10-160B shipping casks, which are Nuclear Regulatory Commission (NRC) approved containers that meet DOT Type B requirements. NRC approved DOT Type B shipping casks are designed and tested to withstand drops, impact, punctures, and fires with the lid bolts in place.

- The waste inventory in the outside area is limited to fourteen RH shipping casks (72-Bs and 10-160Bs) by the HWFP. The RH waste inventory in the RH bay is limited to any combination of two RH shipping casks. The upper hot cell inventory is limited to six loaded facility canisters and ten 30- or 55-gallon drums, with all drums from 10-160B shipping casks. The CUR is limited to one RH shipping cask, while the transfer cell and FCLR are limited to one canister (facility or 72-B). The HWFP also stipulates that RH shipping casks loaded with waste remain on the transportation trailers and are removed from the trailers within the WHB.

- Waste containers are not opened at the WIPP.

- The transfer cell shuttle car and the facility cask can only accommodate one RH waste canister at a time by design.

- WIPP has only one facility cask and 41-ton forklift capable of transporting the facility cask, which limits the number of RH waste canisters to only one in transit from the surface to the disposal room.

- Waste is transported to the underground by way of the waste shaft only and only one facility cask at a time can be transported on the waste shaft conveyance.

- Only electric or diesel powered equipment is used in the underground.

In the HE tables in Appendix A, Tables A-9 through A-12, events are identified by a unique sequential reference consisting of a combination of letters and numbers as described in Section 3.3.1.2.

The evaluation identified events associated with hazardous material and energy sources. The results of these activities are documented in Appendix A, Tables A-9 through A-12, which provide postulated events associated with the hazard sources and an unmitigated evaluation of each event in terms of frequency, consequence, and risk. Frequency estimates for each of the events postulated are based on engineering judgment or existing studies. Frequency estimates qualitatively account for the impact ICs may have on individual events. In addition to the event development, potential controls that might reduce the frequency or lessen the consequences of an event were identified for each event. The controls identified are presented in the HE tables in Appendix A, Tables A-9 through A-12, along with indication as to their preventive or mitigative function, and whether the controls are administrative in nature or design features.

Event selection is the process of identifying the events that require further evaluation in MHE and AA. Events are identified for further evaluation based on the risk for each of the receptors based on Appendix A, Table A-8. Using the results of the UHE process, the events requiring further evaluation were identified. The events requiring further analysis grouped by their event type are as follows:

Fires	Event numbers - WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, WHB1-9, UG1-1, UG1-2, UG1-5
Explosion	Event numbers - WHB2-1, WHB2-2,WHB2-3, WHB2-4, WHB2-5, WHB2-6, WHB2-7, UG2-1, UG2-2, UG2-3, UG2-6
Loss of Containment or Confinement	Event numbers - WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-6, UG3-1, UG3-2, UG3-3, UG3-6
Direct Radiation Exposure	Event numbers - OA4-1, WHB4-1, WHB4-1, WHB4-3, WHB4-4, WHB4-5, UG 4-1
Nuclear Criticality	Event numbers - OA5-1, WHB5-1, UG5-1
External Hazards	Event numbers - OA6-3, WHB6-1, WHB6-2, WHB6-3, WHB6-4, UG6-1, UG6-2, BG6-1
Natural Phenomena	Event numbers - WHB7-1, WHB7-2, WHB7-3, WHB7-6, WHB7-7, UG7-4, BG7-1

The above events were further evaluated in NS-05-004.[11] The basis for the MAR used for the evaluation of these events is described in Section 3.4.1.2. Public and worker safety are the traditional focus of hazard evaluations. These events are evaluated against the worker protection requirements in DOE-STD-3009-94.[3] The potential controls are based on several considerations, including selecting SSCs over ACs, passive features over active features, prevention over mitigation, selection of controls that are closest to the hazard, and selection of controls that may be effective for multiple events. The effectiveness of the controls and ease of control implementation is also considered.

The evaluation for worker protection is shown in Appendix A, Tables A-13 and A-14, which indicate design controls chosen for functional classification as SS and ACs to be included in the TSRs.

3.3.2.3.1 Planned Design and Operational Safety Improvements

There are no planned improvements at this time.

3.3.2.3.2 Defense in Depth

DID as an approach to facility safety has extensive precedent in nuclear safety philosophy. It builds in layers of defense against release of hazardous materials so that no one layer by itself, no matter how good, is completely relied upon. This includes protection of the barriers to avert damage to the plant and to the barriers themselves. It includes further measures to protect the public, workers, and the environment from harm in case these barriers are not fully effective.

The first layer of DID typically involves barriers to contain uncontrolled hazardous material or energy release. The second layer of DID typically involves preventive systems to protect those barriers and the third typically involves systems to mitigate uncontrolled hazardous material or energy releases upon barrier failure.

During the hazard evaluation process potential preventive and mitigative features were identified for each event in Tables A-9 through A-12. The features are either design or administrative in nature. The features that are credited for prevention or mitigation of each event are identified in Table A-13 or A-14 for site and facility worker protection or in Section 3.4 AA for protection of the public. The remainder of the preventive and mitigative features for a specific event identified in the hazard evaluation tables provide DID for that event. Not all available design or administrative features are credited. Controls were selected based on providing the greatest worker protection and additional controls were selected if they prevented/mitigated different initiators for events in the same areas.

<u>Safety Significant SSCs</u>

SS SSCs and ACs were chosen to provide worker protection and significant contribution to DID. These selections are indicated Tables A-13 and A-14. The SS SSCs are described and evaluated in Chapter 4, carried forward to Chapter 5, and are protected in the TSRs. The ACs are carried forward to Chapter 5 and protected in the TSRs

<u>TSRs</u>

TSRs are derived in Chapter 5. TSRs impose controls to protect the SSCs, ACs, and design features that provide protection of the public, the worker, and provide a significant contribution to DID.

3.3.2.3.3 Worker Safety

The UHE for RH waste handling identified a number of waste handling process hazards that could potentially result in worker exposure to radiological and hazardous materials, or worker injury. Reduction of the risk to workers from accidents is accomplished at the WIPP primarily by design features and controls that reduce the frequency or consequences of hazardous events, or both. This is consistent with (1) 10 CFR §830.205, "Technical Safety Requirements"[17]; (2) the DID philosophy; and (3) the philosophy of Process Safety Management, as published in 29 CFR §1910.119, "Process Safety Management of Highly Hazardous Chemicals."[18]

Potential preventive and mitigative design features and ACs for each postulated deviation were identified in the in the UHE Tables A-9 through A-12 in Appendix A. Any event in the UHE with a risk of I or II to the worker resulted in the identification of SS SSCs and/or ACs, as appropriate, for worker protection Those SSCs or controls that are credited to prevent or mitigate worker consequences from accidents are identified in Appendix A, Tables A-13 and A-14. Any event in the UHE with a risk of III but with high consequence was also evaluated and any controls necessary for worker protection were included in Tables A-13 and A-14. A qualitative assessment of the effectiveness of these controls is documented on the site worker and facility worker MHE summary tables. Events with multiple initiators and multiple controls are annotated within the UHE tables to link the preventive/mitigative design feature and AC to the specific cause. Those events that resulted in different consequences for different initiators are noted in NS-05-004.[11]

3.3.2.3.4 Environmental Protection

The potential for airborne radiological releases in the event that waste containers are breached is the primary concern with respect to RH waste handling, storage, and disposal operations. Radiological release is prevented or mitigated by the design features and ACs identified in the MHE, with the SC items identified in Section 3.4 and the SS items identified in Appendix A Table A-13 and A-14 of this chapter. Each of the features that provides DID also contributes to environmental protection. Additional protection from hazardous materials and waste is described in Chapter 8 of this DSA.

3.3.2.3.5 Accident Selection

From Section 3.3.2.3, the events from the UHE requiring AA, grouped based on the event type, are as follows:

Fires	Event numbers - WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, WHB1-9, UG1-1, UG1-2, UG1-5
Explosion	Event numbers - WHB2-1, WHB2-2,WHB2-3, WHB2-4, WHB2-5, WHB2-6, WHB2-7, UG2-1, UG2-2, UG2-3, UG2-6
Loss of Containment or Confinement	Event numbers - WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-6, UG3-1, UG3-2, UG3-3, UG3-6
Direct Radiation Exposure	Event numbers - None identified based on risk to public or facility workers
Nuclear Criticality	Event numbers - BEU based on analysis
External Hazards	Event numbers - OA6-3, WHB6-1, WHB6-2, WHB6-3, WHB6-4, UG6-1, UG6-2, BG6-1

Natural Phenomena	Event numbers - WHB7-1, WHB7-2, WHB7-3, WHB7-6, WHB7-7, UG7-4, BG7-1

3.4 Accident Analysis

This section quantitatively analyzes the postulated accident scenarios selected as discussed in Section 3.3 and tabulated in Appendix A. The selected RH accidents are considered DBAs as defined in DOE-STD-3009-94.[3] These DBAs are used to estimate the response of the WIPP SSCs to the range of accident scenarios that bound the envelope of accident conditions to which the facility could be subjected and evaluate accident consequences. The purpose of the AA is to identify SC SSCs and TSRs necessary to maintain accident consequences such that the accident EG criteria of 25 rem (250 mSv) for the off-site public is not exceeded or significantly challenged. To establish SC SSCs and/or TSR controls, the accident consequences are analyzed for the maximally exposed off-site individual (MOI) located at the WIPP Exclusive Use Area (EUA) boundary. The EUA is within the site boundary and is used in lieu of the site boundary because the public has unrestricted access up to the EUA boundary.

The models and assumptions used in the analysis for determining the amount of radioactivity released to the environment and the extent of exposure to the MOI are provided in the following sections. Activity releases to the environment are given for each postulated accident. CEDE were calculated for the MOI.

The radioactive material in the RH waste that has the potential to be released to the off-site environment (except contamination on the container surface) is contained within the waste container. Physical properties and assumptions for RH waste container inventories used in this analysis are presented in Section 3.3.2.3.

The conservatism in the safety analysis assumptions overestimated rather than underestimated potential consequences. This is consistent with DOE-STD-3009-94[3] and provides a reasonable assurance that the safety envelope of the facility is defined, the design of the facility is adequate, and the TSRs derived will provide for the protection of the public, the worker, and the environment.

The RH HA includes Operational, Natural Phenomena, and External events. Operational events are binned into three major accident categories, fire, explosion and breach of waste container. Breaches of waste containers may occur due to drop, loads dropping on waste containers or vehicle impact. Waste container drops are evaluated based on the energy involved due to drop height. Due to the differences in release and dispersion mechanisms, accidents of each category are evaluated in the surface and underground areas of the facility.

3.4.1 Methodology

3.4.1.1 Receptors

Based on the WIPP Land Management Plan (DOE/WIPP 93-004),[19] public access to the WIPP 16-section area up to the EUA shown in Figure 1.3-2 is allowed for grazing purposes, and up to the DOE Off Limits Area for recreational purposes. Although analyses are traditionally conducted for a MOI at the facility site boundary, the assumed location of the MOI for this analysis is at the closest point of public access, or the EUA.

The closest distance to the EUA boundary from the exhaust shaft vent is approximately 935 ft (285 m) and the closest distance to the EUA boundary from the WHB exhaust lies approximately 1,150 ft (345 m)

Figure 3.4-1. The southeast corner of the WHB CH bay is also approximately 285m from the EUA, Figure 3.4-2.

3.4.1.2 Source Term

The following equation from DOE Handbook 3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*,[20] reflects the calculation for source term:

Q = MAR * DR * ARF * RF * LPF

where:

Q = The Source Term (Ci or mg)

MAR = Material At Risk - The maximum amount and type of material present that may be acted upon with the potentially dispersive energy source (Ci or mg).

DR = Damage Ratio - The DR is that fraction of the MAR actually impacted by the accident condition.

ARF = Airborne Release Fraction - The fraction of that radioactive material actually impacted by the accident condition that is suspended in air.

RF = Respirable Fraction - Fraction of the airborne radioactive particles that are in the respirable size range (i.e., less than 10 μm in aerodynamic equivalent diameter).

LPF = Leakpath Factor - The LPF is the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident.

The MAR is calculated as the quantity (container inventory multiplied by the number of containers damaged [CI * CD]) , where CI is the waste container radiological inventory, and CD is the number of containers breached during the accident.

The resulting equation is:

Q = CI * CD * DR * ARF * RF * LPF (3-1)

Each of the source term variables is dependent upon the accident under consideration. The conservatism in each of the variables is consistent with DOE-STD-3009-94.[3]

<u>Material at Risk</u>

DOE-STD-3009-94[3] states that the source term should represent a reasonable maximum for a given process or activity. As described in Section 3.3.2.1, the maximum radionuclide inventory for direct loaded 72-B waste canisters is 240 PE-Ci, the maximum radionuclide inventory for 72-B waste canisters loaded with three 30- or 55- gallon drums is 240 PE-Ci (80 PE-Ci per drum), and the maximum radionuclide inventory of a 10-160B loaded with ten 30- or 55-gallon drums is 800 PE-Ci (80 PE-Ci per drum). The containers damaged are determined in each specific accident scenario.

NS-05-004[11] analyzes each event with the appropriate waste container for the location of the event. The most bounding case was selected as the basis for control selection. For example, for events occurring in the RH bay the MAR for the 10-160B was used because the 10-160B lid bolts are loosened in the RH bay while the 72-B's inner lid and bolts are left as received; for events occurring in the CUR and upper hot cell the MAR for the 10-160B was used because 72-B waste is not processed in the CUR or upper hot cell. For events occurring in the transfer cell, the FCLR, the waste hoist and the underground, the MAR for the 72-B canister with three drums was used because the 72-B canister is removed from the 72-B cask in the transfer cell. The most bounding case was selected as the basis for control selection. For waste hoist events resulting a fall of the waste down the shaft the MAR for a RH canister containing three solidified/vitrified drums was used.

For combined RH/CH accidents, the bounding MAR and associated DRs for the CH waste containers were based on similar events in the CH DSA.[14]

Damage Ratio

From DOE-STD-3009-94,[3] DR is that fraction of material actually impacted by the accident conditions. Waste containers are damaged by fires, explosions, and loss of confinement events that include drops, punctures and collisions. The DRs assigned to each event and its basis is explained in NS-05-004.[11] The following summarizes the DRs assigned for each type of event:

Fires

The DR for fires is taken from the pool fire methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*.[22] Twenty-five percent of the top row drums exposed to direct flame impingement experience lid ejection with a DR of 1.0. One third of the material is ejected and burns unconfined.
The remainder of the drums and all RH canisters burn with a DR of 0.5. Solidified/vitrified waste and waste contained in closed RH shipping casks are not damaged.

Explosions

All non-solidified waste containers subjected to internal or external explosions are given at DR of 1.0. Solidified/vitirified waste and waste contained in closed RH shipping casks are not damaged.

Loss of Confinement Events

Waste containers are breached by punctures, drops, crushes, and collisions. RH waste canisters and drums are given a 0.5 DR for wind-borne missiles, punctures, and falling debris. RH waste contained in closed RH shipping casks are not damaged.

Waste container drops are characterized by three categories:

- Drops less than 4 ft - The waste containers are certified to meet the requirements for DOT Type A or equivalent and do not release their contents when dropped a distance of 4 ft or less. The DR for drops less than or equal to 4 ft is zero.

- Drops greater than 4 ft but less than 15 ft - Drop tests performed on Type A waste containers provide data used to estimate damage to the waste containers from heights greater than 4 ft. For drops greater than 4 ft but less then 15 ft, estimates of waste container DR of 0.025 based on the analysis provided in PLG-1121, *Damage Assessment of Waste Containers Involved in Accidents at the Waste Isolation Pilot Plant*,[23] and comparison to the available test data.[24,25,26,27]

- Drops greater than 15 ft - All drops from a height greater than 15 ft are given a DR or 1.0. This includes the waste hoist drop which is nominally 2,150 ft.

Crush/Collision

Crushes occur from objects dropped on top of waste containers and a collision is a side impact to waste containers. Both waste drums and canisters are conservatively given a DR of 1.0 for crushes. For crush of waste containers resulting from collapse of the WHB the RH 10-160B shipping cask with the lid unbolted is also given a DR of 1.0. RH waste contained in closed RH shipping casks are not damaged.

Airborne Release and Respirable Fractions

Bounding values for the ARFs and the RFs for events in which the waste container contents are subjected to burning/heat are based on DOE-HDBK-3010-94.[20] Only combustible contents are assumed in events involving the burning or heating of waste containers. The ARF for burning of combustible waste container contents, confined to the container, is 5.0E-04 and RF of 1.0. For combustible contents released from the waste container (unconfined) during fire/heating events, the ARF is 1.0E-02 with a RF of 1.0. Although the waste received at the WIPP may contain plastics and cellulose, this single bounding ARF and RF is used for all consequence assessment.

The ARF for contaminated materials in a waste container that are subjected to impact (drop, puncture, or collision) and breach of the waste container is 1.0E-03 with a RF of 0.1 except for drops down the waste shaft. In this case a RF of 1.0 is used because the event would cause an energetic release of the materials. Both these values are based on DOE-HDBK-3010-94.[20]

The total ARF*RF, for direct loaded waste subjected to an internal explosion of in the waste container is taken from HNF-19492, *Revised Hydrogen Deflagration Analysis*.[28] Conclusions from experimental results were that 5 percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined. The materials contained in a WIPP waste container may consist of cellulose or plastics. Based on DOE-HDBK-3010-94[20] the ARF*RF for plastics is 5E-02 and for cellulose it is 1E-02. The ARF*RF for the unconfined burning is derived as 3.0E-02 based on 50 percent plastics and 50 percent cellulose ((0.5*0.05) + (0.5*0.01) = 3.0E-02). The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04.[20] The effective ARF is 7.86E-04.

Leakpath Factor

The LPF for RH accident scenarios is that fraction of the airborne material released from the facility. A LPF of 1.0 was used for all unmitigated and mitigated analyses.

3.4.1.3 Dispersion Modeling

Nuclear Regulatory Guide (NUREG) 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*,[29] methodology was used to develop the atmospheric dispersion coefficients to assess accidental releases from the WIPP underground exhaust shaft and the WHB exhaust vent. NUREG 1.145[29] provides an NRC acceptable methodology to determine site-specific relative concentration values, χ/Q, and the model reflects experimental data on diffusion from releases at ground level at open sites and from releases at various locations on reactor facility buildings during stable atmospheric conditions with low wind speeds.

The relative concentration value or the atmospheric dispersion coefficient (χ/Q) is the time integrated normalized air concentration at the receptor. It represents the dilution of an airborne contaminant due to atmospheric mixing and turbulence. It is the ratio of the average contaminant air concentration at the receptor to the contaminant release rate at the release point. It is used to determine the dose consequences for a receptor based on the quantity released (i.e., the source term), atmospheric conditions, and the distance to the receptor of interest.

The χ/Q values in this DSA are generated using a computer program called GXQ (WHC-SD-GN-SWD-30002, *GXQ Program Users Guide*).[30] The GXQ program has been verified to produce χ/Q values consistent with NUREG 1.145[29] methodology. The GXQ program used the WIPP site-specific three-year averaged meteorological data obtained at the site meteorology tower. All GXQ atmospheric dispersion coefficients are generated using the methods described in the NUREG 1.145[29] regulatory position three, as recommended in DOE-STD-3009-94.[3] The only correction for which credit is taken in the GXQ model is for building wake and plume meander, as described in the NUREG 1.145[29] model.

Two types of release models are provided in NUREG 1.145[29]: (1) releases through vents or other building penetrations, and (2) stack releases. All release points or areas that are effectively lower than 2.5 times the height of adjacent solid structures are considered nonstack releases. However, NUREG 1.145[29] provides for stack modeling in such cases where it can be demonstrated that the vertical velocity of the effluent plumes will be maintained during the course of the accident. In the unmitigated underground events, the underground exhaust fans are assumed to continue running during the course of the accident maintaining a vertical velocity of the plume. Releases from underground events are assumed to be from an elevation equivalent to the distance of the bottom of the exhaust fan ducts to the ground instead of a ground level release. No actual velocity value is assumed in the dispersion calculations for underground events. Continued operation of ventilation for underground events results in higher consequences to the MOI because without ventilation flow a release from the underground would be greatly reduced. WHB events were considered to be nonstack (ground level) releases except during large fire events that are postulated to breach the roof. The heat from a large fire elevates the dispersion plume. To account for elevated plumes the release point is calculated from a height equivalent to the WHB roof. Elevated plume releases are used for the EUA receptor only. The onsite worker is so close to the WHB use of an elevated plume is not appropriate. The consequence would not be conservative. The ground (nonstack) release would be over conservative because the plume would actually be escaping through the roof. The approach taken was to use the nonstack release with 50 percent meteorology conditions. For both models building wake affects were input with the dimensions of the WHB. All atmospheric dispersion coefficients used for offsite receptors are derived from a 95th percentile of the dose distribution as prescribed in DOE-STD-3009-94,[3] Appendix A.

3.4.1.4 Consequence

Consequence assessment calculations are determined for the MOI located at the EUA boundary and the on-site worker (328 ft [100 m]) for releases from the WHB and the exhaust shaft vent. Atmospheric transport is the only significant release and exposure pathway during normal operations and accident conditions during the disposal phase. Based on the site characteristics information in Chapter 1, surface water and groundwater transport from normal or accidental releases of radioactive material is not considered. Radiological dose consequences, utilizing the dose conversion factors (DCF) from International Commission on Radiological Protection (ICRP) Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*[31], and ICRP Publication 72, *Age-Dependent Doses to Members of the Public from Intake of Radionuclides*,[32] are considered. The dose for the public is conservatively used for calculation of the consequence for both the onsite worker and public receptors. The calculation also assumes the inhalation pathway in 50-year CEDE and using Equation 3-5. CEDE will be reported as the dose consequences for each of the accidents evaluated. The calculated dose in 50-year inhalation CEDE is then compared to the MOI radiological EG of 25 rem. The process of normalizing radionuclides to

PE-Ci's accounts for all contributing isotopes in RH waste and external dose contribution from cloud shine or air immersion.

The main hazardous constituent of concern in RH waste is beryllium in the form of fines or shavings. Using the principles of co-detection, any hazardous material release from breached waste containers will be accompanied with a radiological release. Radiological consequence will encompass any hazardous material consequences.

Source term and consequence calculations for each postulated accident were performed and documented in NS-05-004.[11] Results of these calculations are presented in Table 3.4.1 and described in the descriptions of the DBAs. To assess the potential releases of radiological material the following equation was utilized:

Radiological Releases

$$\mathbf{D = Q * \chi/Q * BR * DCF} \qquad \textbf{(3-5)}$$

where:

D	=	Radiological dose CEDE (rem)
Q	=	Radiological Source Term (Ci)
χ/Q	=	Atmospheric dispersion coefficients calculated for specific distances (s/m^3).
BR	=	Breathing rate for standard man (m^3/sec) International Commission on Radiological Protection Report No.23 (*Report of the Task Group on Reference Man)*[33] Light activity 5.3 gallons/min (20.0 liters/min or 3.33 E-04 m^3/sec)
DCF	=	Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 lung absorption Type M 1.85E+08 rem/Ci)[32] [based on 1 micron activity median aerodynamic diameter (AMAD) to adult public]

The DCF for the "Public" is also used for the worker located at 100 m.

3.4.1.5 Off-Site Radiological/Nonradiological Evaluation Guideline

The EG is 25 rem total effective dose equivalent (TEDE). The dose estimates to be compared to it are those received by a hypothetical MOI at the WIPP EUA boundary. Unmitigated release dose calculations for comparison against the EG are used to determine whether the potential level of hazard in the specific facility section warrants SC SSC designation.[3] The EG is generally accepted as a value indicative of no significant health effects (i.e., low risk of latent health effects and no risk of prompt health effects). For the purposes of this analysis, SC controls are designated for unmitigated consequences that challenge the EG. If unmitigated consequences to the public exceeds 15 rem, it is judged to challenge the EG. This is a reasonable value based on the level of conservatism in the analysis and the location of the WIPP relative to the general public. Specific examples of the conservatism include:

- The MAR used in the analysis is conservative by a factor of five as discussed in Section 3.3.2 of this chapter.
- Fire scenarios use instantaneous release as opposed to delayed release fractions.
- Use of bounding RFs/ARFs
- Use of a LPF=1.0 for both unmitigated and mitigated consequences
- Use of minimum distance to the EUA boundary rather than the site boundary.

The designated SC controls are documented in Section 3.4.2. Several SC controls are specified due to the combined consequences of an event that impacts both CH and RH waste, where the consequences for only the RH contribution would not mandate SC controls.

3.4.2 Design Basis Accidents

3.4.2.1 RH-1 – Fire in the WHB

3.4.2.1.1 Scenario Development

Unmitigated Accident Initiation

The following fire events in the RH portion of the WHB were identified in the UHE that represented risk to the public:

- Fire in the RH bay (WHB1-1)
- Fire in the upper hot cell (WHB1-2)
- Fire in the transfer cell (WHB1-3)
- Fire in the FCLR (WHB1-4)
- Fire in the service room propagates to the transfer cell during waste processing (WHB1-5)
- Fire in the crane maintenance room propagates to the upper hot cell (WHB1-6)
- Fire in the hot cell operating gallery (WHB1-7)
- Fire in the RH bay near the common wall between RH and CH bay (WHB1-8)
- Fire in the CUR (WHB1-9)

The events with the highest consequences for a fire in the WHB are WHB1-2, WHB1-6, and WHB1-7 All these events impact the radiological inventory of the upper hot cell.

A fire in the RH bay (WHB1-1) is postulated to start as a result of sparks from an electrical malfunction igniting nearby combustibles, maintenance activities involving hot work or diesel powered equipment or the 10-160B shipping cask containing flammable/combustible materials.

A fire in the upper hot cell (WHB1-2) is postulated to start as a result of sparks from an electrical malfunction igniting nearby combustibles or due to breaking the shield glass windows such that a spark ignites the leaking oil that fills the windows.

A fire in the transfer cell (WHB1-3) is postulated to start as a result of sparks from an electrical malfunction igniting nearby combustibles.

A fire in the FCLR (WHB1-4) is postulated to start as a result of sparks from an electrical malfunction igniting nearby combustibles including possible leaking hydraulic fluid from the facility cask rotating device (FCRD).

A fire in the service room (WHB1-5) is postulated to start as a result of sparks from an electrical malfunction igniting nearby combustibles and eventually propagates into the transfer cell to impact waste.

A fire in the crane maintenance room (WHB1-6) is postulated to start as a result of sparks from an electrical malfunction or maintenance activities on the upper hot cell crane igniting nearby combustibles and propagating to the upper hot cell and impacting waste in the upper hot cell.

A fire in the hot cell operating gallery (WHB1-7) is postulated to start as a result of sparks from an electrical malfunction or maintenance activities igniting nearby combustibles or the oil that fills the lead glass shield windows and propagates to the upper hot cell.

A fire in the RH bay near the common wall between the RH and CH bay (WHB1-8) postulated a fire in the RH portion of the WHB from the operation of diesel powered equipment in the RH bay that propagates through the common wall and impacts CH waste.

Fire in the CUR (WHB1-9) is postulated to start as a result of sparks from and electrical malfunction igniting nearby combustibles.

For events WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, and WHB1-9 a fire could also result from an internal spontaneous ignition. This would only damage the container involved. The internal fire is of lesser consequence than any of the previously discussed scenarios for these events. This cause is being evaluated separately because the controls to prevent internal fires are different than those for fire external to the waste container. The controls would prevent a fire in a RH container from spreading to CH waste.

3.4.2.1.2 Source Term Analysis

Unmitigated Scenario

WHB1-1 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. This event is based on the maximum inventory of one 10-160B shipping cask with an unbolted lid of 800 PE-Ci. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: It is assumed that all the drums in the 10-160B burn confined. A DR of 0.5 is assigned with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 2.0E-01 PE-Ci.

WHB1-2, WHB1-6, and WHB 1-7 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. Fire events associated with the upper hot cell are based on the maximum inventory that can be stored in the upper hot cell or six fully loaded facility canisters and 10 drums for a total of 2240 PE-Ci. The facility canisters are assumed to burn in a confined manner with a DR of 0.5. The confined waste burns with an ARF*RF of 5.0E-04. Three of the direct loaded drums experience lid ejection with a DR of 1.0. One third of the material is ejected and burns unconfined resulting in an ARF*RF of 1.0E-02. The material remaining in the drums experiencing lid ejection burns confined with an ARF*RF of 5.0E-04. The remaining seven drums are postulated to burn in a confined manner with a DR of 0.5 and an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 1.37E+00 PE-Ci.

WHB1-3, WHB1-4, WHB1-5 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The fires associated with the transfer cell, service room, and FCLR have the same MAR which is assumed to be the contents of a RH waste canister for a total of 240 PE-Ci. The waste canisters are assumed to burn in a confined manner with a DR of 0.5. The confined waste burns with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 6.0E-02 PE-Ci.

WHB1-8 – The source term for this event is developed in NS-05-004[11] and documented in Table 3.4-1. The MAR for this event is 800 PE-Ci from a 10-160B cask (assuming the cask lid bolts are loosened) and two facility pallets of CH waste containing direct loaded drum assemblies (560 PE-Ci per seven-pack with four seven-packs on each facility pallet) for a total MAR of 5280 PE-Ci. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: It is assumed that twenty-five percent of the top level drums in direct view of the fire (four) experience lid ejection with a DR of 1.0. Of those drums experiencing lid loss, one third of the material in the container is ejected and burns unconfined resulting in an ARF*RF of 1.0E-02; the material remaining in the drums experiencing lid ejection burn confined in the containers with an ARF*RF of 5.0E-04. The remainder of CH and RH drums (62) are assumed to experience seal failure with a DR of 0.5. The material in the waste containers experiencing seal failure burns confined with an ARF*RF of 5.0E-04. Due to the shorter height of the CH bay roof with respect to the RH bay roof, a fire near the common RH/CH wall beaches the CH roof based on *WIPP WHB Fire Severity Calculations*[34] causing an elevated plume to be released. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 2.4E+00 PE-Ci.

WHB1-9 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. Fires associated with the CUR are based on the contents of a 10-160B shipping cask with the lid bolts loosened. There are ten drums in the 10-160B each containing 80 PE-Ci for a total of 800 PE-Ci. Only five drums are removed from the 10-160B shipping cask at a time. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: One drum is postulated to be exposed to enough heat to experience lid ejection with a DR of 1.0. One third of the material in the drum is ejected and burns unconfined resulting in an ARF*RF of 1.0E-02; the material remaining in the drum experiencing lid ejection burns confined in the containers with an ARF*RF of 5.0E-04. The remainder of the drums (nine), whether in or being removed from the 10-160B shipping cask, are conservatively assumed to experience seal failure with a DR of 0.5. The material in the drums experiences seal failure and burn confined with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 4.71E-01 PE-Ci.

Internal waste container fire for events WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, and WHB1-9 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. Internal fire events are based on the maximum inventory of a single facility canister containing 240 PE-Ci. The canisters are assumed to burn in a confined manner with a DR of 0.5. The confined waste burns with an ARF*RF of 5.0E-04. If the waste container generates enough internal pressure to eject the lid then the event is considered an internal waste container explosion which is evaluated later in this section. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 6.0E-02 PE-Ci.

Safety Class Mitigated scenario

WHB1-2, WHB1-6, and WHB 1-7 – Implementation of the controls specified in Section 3.4.2.1.5 prevent these events from occurring; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.1.3 Consequence Analysis

Unmitigated Scenario

WHB1-2, WHB1-6, and WHB 1-7 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events exceed the EG.

WHB 1-1, WHB1-3, WHB1-4, WHB1-5, WHB1-8 and WHB1-9 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events do not exceed or challenge the EG. Although WHB1-8 has a higher source term, the consequence is modeled as a elevated plume release because the fire will cause the CH bay roof to breach.

Internal waste container fire for events WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, and WHB1-9 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events do not exceed or challenge the EG.

Safety Class Mitigated Scenario

WHB1-2, WHB1-6, and WHB 1-7 – Implementation of controls specified in Section 3.4.2.1.5 prevents this event from occurring. Therefore, the consequences of these events do not challenge or exceed the EG.

3.4.2.1.4 Comparison to Guidelines

The unmitigated consequence of external fire for events WHB1-2, WHB1-6, and WHB 1-7 exceed the EG. Therefore, SC controls are required to prevent or mitigate the consequences of these events to an acceptable level below the criteria. Implementation of the controls identified in Section 3.4.2.1.5 prevent these events from occurring.

The unmitigated consequence of external fire for events WHB1-1, WHB1-3, WHB1-4, WHB1-5, WHB1-8 and WHB1-9 do not challenge or exceed the EG. Therefore no SC controls are required.

The unmitigated consequence of internal fire for events WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, and WHB1-9 do not challenge or exceed the EG. Therefore no SC controls are required.

3.4.2.1.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
WHB1-2, WHB1-6, and WHB 1-7 Design Feature: WHB structure - Thick concrete walls, floors, and ceiling of the upper hot cell including oil filled lead glass shield windows and steel doors segregate the upper hot cell from the crane maintenance room and the hot cell operating gallery.	Noncombustible construction prevents fire propagation.

WHB1-2, WHB1-6, and WHB 1-7 (AC) - Combustible Loading Control Program that: - Prevents storage of combustible material, flammable gas, and flammable compressed gas in the crane maintenance room, the hot cell operating gallery, or the hot cell and prevents use of flammable gas and flammable compressed gas in the upper hot cell and hot cell operating gallery when waste is present in the upper hot cell. - Flammable gas and flammable compressed gas cylinders are not used in the crane maintenance room when waste is present in the upper hot cell unless the crane maintenance shield door is closed.	Prevents fires by controlling the amount of combustible material in the upper hot cell, the hot cell operating gallery, and the crane maintenance room.
(AC) - Waste handling restriction that requires the crane maintenance room shield door to be closed except when transferring the upper hot cell crane to and from the crane maintenance room.	Prevents a fire in the crane maintenance room from propagating to the upper hot cell.

3.4.2.2 RH-2 – Fire in the Underground

3.4.2.2.1 Scenario Development

Unmitigated Scenario Initiation

The following fire events were identified in the UHE as representing significant risk to the public:

- Fire in disposal path involving both RH and CH waste (UG1-1)
- Fire in disposal room involving both RH and CH waste (UG1-2)

Fire in the Waste Hoist Tower (UG1-5) is identified in the HE as a fire event. However, the fire does not directly result in radiological consequence. The fire damages the waste hoist as another initiator for waste hoist failure. This event is discussed with underground waste container breach events in Section 3.4.2.6.

The highest consequence fire in the underground is UG1-2, Fire in the Disposal Room. The following describes the initiation and progression of the unmitigated fire scenarios in the underground evaluated in this section.

UG1-1 - A fire is started in the disposal path involving both RH and CH waste, the most likely initiator being a fire on the RH 41-ton waste handling forklift that results from fuel or hydraulic leaks or the diesel engine in the vicinity of the CH waste transporter. Both the RH facility cask and the CH waste being transported to the disposal panel are engulfed in flames, causing damage to RH and CH waste containers resulting in a release to the public via the underground exhaust ventilation system.

UG1-2 - A fire is started near the CH disposal array waste face in the active disposal room, the most likely initiator being a fire on the RH 41-ton waste handling forklift that results from fuel or hydraulic leaks or the diesel engine in the vicinity of CH waste. This results in damage to RH and CH waste containers and a release to the public via the underground exhaust ventilation system.

UG1-1 and UG1-2 - A fire could also result from an internal spontaneous ignition. This would only damage the container involved. The internal fire is of lesser consequence than any of the previously discussed scenarios for these events. This cause is being evaluated separately because the controls to prevent internal fires are different than those for fire external to the waste container.

3.4.2.2.2 Source Term Analysis

Unmitigated Scenario

UG1-1 – The source term for this event is developed in NS-05-004[11]. Based on the UHE, the MAR for this event is one RH waste canister (240 PE-Ci) and one facility pallet payload with direct loaded drums on the CH underground transporter (2240 PE-Ci), for a total of 2480 PE-Ci. Using the pool fire source term methodology in RFP-5098[21] and WHC-SD-SQA-ANAL-501[22] the following values were developed: Three drums experience lid loss with a DR of 1.0. This is derived from only the top two rows of drums which are exposed to direct flame impingement (total of twelve drums with 25 percent experiencing a lid loss). One third of the material from containers experiencing lid loss is ejected from the containers and burns unconfined with an ARF*RF of 1.0E-02. The remaining waste in the drums experiencing lid loss burns confined in the drums with an ARF*RF of 5.0E-04. The remaining CH drums and the RH canister experience seal failure with a DR of 0.5 and burn confined with an ARF*RF of 5.0E-4. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 1.43E+00 PE-Ci.

UG1-2 – The source term for this event is developed in NS-05-004.[11] Based on the UHE, the MAR for this event is one RH waste canister (240 PE-Ci) and three columns (nine seven-packs of CH) of waste in the disposal array (5,040), for a total of 5,280 PE-Ci. This MAR was postulated in the UHE and is based on the potential size of a diesel pool fire that could occur at the face of the waste array. Using the pool fire source term methodology in RFP-5098[21] and WHC-SD-SQA-ANAL-501[22] the following values were developed: Five drums experience lid loss with a DR of 1.0. This is derived from twenty-five percent of the top row outer drums which are exposed to direct flame impingement. One third of the material from containers experiencing lid loss is ejected from the containers and burns unconfined with an ARF*RF of 1.0E-02. The remaining waste in the drums experiencing lid loss burns confined in the drums with an ARF*RF of 5.0E-04. The remaining CH drums and the RH canister experience seal failure with a DR of 0.5 and burn confined with an ARF*RF of 5.0E-4. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 2.67E+00 PE-Ci.

Internal waste container fire for events UG1-1 and UG1-2 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. Internal fire events are based on the maximum inventory of a single facility canister containing 240 PE-Ci. The canisters are assumed to burn in a confined manner with a DR of 0.5. The confined waste burns with an ARF*RF of 5.0E-04. If the waste container generates enough internal pressure to eject the lid then the event is considered an internal waste container explosion which is evaluated later in this section. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a source term of 6.0E-02 PE-Ci.

Safety Class Mitigated Scenario

UG1-1 and UG1-2 – Implementation of the controls specified in Section 3.4.2.2.5 prevent these events from occurring; therefore, a source term for a Safety Class Mitigated Scenario has not been developed.

3.4.2.2.3 Consequence Analysis

Unmitigated Scenario

UG1-1 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. Based on a stack release from the underground, the MOI at the EUA would receive a dose for this event that challenges the EG.

UG1-2 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. Based on a stack release from the underground, the MOI at the EUA would receive a dose for this event that exceeds the EG.

Internal waste container fire for events UG1-1 and UG1-2 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events do not exceed or challenge the EG.

Safety Class Mitigated Scenario

UG1-1 - Implementation of the controls identified in Section 3.4.2.2.5 prevents these events from occurring. Therefore, the consequences of these events do not challenge or exceed the EG.

UG1-2 - Implementation of the controls identified in Section 3.4.2.2.5 prevents these events from occurring. Therefore, the consequences of these events do not challenge or exceed the EG.

3.4.2.2.4 Comparison to Guidelines

The unmitigated consequence of UG1-1 challenges the EG and the unmitigated consequence of UG1-2 exceeds the EG. Therefore, SC controls are required to prevent or mitigate the consequences of these events to an acceptable level below the criteria. Implementation of the controls identified in Section 3.4.2.2.5 prevent these accidents from occurring.

The unmitigated consequence of internal fire for events UG1-1 and UG1-2 do not challenge or exceed the EG. Therefore no SC controls are required.

3.4.2.2.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
UG1-1 and UG1-2	
(SSC) Automatic/manual fire suppression system on the diesel powered RH waste handling equipment including the 41-ton, 20-ton, and 6-ton forklifts.	Prevents small fires associated with waste handling vehicles including fuel line leaks or the engine from becoming large fires with the potential to impact waste containers.
(AC) Waste Handling Restrictions - Use of a spotter when RH vehicles are within 75 ft of the CH waste array. - A minimum standoff distance of 75 ft. is maintained between RH 41-ton waste handling forklift and the CH waste transporter loaded with waste.	Prevents collisions that could result in a fire or collisions with the waste face, or running over electrical equipment associated with power to the horizontal emplacement retrieval equipment (HERE) or borehole machine.

3.4.2.3 RH-3 – Explosions Followed by Fire in the WHB

3.4.2.3.1 Scenario Development

The following explosion events were identified in the UHE as representing significant risk to the public:

- Explosion followed by fire in the RH bay (WHB2-1)
- Explosion followed by fire in the CUR (WHB2-2)
- Explosion followed by fire in the upper hot cell (WHB2-3)
- Explosion followed by fire in transfer cell (WHB2-4)
- Explosion followed by fire in FCLR (WHB2-5)
- Explosion followed by fire in crane maintenance room (WHB2-6)
- Explosion followed by fire in hot cell operating gallery (WHB2-7)

Unmitigated Accident Initiation

WHB2-1 – Explosion followed by fire in the RH bay. The inventory of one 10-160B shipping cask with an unbolted lid is impacted. This event may be caused by an explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the lower flammability limit (LFL) in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. The ejected lid impacts another drum in the 10-160B shipping cask. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. The container impacted by the ejected lid spills its radiological inventory. For an explosion external to the waste containers, flammable gas from leaking flammable compressed gas cylinders accumulates in the RH bay and subsequently ignites. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers in the 10-160B shipping cask with unbolted lid. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-2 – Explosion followed by fire in the CUR. The inventory of one 10-160B shipping cask being unloaded is impacted. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. The ejected drum lid impacts adjacent drums in the drum basket. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. The container impacted by the ejected lid spills its radiological inventory. For an explosion external to the waste containers, flammable gas from leaking flammable compressed gas cylinders accumulates in the CUR and subsequently ignites. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers in the CUR. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-3 – Explosion followed by fire in the upper hot cell. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. The ejected lid impacts another drum staged in the upper hot cell. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. The container impacted by the ejected lid spills its radiological inventory. For an explosion external to the waste containers, flammable gas from leaking flammable compressed gas cylinders in the upper hot cell accumulates in the upper hot cell and subsequently ignites. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers staged in the upper hot cell. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-4 – Explosion followed by fire in transfer cell. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. For an explosion external to the waste containers, flammable gas from leaking flammable compressed gas cylinders accumulates in the transfer cell and subsequently ignites. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers staged in the upper hot cell. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-5 – Explosion followed by fire in FCLR. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. For an explosion external to the waste container, flammable gas from leaking flammable compressed gas cylinders in the FCLR accumulates and subsequently ignites. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers staged in the upper hot cell. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-6 – Explosion followed by fire in crane maintenance room. This event may be only be caused by an explosion external to the waste containers. For an explosion external to the waste container, the accumulation of a flammable concentration of gas external to the waste container, from leaking compressed flammable gas cylinders in the crane maintenance room, that is subsequently ignited. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers staged in the upper hot cell. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

WHB2-7 – Explosion followed by fire in hot cell operating gallery. This event may be only be caused by an explosion external to the waste containers. For an explosion external to the waste container, the accumulation of a flammable concentration of gas external to the waste container, from leaking compressed flammable gas cylinders in the hot cell operating gallery, that is subsequently ignited. The pressure/shock wave created by the explosion are postulated to cause damage to waste containers staged in the upper hot cell. The damage results in release of radioactive material to the environment as no credit is taken for the building structure or its ventilation.

3.4.2.3.2 Source Term Analysis

Unmitigated Scenario

WHB2-1 – The source term for this event is developed in NS-05-004.[11] The MAR for this event is ten drums for a 10-160B payload for total of 800 PE-Ci. The source term is based on both an external and internal explosion followed by fire. For the external explosion, a DR of 1.0 is assigned and the ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. Ten of the drums are postulated to burn in a follow-on fire. The fire source term derivation is described previously as event WHB1-1. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.0E+00 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

WHB2-2 – The source term for this event is developed in NS-05-004.[11] The MAR for this event is ten drums for a 10-160B payload for total of 800 PE-Ci. The source term is based on both an external and internal explosion followed by fire. For the external explosion, a DR of 1.0 is assigned and the ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. Ten of the drums are postulated to burn in a follow-on fire. The fire source term derivation is described previously as event WHB1-9. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.27E+00 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

WHB2-3, WHB2-6 and WHB2-7 – The source term for these events is developed in NS-05-004.[11] The MAR for these events is six loaded facility canisters containing 240 PE-Ci each and ten staged drums with a maximum inventory of 800 PE-Ci, for a total of 2240 PE-Ci. The source term is based on both an external and internal explosion followed by fire for event WHB2-3. The source term for events WHB2-6 and WHB2-7 is based on external explosions followed by fire only. For the external explosion, a DR of 1.0 is assigned and the ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. The follow-on fire source term derivation for these events is described previously as event WHB1-2. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 3.61E+00 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

WHB2-4 and WHB2-5 – The source term for these events is developed in NS-05-004.[11] The MAR for these events is a single 72-B or facility canister containing 240 PE-Ci. The source term is based on both an external and internal explosion followed by fire. For the external explosion, a DR of 1.0 is assigned and the ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. The follow-on fire source term derivation for these events is described previously as event WHB1-3. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 3.0E-01 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

Safety Class Mitigated Scenario

WHB2-1, WHB2-2, WHB2-3, WHB2-6 and WHB 2-7 – Implementation of the controls specified in Section 3.4.2.3.5 prevent these events from occurring; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.3.3 Consequence Analysis

Unmitigated Scenario

WHB2-1 – The consequences of this event were computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for this event challenge the EG.

WHB2-2 – The consequences of this event were computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for this event exceeds the EG.

WHB2-3, WHB2-6 and WHB2-7 – The consequences of these events were computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events exceed the EG.

WHB2-4 and WHB2-5 – The consequences of these events were computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events do not exceed or challenge the EG.

Safety Class Mitigated Scenario

WHB2-1 – Implementation of the controls identified in Section 3.4.2.3.5 prevent this event from occurring. Therefore, the consequences of this event do not challenge or exceed the EG.

WHB2-2 – Implementation of the controls identified in Section 3.4.2.3.5 prevent this event from occurring. Therefore, the consequences of this event do not challenge or exceed the EG.

WHB2-3, WHB2-6 and WHB2-7 – Implementation of the controls identified in Section 3.4.2.3.5 prevent these events from occurring. Therefore, the consequences of these events do not challenge or exceed the EG.

3.4.2.3.4 Comparison to Guidelines

The unmitigated consequences from external explosions for event WHB2-1 challenges the EG. The unmitigated consequences from external explosions for events WHB 2-2, WHB2-3, WHB2-6 and WHB2-7 exceed the EG. Therefore, SC controls are required to prevent or mitigate the consequences of these events to an acceptable level below the criteria. Implementation of the controls identified in Section 3.4.2.3.5 prevent these events from occurring.

The unmitigated consequence from internal explosion for events WHB2-1, WHB 2-2, WHB2-3, WHB2-6 and WHB2-7 do not challenge or exceed the EG. Therefore, SC controls are not required to prevent or mitigate the consequence of these events to an acceptable level below the criteria.

3.4.2.3.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
WHB2-1, WHB2-2, WHB2-3, WH2-6, WHB2-7 (AC) Combustible Loading Control Program - WHB that prohibits use of flammable gas and flammable compressed gas cylinders in the following areas and under the specified conditions: - The RH bay when the 10-160B shipping cask is loaded with RH waste and the lid is unbolted. - The CUR when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell or transfer cell when waste is in the CUR unless the upper hot cell floor shield plugs are installed and the CUR floor shield valve is closed. - The upper hot cell and hot cell operating gallery when waste is present in the upper hot cell. Also flammable gas and flammable compressed gas cylinders are not used in the CUR when waste is present in the upper hot cell unless the upper hot cell shield plugs are installed. - The crane maintenance room when waste is present in the upper hot cell unless the crane maintenance room shield door is closed. Prohibits storage of flammable gas and flammable compressed gas cylinders in the WHB.	Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.
WHB2-1 Design Feature: WHB structure - The RH bay segregated from the hot cell complex by thick concrete walls, steel doors, and the CUR concrete and steel shield door.	Robust noncombustible construction prevents explosion/fire propagation.
(AC) Waste handling restriction to: - Prohibit removal of RH waste drums or canisters from the shipping cask outside the hot cell complex - Require that the 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed if left unattended.	Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.

WHB2-2 Design Feature: WHB structure - The CUR is segregated from the RH bay and other parts of the hot cell complex by thick concrete walls, floors, and ceiling, concrete shield plugs, steel shield valves and doors, and the thick concrete and steel shield door. (AC) - Waste handling restriction to require the upper hot cell shield plugs to be installed except when transferring items into and from the upper hot cell.	Robust noncombustible construction prevents explosion/fire propagation. Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.
WHB2-3 Design Feature: WHB structure - Upper hot cell is segregated from other parts of the hot cell complex and WHB by thick concrete floors, walls, ceiling, shield plugs, lead glass windows, and steel shield valves and doors. (AC) - Waste handling restriction to require the upper hot cell shield plugs to be installed except when transferring items into and from the upper hot cell.	Robust noncombustible construction prevents explosion/fire propagation. Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.
WHB2-6 Design Feature: WHB structure - Crane maintenance room is segregated from upper hot cell by a raised concrete wall and a shield door (AC) - Waste handling restriction requires that the door between the crane maintenance room and the upper hot cell shield door is closed except when transferring the upper hot cell crane into and from the crane maintenance room.	Robust noncombustible construction prevents explosion/fire propagation. Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.
WHB2-7 Design Feature: WHB structure - The hot cell operating gallery is segregated from the hot cell complex by thick concrete walls, floors, ceilings, lead glass windows and steel doors.	Robust noncombustible construction prevents explosion/fire propagation.

3.4.2.4 RH-4 – Explosions in the Underground

3.4.2.4.1 Scenario Development

Unmitigated Accident Initiation

The following explosion events were identified in the UHE as representing significant risk to the public:

- Explosion followed by fire in the disposal path affects RH or RH and CH waste (UG2-1)
- Explosion followed by fire in the disposal room affects RH or RH and CH waste (UG2-2)
- Battery Explosion on the 41-ton RH forklift impacting RH and CH waste (UG2-3)

Explosion in the Waste Hoist Tower (UG2-6) is identified in the HE as an explosion event. While an explosion in the waste hoist tower does not directly result in radiological consequence, the explosion can be an initiator for waste hoist failure. This event is discussed with underground waste container breach events in Section 3.4.2.6.

UG2-1 – Explosion followed by fire in the disposal path impacting RH and CH waste. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. The ejected lid impacts another drum on the facility pallet. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. The container impacted by the ejected lid spills its radiological inventory. For an explosion external to the waste container, flammable gas or leakage from flammable compressed gas cylinders accumulates and subsequently ignites. The explosion is postulated to cause damage to all RH and CH waste containers in the disposal path.

UG2-2 – Explosion followed by fire in the disposal room impacting RH and CH waste. This event may be caused by explosion internal or external to the waste container. For an internal explosion, flammable gas generation in a waste container could result in hydrogen concentration reaching the LFL in the container's vapor spaces. An ignition source is assumed to be present resulting in an internal waste container explosion ejecting the lid from a single affected container. The ejected lid impacts another drum on the facility pallet or in the waste array. A fraction of the contents from the container with the ejected lid is ejected and burns in an unconfined manner, while the balance remains confined in the container and burns. The container impacted by the ejected lid spills its radiological inventory. For an explosion external to the waste container, flammable gas or leakage from flammable compressed gas cylinders accumulates and subsequently ignites. The explosion is postulated to cause damage to the RH waste container and three columns (nine seven-packs) of CH waste in the disposal room.

UG2-3 – Battery Explosion on the RH waste handling forklifts. A battery explosion on the RH waste handling forklifts is postulated to occur in close proximity of CH waste in the CH disposal room. The RH waste handling forklifts are equipped with battery chargers that can be plugged into any utility outlet in the underground. The explosion creates missiles that impact and breach the RH waste container and three columns (nine seven-packs) of CH waste in the disposal room.

3.4.2.4.2 Source Term Analysis

Unmitigated Scenario

UG2-1 –The source terms for this event is developed in NS-05-004.[11] Based on the UHE, the MAR for this event is one RH waste canister (240 PE-Ci) and one facility pallet payload with direct loaded drum on the CH underground transporter (2240 PE-Ci), for total of 2480 PE-Ci. The source term is based on both an external and internal explosion followed by fire. For the external explosion, a DR of 1.0 is used for all waste containers impacted by the explosion. The ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. All the waste containers are postulated to burn in a follow-on fire. The follow-on fire source term derivation for this event is described previously as event UG1-1. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 3.91E+00 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

UG2-2 –The source terms for this event is developed in NS-05-004.[11] Based on the UHE, the MAR for this event is one RH waste canister (240 PE-Ci) and three columns (nine seven-packs of direct loaded CH drums) of waste in the disposal array (5040 PE-Ci), for a total of 5280 PE-Ci. The source term is based on both an external and internal explosion followed by fire. For the external explosion, a DR of 1.0 is used for all waste containers impacted by the explosion. The ARF*RF is 1.0E-03 for the initial explosion impact to waste containers. The RH canister and three columns of CH waste are postulated to burn in a follow-on fire. The follow-on fire source term derivation for this event is described previously as event UG1-2. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 7.95E+00 PE-Ci.

The MAR for an internal explosion is based on an internal over-pressurization of a RH waste canister (240 PE-Ci) causing the lid to eject and damages a drum containing 80 PE-Ci. Based on HNF-19492 methodology: Five percent of the MAR would be ejected by the explosion and of that, 18 percent would burn unconfined with an ARF*RF of 3.0E-02. The other 82 percent of the ejected waste (unburned) would be subjected to forces that could remove contamination from the waste with an ARF*RF of 1.0E-03. The waste remaining in the drum after the explosion (95 percent of MAR) will continue to burn as confined combustible material with an ARF*RF of 5.0E-04. The drum damaged by the ejected lid is given a DR of 0.5 with an ARF*RF of 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 1.93E-01 PE-Ci.

UG2-3 –The source terms for this event is developed in NS-05-004.[11] Based on the UHE, the MAR for this event is one RH waste canister (240 PE-Ci) and three columns (nine seven-packs of direct loaded CH drums) of waste in the disposal array (5040 PE-Ci), for a total of 5280 PE-Ci. The source term is based on an external explosion followed by fire only. A DR of 0.5 is used for all waste containers involved. The ARF*RF is 1.0E-04 for impact to waste containers. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 2.64E-01 PE-Ci.

Safety Class Mitigated Scenario

UG2-1 and UG2-2 – Implementation of the controls specified in Section 3.4.2.4.5 prevent these events from occurring; therefore, a source term for a Safety Class Mitigated Scenario has not been developed. The consequences from only the RH waste do not challenge the EG. The controls specified in 3.4.2.4.5 prevent explosions within an RH waste container and any subsequent impact to CH waste.

UG2-3 – No mitigated scenario is required for UG2-3 because it does not challenge or exceed the EG.

3.4.2.4.3 Consequence Analysis

Unmitigated Scenario

UG2-1 and UG2-2 – The consequences of these events were computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI at the EUA boundary for these events exceed the EG.

UG2-3 – The unmitigated consequence for this event does not challenge or exceed the EG.

Safety Class Mitigated Scenario

UG2-1 and UG2-2 – These events are prevented by the implementation of the controls specified in Section 3.4.2.4.5; therefore, the consequences of a mitigated scenario are not calculated.

3.4.2.4.4 Comparison to Guidelines

The unmitigated consequence of external explosions for events UG2-1 and UG2-2 exceed the EG. However, implementation of the controls specified in Section 3.4.2.4.5 prevent these events.

The unmitigated consequence of Event UG2-3 does not challenge or exceed the EG. Therefore, SC controls are not required to prevent or mitigate the consequence of these events to an acceptable level below the criteria.

The unmitigated consequence from internal explosion for events UG2-1, UG2-2 and UG2-3 do not challenge or exceed the EG. Therefore, SC controls are not required to prevent or mitigate the consequence of these events to an acceptable level below the criteria.

3.4.2.4.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
UG2-1, UG2-2 (AC) - Combustible Loading Control Program including: - No storage of flammable gas and flammable compressed gas in the disposal path from the base of the waste shaft to the active disposal room or in the active disposal room. - No use of flammable compressed gas cylinders in the disposal path or active disposal room during waste handling	Prevents explosions/fires in the disposal path and active disposal room.

3.4.2.5 RH-5 – Waste Container(s) Breach in the WHB

3.4.2.5.1 Scenario Development

Unmitigated Accident Initiation

The following loss of confinement events were identified in the UHE as representing significant risk to the public:

- Loss of RH shipping cask confinement in the RH bay (WHB3-1)
- Loss of confinement in CUR (WHB3-2)
- Loss of confinement in transfer cell (WHB3-3)
- Loss of confinement in upper hot cell (WHB3-4)
- Loss of confinement in WHB impacting RH and CH waste (WHB3-6)
- Errant vehicle collides with WHB (WHB6-1)

WHB3-1 – The RH bay crane fails such that the crane or the load being lifted by the crane drops, crushes or punctures the RH shipping casks in the RH bay.

WHB3-2 – During movement or unloading of RH shipping casks in the CUR, the CUR crane, upper hot cell crane, rotating block, grapples, or lift fixtures associated with the CUR or upper hot cell fail such that the RH 72-B canisters or 10-160B drums are crushed, or punctured.

WHB3-3 – The CUR crane, upper hot cell crane, rotating block, grapples, or lift fixtures associated with the CUR or upper hot cell fail such that the 72-B casks or facility canisters are damaged; or shield valves in the transfer cell ceiling, upper hot cell floor, or facility cask close during transfer of RH waste cask/canister. This severs the crane hoist ropes, crushes the cask or canister or dislodges the load. It is postulated a facility canister from the upper hot cell falls onto another canister already in place in the transfer cell shuttle car.

WHB3-4 – The upper hot cell crane/grapple or overhead powered manipulator fails such that the crane, grapple, or overhead powered manipulator drops, crushes or punctures waste containers by either falling on the waste, by dropping the waste, or by dropping object(s) on the waste.

WHB3-6 – During movement of a loaded RH trailer in the RH bay the trailer is backed into the common wall between the RH and CH waste processing areas. This breaches one facility pallet payload of overpacked CH waste containers. The two lower CH waste assemblies are crushed by the impact and the two upper assemblies fall to the WHB floor.

WHB6-1 – The UHE postulated a vehicle collision into the RH bay causing damage to staged RH shipping cask.

3.4.2.5.2 Source Term Analysis

Unmitigated Scenario

WHB3-1, WHB3-2, and WHB6-1 – The source term for these events is developed in NS-05-004.[11] The MAR for these events are same and consists of the entire ten drum inventory of one 10-160B shipping cask containing 800 PE-Ci. A DR of 1.0 is assigned for all the drums. The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The resulting source term is 8.0E-02 PE-Ci.

WHB3-3 – The source term for this event is developed in NS-05-004.[11] The MAR for this event is derived from a facility canister from the upper hot cell falling on another canister already present in the transfer cell shuttle car. Each canister has 240 PE-Ci for a total of 480 PE-Ci. DR of 1.0 is assigned both canisters. The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The resulting source term is 4.8E-02 PE-Ci.

WHB3-4 – The source term for this event is developed in NS-05-004[11] and not only considers breach of the entire upper hot cell inventory but also considers a lesser event where the upper hot cell shield plugs are dropped on four canisters located in the storage wells.

The MAR for the entire inventory event is six facility canisters containing 240 PE-Ci each and 10 drums with 80 PE-Ci each, for a total of 2240 PE-Ci. A DR of 1.0 is assigned for all the containers. The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The resulting source term is 2.24E-01 PE-Ci.

The MAR for a lesser event is four facility canisters containing 240 PE-Ci each, for a total of 960 PE-Ci. A DR of 1.0 is assigned for all the containers. The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The resulting source term is 9.6E-02 PE-Ci.

WHB3-6 – The source term for this event is developed in NS-05-004.[11] The MAR for this event is four four-packs of overpacked CH waste containing 1200 PE-Ci each, for a total of 4800 PE-Ci. Overpacked CH waste assemblies are selected because this configuration has a higher DR and source term than direct loaded CH waste containers when crushed. The two lower CH waste assemblies are crushed by the impact and given a DR of 1.0. The two upper assemblies fall to the WHB floor and are assigned a DR of 0.025. The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The resulting source term is 2.46E-01 PE-Ci.

Safety Class Mitigated Scenario

WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-6, and WHB6-1 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.5.3 Consequence Analysis

Unmitigated Scenario

WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-6, and WHB6-1 – The consequence of these events is computed in NS-05-004[11] and documented in Table 3.4-1. The consequences to the MOI for these events do not challenge or exceed the EG.

Safety Class Mitigated Scenario

WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-6, and WHB6-1 – Safety class SSCs or TSR controls are not required for these events; therefore, consequence analysis for safety class mitigated scenario has not been developed.

3.4.2.5.4 Comparison to Guidelines

The unmitigated consequences of these events do not challenge or exceed the EG, therefore, SC controls are not required.

3.4.2.5.5 Summary of Safety Class SSCs and TSR Controls

No SC SSCs or TSR controls are required based on the consequences of these events.

3.4.2.6 RH-6 – Waste Container(s) Breach in the Underground

3.4.2.6.1 Scenario Development

Unmitigated Accident Initiation

The following loss of confinement events were identified in the UHE as representing significant risk to the public:

- Fire in waste hoist tower damages hoist (UG1-5)
- Explosion followed by fire in the waste hoist tower damages hoist (UG2-6)
- Waste hoist failure (UG3-1)
- Loss of confinement in the disposal path involving RH and CH waste (UG3-2)
- RH collision into CH waste array (UG3-3)
- Loaded facility cask transfer car (FCTC) driven into waste shaft impacting CH waste in transit to the underground (UG3-6)
- Equipment dropped down waste shaft while RH waste is in transit to the underground (UG6-2)

The highest unmitigated consequences result from the event in which the loaded FCTC is driven into waste shaft impacting CH waste in transit (UG3-6). The event results in breach of RH and CH waste containers and a radioactive material release.

The waste hoist failure (UG3-1) event assumes a mechanical/structural failure of the waste hoist which results in material dropping down the waste shaft. This may also be caused by overloading the waste shaft conveyance. A fire (UG1-5) or explosion (UG2-6) in the waste hoist tower (UG6-1) could be an initiators for event UG3-1 but the fire or explosion do not directly result in radiological consequences.

Loss of confinement between the waste shaft station and disposal room involving RH and CH waste (UG3-2) can either impact RH or RH and CH waste containers. This event assumes the RH FCTC is driven into the waste shaft at the underground waste shaft station (no CH waste involved), the 41-ton RH waste handling forklift loaded with RH waste collides with equipment or other vehicles or the facility cask is impacted by compressed gas cylinder missiles, mechanical failure or hydraulic failure. The collision between the 41-ton RH waste handling forklift loaded with RH waste and a loaded CH waste transporter results in the highest source term for evaluation of this event.

RH collision into CH waste array (UG3-3) assumes the 41-ton RH waste handling forklift transporting the loaded facility cask collides into the CH waste disposal array impacting four columns of CH waste.

Event UG6-2, equipment dropped down the waste shaft while RH waste is in transit assumes equipment or material enters the waste shaft collar and drops down the shaft when the conveyance is not there. This damages the RH waste in transit to the underground.

The events are grouped together in the following manner for evaluation based on their deviation type:

- Events UG1-5, UG2-6, and UG3-1
- Event UG3-2
- Event UG3-3
- Event UG3-6
- Event UG6-2

3.4.2.6.2 Source Term Analysis

Unmitigated Scenario

UG1-5, UG2-6, and UG3-1 – The source term for UG1-5, UG2-6 and UG3-1 are developed in NS-05-004.[11] Solidified drums overpacked in a RH canister is the bounding waste container configuration for these events. This results in a bounding MAR of 5,400 PE-Ci. It is assumed the waste container is crushed upon impact with the underground, resulting in a DR of 1.0. The ARF*RF assumed for this event is 1.0E-03. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a total source term of 5.40E+00 PE-Ci.

UG3-2 – The source term for UG3-2 is developed in NS-05-004.[11] The MAR is one RH waste container containing 240 PE-Ci and one CH facility payload of overpacked drums containing 4800 PE-Ci, for a total of 5040 PE-Ci. Overpacked CH waste assemblies are selected because this configuration has a higher DR and source term than direct loaded CH waste containers when crushed. Two of the overpacked four-packs are assumed to be crushed by a side impact from the collision and are assigned a DR of 1.0. Two of the overpacked four-packs are postulated to fall from the underground waste transporter and are assigned a DR of 0.025. The ARF*RF assumed for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a total source term of 2.70E-01 PE-Ci.

UG3-3 – The source term for UG3-3 is developed in NS-05-004.[11] The MAR is one RH waste container containing 240 PE-Ci and four columns of overpacked CH waste (12 four-packs) containing 14,400 PE-Ci, for a total of 14,640 PE-Ci. Overpacked CH waste assemblies are selected because this configuration has a higher DR and source term than direct loaded CH waste containers when crushed. Because of the configuration of the hexagonal CH disposal array and profile of RH facility cask, the waste containers in two columns of waste in the array are postulated to be crushed and assigned a DR of 1.0 and two columns of waste recessed from the front leading edge of the waste array are crushed with a DR of 0.5. The RH waste container being transported in the facility cask is also assigned a DR of 1.0 The ARF*RF for this event is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a total source term of 1.10E+00 PE-Ci.

UG3-6 – The source term for this event is developed in NS-05-004.[11] The MAR is one RH waste container containing 5,400 PE-Ci and one CH facility payload of overpacked drums containing 4,800

PE-Ci, for a total of 10,200 PE-Ci. Overpacked CH waste assemblies are selected because this configuration has a higher DR and source term than direct loaded CH waste containers when crushed. It is assumed all the waste containers are crushed upon impact with the underground, resulting in a DR of 1.0. The ARF*RF assumed for this event is 1.0E-03. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a total source term of 1.02E+01 PE-Ci.

UG6-2 – The source term for this event is developed in NS-05-004.[11] Solidified drums overpacked in a RH canister is the bounding waste container configuration for these events. This results in a bounding MAR of 5,400 PE-Ci. It is assumed the waste container is crushed upon impact with the underground, resulting in a DR of 1.0. The ARF*RF assumed for this event is 1.0E-03. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. This results in a total source term of 5.40E+00 PE-Ci.

Safety Class Mitigated Scenario

UG1-5, UG2-6, and UG3-1 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

UG3-2 – Safety class SSCs or TSR controls are not required for event UG3-2; therefore, a source term for safety class mitigated scenario has not been developed.

UG3-3 – Implementation of the controls specified in Section 3.4.2.6.5 prevent this event from occurring; therefore, a source term for a Safety Class Mitigated Scenario has not been developed.

UG3-6 – Implementation of the controls specified in Section 3.4.2.6.5 prevent this event from occurring; therefore, a source term for a Safety Class Mitigated Scenario has not been developed.

UG6-2 – Implementation of the controls specified in Section 3.4.2.6.5 prevent this event from occurring; therefore, a source term for a Safety Class Mitigated Scenario has not been developed.

3.4.2.6.3 Consequence Analysis

Unmitigated Scenario

UG3-2 – The consequences of this event were computed in NS-05-004[11] and are also documented in Table 3.4-1. The unmitigated consequence for this event does not challenge or exceed the EG therefore SC controls are not required.

Safety Class Mitigated Scenario

UG1-5, UG2-6, and UG3-1 – These events are prevented by the implementation of the controls specified in Section 3.4.2.6.5; therefore the consequences of a mitigated scenario are not calculated.

UG3-3 – This event is prevented by the implementation of the controls specified in Section 3.4.2.6.5; therefore, the consequences of a mitigated scenario are not calculated.

UG3-6 – This event is prevented by the implementation of the controls specified in Section 3.4.2.6.5; therefore, the consequences of a mitigated scenario are not calculated.

UG6-2 – This event is prevented by the implementation of the controls specified in Section 3.4.2.6.5; therefore, the consequences of a mitigated scenario are not calculated.

3.4.2.6.4 Comparison to Guidelines

The unmitigated consequence for Events UG3-2 and UG6-2 do not challenge or exceed the EG.

UG1-5, UG2-6, and UG3-1 – The unmitigated consequence of Events UG1-5, UG2-6, and UG3-1, exceed the EG. However, implementation of the control specified in Section 3.4.2.6.5 prevents these events from occurring.

UG3-3 – The unmitigated consequence of Event UG3-3 challenges the EG. However, implementation of the control specified in Section 3.4.2.6.5 prevents the event from occurring.

UG3-6 – The unmitigated consequence of Event UG3-6 exceeds the EG. However, implementation of the control specified in Section 3.4.2.6.5 prevents the event from occurring.

UG6-2 – The unmitigated consequence of Event UG6-2 exceeds the EG. However, implementation of the control specified in Section 3.4.2.6.5 prevents the event from occurring.

3.4.2.6.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	**Safety Function**
Events UG1-5, UG2-6, and UG3-1 Design Features: Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower	Prevents uncontrolled movement of loaded waste conveyance down the waste shaft.
Waste hoist brakes	Redundant brakes prevents uncontrolled movement of the waste conveyance.
(AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB and prohibits its use in the waste hoist tower during waste transport using the waste shaft conveyance.	Prevents fires in the waste hoist tower.
Event UG 3-3 (AC) - A spotter is required when operating the RH 41-ton, 20-ton, or 6-ton waste handling forklifts within 75 ft. of the CH disposal array waste face.	Prevents RH waste handling equipment from colliding with the CH waste face.

Events UG 3-6 and UG6-2 (AC) - Toplander control of waste shaft access	Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position. Also prevents any load from being dropped down the waste shaft or a load from inadvertently entering the waste shaft.
(AC) - Waste handling restriction requires that the waste shaft conveyance is at the collar of the waste shaft before the loaded FCTC is moved from the FCLR to the waste shaft collar area.	Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position.

3.4.2.7 RH-7 – Aircraft Crash

3.4.2.7.1 Scenario Development

Unmitigated Accident Initiation

WHB6-3, BG6-1, and OA6-3 – The Evaluation of a possible aircraft crash is required by DOE-STD-3009-94.[3] The possibility of an aircraft crash into the WHB was identified as part of the UHE as event WHB6-3, aircraft crash into the WHB; BG6-1, an aircraft crashes into the waste hoist tower with fuel going down the waste shaft; and OA6-3 an aircraft crashes into parked RH shipping casks.

As discussed in Chapter 1 of this CH DSA,[14] two federal ten-mile-wide airways (one jet route and one low-altitude route) pass within five miles of the WIPP. Traffic data show that the combined traffic is about 32 instrument flight rule flights per day. There are no airports or approaches within a five-mile radius of the WIPP. The nearest airstrip to the WIPP, now no longer in use, is twelve miles north of the site. The nearest commercial airport is 28 miles to the west in Carlsbad. The closest military air base is Holloman Air Force Base, located 138 miles NW of the site.

DOE-STD-3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities*,[35] provides criteria for the development of frequencies of aircraft accidents used in analyses for nuclear power plants and for crash frequency contributions associated with airport operations (takeoffs and landings), and federal airway activity. Using DOE-STD-3014-96, the total aircraft hazard probability (combined airway and airport) at the WIPP site is 3.6E-07/yr and is documented in ITSC-WIPP-2000-01, *Estimate of Aircraft Impact Frequency and Consequences at the WIPP*.[36]

3.4.2.7.2 Source Term Analysis

Unmitigated Scenario

WHB6-3, BG6-1, and OA6-3 – The frequency of the aircraft crash accident scenario is beyond extremely unlikely; therefore, unmitigated source term development is not required.

Safety Class Mitigated Scenario

WHB6-3, BG6-1, and OA6-3 – The frequency of the aircraft crash accident scenario is beyond extremely unlikely; therefore, safety class mitigated source term development is not required.

3.4.2.7.3 Consequence Analysis

Unmitigated Scenario

WHB6-3, BG6-1, and OA6-3 – The frequency of the aircraft crash accident scenario is beyond extremely unlikely; therefore, unmitigated consequence development is not required.

Safety Class Mitigated Scenario

WHB6-3, BG6-1, and OA6-3 – The frequency of the aircraft crash accident scenario is beyond extremely unlikely; therefore, safety class mitigated consequence development is not required.

3.4.2.7.4 Comparison to Guidelines

WHB6-3, BG6-1, and OA6-3 – Consequence analysis is not required for these events; therefore, a comparison to the EG is not required.

3.4.2.7.5 Summary of Safety Class SSCs and TSR Controls

WHB6-3, BG6-1, and OA6-3 – No SC SSCs or TSR controls are required based on the frequency of these events.

3.4.2.8 RH-8 – Seismic

3.4.2.8.1 Scenario Development

Unmitigated Accident Initiation

Two seismic events were postulated in the HA that represented significant risk for impacting and breaching waste containers in the WHB.

- Earthquake impacts RH bay and underground (BG7-1)
- Earthquake with fire (WHB7-2)

BG7-1 and WHB7-2 – The DBE is the most severe credible earthquake expected to occur at the WIPP site and is based on a 1,000-year return interval. The maximum ground acceleration for the DBE is 0.1 g in both the horizontal and vertical directions. The DBE could disrupt the process of moving RH waste in the WHB or during transport to the underground. The DBE could cause waste to be dropped or items to be dropped on waste, or could cause waste containers to topple. The WIPP site does not have gas pipelines within the property protection area (PPA) that could create a large fire following an earthquake. Nevertheless, a follow-on fire is postulated to occur.

3.4.2.8.2 Source Term Analysis

Unmitigated Scenario

WHB7-2 – The source term for these events is developed in NS-05-004.[11] The UHE postulated the full RH inventory in the WHB would be impacted by the seismic event. The MAR for these events is based on one 10-160B shipping with an unbolted lid in the RH bay (800 PE-Ci), six facility canisters and 10 drums in the upper hot cell (2240 PE-Ci), one RH canister in the transfer cell (240 PE-Ci) and one RH canister in the FCLR or on the waste shaft conveyance (240 PE-Ci), for a total of 3520 PE-Ci. All waste containers are assigned a DR of 1.0 and an ARF*RF assumed is 1.0E-04 for the initial breach. All the waste containers are also impacted by a follow-on fire. The follow-on fire source term derivation for these events is described as event WHB6-2. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 2.04E+00 PE-Ci.

BG7-1 – The source term for these events is developed in NS-05-004.[11] The UHE postulated the full RH inventory in the WHB would be impacted by the seismic event. The MAR for these events is based on one 10-160B shipping with an unbolted lid in the RH bay (800 PE-Ci), six facility canisters and 10 drums in the upper hot cell (2240 PE-Ci), one RH canister in the transfer cell (240 PE-Ci) and one RH canister in the FCLR or on the waste shaft conveyance (240 PE-Ci), for a total of 3520 PE-Ci. All waste containers are assigned a DR of 1.0 and an ARF*RF assumed is 1.0E-04 for the initial breach. For this seismic event there is no postulated follow-on fire. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for these events is 3.52E-01 PE-Ci.

Safety Class Mitigated Scenario

WHB7-2 – These event is prevented by the implementation of the controls specified in Section 3.4.2.8.5; therefore, the consequences of a mitigated scenario are not calculated.

BG7-1 – Safety class SSCs or TSR controls are not required for event UG3-2; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.8.3 Consequence Analysis

Unmitigated Scenario

WHB7-2 – The consequence of this event was computed in NS-05-004[11] and documented in Table 3.4-1. The unmitigated consequence to the MOI at the EUA boundary for this event exceeds the EG.

BG7-1 – The consequences of this event were computed in NS-05-004[11] and are also documented in Table 3.4-1. The unmitigated consequence for this event does not challenge or exceed the EG therefore SC controls are not required.

Safety Class Mitigated Scenario

WHB7-2 – The controls specified in Section 3.4.2.8.5 prevent the consequences of BG7-1 and WHB7-2. Therefore, the mitigated consequence of these events are acceptable with respect to the EG.

3.4.2.8.4 Comparison to Guidelines

WHB7-2 – The unmitigated consequences of these events exceed the EG and requires SC controls. Implementation of the controls specified in Section 3.4.2.8.5 prevent the consequences from these events.

BG7-1 – The unmitigated consequence for this event does not challenge or exceed the EG.

3.4.2.8.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
Event WHB7-2 Design Feature: WHB structure - Designed to withstand the DBE - Noncombustible construction	Prevents the WHB from collapsing on waste. Prevents fire propagation
(AC) - Combustible Loading Control Program that: Prevents storage of combustible material, flammable gas, and flammable compressed gas in the crane maintenance room, the hot cell operating gallery, or the hot cell and prevents use of flammable gas and flammable compressed gas in the upper hot cell and hot cell operating gallery when waste is present in the upper hot cell. Flammable gas and flammable compressed gas cylinders are not used in the crane maintenance room when waste is present in the upper hot cell unless the crane maintenance shield door is closed.	Prevents fires by controlling the amount of combustible material in the upper hot cell, the hot cell operating gallery, and the crane maintenance room.

3.4.2.9 RH 9 - External Fire Damage WHB and Waste Containers

3.4.2.9.1 Scenario Development

Unmitigated Accident Initiation

The UHE postulated two fire events initiated outside the WHB that propagate to the WHB causing damage to and radioactive release from waste containers:

- External Fire Propagates to WHB (WHB6-2)
- Wildland Fire Propagates to WHB (WHB7-1)

WHB6-2 and WHB7-1 – The UHE postulated in event WHB6-2, that fires external to the WHB but within the PPA could propagate to the WHB causing damage to waste containers housed in the building and a release path to the environment. Event WHB7-1 postulated that a wildland fire, external to the PPA, could cause the WHB to catch fire which would result in damage to waste containers. Both these events postulated the entire RH inventory of the WHB burns.

3.4.2.9.2 Source Term Analysis

Unmitigated Scenario

WHB6-2 and WHB7-1 – The source term for these events is developed in NS-05-004.[11] The consequences for both these events are the same. The MAR is based on one 10-160B shipping with an unbolted lid in the RH bay (800 PE-Ci), six facility canisters and 10 drums in the upper hot cell (2240 PE-Ci), one RH canister in the transfer cell (240 PE-Ci) and one RH canister in the FCLR or on the waste shaft conveyance (240 PE-Ci), for a total of 3520 PE-Ci. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: It is assumed twenty-five percent of the drums in the upper hot cell (three drums) burn unconfined and experience lid ejection with a DR of 1.0. One third of the material in the drums is ejected and burns unconfined resulting in an ARF*RF of 1.0E-02; the material remaining in the drums experiencing lid ejection burn confined in the containers with an ARF*RF of 5.0E-04. The remainder of the waste containers burns in a confined manner with a DR of 0.5 and an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 1.69E+00 PE-Ci.

Safety Class Mitigated Scenario

WHB6-2 and WHB7-1 – The source term for these events is developed in NS-05-004.[11] Implementation of the controls specified in Section 3.4.2.9.5 mitigates the consequence of the fire. The MAR is based on one 10-160B shipping with an unbolted lid in the RH bay (800 PE-Ci). Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: All ten drums burn confined in the containers with a DR of 0.5 with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 2.0E-01 PE-Ci.

3.4.2.9.3 Consequence Analysis

Unmitigated Scenario

WHB6-2 and WHB7-1 – The consequences of these events are the same and are computed in NS-05-004[11] and documented in Table 3.4-1. Based on ground release dispersion, the consequence to the MOI at the EUA boundary for this event exceeds the EG.

Safety Class Mitigated Scenario

WHB6-2 and WHB7-1 – The controls specified in Section 3.4.2.9.5 prevents the consequences of WHB6-2 and WHB7-1.

3.4.2.9.4 Comparison to Guidelines

The unmitigated consequence of Events WHB6-2 and WHB7-1 exceed the EG and require SC controls. However, the controls specified in Section 3.4.2.9.5 prevents the consequences from these events.

3.4.2.9.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
WHB6-2 and WHB7-1 Design Feature WHB structure - Noncombustible construction. The WHB including thick concrete walls, floors, ceilings, shield plugs, lead glass windows, and steel shield valves and doors of the hot cell complex.	Prevents fires from propagating into and within the RH facility.
(AC) - Waste handling restriction that prevents removal of RH waste containers from shipping casks outside the hot cell complex.	The hot cell complex prevents propagation of fires to areas where RH waste is outside of shipping casks.

3.4.2.10 RH-10 – Lightning Strikes WHB - Damages Waste Containers

3.4.2.10.1 Scenario Development

Unmitigated Accident Initiation

WHB7-3 – The UHE postulated an event in which a lightning strike to the WHB structure travels to the waste containers housed in the upper hot cell. The lightning is assumed to breach the waste containers being lifted by the crane and result in a radioactive release.

UG7-4 – The UHE postulated lightning would strike the waste hoist head frame and damage waste in transit to the underground.

3.4.2.10.2 Source Term Analysis

Unmitigated Scenario

WHB7-3 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. Fires associated with the CUR are based on the contents of a 10-160B shipping cask with the lid bolts loosened. There are ten drums in the 10-160B each containing 80 PE-Ci for a total of 800 PE-Ci. Only five drums are removed from the 10-160B shipping cask at a time. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: One drum is postulated to be exposed to enough heat to experience lid ejection with a DR of 1.0. One third of the material in the drum is ejected and burns unconfined resulting in an ARF*RF of 1.0E-02; the material remaining in the drum experiencing lid ejection burns confined in the containers with an ARF*RF of 5.0E-04. The remainder of the drums (nine) being removed from the 10-160B shipping cask are assumed to experience seal failure with a DR of 0.5. The material in the drums experiences seal failure and burn confined with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 4.71E-01 PE-Ci.

UG7-4 – The consequences of this event are computed in NS-05-004[11] and documented in Table 3.4-1. The MAR for this event is one RH canister containing 240 PE-Ci. Using the pool fire source term methodology in RFP-5098, Safety Analysis and Risk Assessment Handbook[21] and

WHC-SD-SQA-ANAL-501, *Fire Protection Guide for Waste Drum Storage Arrays*,[22] the following values were developed: The RH canister is not postulated to experience lid ejection and unconfined burning. It is assumed to experience a seal failure with a DR of 0.5. The material in the canister burns confined with an ARF*RF of 5.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term for this event is 6.0E-02 PE-Ci.

Safety Class Mitigated Scenario

WHB7-3 and UG7-4 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.10.3 Consequence Analysis

Unmitigated Scenario

WHB7-3 and UG7-4 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The unmitigated consequence to the MOI at the EUA boundary for these events does not challenge or exceed the EG.

Safety Class Mitigated Scenario

WHB7-3 and UG7-4 – Safety class SSCs or TSR controls are not required for these events; therefore, consequence analysis for safety class mitigated scenario has not been developed.

3.4.2.10.4 Comparison to Guidelines

These events do not challenge or exceed the EG, therefore, no SC SSCs or controls are required for this event.

3.4.2.10.5 Summary of Safety Class SSCs and TSR Controls

No SC SSCs or TSR controls are required based on the consequences of these events.

3.4.2.11 RH-11 – Snow/Ice Load on WHB Roof Causes Roof to Fall - Damages Waste Containers

3.4.2.11.1 Scenario Development

Unmitigated Accident Initiation

WHB7-6 – The UHE postulated a hail load event that results in a failure of the RH facility roof resulting in damage of waste containers.

WHB7-7 – The UHE postulated a snow load event that results in a failure of the RH facility roof resulting in damage of waste containers.

Safety Class Mitigated Scenario

WHB7-6 and WHB7-7 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.11.2 Source Term Analysis

Unmitigated Scenario

WHB7-6 and WHB7-7 – The source term for these events is developed in NS-05-004.[11] The UHE postulated the full RH inventory in the WHB would be impacted by the seismic event. The MAR for this event is based on one 10-160B shipping with an unbolted lid in the RH bay (800 PE-Ci), six facility canisters and 10 drums in the upper hot cell (2240 PE-Ci), one RH canister in the transfer cell (240 PE-Ci) and one RH canister in the FCLR or on the waste shaft conveyance (240 PE-Ci), for a total of 3520 PE-Ci. All waste containers are assigned a DR of 1.0. The ARF*RF assumed is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term is 3.52E-01 PE-Ci.

Safety Class Mitigated Scenario

WHB7-6 and WHB7-7 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

3.4.2.11.3 Consequence Analysis

Unmitigated Scenario

WHB7-6 and WHB7-7 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The unmitigated consequence to the MOI at the EUA boundary for these events does not challenge or exceed the EG based on the RH inventory.

Safety Class Mitigated Scenario

WHB7-6 and WHB7-7 – Safety class SSCs or TSR controls are not required for these events; therefore, consequence analysis for safety class mitigated scenario has not been developed.

3.4.2.11.4 Comparison to Guidelines

These events do not challenge the EG, therefore, no SC SSCs or TSR controls are required for these events, based on the RH inventory.

3.4.2.11.5 Summary of Safety Class SSCs and TSR Controls

These events do not challenge the EG, therefore, no SC SSCs or TSR controls are required for these events based on only the RH inventory. Based on the consequence analysis in the CH DSA for this event, however, the WHB design to withstand snow and ice load is designated as SC.

3.4.2.12 RH-12 - Loss of Electrical Power

3.4.2.12.1 Scenario Development

Unmitigated Accident Initiation

The following loss of power events were identified in the UHE as representing significant risk to the public:

- Loss of electrical power in WHB (WHB6-4)
- Loss of electrical power in the underground (UG6-1)

WHB6-4 – The UHE postulates a loss of electrical power caused by a storm, electrical fire or utility error. This causes all RH waste containers suspended at the time of the loss of power to fall and damage waste containers. The shield plug is postulated to fall on four facility canisters and one facility canister is dropped.

UG6-1 – The UHE postulates a loss of electrical power caused by a storm, electrical fire or utility error. This becomes another initiator for the waste hoist failure event (UG3-1) which results in material dropping down the waste shaft.

3.4.2.12.2 Source Term Analysis

Unmitigated Scenario

WHB6-4 – The source term for this event is developed in NS-05-004.[11] The MAR is four facility canisters (960 PE-Ci) and one RH waste canister (240 PE-Ci) for a total of 1200 PE-Ci. All waste containers are assigned a DR of 1.0. The ARF*RF assumed is 1.0E-04. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term is 1.20E-01 PE-Ci.

UG6-1 – The source term for this event is developed in NS-05-004.[11] Solidified drums overpacked in a RH canister is the bounding waste container configuration for this event. This results in a bounding MAR of 5,400 PE-Ci. A DR of 1.0 is assigned. The ARF*RF assumed is 1.0E-03. No credit is taken for ventilation filtration or deposition, therefore, the assumed LPF is 1.0. The total source term is 5.40E+00 PE-Ci.

Safety Class Mitigated Scenario

WHB6-4 – Safety class SSCs or TSR controls are not required for these events; therefore, a source term for safety class mitigated scenario has not been developed.

UG6-1 – This event is prevented by the implementation of the controls specified in Section 3.4.2.12.5; therefore, the consequences of a mitigated scenario are not calculated.

3.4.2.12.3 Consequence Analysis

Unmitigated Scenario

WHB6-4 – The consequences of these events are computed in NS-05-004[11] and documented in Table 3.4-1. The consequences of these events do not challenge or exceed the EG; therefore SC controls are not required.

Safety Class Mitigated Scenario

UG6-1 – This event is prevented by the implementation of the controls specified in Section 3.4.2.12.5; therefore, the consequences of a mitigated scenario are not calculated.

3.4.2.12.4 Comparison to Guidelines

WHB6-4 – The unmitigated consequence of Event WHB6-4 does not challenge or exceed the EG, therefore, no SC SSCs or TSR controls are required for this event.

UG6-1 – The unmitigated consequence of Event UG6-1 exceeds the EG. However, implementation of the controls specified in Section 3.4.2.12.5 prevents this event from occurring.

3.4.2.12.5 Summary of Safety Class SSCs and TSR Controls

Credited SSC or TSR Control	Safety Function
UG6-1 Design Feature and (SSC) - Waste hoist brakes	Prevents the uncontrolled movement of the waste shaft conveyance upon loss of power

3.4.3 Beyond Design Basis Accidents

As explained in DOE-STD-3009-4[3] beyond design basis accidents (BDBA) are those accidents with more severe conditions or equipment failures than are estimated for the corresponding DBA.

The DBA tornado and straight wind event is assumed to result in the release of a the full inventory of the RH portion of the WHB. A BDBA tornado and straight wind would have the same result. Therefore, there is no residual risk for tornado and high wind events. And the consequences of both the DBA and BDBA are less than 1 rem to the MOI at the EUA boundary.

The DBA earthquake results in a release of the full inventory of the RH portion of the WHB. However, this consequence has been prevented by the WHB design. A BDBA earthquake would have the same result. However the BDBA event will exceed the design of the WHB. Therefore, it is assumed the consequences for a BDBA earthquake would be from the total RH MAR in the WHB. Therefore, the residual risk for a beyond design basis earthquake is greater than 25 rem.

An aircraft crash could impact the entire inventory of waste in the WHB, concurrent with waste being transferred to the underground on the waste shaft conveyance. Through analysis performed in ITSC-WIPP-2000-01,[36] aircraft crash is shown to be BEU and therefore, no consequences are developed for this event.

References for Chapter 3

1. 10 CFR Part 830, "Nuclear Safety Management," January 10, 2001.

2. DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23*, Nuclear Safety Analysis Reports, Change Notice No. 1, September 1997.

3. DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, Change Notice No. 2, April 2002.

4. DOE Order 420.1A, *Facility Safety*, May 20, 2002.

5. DOE-STD-1186-2004, *Specific Administrative Controls*, August 2004.

6. DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*, October 24, 2001.

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Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-1	Fire in the WHB	3.4.2.1	WHB1-1	Fire in the RH bay	4.9	NA	
			WHB1-2	Fire in the upper hot cell	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.1.5.
			WHB1-3	Fire in the transfer cell	1.5	NA	
			WHB1-4	Fire in the facility CUR	1.5	NA	
			WHB1-5	Fire in the service room	1.5	NA	
			WHB1-6	Fire in the crane maintenance room	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.1.5.
			WHB1-7	Fire in the hot cell operating gallery	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.1.5.
			WHB1-8	Fire in RH bay near a RH/CH common wall	8.4	NA	
			WHB1-9	Fire in the CUR	11.6	NA	
				Internal Waste Container Fire	1.5	NA	Applicable to events WHB1-1 through WHB1-9.

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-2	Fire in the Underground	3.4.2.2	UG1-1	Fire in Waste Disposal Path involving both RH and CH waste	22.8	Prevented	Prevented by the controls specified in Section 3.4.2.2.5.
			UG1-2	Fire in Waste Disposal Room involving both RH and CH waste	>25 rem	Prevented	Prevented by the controls specified in Section 3.4.2.2.5.
				Internal Waste Container Fire	0.95	NA	Applicable to events UG1-1 and UG1-2.
RH-3	Explosion in WHB	3.4.2.3	WHB2-1	Explosion/Fire in RH bay	24.6 rem	Prevented	Prevented by controls specified in Section 3.4.2.3.5.
			WHB2-2	Explosion/Fire in CUR	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.3.5.
			WHB2-3	Explosion/Fire in upper hot cell	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.3.5.
			WHB2-4	Explosion/Fire in transfer cell	7.4	NA	
			WHB2-5	Explosion/Fire in the FCLR	7.4	NA	
			WHB2-6	Explosion/Fire in the crane maintenance room	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.3.5.
			WHB2-7	Explosion/Fire in hot cell operating gallery	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.1.5.
				Internal Waste Container Explosion	4.7	NA	Applicable to events WHB2-1 through WHB 2-7.

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-4	Explosion in the Underground	3.4.2.4	UG2-1	Explosion/Fire in the disposal path impacting RH and CH waste	> 25 rem	Prevented	Prevented by the controls specified in Section 3.4.2.4.5.
			UG2-2	Explosion/Fire in the disposal room impacting RH and CH waste	> 25 rem	Prevented	Prevented by the controls specified in Section 3.4.2.4.5.
			UG2-3	Battery explosion on the 41-ton RH forklift impacting RH and CH waste	4.2	NA	
				Internal Waste Container Explosion	3.0	NA	Applicable to events UG2-1 through UG2-3.

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-5	Waste Containers Breach in WHB	3.4.2.5	WHB3-1	Loss of confinement in RH bay	2.0	NA	
			WHB3-2	Loss of confinement in CUR	2.0	NA	
			WHB3-3	Loss of confinement in transfer cell	1.2	NA	
			WHB3-4	Loss of confinement in upper hot cell	5.5	NA	
			WHB3-6	Loss of confinement in WHB impacting RH and CH waste	6.0	NA	
			WHB6-1	Vehicle collides with WHB	2.0	NA	

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-6	Waste Container(s) Breach in the Underground	3.4.2.6	UG1-5	Fire in waste hoist tower damages hoist	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.6.5
			UG2-6	Explosion in waste hoist tower damages hoist	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.6.5
			UG3-1	Waste hoist failure	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.6.5
			UG3-2	Loss of confinement between the waste shaft station and disposal room involving RH and CH waste	4.3	NA	
			UG3-3	RH collision into CH waste array	17.5	Prevented	Prevented by the controls specified in Section 3.4.2.6.5.
			UG3-6	Loaded FCTC drives into waste shaft impacting CH waste	> 25 rem	Prevented	Prevented by the controls specified in Section 3.4.2.6.5.
			UG6-2	Equipment dropped down waste shaft while RH is in transit	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.6.5

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-7	Aircraft Crash	3.4.2.7	OA6-3	Aircraft crashes into parking area	NA	NA	Frequency of an aircraft crash at the WIPP is BEU based on ITSC-WIPP-2000-01 and is an external event. Therefore, further analysis not required.
			WHB6-3	Aircraft crashes into WHB	NA	NA	
			BG6-1	Aircraft crashes into entire facility	NA	NA	
RH-8	Seismic	3.4.2.8	BG7-1	Earthquake impacts RH bay and underground	8.7	Prevented	Based on the CH DSA, the WHB design to withstand the DBE is designated SC.
			WHB7-2	Earthquake with fire in the WHB	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.8.5.
RH-9	External Fires Damage WHB and Waste Containers	3.4.2.9	WHB6-2	External fire propagates to WHB	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.9.5.
			WHB7-1	Wildland fire propagates to WHB	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.9.5.
RH-10	Lightning Strikes WHB	3.4.2.10	WHB7-3	Lightning strikes WHB	11.6	NA	
			UG7-4	Lightning strikes waste shaft conveyance	0.95	NA	
RH-11	Snow/Ice Load on WHB Causes Roof to Fall	3.4.2.11	WHB7-6	Hail load on WHB	8.7	Prevented	Based on the CH DSA, the WHB design to withstand snow/ice loading is designated SC.
			WHB7-7	Snow/ice load on WHB	8.7	Prevented	

Table 3.4-1 - Design Basis Accident Consequence Results

DBA #	DBA Title	DSA Section	UHE Event #		Unmitigated Consequence (Rem)	Mitigated Consequence (Rem)	Comments
RH-12	Loss of Electrical Power	3.4.2.12	WHB6-4	Loss of electrical power in WHB	2.9	N/A	
			UG6-1	Loss of electrical power in the underground	> 25 rem	Prevented	Prevented by controls specified in Section 3.4.2.12.5.

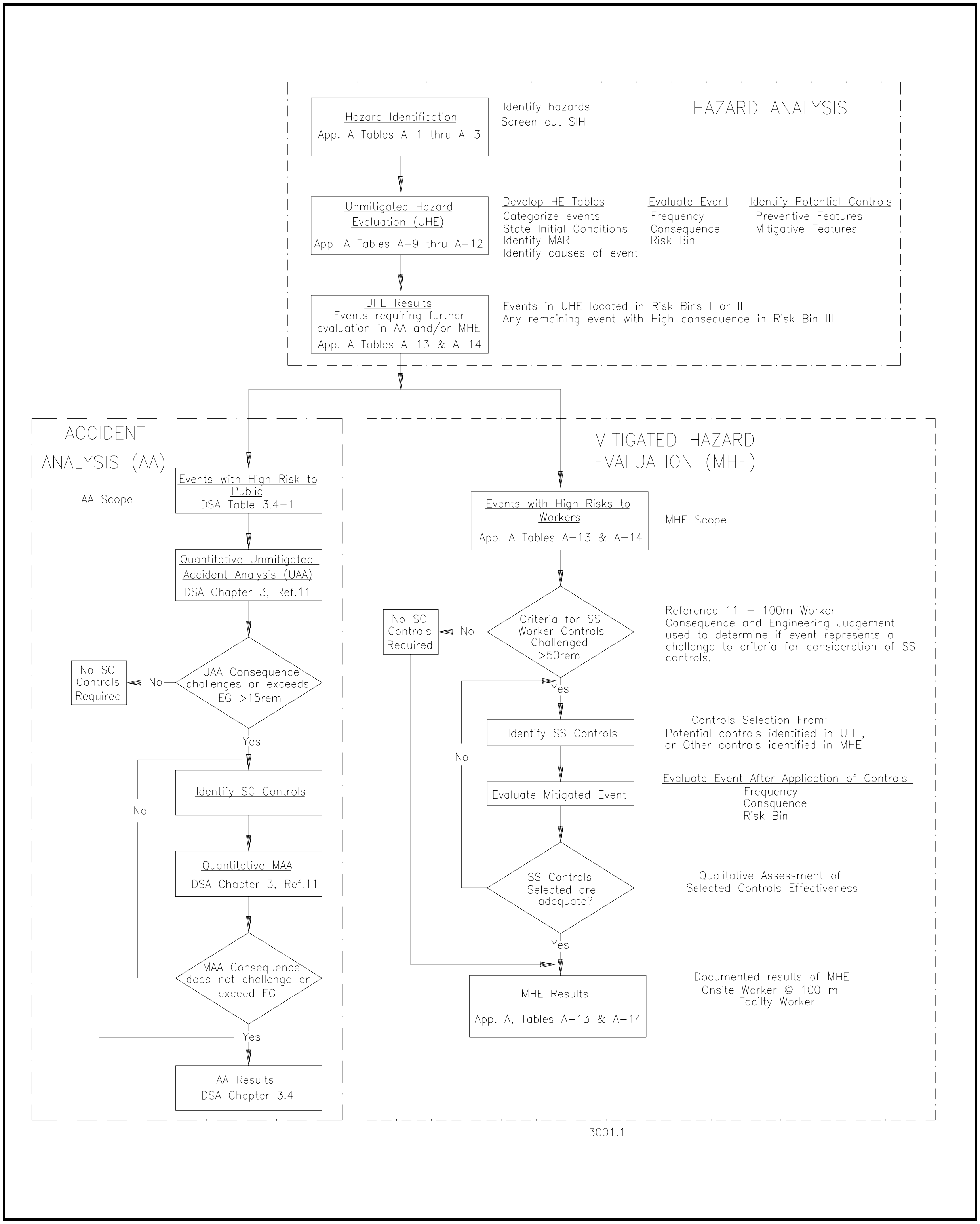

Figure 3.3-1 - Hazard Evaluation and Accident Analysis Flow Chart

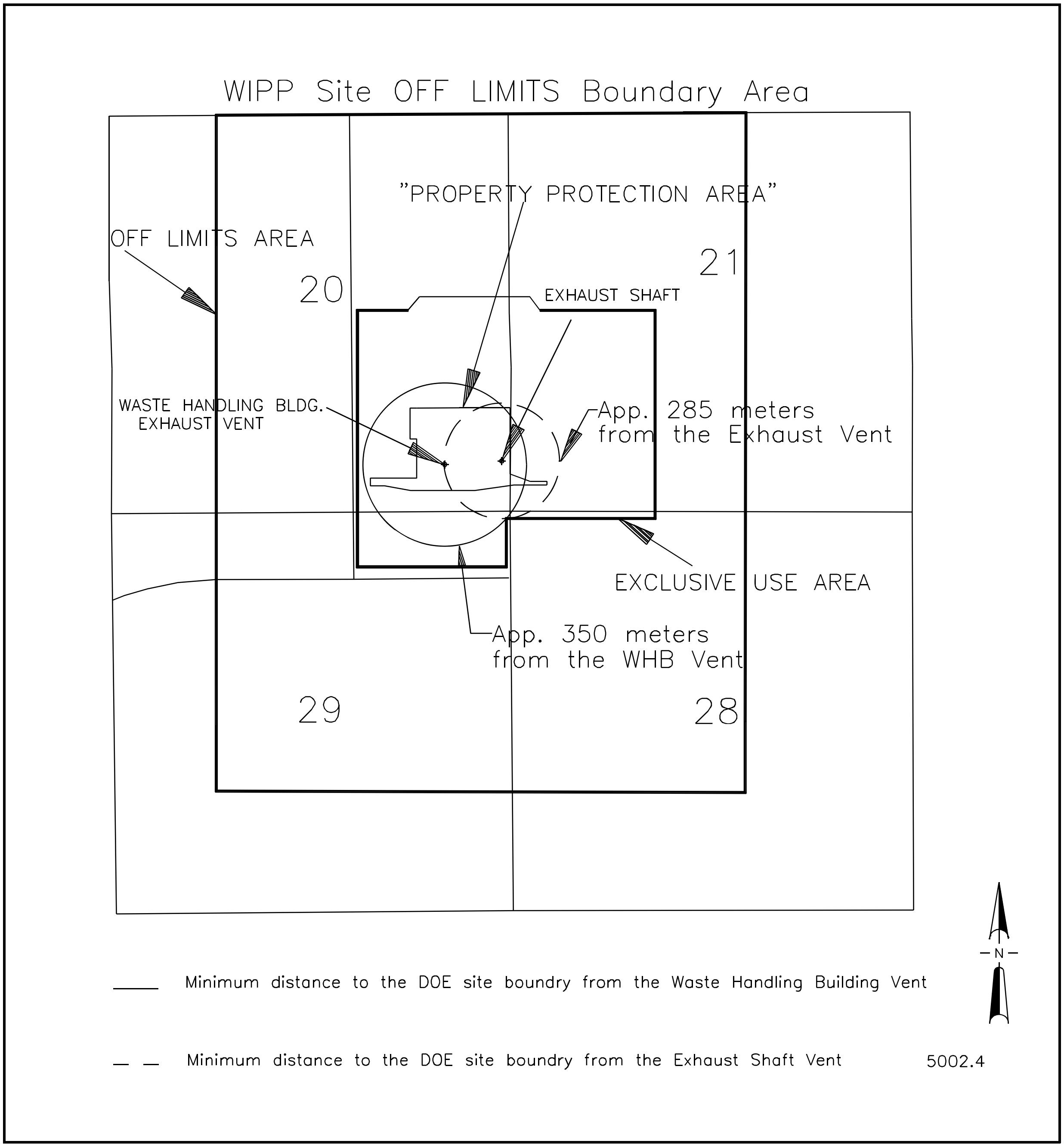

Figure 3.4-1 - WIPP Site Off-Limits Boundary Area

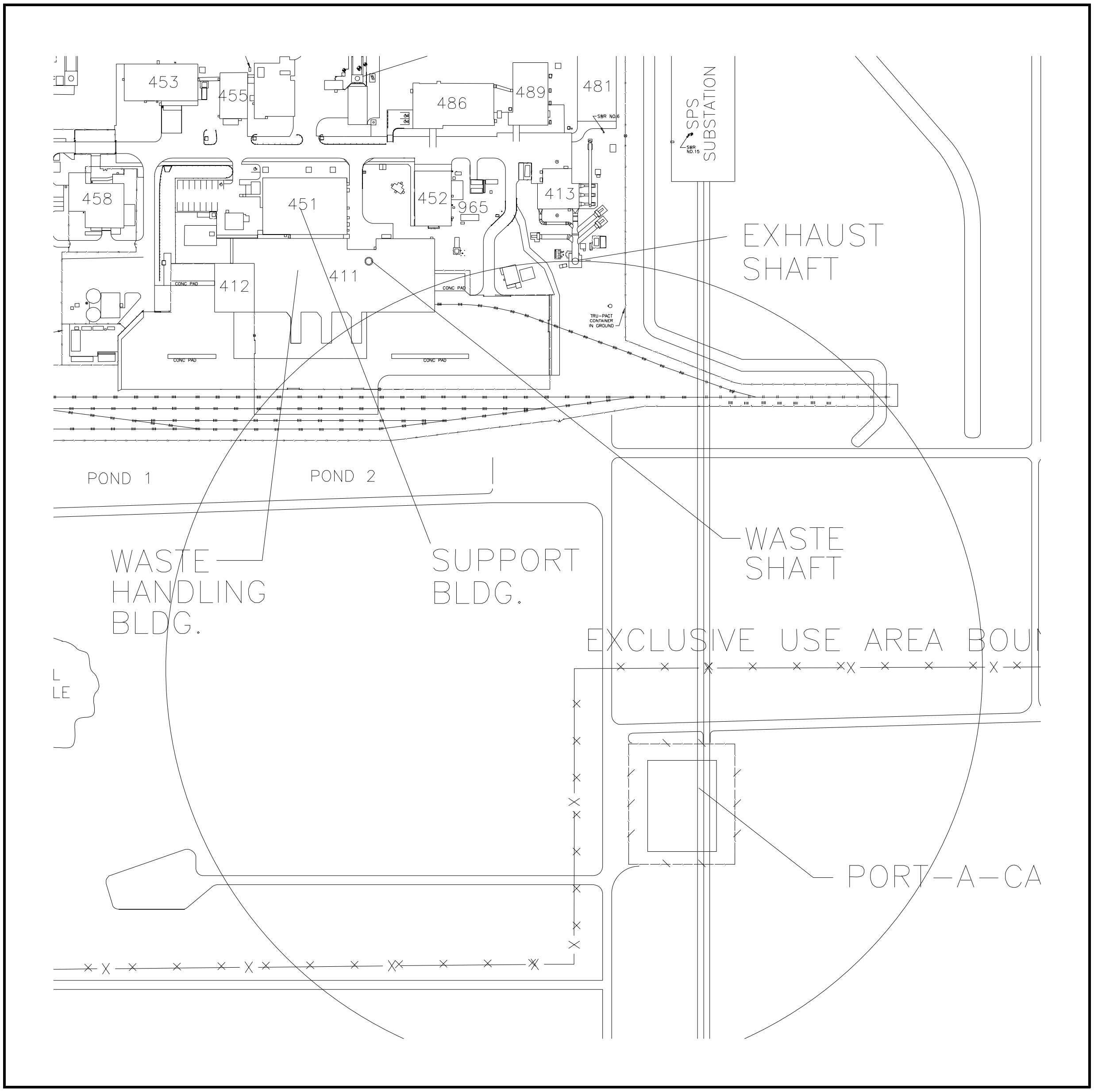

Figure 3.4-2 - 285 Meter Radius from Closest Point of Exclusive Use Area Boundary

Appendix A
Hazard Analysis Tables

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
1	Electrical			
1.1	Battery banks	Y	Electric forklifts, man lifts, electric golf cars used by maintenance or waste handling personnel may be in the RH parking area, mining equipment may be in use or parked adjacent to transport route.	N
1.2	Cable runs	Y	Power to gate, buried cables to substations, heat pumps, etc.	Y
1.3	Diesel generators	Y	Backup diesel generators, portable diesel generator, diesel fire pump in pumphouse, Building 456	Y
1.4	Electrical equipment	Y	Vehicle trap gate is operated using an electric motor, communication equipment antennas and towers, light posts	Y
1.5	Heaters	Y	Vehicles, heat pumps	Y
1.6	High voltage (> 600V)	Y	Substations, switch gear	N
1.7	Locomotive, electrical	N		NA
1.8	Motors	Y	Vehicle trap gate- underground ventilation fans	Y
1.9	Power tools	Y	Incidental maintenance activities	Y
1.10	Pumps	N	Pumphouse, evaporation pond	Y
1.11	Service outlets, fittings	Y	Service outlets on the outside of the gatehouse, WHB/TMF	Y
1.12	Switchgear	Y	Substations 254.1, 254.2, 254.3, 254.4, 254.7, 254.9	N
1.13	Transformers	Y	Substations 254.2, 254.2, 254.3, 254.4, 254.7, 254.9	N
1.14	Transmission lines	Y	East side of site away from transportation route	Y
1.15	Wiring/underground wiring	Y	Power supply to buildings, buried electrical distribution	Y
1.16	Other	Y	Lightning dissipation array, street lights, lighting at the super sack storage area, lighting in the 474 HAZMAT area	Y
2	**Thermal**			
2.1	Boilers	N		NA
2.2	Bunsen burner hot plates	N		NA
2.3	Electrical equipment	Y	At vehicle trap, Substations 254.1, 254.2, 254.3, 254.4, 254.7, 254.9	N
2.4	Electrical wiring	Y	At vehicle trap, Substations 254.1, 254.2, 254.3, 254.4, 254.7, 254.9	N
2.5	Engine exhaust	Y	Vehicles operating along the transportation path from security gate to the parking area	N
2.6	Furnaces	N		NA
2.7	Heaters	Y	Vehicles, heat pumps, Substations 254.1, 254.2, 254.3, 254.4, 254.7, 254.9	N
2.8	Lasers	N	Lasers used for surveying are low energy	Y

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
2.9	Steam lines	N		NA
2.10	Welding surfaces	Y	Maintenance activities outside of maintenance shop.	N
2.11	Welding torch	Y	Used in maintenance activities outside maintenance shop.	N
2.12	Other	Y	Chillers on west side of WHB away from transport path.	Y
3	**Pyrophoric Material**			
3.1	Pu and U metal fines	Y	Inside waste containers	N
3.2	Other	N		NA
4	**Open Flame**			
4.1	Bunsen burners	N		NA
4.2	Welding/cutting torches	Y	Used in maintenance activities outside of maintenance shop.	N
4.3	Other	Y	Smoking, matches	N
5	**Flammables**			
5.1	Cleaning/decontamination solvents	Y	Vehicle trap is main entry point for all materials entering site.	N
5.2	Flammable gases	Y	Vehicle trap is main entry point for all materials entering site.	N
5.3	Flammable liquids	Y	Vehicle trap is main entry point for all materials entering site, gasoline station, diesel powered trailer jockey used for on-site movement of the 72-B shipping cask. Site refueling station has both diesel and gasoline.	N
5.4	Gasoline	Y	Vehicle trap is main entry point for all materials entering site. Site refueling station	N
5.5	Natural gas	N		NA
5.6	Nitric acid soaked rags (spontaneous combustion)	N		NA
5.7	Nitric acid and organics	Y	Nitric acid is used for preserving environmental samples and is stored in a cabinet suitable for acid in Trailer 918.	Y
5.8	Paint/paint solvent	Y	Maintenance activities and vehicle trap is main entry point for all materials entering site.	N
5.9	Propane	Y	Decontamination trailer	N
5.10	Spray paint	Y	Maintenance activities and vehicle trap is main entry point for all materials entering site.	N
5.11	Other	N		NA

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
6	**Combustibles**			
6.1	Paper/wood products	Y	Vehicle trap is main entry point for all materials entering site. Wooden pallets used to support procured items including super sacks, slip sheets, rail road ties, chain link, bolts, office furniture, etc.	N
6.2	Petroleum based products	Y	Vehicles, forklifts, and other equipment may contain lubricating oils, fuels, hydraulic fluid, etc. Used oil staged at the non-hazardous waste storage area.	N
6.3	Plastics	Y	Slipsheets and super sacks staged in the parking area prior to use, vehicles, pallets and general supplies.	N
6.4	Other	Y	Tumbleweeds	N
7	**Chemical Reactions**			
7.1	Concentration	N		NA
7.2	Disassociation	N		NA
7.3	Exothermic	N		NA
7.4	Incompatible chemical mixing	N		NA
7.5	Uncontrolled chemical reactions	N		NA
8	**Explosive Material**			
8.1	Caps	N		NA
8.2	Dusts	N		NA
8.3	Dynamite	N		NA
8.4	Electric squibs	N		NA
8.5	Explosive chemicals	N		NA
8.6	Flammable gases	Y	Acetylene used to support welding gasoline at site refueling station.	N
8.7	Hydrogen	Y	Hydrogen may be present in the waste containers.	N
8.8	Hydrogen (batteries)	Y	Lead acid batteries are used in vehicles and forklifts. Hydrogen from battery chargers when charging batteries.	N
8.9	Nitrates	N		NA
8.10	Peroxides	N		NA
8.11	Primer cord	N		NA
8.12	Propane	Y	Two 7 gallon tanks inside the decontamination trailer.	N
8.13	Other	Y	Hilti charges	N

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
9	**Kinetic (Linear and Rotational)**			
9.1	Acceleration/deceleration	Y	Trailer jockey, trucks, forklifts used to load and unload transporters may collide. CH transporter may collide the RH transporter. Mining dump trucks may collide with waste being transported. Other vehicles being operated onsite may collide with transporter.	N
9.2	Bearings	Y	Associated with vehicles	Y
9.3	Belts	Y	Associated with vehicles	Y
9.4	Carts/dollies	Y	Electric carts, dollies	Y
9.5	Centrifuges	N		NA
9.6	Crane loads (in motion)	Y	Maintenance activities	N
9.7	Drills	Y	Maintenance activities	Y
9.8	Fans	Y	Heat pumps, chiller fans, exhaust fans	Y
9.9	Firearm discharge	Y	From site boundary, security	N
9.10	Forklifts	Y		N
9.11	Gears	Y	Vehicle trap gate	Y
9.12	Grinders	Y	Maintenance activities	Y
9.13	Motors – electric	Y	Vehicle trap gate, heat pumps, chillers	Y
9.14	Power tools	Y	Maintenance activities	Y
9.15	Presses shears	N		NA
9.16	Rail cars	N	Rail tracks are inactivated.	NA
9.17	Saws	Y	Maintenance activities	Y
9.18	Vehicles	Y	See 9.1 above	N
9.19	Vibration	Y	Vehicles	Y
9.20	Other: Lifter	Y	Diesel powered equipment during maintenance activities.	N
	Other: Hand tools	Y	Pneumatic tools used tie and untie TRUPACT-IIs and HalfPACTs to the trailer.	Y
10	**Potential (Pressure)**			
10.1	Autoclaves	N		NA
10.2	Boilers	N		NA
10.3	Coiled springs	Y	Vehicles	Y
10.4	Furnaces	N		NA
10.5	Gas bottles	Y	Vehicle trap is main entry point for all materials entering site, bottles contained within HAZMAT facility, bottles at south side of Building 452, and at the air intake shaft (AIS).	N
10.6	Gas receivers	N		NA
10.7	Pressure vessels	Y	Vehicle trap is main entry point for all materials entering site.	N

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
10.8	Pressurized system (e.g., air)	Y	Compressed air lines used in waste handling and maintenance activities. Fire water distribution, fire water tanks, e.g. fire hydrants. Domestic water lines.	Y
10.9	Steam headers and lines	N		NA
10.10	Stressed members	N		NA
10.11	Other	N		NA
11	**Potential (Height/Mass)**			
11.1	Cranes/hoists	Y	Maintenance activities	N
11.2	Elevated doors	N		NA
11.3	Elevated work surfaces	Y	Steps into vehicles, work platform on trailer jockey, and elevated cab on trailer jockey.	Y
11.4	Elevators	N		N
11.5	Lifts	Y	Vehicle trap is main entry point for all materials entering site.	Y
11.6	Loading docks	N		NA
11.7	Mezzanines	N		NA
11.8	Floor pits	N		NA
11.9	Scaffolds and ladders	Y	Maintenance activities	Y
11.10	Stacked material	Y	Rack for Supersacks, slipsheets, stored one pallet high.	Y
11.11	Stairs	N		NA
11.12	Other	N	Cable pull box covers near road	NA
12	**Flooding Sources**			
12.1	Domestic water	Y		Y
12.2	Fire suppression piping	Y		Y
12.3	Process water	N		NA
12.4	Other	Y	Portable water tanks to provide dust control, approximately 500 gallons, refilling area on surface.	Y
13	**Physical**			
13.1	Sharp edges or points	Y	Connecting and disconnecting the trailer.	Y
13.2	Pinch points	Y	Connecting and disconnecting the trailer.	Y
13.3	Confined space	Y	Manholes	Y
13.4	Tripping	Y	Wheel chocks, railroad tracks.	Y
13.5	Other	N		NA
14	**Radiological Material**			
14.1	Radiological material	Y	Waste container contents	N

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
15	**Hazardous Material**			
15.1	Asphyxiates	Y	High-wattage waste is purged with nitrogen gas. (In the outside this does not constitute a significant hazard.). Liquid nitrogen used in onsite labs	Y
15.2	Bacteria/ viruses	N		NA
15.3	Beryllium and compounds	Y	There may be beryllium contaminated materials in some waste containers	N
15.4	Biologicals	Y	Sanitary waste truck, sewer lines	Y
15.5	Carcinogens	N		NA
15.6	Chlorine and compounds	N		NA
15.7	Corrosives	Y	Vehicle batteries	N
15.8	Decontamination solutions	Y	Vehicle trap is main entry point for all materials entering site. Typical solution is environmentally friendly.	Y
15.9	Dusts and particles	Y	Dust storms	Y
15.10	Fluorides	N		NA
15.11	Hydrides	N		NA
15.12	Lead	Y	Vehicle batteries	Y
15.13	Oxidizers	Y	Compressed oxygen	N
15.14	Poisons (herbicides, insecticides)	Y	Periodic ground maintenance	Y
15.15	Other	Y	Liquid nitrogen	N
16	**Ionizing Radiation Sources**			
16.1	Contamination	Y	Waste container contents	N
16.2	Electron beams	N		NA
16.3	Radioactive material	Y	Waste container contents	N
16.4	Radioactive sources	Y	Transportation on site	Y
16.5	Radiography equipment	N		NA
16.6	X-ray machines	N		NA
16.7	Other	N		NA
17	**Non-Ionizing Radiation**			
17.1	Lasers	Y	Low energy lasers used in survey equipment or levels.	Y
17.2	Other	Y	Bar code readers used to identify waste containers	Y
18	**Criticality**			
18.1	Fissile material	Y	Waste container contents	N
19	**Non-facility Events**			
19.1	Explosion	Y	Vehicles outside exclusive use area fence.	N
19.2	Fire	Y	Wildland fires	N
19.3	Power outage	Y		Y

Table A-1 - RH Waste Handling On-Site Transportation Route Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
19.4	Other	Y	Firearms, hunters	N
20	**Vehicles in Motion (external to facility)**			
20.1	Airplane	Y		N
20.2	Crane/hoist	Y	Maintenance activities	N
20.3	Forklifts	Y		N
20.4	Heavy construction equipment	Y	Maintenance activities	N
20.5	Helicopter	Y		N
20.6	Train	N		NA
20.7	Truck/car	Y		N
21	**Natural Phenomena**			
21.1	Earthquake	Y		N
21.2	Flood	Y		N
21.3	Lightning	Y		N
21.4	Rain/hail	Y		N
21.5	Snow/freezing weather	Y		N
21.6	Straight wind	Y		N
21.7	Tornado	Y		N

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
1	**Electrical**			
1.1	Battery banks	Y	Forklifts, communication equipment on the waste conveyance, uninterruptible power supply (UPS) on overhead powered manipulator for the upper hot cell	N
1.2	Cable runs	Y	Waste hoist tower, transfer cell, upper hot cell, RH bay cable reels, service room, cameras, monitoring equipment, etc.	Y
1.3	Diesel generators	N		NA
1.4	Electrical equipment	Y	Cranes, radiation monitoring and counting equipment, lighting, comfort fans, operations computer in RH bay, vision cameras and monitors, canister transfer system controls, shuttle car motor, swipe delivery system, detension and swipe robots, grapple hoist in Cask Loading Room, motors for transfer cars, door, and shield valve motors and controls, electric powered man lifts in RH bay, etc.	N
1.5	Heaters	Y	Shaft collar, space heaters in electrical switchgear and motor control centers	Y
1.6	High voltage (> 600V)	Y	Waste hoist substation and switchgear, radiation monitoring equipment	N
1.7	Locomotive, electrical	N		NA
1.8	Motors	Y	Transfer cars, airlock doors, robots, swipe delivery system blower, shield valves, cameras, grapple, fans, cranes in RH bay, CUR, FCLR, upper hot cell crane and overhead powered manipulator, upper hot cell wall mounted manipulators servo motors, transfer drawer to upper hot cell, shuttle car motor, etc.	N
1.9	Power tools	Y	Hand tools incidental to maintenance activities	Y
1.10	Pumps	Y	Vacuum pump, vent tool, torque wrench, FCRD hydraulic pump	Y
1.11	Service outlets, fittings	Y	FCLR, upper hot cell, RH bay and corridor, filter gallery airlocks	Y
1.12	Switchgear	Y	Waste hoist switchgear, upper hot cell gallery	N
1.13	Transformers	Y	Room 121, upper hot cell gallery, 41P MCC 04/1 and 04/2.	N
1.14	Transmission lines	Y	Bus bars 140/25-ton crane in RH bay, festooned cables for jib crane, CUR crane, upper hot cell crane trolley, and overhead powered manipulator	N
1.15	Wiring/underground wiring	Y	Control cabinets, plug-ins for vent tool, cables for transfer car and FCRD, power cords for counting equipment.	N
1.16	Other	N		NA

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
2	**Thermal**			
2.1	Boilers	N		NA
2.2	Bunsen burner hot plates	N		NA
2.3	Electrical equipment	Y		N
2.4	Electrical wiring	Y		N
2.5	Engine exhaust	Y	Tractor and trailer jockey, diesel powered man lift used for ventilation system maintenance	N
2.6	Furnaces	N		NA
2.7	Heaters	Y	Associated with MCCs	Y
2.8	Lasers	Y	Low energy lasers in upper hot cell, CUR, and resolver on shuttle car	Y
2.9	Steam lines	N		NA
2.10	Welding surfaces	Y	Maintenance and construction repair	N
2.11	Welding torch	Y	Maintenance and construction repair	N
2.12	Other	N		NA
3	**Pyrophoric Material**			
3.1	Pu and U metal fines	Y	May be present in the waste; waste is predominately contaminated material.	N
3.2	Other	N		NA
4	**Open Flame**			
4.1	Bunsen burners	N		NA
4.2	Welding/cutting torches	Y	Incidental maintenance activities	N
4.3	Other	N		NA
5	**Flammables**			
5.1	Cleaning/decontamination solvents	Y	Isopropyl alcohol used to clean O-rings prior to shipping empty casks back to the generator sites	N
5.2	Flammable gases	Y	Acetylene used in welding	N
5.3	Flammable liquids	Y	Isopropyl alcohol used to clean O-rings prior to shipping empty casks back to the generator sites	N
5.4	Gasoline	N		NA
5.5	Natural gas	N		NA
5.6	Nitric acid soaked rags (spontaneous combustion)	N		NA
5.7	Nitric acid and organics	N		NA
5.8	Paint/paint solvent	Y	Incidental maintenance activities	N
5.9	Propane	N		NA
5.10	Spray paint	Y	Incidental maintenance activities	N
5.11	Other	Y	P10 gas cylinders used for counting equipment	N

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
6	**Combustibles**			
6.1	Paper/wood products	Y	Procedures, forms, operator's computers, printers, office furniture and equipment, cribbing, radiological filters.	N
6.2	Petroleum based products	Y	Vehicles and other equipment may contain lubrication oils, fuels, hydraulic fluid, etc.	N
6.3	Plastics	Y	Vent tool for 10-60B, swipe delivery system rabbit, office equipment, computers, radiation monitoring equipment, spray bottles, trash bags	N
6.4	Other	N		NA
7	**Chemical Reactions**			
7.1	Concentration	N		NA
7.2	Disassociation	N		NA
7.3	Exothermic	N		NA
7.4	Incompatible chemical mixing	N		NA
7.5	Uncontrolled chemical reactions	N		NA
8	**Explosive Material**			
8.1	Caps	N		NA
8.2	Dusts	N		NA
8.3	Dynamite	N		NA
8.4	Electric squibs	N		NA
8.5	Explosive chemicals	N		NA
8.6	Flammable gases	Y	Acetylene incidental to maintenance activities	N
8.7	Hydrogen	Y	Hydrogen may be present in the waste containers for high wattage waste. Battery charging.	N
8.8	Hydrogen (batteries)	Y	Lead acid batteries used in vehicles and forklifts. Hydrogen from batteries during charging.	N
8.9	Nitrates	N		NA
8.10	Peroxides	N		NA
8.11	Primer cord	N		NA
8.12	Propane	N		NA
8.13	Other	N		NA
9	**Kinetic (Linear and Rotational)**			
9.1	Acceleration/deceleration	Y	Transfer cars, transporter or trailer jockey, and vehicles, floor scrubber, man lifts and cable reels, shield valves, MSM scissor lift	Y
9.2	Bearings	Y	Bearings in motors and vehicles.	Y

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
9.3	Belts	Y	Belt on shuttle car drive motor. Chain drive for shuttle car. Belts on ventilation equipment in the RH bay and waste hoist tower.	Y
9.4	Carts/dollies	Y	Electric cars, hand push carts.	Y
9.5	Centrifuges	N		NA
9.6	Crane loads (in motion)	Y	RH bay, jib crane at cask prep station, upper hot cell, FCLR, CUR, crane maintenance room	N
9.7	Drills	Y	Nut runner, jib crane, robots, and incidental maintenance activities, hand tools	Y
9.8	Fans	Y	RH bay, hoist tower, swipe delivery system blower.	Y
9.9	Firearm discharge	N		NA
9.10	Forklifts	Y	Incidental to maintenance activities and material hauling.	N
9.11	Gears	Y	Grapple, cranes, hoists, FCRD, overhead powered manipulator, shield valves, master slave manipulators, and transfer cars.	Y
9.12	Grinders	Y	Incidental to maintenance activities.	Y
9.13	Motors – electric	Y	Grapple, cranes, hoist, FCRD, overhead powered manipulator, shield valves, master slave manipulators, transfer cars, radiation monitoring equipment.	Y
9.14	Power tools	Y	Nut runners and incidental maintenance activities	Y
9.15	Presses shears	N		NA
9.16	Rail cars	Y	FCTC and shipping casks	N
9.17	Saws	Y	Incidental to maintenance activities.	Y
9.18	Vehicles	Y		N
9.19	Vibration	Y	Vehicles and rails.	Y
9.20	Other	Y	Turntable	Y
10	**Potential (Pressure)**			
10.1	Autoclaves	N		NA
10.2	Boilers	N		NA
10.3	Coiled springs	Y	Vehicles and roll-up door between CH and RH bays	Y
10.4	Furnaces	N		NA
10.5	Gas bottles	Y	P10 to support counting equipment.	N
10.6	Gas receivers	N		NA
10.7	Pressure vessels	Y	CUR door, pneumatic locks on master slave manipulators.	Y
10.8	Pressurized system (e.g., air)	Y	CUR door, turntable, compressed air cylinder, FCRD, jib crane, tools, vehicle hydraulics, waste hoist.	Y

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
10.9	Steam headers and lines	N		NA
10.10	Stressed members	Y	Cranes, grapple, overhead powered manipulator, shuttle car rails, shuttle car, and counter weights.	N
10.11	Other	N		NA
11	**Potential (Height/Mass)**			
11.1	Cranes/hoists	Y	CUR, FCLR, upper hot cell, RH bay, and cask prep station.	N
11.2	Elevated doors	Y	Crane maintenance room door, roll-up door between CH and RH bays.	N
11.3	Elevated work surfaces	Y	RH bay maintenance mezzanine, trailer, cask prep station, CUR, and catwalks for upper hot cell and crane.	Y
11.4	Elevators	Y	Elevator for personnel to access the waste hoist tower.	Y
11.5	Lifts	Y	Man lifts, scissor lift, master slave manipulator lift.	Y
11.6	Loading docks	N		NA
11.7	Mezzanines	Y	Maintenance mezzanine to second floor.	Y
11.8	Floor pits	Y	Fire water sumps in lower hot cell and transfer cell, RH bay.	Y
11.9	Scaffolds and ladders	Y	Incidental maintenance activities. Rolling ladder, scissor lift, master slave manipulator lift in operating gallery.	Y
11.10	Stacked material	Y	72-B and 10-160B lid stands and impact limiter stands.	Y
11.11	Stairs	Y	Stairs to transfer cell, upper hot cell, operating gallery, and to catwalks.	Y
11.12	Other	Y	Over ride tools used for RH bay catwalk, pentapod, drum carriage fixture, shield plugs	N
12	**Internal Flooding Sources**			
12.1	Domestic water	Y	RH bay to hot cell complex	Y
12.2	Fire suppression piping	Y	RH bay, operating gallery, FCLR.	Y
12.3	Process water	N		NA
12.4	Other	Y	Water weight test on crane.	Y
13	**Physical**			
13.1	Sharp edges or points	Y	Storage stand, trailers, hooks on cranes, prep station, FCLR door, FCRD, turntable, and various other waste handling equipment throughout RH bay and hot cell complex.	N
13.2	Pinch points	Y	Storage stand, trailers, hooks on cranes, prep station, FCLR door, FCRD, turntable, and various other waste handling equipment throughout RH bay and hot cell complex, shield door, shield valves	N

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
13.3	Confined space	Y	Facility cask, hot cell ventilation intake.	Y
13.4	Tripping	Y	Stairs, rails, cable reels, chain driver, turntable	Y
13.5	Other	N		NA
14	**Radiological Material**			
14.1	Radiological material	Y	Waste containers	N
15	**Hazardous Material**			
15.1	Asphyxiates	Y	P-10 used in counting equipment.	Y
15.2	Bacteria/viruses	N		NA
15.3	Beryllium and compounds	Y	Waste contents.	N
15.4	Biologicals	Y	Sanitary waste.	Y
15.5	Carcinogens	N		NA
15.6	Chlorine and compounds	N		NA
15.7	Corrosives	Y	Lead acid batteries in vehicles.	Y
15.8	Decontamination solutions	Y	Alcohol and cleaning solutions incidental to decontamination.	Y
15.9	Dusts and particles	Y	Maybe in waste.	N
15.1	Fluorides	N		NA
15.11	Hydrides	N		NA
15.12	Lead	Y	Shuttle car drive counter balance weights, facility cask shielding, shipping casks	Y
15.13	Oxidizers	Y	Compressed oxygen	Y
15.14	Poisons (herbicides, insecticides)	N	Periodic pesticide spraying	Y
15.15	Other:	N		NA
16	**Ionizing Radiation Sources**			
16.1	Contamination	Y	Waste container contents.	N
16.2	Electron beams	N		NA
16.3	Radioactive material	Y	Waste container contents.	N
16.4	Radioactive sources	Y	Counting equipment and permanent equipment	Y
16.5	Radiography equipment	N		NA
16.6	X-ray machines	N		NA
16.7	Other	N		NA
17	**Non-Ionizing Radiation**			
17.1	Lasers	Y	Low energy lasers on vision system, robots, and transfer cell shuttle car range finders.	Y
17.2	Other	Y	Light sensors for transfer cars and shield plugs; infrared sensor for light curtain into transfer cell.	Y
18	**Criticality**			
18.1	Fissile material	Y	Waste container contents.	N
19	**Non-Facility Events**			

Table A-2 - RH Waste Handling Waste Handling Building Hazard ID Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
19.1	Explosion	N		NA
19.2	Fire	Y	Wildland fires.	N
19.3	Power outage	Y		N
20	**Vehicles in Motion**			
20.1	Airplane	Y		N
20.2	Crane/hoist	Y	RH bay cranes, condor, CUR, upper hot cell, FCLR.	N
20.3	Forklifts	Y	Incidental use in maintenance activities and hauling equipment.	N
20.4	Heavy construction equipment	N		NA
20.5	Helicopter	Y	SPS surveys and gas pipeline surveys	N
20.6	Train	N		NA
20.7	Truck/car	Y	Transport tractor and trailer jockey.	N
20.8	Other	N		NA
21	**Natural Phenomena**			
21.1	Earthquake	Y		N
21.2	Flood	Y		N
21.3	Lightning	Y		N
21.4	Rain/hail	Y		N
21.5	Snow/freezing weather	Y		N
21.6	Straight wind	Y		N
21.7	Tornado	Y		N

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
1	Electrical			
1.1	Battery banks	Y	Mine phone, forklifts, UPS in local processing unit (LPU) at waste shaft station, fire alarm box, hoist phone, charger for battery operated tow vehicle, scissor lifts.	N
1.2	Cable runs	Y	Down waste shaft, at the waste shaft station, in E-140, and associated in the room ahead of the actual emplacement room. Cable to HERE.	N
1.3	Diesel generators	Y	Mobile diesel generator to power miner	N
1.4	Electrical equipment	Y	Power skids, Substation #2 north of bulkheads E-140, power panels, distribution panels, LPU at waste shaft station, portable power centers, electric cart charging areas, and borehole drilling machine, HERE, Marietta Miner (480 VAC).	N
1.5	Heaters	Y	Portable power centers, connex buildings	N
1.6	High voltage (> 600V)	Y	Substation 13.8 kV to 480 VAC, portable power centers energized in alcoves off transport route. EMICO Miner (950 volts) DOSCO Miner (950 volts)	N
1.7	Locomotive, electrical	N		NA
1.8	Motors	Y	Motors on screw jacks, HERE, alignment fixture, and carts.	N
1.9	Power tools	Y	Hand tools incidental to maintenance activities	Y
1.10	Pumps	Y	Hydraulic pumps on HERE and sump pump at waste shaft station.	N
1.11	Service outlets, fittings	Y	Power skids in alcoves up to 120 to 480 VAC.	N
1.12	Switchgear	Y	Not in transport route	Y
1.13	Transformers	Y	Not in transport route	Y
1.14	Transmission lines	Y	Down drift E-140. 13.8 kV down shaft, to the panel and borehole machine	N
1.15	Wiring/underground wiring	Y		N
1.16	Other	N		NA
2	**Thermal**			
2.1	Boilers	N		NA
2.2	Bunsen burner hot plates	N		NA
2.3	Electrical equipment	Y	13.8 kV power skids, substation #2 north of bulkheads in E-140, power panels, distribution panels, LPU at waste shaft station, portable power centers and borehole machine.	N
2.4	Electrical wiring	Y	Throughout underground. Control panel for the HERE.	N

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
2.5	Engine exhaust	Y	20-ton, 41-ton, and 6-ton forklifts used to move the HERE, facility cask, and shield plugs respectively. Load hauler to remove mined salt from boreholes.	N
2.6	Furnaces	N		NA
2.7	Heaters	Y	Portable power centers, space heaters in connex buildings.	N
2.8	Lasers	Y	Low power lasers for underground surveying and mining.	Y
2.9	Steam lines	N		NA
2.10	Welding surfaces	Y	Incidental maintenance activities.	N
2.11	Welding torch	Y	Incidental maintenance activities.	N
2.12	Other	N		NA
3	**Pyrophoric Material**			
3.1	Pu and U metal fines	Y	Pu and U are present in the waste; waste is predominately contaminated material.	N
3.2	Other	N		NA
4	**Open Flame**			
4.1	Bunsen burners	N		NA
4.2	Welding/cutting torches	Y	Incidental maintenance activities.	N
4.3	Other	N		NA
5	**Flammables**			
5.1	Cleaning/decontamination solvents	Y	Used in maintenance shop.	N
5.2	Flammable gases	Y	Acetylene.	N
5.3	Flammable liquids	Y	Diesel fuel, lubricating oil and hydraulic fluid, maintenance shop materials.	N
5.4	Gasoline	N		NA
5.5	Natural gas	N		NA
5.6	Nitric acid soaked rags (spontaneous combustion)	N		NA
5.7	Nitric acid and organics	N		NA
5.8	Paint/paint solvent	Y	Incidental maintenance activities.	N
5.9	Propane	N		NA
5.10	Spray paint	Y	Incidental maintenance activities.	N
5.11	Other	N		NA
6	**Combustibles**			
6.1	Paper/wood products	Y	Cribbing. Wood guides in the salt handling shaft. Wood timber for waste hoist crash beams, procedures, MgO sacks, packaging.	N

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
6.2	Petroleum based products	Y	Vehicles, forklifts, and other equipment may contain lubricating oils, fuels, hydraulic fluid, etc.	N
6.3	Plastics	Y	Brattice cloth, rubber flashing or gasket material for bulkheads, notebooks, and radiation monitoring equipment.	N
6.4	Other	N		NA
7	**Chemical Reactions**			
7.1	Concentration	N		NA
7.2	Disassociation	N		NA
7.3	Exothermic	N		NA
7.4	Incompatible chemical mixing	N		NA
7.5	Uncontrolled chemical reactions	N		NA
8	**Explosive Material**			
8.1	Caps	N		NA
8.2	Dusts	N		NA
8.3	Dynamite	N		NA
8.4	Electric squibs	N		NA
8.5	Explosive chemicals	N		NA
8.6	Flammable gases	Y	Acetylene.	N
8.7	Hydrogen	Y	Hydrogen may be present in waste containers.	N
8.8	Hydrogen (batteries)	Y	Lead acid batteries used in vehicles and forklifts. Hydrogen from battery chargers when charging batteries.	N
8.9	Nitrates	N		NA
8.10	Peroxides	N		NA
8.11	Primer cord	N		NA
8.12	Propane	N		NA
8.13	Other	Y	Hilti cartridges. Spent Hilti cartridges are stored in a satellite accumulation Area.	N
9	**Kinetic (Linear and Rotational)**			
9.1	Acceleration/deceleration	Y	Underground equipment, scissor lifts and hoists.	N
9.2	Bearings	Y	Associated with vehicles and shaft conveyances. Bearings are used in motors, conveyors, and other equipment.	Y
9.3	Belts	Y	Associated with vehicles.	Y
9.4	Carts/dollies	Y	Electric carts, hand push carts.	Y
9.5	Centrifuges	N		NA

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
9.6	Crane loads (in motion)	Y	Waste Hoist, maintenance boom truck.	N
9.7	Drills	Y	Roof bolters, jackleg drills, probe-hole drill, RH borehole machine.	N
9.8	Fans	Y	Ventilation fans at waste shaft station, auxiliary fans.	Y
9.9	Firearm discharge	N		NA
9.10	Forklifts	Y		N
9.11	Gears	Y	41-ton forklift, borehole machine, HERE, 6-ton and 20-ton forklifts, haul trucks, and underground transporter	N
9.12	Grinders	Y	Incidental maintenance.	Y
9.13	Motors – electric	Y	borehole machine, HERE, carts, and mining equipment.	Y
9.14	Power tools	Y	Ground control, maintenance.	Y
9.15	Presses shears	Y	Fabrication shop.	Y
9.16	Rail cars	Y	FCTC is rail mounted.	N
9.17	Saws	Y	Maintenance shop, chain saws to cut guides.	Y
9.18	Vehicles	Y	Load haul truck used in handling cuttings from borehole, electric carts, forklifts, scissor lifts, tow cart, diesel equipment, water truck.	N
9.19	Vibration	Y	Vehicles, roof bolt operations.	Y
9.20	Other	N		NA
10	**Potential (Pressure)**			
10.1	Autoclaves	N		NA
10.2	Boilers	N		NA
10.3	Coiled springs	N		NA
10.4	Furnaces	N		NA
10.5	Gas bottles	Y	Acetylene, oxygen, nitrogen for experiment purging, self-contained self-rescuers, and trauma kit O_2 bottles.	N
10.6	Gas receivers	N		NA
10.7	Pressure vessels	Y	HERE hydraulic system, automatic fire suppression systems on equipment. Accumulators at waste shaft station for chairing device.	N
10.8	Pressurized system (e.g., air)	Y	Air compressor for facility cask. 90 psi compressed air line.	N
10.9	Steam headers and lines	N		NA
10.10	Stressed members	Y	Roof bolts, rails at waste shaft station.	N
10.11	Other	Y	Portable fire extinguishers	Y
11	**Potential (Height/Mass)**			
11.1	Cranes/hoists	Y	Waste hoist, maintenance boom truck.	N

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
11.2	Elevated doors	N		NA
11.3	Elevated work surfaces	Y	Borehole machine, two lift trucks for elevated work.	Y
11.4	Elevators	N		NA
11.5	Lifts	Y	Back of transporter, two lift trucks for elevated work, scissor lift, 6-ton, 20-ton, and 41-ton forklifts.	N
11.6	Loading docks	N		NA
11.7	Mezzanines	N		NA
11.8	Floor pits	Y	Waste shaft sump, salt shaft sump.	N
11.9	Scaffolds and ladders	Y		Y
11.10	Stacked material	Y	Supersacks, roof bolts staged for installation.	Y
11.11	Stairs	Y	CAM work platforms.	Y
11.12	Other	Y	Roof and walls of passages (falls and bumps). Waste conveyance. Waste conveyance counterweight..	N
12	**Internal Flooding Sources**			
12.1	Domestic water	N		NA
12.2	Fire suppression piping	Y	Waste hoist tower.	N
12.3	Process water	N		NA
12.4	Other	Y	Portable water tanks to provide dust control, approximately 500 gallons.	Y
13	**Physical**			
13.1	Sharp edges or points	Y	Borehole machine, forklifts, MgO racks.	N
13.2	Pinch points	Y	Borehole machine, FCTC, forklifts, HERE, CAMS, transporters, load haul vehicles.	Y
13.3	Confined space	Y	Boreholes.	Y
13.4	Tripping	Y	Mining environment, uneven floor, cables, cribbing, forklift tines.	Y
13.5	Other	N		NA
14	**Radiological Material**			
14.1	Radiological material	Y	Waste container contents.	N
15.0.	**Hazardous Material**			
15.1	Asphyxiates	Y	Nitrogen for experiments in north end.	Y
15.2	Bacteria/viruses	N		NA
15.3	Beryllium and compounds	Y	Beryllium contaminated materials in some waste containers.	N
15.4	Biologicals	Y	Porta-potties.	Y
15.5	Carcinogens	Y	Diesel exhaust fumes.	Y
15.6	Chlorine and compounds	N		NA
15.7	Corrosives	Y	Lead acid batteries.	Y

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
15.8	Decontamination solutions	N		NA
15.9	Dusts and particles	Y	May be packaged in TRU waste bags inside the TRU waste container.	Y
15.10	Fluorides	N		NA
15.11	Hydrides	N		NA
15.12	Lead	Y	Lead acid batteries. Facility cask shielding.	Y
15.13	Oxidizers	Y	Compressed oxygen.	N
15.14	Poisons (herbicides, insecticides)	N		NA
15.15	Other: Cryogenics	Y	Liquid nitrogen in experiments. Mercury in tilt sensors on HERE.	Y
16	**Ionizing Radiation Sources**			
16.1	Contamination	Y	Waste container contents.	N
16.2	Electron beams	N		NA
16.3	Radioactive material	Y	Waste container contents.	N
16.4	Radioactive sources	Y	Sources used are small activity sources used in counting equipment source checks.	Y
16.5	Radiography equipment	N		NA
16.6	X-ray machines	N		NA
16.7	Other	N		NA
17	**Non-Ionizing Radiation**			
17.1	Lasers	Y	Low energy lasers used in mining.	Y
17.2	Other	Y	Bar code readers used to identify waste containers	Y
18	**Criticality**			
18.1	Fissile material	Y	Waste container contents.	N
19	**Non-Facility Events**			
19.1	Explosion	N		NA
19.2	Fire	Y	Wildland fires.	N
19.3	Power outage	Y		N
20	**Vehicles in Motion**			
20.1	Airplane	Y		N
20.2	Crane/hoist	Y	Waste hoist, maintenance boom truck.	N
20.3	Forklifts	Y	Used to move facility cask, HERE, and shield plugs.	N
20.4	Heavy construction equipment	Y	Borehole drilling. Mining equipment used for ground support, installation of ventilation barriers, used for closure activities, haulage equipment to carry excess salt, bobcats.	N
20.5	Helicopter	Y		NA
20.6	Train	N		NA

Table A-3 - RH Waste Handling Underground Hazard Identification Table

Item	Hazard Energy Source or Material	Exists (Y/N)	Description	SIH Screening
20.7	Truck/car	Y	Electric golf carts, fire truck, ambulance, lube trucks.	N
20.8	Other	Y	FCTC, scissor lift.	N
21	**Natural Phenomena**			
21.1	Earthquake	Y		N
21.2	Flood	Y		N
21.3	Lightning	Y		N
21.4	Rain/hail	N		N
21.5	Snow/freezing weather	N		N
21.6	Straight wind	Y		N
21.7	Tornado	Y		N

Table A-4 - Event Categories for Hazard Review

Event Cat	Event Type	Consequence/Release Mechanism
E-1	Fire	Consequences typically due to inhalation/ingestion of release hazardous material. Release of material is due to thermal effects on the material or the material container.
E-2	Explosion	Consequences typically due to inhalation/ingestion of released hazardous material. Release of material is due to explosion or impact from missile(s) produced by the explosion. (Note: explosion includes detonations and deflagrations.)
E-3	Loss of Containment/ Confinement	Consequences typically due to inhalation/ingestion of released hazardous material. Release of material is due to impacts (including dropping) on the material or material containment and energetic failures due to over pressurization.
E-4	Direct Exposure	Consequences typically due to direct exposure to a hazard (contact chemical exposure, radionuclide shine).
E-5	Nuclear Criticality	Consequences typically due to direct exposure and release of fission products.
E-6	External Hazards	Consequences typically due to inhalation/ingestion of released hazardous material.
E-7	Natural Phenomena	Consequences typically due to inhalation/ingestion of released hazardous material.

Table A-5 - Hazard Sources and Potential Events

Group No.	Hazard Energy Source or Material Group	Potential Events by Category
1	Electrical	E-1 – In combination with combustible/flammable material E-2 – In combination with explosive material
2	Thermal	E-1 – In combination with combustible/flammable material E-2 – In combination with explosive material
3	Pyrophoric Material	E-1 – Pyrophoric fire; could serve as ignition source for larger fires E-2 – In combination with explosive material
4	Open Flame	E-1 – In combination with combustible/flammable material E-2 – In combination with explosive material
5	Flammables	E-1 – In combination with ignition source
6	Combustibles	E-1 – In combination with ignition source
7	Chemical Reactions	E-1 – Fire or other thermal effect E-2 – Explosion or over pressurization E-3 – Toxic gas generation
8	Explosive Material	E-2 – In combination with ignition source E-3 – Missiles (in combination with ignition source)
9	Kinetic (Linear and Rotational)	E-3 – Impacts, acceleration/deceleration, missiles
10	Potential (Pressure)	E-3 – Impacts, missiles
11	Potential (Height/Mass)	E-3 – Impacts (falling objects), dropping
12	Internal Flooding Sources	E-3 – Ground/surface water runoff
13	Physical	E-3 – Puncture, dropping
14	Radiological Material	All Events – Potentially releasable material
15	Hazardous Material	All Events – Potentially releasable material
16	Ionizing Radiation	E-4 – Direct exposure to worker
17	Non-Ionizing Radiation	E-1 – Potential for thermal effects in combination with combustible/flammable material E-2 – Potential thermal effects in combination with explosive material
18	Criticality	E-5 – Criticality
19	Non-facility Events	E-6 – External Events. Could lead to any event category (E-1 through E-5)
20	Vehicles in Motion (external to facility)	E-6 – External Events. Could lead to any event category (E-1 through E-5)
21	Natural Phenomena	E-7 – NPH Events. Could lead to any event category (E-1 through E-5)

Table A-6 - Frequency Evaluation Levels

Frequency Level	Abbreviation	Frequency	Qualitative Description
Anticipated	A	$f \geq 10^{-2}$/year	Events that might occur several times during the lifetime of the facility
Unlikely	U	$10^{-4} \leq f < 10^{-2}$/year	Events not anticipated during the lifetime of the facility
Extremely Unlikely	EU	$10^{-6} \leq f < 10^{-4}$/year	Events that will probably not occur during the lifetime of the facility
Beyond Extremely Unlikely	BEU	$f < 10^{-6}$/year	All other events

Table A-7 - Consequence Evaluation Levels for Hazard Receptors

Consequence Level	**Public** Shortest distance to unrestricted public access	**On-Site** Individuals outside the occupied area of the hazard but the site boundary	**Worker** Individuals immediately adjacent to, or in, the occupied area of the hazard
High	Considerable off-site impacts Radiological: C ≥ 25 rem TEDE Chemical: C ≥ ERPG-2	Considerable on-site impacts Radiological: C ≥ 100 rem TEDE Chemical: C ≥ ERPG-3	Prompt death, serious injury, or significant radiological or chemical
Moderate	Minor off-site impacts Radiological: 25 > C ≥ 1 rem TEDE Chemical: ERPG-2 > C ≥ ERPG-1	Considerable on-site impacts Radiological: 100 > C ≥ 25 rem TEDE Chemical: ERPG-3 > C > ERPG-2	
Low	Negligible off-site impacts Radiological: C < 1 rem TEDE Chemical: C < ERPG-1	Minor on-site impacts Radiological: C < 25 rem TEDE Chemical: C < ERPG-2	< High

Table A-8 - Qualitative Risk Bins

Frequency Level ⇒ Consequence Level ⇓	Beyond Extremely Unlikely	Extremely Unlikely	Unlikely	Anticipated
High	III	II	I	I
Moderate	IV	III	II	I
Low	IV	IV	III	III

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA1-1	Fire on transport tractor or trailer jockey impacts 72-B or 10-160B shipping cask MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire Hazard Source: Radioactive Material/Beryllium	1. Fuel leak and ignition of fumes with electrical short or open flame 2. Nearby gasoline powered vehicle catches fire and impacts the tractor/trailer 3. Collision with other vehicle creates a spark and ignites forklift or nearby combustible material 4. Flammable liquid leak, ignition of fumes (by engine or exhaust heat). 5. Nearby fire within PPA propagates to the transport vehicle.	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Paved and graveled PPA prevents propagation (All) Administrative: 1. Designated smoking areas (5) 2. Combustible Loading Control Program (2, 3,4, 5) 3. Periodic equipment inspection and preventive maintenance (1, 5)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators 3. WIPP fire brigade and external firefighting support 4. Hand held fire extinguisher on tractor and trailer jockey.

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA2-1	Ignition of fumes from transport vehicle fuel or nearby vehicle results in an explosion with subsequent missiles that impact RH shipping cask MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Fuel leak and ignition of fumes with electrical short or open flame 2. Nearby gasoline powered vehicle catches fire and impacts the tractor/trailer 3. Collision with other vehicle creates a spark and ignites forklift or nearby combustible material 4. Nearby fire within PPA ignites fumes from transport or nearby vehicle.	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: None Administrative: 1. Designated smoking areas (1) 2. Combustible Loading Control Program that requires flammable or hazardous materials including flammable compressed gases to be stored in designated areas (1, 2, 3, 4) 3. Periodic equipment inspection and preventive maintenance (1, 2)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators 3. WIPP fire brigade and external firefighting support

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA2-2	Battery explosion within transport vehicle or nearby vehicles results in missiles that impact the RH shipping cask MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Battery malfunction 2. Electrical malfunction creates spark which ignites hydrogen generated by vehicle battery 3. Heat sources ignite hydrogen from battery	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Vented battery compartments (2, 3) Administrative: 1. Preventive maintenance program for onsite mobile equipment including periodic inspections of onsite electrical equipment (1, 2) 2. Preventive maintenance on the transport vehicles (1, 2)	Design : None Administrative: 1. Emergency response procedures 2. Trained operators
0A3-1	Drop of or impact to the 72-B or10-160B during transport from the security gate to the parking area or in the parking area MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Transporter impacts or is impacted by mining dump truck, delivery trucks, front end loader or other surface mobile equipment (including forklifts) 2. Transport vehicle improperly turns and falls into drainage ditch near guard and security building 3. Operator error	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: None Administrative: 1. Trained drivers and trained onsite vehicle drivers (1, 2, 3)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA3-2	Mechanical failure of nearby equipment components (e.g. fans, belts) produces a missile that impacts RH cask MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Failure of nearby components due to corrosion, degradation, vibration or stress	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: None Administrative: 1. Periodic inspection and preventive maintenance of transportation equipment and waste handling equipment (1)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators
OA4-1	Direct exposure to radiation in excess of anticipated levels MAR: NA Location: In transit from security gate to parking area or in parking area Initial Condition: RH waste arrives at the WIPP in the 72-B or 10-160B Type B shipping cask that provides shielding for 1000 Rem/hr RH canister or drum. Hazard Source: Ionizing radiation	1. Waste exceeds 1000 rem/hr limit for RH waste as defined by the Land Withdrawal Act[13]	U	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	Design: None Administrative: 1. Generator site characterization program must ensure that RH waste does not exceed 1000 Rem/hr on contact as required by the RH WAC (1)	Design: None Administrative: 1. Receipt inspection and surveys at the security gate 2. Radiation protection program

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA4-2	Exposure to surface contamination on the 72-B or 10-160B cask MAR: NA Location: In transit from security gate to parking area or in parking area Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Ionizing radiation	1. Mishandling at generator site results in contamination on surface of RH shipping cask	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 III III III NA NA NA	Design: None Administrative: 1. Radiation protection program (1) 2. Receipt inspection of RH shipping cask (1)	Design: None Administrative: 1. Radiation protection program 2. Trained operators
OA5-1	Nuclear criticality in shipping cask MAR: NA Location: In transit from security gate to parking area or in parking area Initial Condition: None Hazard Source: Ionizing radiation	1. No limits on fissile mass in 72-B or 10-160B shipping cask	EU	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 II IV IV NA NA NA	Design: None Administrative: 1. Criticality safety program that requires: - Fissile limits of 325 FGE for 72-B RH waste canisters with no single drum exceeding 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment in accordance with the RH WAC. (1) - No drum shipped in a 10-160B cask can exceed 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment in accordance with the RH WAC. (1)	Design: 1. Shipping cask shielding Administrative: 1. Emergency response procedures

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA6-1	Fire external to the PPA propagates to engulf RH shipping cask MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire Hazard Source: Radioactive Material/Beryllium	1. External vehicle fire 2. Fire involving staged equipment and combustible materials	A	<u>Radiological</u> Fac Worker - Low Site Worker - Low Public - Low <u>Chemical</u> Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	<u>Design:</u> 1. Paved transport roads and parking area limit the potential for external fire to reach RH shipping casks inside the PPA. (1) <u>Administrative:</u> 1. Emergency response including offsite fire response to prevent external fire from propagating to PPA. (2) 2. Combustible Loading Control Program. (2)	<u>Design:</u> None <u>Administrative:</u> 1. Emergency response procedures 2. Trained operators
OA6-2	External explosion and subsequent missiles impact RH shipping cask MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Vehicle malfunction resulting in an explosion on nearby road 2. Pipeline explosion	U	<u>Radiological</u> Fac Worker - Low Site Worker - Low Public - Low <u>Chemical</u> Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	<u>Design:</u> 1. No gas pipelines in the PPA (2) 2. Paved and graveled PPA prevents fire propagation. (All) <u>Administrative:</u> None	<u>Design:</u> None <u>Administrative:</u> 1. Emergency response procedures 2. Trained operators

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level Unprev.	Consequence Level Unmitigated	Risk Bin Unmit.	Potential Preventive Features	Potential Mitigative Features
OA6-3	Aircraft crashes into the parking area and generates a follow on fire that impacts RH shipping casks MAR: Worse case is fourteen 10-160B shipping casks with 800 PE-Ci each for a total of 11,200 PE-Ci. Location: In parking area Release Mechanism: Impact, breach, and thermal Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Pilot error or aircraft malfunction	EU	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 II II II II II II	Design: 1. WIPP is located in a remote area that is not on a direct flight path for normal aircraft traffic (1) Administrative: None	Design: None Administrative: 1. Emergency response procedures
OA6-4	RH shipping cask damage due to fire arm discharge MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Errant shot from hunter in area adjacent to the WIPP site due to multiple land use 2. Inadvertent fire arm discharge onsite by local law enforcement personnel.	U	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: None Administrative: 1. Signs posted at EUA to notify the public to prevent hunting beyond the EUA boundary. (1) 2. Trained security force (2)	Design: None Administrative: 1. Emergency response procedures

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev.	Unmitigated	Unmit.		
OA7-1	Lightning impacts RH shipping casks MAR: 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Severe weather generates lightning	U	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Lightning dissipation system installed on perimeter lighting and tall structures along transport path (1) Administrative: None	Design: None Administrative: 1. Emergency response procedures 2. Trained operators - workers trained to seek shelter if severe weather conditions exist
OA7-2	Tornado induced missiles breach RH shipping casks MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: During transport from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Severe weather	U	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low Note: Robust design and mass of RH shipping cask will withstand the impact of a PC-4 missile	 III III III III III III	Design: None Administrative: 1. Procedures for inclement weather response (1)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators - workers trained to seek shelter if severe weather conditions exist

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level Unprev.	Consequence Level Unmitigated	Risk Bin Unmit.	Potential Preventive Features	Potential Mitigative Features
OA7-3	Straight line wind produced missiles breach RH shipping casks MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: During transport from security gate to parking area or in parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Severe weather	U	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low Note: Robust design and mass of RH shipping cask will withstand the impact of a PC-4 missile	 III III III III III III	Design: None Administrative: 1. Procedures for inclement weather response (1)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators - workers trained to seek shelter if severe weather conditions exist
OA7-4	Heavy rains result in shallow flooding of outside area and impacts RH shipping casks MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In transit from gate to parking area or in the parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed to withstand in leakage Hazard Source: Radioactive Material/Beryllium	1. Severe weather or thunderstorms	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Water run-off and drainage system around the WIPP site (1) Administrative: 1. Maintenance of berms and storm water drainage system (1) 2. Procedures for inclement weather response (1)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators - workers trained to seek shelter if severe weather conditions exist

Table A-9 - Hazard Evaluation for RH On-Site Transportation Route

Event No.	Event Description	Causes	Freq. Level Unprev.	Consequence Level Unmitigated	Risk Bin Unmit.	Potential Preventive Features	Potential Mitigative Features
OA7-5	Hail impacts RH shipping casks MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In parking area or in transit from gate to parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drops Hazard Source: Radioactive Material/Beryllium	1. Severe weather or thunderstorms	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: None Administrative: 1. Procedures for inclement weather response (1)	Design: 1. Robust cask design Administrative: 1. Emergency response procedures 2. Trained operators - workers trained to seek shelter if severe weather conditions exist
OA7-6	Wildland fire propagates from the outside area and impacts RH shipping casks MAR: Up to 14 RH shipping casks at 240 PE-Ci per 72-B with 3 drums at 80 PE-Ci each; 800 PE-Ci per 10-160B Location: In parking area or in transit from gate to parking area Release Mechanism: None Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire, impact, and drop. Hazard Source: Radioactive Material/Beryllium	1. Lightning 2. Cigarettes or matches dropped outside the site boundary and ignites vegetation 3. Unattended campfires on areas outside the EUA	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Fire breaks surrounding facility (eg. roads, parking lots) limit likelihood of fire to impact shipping containers (1, 2, 3) Administrative: 1. Combustible control program (1, 2, 3) 2. Vegetation control along access road to the WIPP (2) 3. Memorandum of understanding with external agency which extinguishes fire before fire reaches the PPA (1, 2, 3)	Design: None Administrative: 1. Emergency response procedures 2. Trained operators - workers to evacuate in emergency situations. 3. Combustible control program 4. WIPP fire brigade and external fire fighting support

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB1-1	Fire in RH bay impacts RH waste containers MAR: 800 PE-Ci - the inventory for one 10-160B shipping cask Release Mechanism: Thermal when the 10-160B lid bolts are remove Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lids bolted in place. Hazard Source: Radioactive Material/Beryllium	1. Malfunction of electrical equipment generates a spark and ignites nearby combustible material and subsequently results in a transport tractor fuel fire. 2. Spontaneous combustion of rags 3. Transport tractor fuel/hydraulic leak or transport trailer hydraulic leak lighted by an ignition source 4. Maintenance activities involving hot work ignites nearby combustibles 5. Maintenance activities in the overhead using a diesel powered lift 6. Waste container in 10-160B cask contains flammable material/liquid that ignite. 7. Fire from other part of the WHB propagates to the RH bay.	A	<u>Radiological</u> Fac Worker - High Site Worker - Moderate Public -Moderate <u>Chemical</u> Fac Worker - High Site Worker - Moderate Public -Moderate	 I I I I I I	<u>Design:</u> 1. Electrical installation that meets NEC. (1) 2. Noncombustible construction of the WHB. Also the RH bay is segregated from hot cell complex by thick concrete walls and floors that prevent fires in the hot cell complex from propagating to the RH bay. (7) <u>Administrative:</u> 1. Combustible Loading Control Program (1, 2, 4, 7) 2. Work control process (4, 5) 3. Hot work permit (4) 4. Preventive maintenance program on electrical equipment. (1) 5. Restricted access to the RH bay during waste handling (4, 5) 6. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (6) 7. Waste handling restriction that prohibits removal of loaded RH waste drums or canisters from the shipping cask outside the hot cell complex. (2, 3, 4, 5) 8. Waste handling restriction requires that the 10-160B cask cannot be left unattended in the RH bay with the lid bolts loosened - it must either have the lid bolts installed or be in the CUR with the shield door closed. (3, 4, 5, 7)	<u>Design:</u> 1. Metal 72-B canister, metal drums 2. RH facility ventilation system 3. Fire suppression system in RH bay 4. Noncombustible construction of the WHB. <u>Administrative:</u> 1. Emergency response procedures 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-2	Fire in the upper hot cell impacts waste in upper hot cell MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Thermal Initial condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment short or malfunction or crane collision causes. sparks which ignite combustibles or flammable materials (shield window oil) in the upper hot cell. 2. Crane or overhead powered manipulator impacts and breaks shield windows and nearby spark ignites shield window oil. 3. Waste container in upper hot cell contains flammable material/liquid that ignites. 4. Fire outside the upper hot cell propagates into the upper hot cell.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Oil used in upper hot cell shield windows has a flashpoint of 345 degrees F. (1, 2, 4) 2. Electrical installation meets NEC. (1) 3. Metal facility canister with bolted or pinned lid prevent direct flame impingement. (1, 2, 4) 4. Canister storage wells prevent direct flame impingement on stored canisters. (1, 2, 4) 5. Noncombustible construction of the WHB including thick concrete walls, ceiling, and lead glass windows (one section of glass on the hot cell side, three sections of glass on the operating gallery side) surround hot cell complex; upper hot cell also includes thick concrete floors and shield plugs, metal doors and shield valves. (4) Administrative: 1. Combustible Loading Control Program. (1, 4) 2. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (3) 3. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (Prevents worker consequence from all causes) 4. Trained operators for crane and overhead powered manipulator. (2) 5. Preventive maintenance program on electrical equipment. (1)	Design: 1. Noncombustible construction of the WHB including thick concrete walls, ceiling, and lead glass windows surround hot cell complex; upper hot cell also includes thick concrete floors and shield plugs, metal doors and shield valves. 2. Hot cell ventilation system maintains a differential pressure with respect to the RH bay with the shield plugs installed. Administrative: 1. Emergency response procedures 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB1-3	Fire in the transfer cell impacts waste MAR: 240 PE-Ci per - 72-B with 3 drums at 80 PE-Ci each or 240 PE-Ci for the facility canister Release Mechanism: Thermal Initial Conditions: Shuttle car design limits inventory to one 72-B or facility canister in the transfer cell at a time. 72-B shipping cask is designed and tested to withstand fire with the lid bolts in place Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment malfunction (de-tensioner robot and swipe robot motors and controls, camera motors, swipe delivery system motors, blowers and control, CCTV monitor, cameras, transfer cell shield valve motor, radiation monitoring. equipment, lighting. 2. Waste container in transfer cell contains flammable material/liquid that ignites. 3. Fire from outside the transfer cell propagates to the transfer cell.	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Electrical installation that meets NEC. (1) 2. Metal 72 B or facility canister prevents direct flame impingement (1, 3) 3. Metal transfer cell shuttle car, 72-B shipping cask, or shielded insert prevent direct flame impingement on canister. (1, 3) 4. Noncombustible construction of the WHB including thick concrete walls, ceiling, and floors that surround the hot cell complex including the transfer cell. (3) Administrative: 1. Combustible Loading Control Program. (1, 3) 2. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (Prevents worker consequence from all causes) 3. Preventive maintenance program on electrical equipment. (1) 4. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 5. 72-B waste canister is required to have a welded or mechanical lid as implemented at generator sites through adherence to the RH WAC. (1)	Design: 1. Hot cell ventilation system during facility canister transfer. 2. Noncombustible construction of the WHB including thick concrete walls, ceiling, and shield valves that surround the transfer cell and protect other parts of the RH facility from fire in the transfer cell. Administrative: 1. Emergency response procedures 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-4	Fire in the FCLR impacts waste MAR: 240 PE-Ci per - 72-B with 3 drums at 80 PE-Ci each or 240 PE-Ci for the facility canister Release Mechanism: Thermal Initial Condition: Facility cask holds only one RH waste canister Hazard Source: Radioactive Material/Beryllium	1. Electrical malfunction ignites nearby combustibles. 2. Leaking hydraulic fluid from the FCRD is ignited. 3. Waste container in FCLR contains flammable material/liquid that ignites. 4. Fire outside the FCLR propagates to the FCLR.	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Electrical installations meets NEC (1) 2. FCRD hydraulic fluid flash point is 302° F. (2) 3. Metal facility cask, telescoping port shield, and shield bell prevent direct flame impingement on RH waste canister during canister transfer. (1, 2) 4. Metal facility cask prevents direct flame impingement on waste canister after transfer of the canister is complete. (1, 2) 5. Metal facility canister with bolted or pinned lid prevent direct flame impingement. (1, 2) 6. Noncombustible construction of the WHB including thick concrete walls, ceiling, and floors, metal doors, and shiel that surround the hot cell complex including the FCLR. (4) Administrative: 1. Combustible Loading Control Program. (1) 2. Preventive maintenance program on electrical equipment. (1) 3. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (3) 4. 72-B waste canister is required to have a welded or mechanical lid as implemented at generator sites through adherence to the RH WAC. (1, 2)	Design: 1. Limited inventory (40 gallon) of hydraulic fluid on the FCRD. 2. RH facility ventilation system. 3. WHB fire suppression system in the FCLR. 4. Noncombustible construction of the WHB including thick concrete walls, floors, and ceiling, and steel doors protect other portions of the RH facility from a fire in the FCLR. Administrative: 1. Emergency response procedures. 2. WIPP fire brigade and external agency fire fighting support. 3. Limited access to FCLR during waste transfer to the facility cask.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-5	Fire in the service room propagates to transfer cell during waste processing and impacts waste MAR: 240 PE-Ci per - 72-B with 3 drums at 80 PE-Ci each or 240 PE-Ci for the facility canister Release Mechanism: Thermal Initial Condition: None Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment malfunction (fume hood blower or swipe delivery system or motor for transfer cell shuttle car, or radiation monitoring equipment) creates sparks that ignite insulation or nearby combustibles. 2. Grapple override tool cover is not in place and fire propagates from service room to transfer cell.	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Electrical installation that meets NEC. (1) 2. Noncombustible construction of the WHB including thick concrete shield walls and override port shield plugs separate the service room from the transfer cell and prevent fire from propagating to the transfer cell. (2) Administrative: 1. Combustible Loading Control Program. (1) 2. Preventive maintenance program on electrical equipment. (1) 3. Waste handling restrictions require grapple override port shield plug to be installed except when override tools are in use. (2)	Design: 1. RH facility ventilation system. 2. Noncombustible WHB construction protects the other parts of the WHB from a fire in the service room. Administrative: 1. Emergency response procedures. 2. WIPP fire brigade and external agency fire fighting support. 3. Limited access to service room during waste transfer to the facility cask.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-6	Fire in the crane maintenance room propagates to the upper hot cell and impacts waste MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Thermal Initial condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment malfunction (lights, motors for opening and closing the shield door, upper hot cell crane motor) creates sparks that ignite insulation and/or nearby combustibles that propagates to upper hot cell. 2. Cleaning solvents used to repair crane ignite and fall into upper hot cell. 3. Welding to repair crane ignites nearby combustibles.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Noncombustible construction of the WHB. Crane maintenance room is segregated from the upper hot cell by a raised concrete wall and a shield door that is normally closed. (1, 2, 3) 2. Electrical installations meet NEC. (1) 3. Fire suppression system in the in crane maintenance room prevents propagation of fire to upper hot cell. (1, 2, 3) Administrative: 1. Combustible Loading Control Program (1) 2. Access control to crane maintenance room when repairing the upper hot cell crane. No access to the crane maintenance room when waste is present in the upper hot cell without the shield door being closed. (1, 2, 3) 3. Work control process. (2, 3) 4. Hot work permit. (3) 5. Crane maintenance room shield door is required to be closed except when transferring the upper hot cell crane into the room for maintenance. (1, 2, 3)	Design: 1. Hot cell ventilation system maintains the upper hot cell at a lower pressure than the RH bay with the shield plugs installed. 2. Noncombustible construction of the WHB protects other portions of the WHB from a fire in the crane maintenance room. Administrative: 1. Emergency response procedures. 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-7	Fire in the hot cell operating gallery impacts waste in upper hot cell MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Thermal Initial condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums. Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment malfunction creates sparks that ignite insulation and/or nearby combustibles. 2. Cables in electrical penetrations ignite 3. Fire propagates from transfer drawer motors into the upper hot cell. 4. Fire impacts oil in shield glass windows which breaches the windows and impacts waste in the upper hot cell.	A	<u>Radiological</u> Fac Worker - High Site Worker - High Public - High <u>Chemical</u> Fac Worker - High Site Worker - High Public - High	 I I I I I I	<u>Design:</u> 1. WHB fire suppression system in the hot cell operating gallery prevents fire from propagating into the upper hot cell (1, 2, 3, 4). 2. Electrical installations meet NEC. (1, 2) 3. Mineral oil in lead windows has a flashpoint of 345 degrees F. (4) 4. Noncombustible construction of the WHB including the thick concrete walls, shield doors, and lead glass windows (one section of glass on the hot cell side, three sections of glass on the operating gallery side) that prevent fire propagation from the operating gallery to the upper hot cell. (1, 2, 3) <u>Administrative:</u> 1. Combustible Loading Control Program. (1, 4) 2. Restricted access to operating gallery during upper hot cell waste handling operations and when waste is present in the upper hot cell. (4) 3. Preventive maintenance program on shield windows and electrical equipment. (1, 2, 4)	<u>Design:</u> 1. Noncombustible constructio or the WHB including thick concrete walls, shield doors, and lead glass windows that protect other portions of the WHB from a fire in the hot cell operating gallery. 2. Penetrations are offset and/or have plugs containing lead to minimize the likelihood of fire propagating. <u>Administrative:</u> 1. Emergency response procedures. 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB1-8	Fire in the RH bay near the common RH/CH wall impacts RH waste or RH and CH waste MAR: 5280 PE-Ci total - two facility pallets (8 seven packs of CH waste at 560 PE-Ci per seven pack) and 800 PE-Ci - the inventory for one 10-160B shipping cask Release Mechanism: Thermal Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lids bolted in place. Hazard Source: Radioactive Material/Beryllium	1. Diesel/electrical equipment creates sparks that ignite insulation and/or nearby combustibles. 2. Maintenance activities. 3. Transport tractor or trailer catches fire in the RH bay.	A	Radiological Fac Worker - High Site Worker - High Public - Moderate Chemical Fac Worker - High Site Worker - High Public - Moderate Note: The 10-160B cask inventory is at risk when the lid is unbolted with the bolts loosened.	 I I I I I I	Design 1. Noncombustible construction of the WHB. (1, 2, 3) 2. Stops associated with rails in the RH bay prevent transport tractor from being close to the common wall. (3) Administrative 1. Combustible Loading Control Program: - requires a standoff distance of 15 ft from common CH/RH wall for diesel powered equipment operated in the RH bay or post a fire watch. (1, 2, 3) - prohibits storage of combustibles in the RH bay within 4 ft of the common RH/CH wall. (1) 3. Waste handling restriction that prohibits removal of loaded RH waste drums or canisters from the shipping cask outside the hot cell complex. (1, 2, 3) 4. Waste handling restriction requires that the 10-160B cask cannot be left unattended in the RH bay with the lid bolts loosened - it must either have the lid bolts installed or be in the CUR with the shield door closed to be left unattended. (1, 2, 3)	Design: 1. Fire suppression system in RH bay. 2. RH facility ventilation system . 3. Noncombustible construction of the WHB protects other portions of the WHB from a fire in the RH bay. Administrative: 1. Emergency response procedures. 2. WIPP fire brigade and external agency fire fighting support.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB1-9	Fire in the CUR impacts RH waste MAR: 800 PE-Ci total - the inventory for one 10-160B shipping cask Release Mechanism: Thermal Initial Condition: 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lids bolted in place. Hazard Source: Radioactive Material/Beryllium	1. Electrical equipment (lights, crane motor, etc.) malfunction creates sparks that ignite insulation and/or nearby combustibles. 2. Maintenance activities. 3. Waste containers in the 10-160B shipping cask contain flammable material/liquid that ignites. 4. Fire outside the CUR propagates to the CUR	A	Radiological Fac Worker - High Site Worker - High Public - Moderate Chemical Fac Worker - High Site Worker - High Public - Moderate Note: The 10-160B cask inventory is at risk when the lid is unbolted with the bolts loosened.	 I I I I I I	Design: 1. Electrical installations meet NEC. (1) 2. Noncombustible construction of the WHB including the thick concrete walls, floors, ceiling, steel doors and shield valves, and the large CUR concrete shield door that is closed for storing the loaded 10-160B shipping cask and for moving drums from the 10-160B shipping cask to the upper hot cell. (1, 4) Administrative: 1. Combustible Loading Control Program. (1) 2. Work control process. (2) 3. Hot work permit. (2) 4. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (3) 5. Preventive maintenance program - periodic inspections of electrical equipment. (1) 6. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (2) 7. Waste handling restriction requires the CUR door to be closed when storing a loaded 10-160B shipping cask in the CUR and whenemoving drums from the 10-160B shipping cask to the upper hot cell. Also door is required to be closed when the upper hot cell shield plugs are removed and waste is in the upper hot cell. (4)	Design: 1. Hot cell ventilation system with the shield plugs removed. 2. Noncombustible constructio o f the WHB including thick concrete walls, floors, and ceiling, shield door, shield plugs and metal shield valves protect other parts of the RH facility from fires in the CUR. Administrative: 1. Emergency response procedures 2. WIPP fire brigade and external agency fire fighting support. 3. Waste handling restriction requires the CUR door to be closed when storing a loaded 10-160B shipping cask in the CUR and whenemoving drums from the 10-160B shipping cask to the upper hot cell. Also door is required to be closed when the upper hot cell shield plugs are removed and waste is in the upper hot cell.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB2-1	Explosion followed by fire in the RH bay MAR: 800 PE-Ci total - the inventory for one 10-160B shipping cask Release Mechanism: Impact and Breach Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lids bolted in place. Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable gas or flammable compressed gas cylinders. 2. Explosion within a waste container. 3. Explosion in other parts of the WHB propagates to the RH bay.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High Note: The 10-160B cask inventory is at risk when the lid is unbolted with the bolts loosened	 I I I I I I	Design: 1. The RH bay is segregated from hot cell complex by thick concrete walls and floors, and steel doors. (3) Administrative: 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 2. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC (3) 3. Combustible Loading Control Program including controls for storage and use of flammable gas or flammable compressed gas cylinders in the WHB. (1, 3) 4. Work control process (1, 3) 5. Hot work permit (1, 3) 6. Waste handling restriction that requires the CUR shield door to be closed when storing a loaded 10-160B shipping cask in the CUR and when moving drums from the 10-160B shipping cask to the upper hot cell.	Design: 1. RH facility ventilation system 2. The RH bay is segregated from hot cell complex by thick concrete walls and floors that protect the hot cell complex from explosions in the RH bay or other portions of the WHB. 3. WHB fire suppression system in RH bay. Administrative: 1. Emergency response procedures 2. Waste handling restriction that requires the CUR shield door to be closed when storing a loaded 10-160B shipping cask in the CUR and when moving drums from the 10-160B shipping cask to the upper hot cell.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB2-2	Explosion followed by fire in the CUR impacts RH waste MAR: 800 PE-Ci total - the inventory for one 10-160B shipping cask Release Mechanism: Impact, Breach, and Thermal Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact with the lid bolts in place Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable gas or flammable compressed gas cylinders. 2. Explosion within a waste container. 3. Explosion outside the CUR propagates to the CUR.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. The CUR is segregated from the RH bay and other parts of the hot cell complex by thick concrete walls, floors, and ceiling, concrete shield plugs, steel shield valves and doors, and the thick concrete and steel shield door. Administrative: 1. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders. (1, 3) 2. Work control process. (1, 3) 3. Hot work permit. (1, 3) 4. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 5. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (2) 6. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (Prevents worker consequence from all causes) 7. Waste handling restriction that requires the CUR shield door to be closed when storing a loaded 10-160B shipping cask in the CUR and when moving drums from the 10-160B shipping cask to the upper hot cell. Also door is required to be closed when the upper hot cell shield plugs are removed and RH waste is in the upper hot cell. (3)	Design: 1. RH facility ventilation system. 2. The CUR is segregated from the RH bay and other parts of the hot cell complex by thick concrete walls, floors, and ceiling, concrete shield plugs, steel shield valves and doors, and the thick concrete and steel shield door. Administrative: 1. Emergency response procedures. 2. Waste handling restriction that requires theCUR shield door to be closed when storing a loaded 10-160B shipping cask in the CUR and when moving drums from the 10-160B shipping cask to the upper hot cell. Also door is required to be closed when the upper hot cell shield plugs are removed and RH waste is in the upper hot cell.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB2-3	Explosion followed by fire in the upper hot cell MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Impact, Breach, and Thermal Initial Condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable gas or flammable compressed gas cylinders. 2. Explosion within a waste container. 3. Explosion outside the upper hot cell propagates to the upper hot cell.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker -High Public - High	 I I I I I I	Design: 1. Upper hot cell is segregated from other parts of the hot cell complex and WHB by thick concrete floors, walls, ceiling, shield plugs, lead glass windows, and steel shield valves and doors. (3) Administrative: 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 2. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (2) 3. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders. (1, 3) 4. Work control process. (1, 3) 5. Hot work permit. (1, 3) 6. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (Prevents worker consequence from all causes)	Design: 1. Facility canister. 2. Hot cell ventilation system. maintains a differential pressure with respect to the RH bay with the shield plugs installed. 3. Thick concrete shield walls and lead glass windows surround hot cell complex and segregate it from the RH bay. 4. Upper hot cell is segregated from other parts of the hot cell complex and WHB by thick concrete floors, walls, ceiling, shield plugs, lead glass windows, and steel shield valves and doors. Administrative: 1. Emergency response procedures

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB2-4	Explosion followed by fire in the transfer cell or service room MAR: One 72-B canister at 240 PE-Ci or one facility canister at 240 PE-Ci Release Mechanism: Impact, Breach, and Thermal Initial Condition: Shuttle car design limits transfer cell inventory to one 72-B or facility canister in the transfer cell at a time. Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable gas or flammable compressed gas cylinders. 2. Explosion within a waste container. 3. Explosion outside the transfer cell propagates to the transfer cell.	A	Radiological Fac Worker - High Site Worker - High Public - Moderate Chemical Fac Worker - High Site Worker - High Public - Moderate	 I I I I I I	Design: 1. Thick concrete walls, floors, and ceiling , and metal shield valves segregate the transfer cell from the service room and other portions of the hot cell complex and WHB. (3) Administrative: 1. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders. (1, 3) 2. Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (Prevents worker consequence from all causes) 3. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 4. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (2)	Design: 1. Hot cell ventilation system. directs airflow from the transfer cell through the upper hot cell during canister transfer. 2. Thick concrete walls, floors, and ceiling , and metal shield valves segregate the transfer cell from the service room and other portions of the hot cell complex and WHB. Administrative: 1. Emergency response procedures.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB2-5	Explosion followed by fire in the FCLR MAR: One 72-B canister at 240 PE-Ci or one facility canister at 240 PE-Ci Release Mechanism: Impact, Breach, and Thermal Initial Condition: Facility cask holds only one RH canister. Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable compressed gas cylinders. 2. Explosion within a facility canister or 72-B canister. 3. Explosion from outside the FCLR propagates to the FCLR.	A	Radiological Fac Worker - High Site Worker - High Public - Moderate Chemical Fac Worker - High Site Worker - High Public - Moderate	 I I I I I I	Design: 1. Facility cask protects waste canister from external explosion and contains canister explosions occurring in the facility cask. (1, 2) 2. Shield bell and telescoping port shield also protects the waste canister from external explosion (1) 3. Fire suppression system in FCLR (1, 2) 4. FCLR is segregated from the rest of the RH facility by thick concrete walls, floors, and ceiling and steel doors. (3) Administrative: 1. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders (1, 4) 2. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (2) 3. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (2)	Design: 1. RH facility ventilation system 2. Operator console is segregated from the rotating device and facility cask with a shadow shield 3. FCLR is segregated from the rest of the RH facility by thick concrete walls, floors, and ceiling and steel doors. Administrative: 1. Emergency response procedures 2. Access control to FCLR during waste transfer to the facility cask

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB2-6	Explosion followed by fire in the crane maintenance room impacts waste in upper hot cell MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Impact and Breach Initial Condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable compressed gas cylinders resulting in a missile that falls on waste containers.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker -High Public - High	 I I I I I I	Design: 1. Crane maintenance room is segregated from the upper hot cell by a raised concrete wall and a shield door. (1) 2. Storage wells (1) 3. Facility canister design (1) Administrative: 1. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders. (1) 2. Work control process. (1) 3. Hot work permit. (1) 4. The crane maintenance room shield door must be closed when waste is present in the upper hot cell. (1)	Design: 1. Hot cell ventilation system maintains a differential pressure with respect to the RH bay with the shield plugs installed. 2. Fire suppression system in crane maintenance room. 3. Crane maintenance room is segregated from other parts of the WHB by thick concrete walls, floor, and ceiling. Administrative: 1. Emergency response procedures. 2. Access controlled to crane maintenance when waste is present in the upper hot cell.
WHB2-7	Explosion followed by fire in the upper hot cell operating gallery MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci. Release Mechanism: Impact and Breach Initial Condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable compressed gas cylinders resulting in a missile.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Upper hot cell operating gallery is segregated from the waste in the hot cell complex by thick concrete shield walls, steel doors, and lead glass windows. (1) 2. Storage wells (1) 3. Facility canister design (1) Administrative: 1. Combustible Loading Control Program restricts storage and use of flammable gas or flammable compressed gas cylinders. (1) 2. Hot work permit. (1) 3. Work control. (1)	Design: 1. RH facility and hot cell ventilation system. 3. WHB fire suppression system in hot cell operating gallery.. Administrative: 1. Emergency response procedures. 2. Access controlled to upper hot cell operating gallery when waste is present in the upper hot cell.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-1	Loss of RH shipping cask confinement in the RH bay MAR: Two RH shipping casks either two 72-B or 10-160B or any combination with the maximum being two 10-160B casks with canisters at 800 PE-Ci each Release Mechanism: Impact/puncture/crush and breach Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact with the lid bolts installed. Hazard Source: Radioactive Material/Beryllium	1. RH bay crane drops loaded shipping cask or fails/falls on loaded shipping cask. 2. RH bay crane drops impact limiters or turnbuckles or lifting yoke or RCTC on a loaded shipping cask. 3. Swinging load from RH bay crane knocks over shipping cask from RCTC or from the trailer. 4. CUR shield door closes during transfer of shipping cask to CUR knocking loaded cask from the RCTC. 5. Compressed gas cylinder becomes a missile. 6. Forklift used for maintenance activities impales/knocks over shipping cask. 7. Jib crane fails and falls onto loaded shipping cask 8. Upper hot cell crane override tools are dropped from catwalk during transfer of shipping cask from prep station to CUR	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. If CUR shield door hits something the door tilts and the air bearings lose pressure and door stops moving. (Prevents cause 4) 2. Insufficient shield door force to knock RCTC off rails. (Prevents cause 4) 3. RH bay crane is designed to hold load during loss of power (LOP). (Prevents cause 1, 2) 4. WHB/crane designed for design basis loads (Prevents cause 1, 2) Administrative: 1. Trained operators (Prevents cause 1, 2, 3 , 8) 2. Preoperational checks on waste handling equipment (Prevents cause 1, 2, 8) 3. Compressed gas cylinder control. (Prevents cause 5) 4. Preventive maintenance program including structural integrity inspections on the RH bay cranes and interface with the WHB structural supports for the crane. (Prevents cause 1, 2, 7) 5. Waste handling restrictions to prohibit more than one shipping cask at the cask preparation station at a time. (Prevents cause 3) 6. No non-waste handling activities allowed in RH bay when 10-160B lid bolt are loosened (Prevents cause 6) 7. Storage provision for grapple override tools when not in use (Prevents cause 8)	Design: 1. RH facility ventilation system Administrative: 1. Emergency response procedures

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-2	Loss of confinement in the CUR MAR: One 72-B canister at 240 PE-Ci or 10 drums from a 10-160B cask at a total of 800 PE-Ci Release Mechanism: Impact/puncture/crush and breach Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impacts with lid bolts in place Hazard Source: Radioactive Material/Beryllium	1. CUR crane fails and drops shipping cask or falls on cask. 2. Upper hot cell crane, rotating block, and/or grapple fails and drops item on loaded 10-160B cask or drops loaded drum carriages into CUR. 3. Lift fixtures associated with CUR or upper hot cell crane fail and drop load or items onto waste containers. 4. Drop of 10-160B cask lid or drum carriages into CUR. 5. Shipping cask is dislodged from RCTC as a result of hitting it with the hot cell crane grapple, hook or rotating block or CUR crane. 6. RCTC runs off end of rails. 7. Misaligned RCTC with the upper hot cell shield plug opening.	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. WHB structure, CUR crane, upper hot cell crane, and lift fixtures are designed to handle design basis loads. (Prevents causes 1, 2, 3,4) 2. Torque limiter on shield valve motor. (Prevents cause 8) 3. Interlock on crane requires CUR crane to be in the high position before the CUR shield valve can be either opened or closed. (Prevents cause 8) 4. RCTC rails have stops to prevent car from running off the rails. (Prevents cause 6) 5. Positioner for 10-160B RCTC to ensure it is centered under the upper hot cell shield plugs. (Prevents cause 5, 7) 6. Grapple interlocked with crane load cell and grapple "pintle contact" proximity switch such that the grapple lifting dogs cannot disengage during lifting or carrying a load. (Prevents cause 4) 7. CUR shield door is interlocked with the upper hot cell shield plugs. (Prevents cause 9) Administrative: 1. Trained operators. (Prevents 5, 6, 7, 9) 2. Waste handling restrictions ensure RCTC is not operated during lifting with CUR crane or upper hot cell crane.(Prevents cause 5) 3. Waste handling restriction to ensure the CUR crane is positioned to provide adequate clearance to perform 10-160B process. (Prevents cause 5, 7)	Design: 1. RH facility ventilation system. 2. Interlock with personnel door for annunciation and alarm and shield door to prevent opening the door to the CUR on an area radiation monitor alarm. 3. Drum carriage design prevents damage to drums in lower drum carriage. Administrative: 1. Waste handling restrictions require shield door to CUR to be closed during removal of lid and drums from 10-160B cask. 2. Emergency response procedures.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-2 Contd.	Loss of confinement in the CUR (continued)	8. CUR floor shield valve closes during transfer of 72-B cask resulting in the cask being dislodged from CUR crane hook and fall in CUR. 9. CUR shield door closes during movement of the RCTC and dislodges waste from the car 10. Compressed gas cylinder becomes a missile.				4. Periodic testing of shield door and shield valve interlocks with CUR crane and hot cell crane. (Prevents cause 8) 5. Compressed gas cylinder control. (Prevents cause 10) 6. Preventive maintenance program including structural integrity inspections of CUR crane and upper hot cell crane, WHB interface, and lift fixtures. (Prevents cause 1, 2, 3, 4) 7. Access control to prohibit personnel access to the CUR when removing the upper hot cell shield plugs, 10-160B shipping cask lid or loaded drum carriages. (Prevents worker consequences from 10-160B related loss of confinement events 1, 2, 3, 4,5, 7)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-3	Loss of confinement in the transfer cell MAR: Up to two 72-B or facility canisters at 240 PE-Ci each. Release Mechanism: Impact/puncture/crush and breach Initial Condition: RH waste arrives at the WIPP in 72-B shipping cask designed and tested to withstand impacts with lid bolts in place Hazard Source: Radioactive Material/Beryllium	1. CUR crane fails and drops shipping cask or falls on cask. 2. Upper hot cell crane, rotating block, and/or grapple fails and drops loaded facility canister during transfer to the transfer cell 3. Grapple hoist fails and drops loaded canister, drops 72-B inner cask lid onto canister, or falls on canister during transfer to the facility cask. 4. Shield valve(s) in the transfer cell ceiling, upper hot cell floor, CUR floor, or facility cask close during transfer of RH waste cask/canister and severs the crane or hoist ropes, crushes the cask or canister, or dislodges load from the hook/grapple. 5. Upper hot cell crane drops facility canister onto another loaded canister in the shuttle car	A	Radiological Fac Worker - High Site Worker - Low Public - Moderate Chemical Fac Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. CUR crane, upper hot cell crane, and grapple hoist designed to handle design basis loads. Pin that holds the grapple to the rotating block has a 4/1 safety factor. (Prevents cause1, 2, 3, 5) 2. Shield valve motors have torque limiters. (Prevents cause 4) 3. Upper hot cell crane and grapple are designed to handle design basis load and hold their load during LOP. Pin that holds the grapple to the rotating block has a 4/1 safety factor. (Prevents cause 2, 5) 4. The grapples used with the upper hot cell crane and in the FCLR are designed with three pivot dogs that move together to hold a canister pintle.(Prevents cause 2, 3, 4, 5, 8) 5. Guide tubes are flared with a guard ring at bottom to keep cables and rope from getting caught. (Prevents cause 6) 6. Shield valve interlocks require grapple or crane hooks to be in an upper position to allow the shield valve to move. Applies to CUR, upper hot cell and FCLR cranes. (Prevents cause 4) 7. Shuttle car is interlocked with shield valves such that all three shield valves must be closed before the shuttle car can move. (Prevents cause 7) 8. Transfer cell shield valve cannot be opened with the facility cask bottom shield valve closed and can not be closed with the facility cask bottom shield valve open. (Prevents cause 4 for canister transfer to the facility cask)	Design: 1. An impact limiter is installed below each of the three transfer ports into the transfer cell to absorb energy in the event of a dropped load into the cell from the CUR, the upper hot cell or the FCLR. 2. Hot cell complex ventilation system during canister transfer from upper hot cell. 3. Metal transfer cell shuttle car shipping cask receiver encases 72-B shipping cask or shielded insert for the facility canister. 4. Bottom of shuttle car basket is designed to yield and allow dropped cask/canister to be directed to the impact limiters. Administrative: 1. Emergency response procedures.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-3	Loss of confinement in the transfer cell (continued)	6. Upper hot cell rotating block/grapple or cables catch on guide tubes, causing the rotating block or grapple to sheer and fall on a loaded canister in the shuttle car. 7. Transfer cell shuttle car moves before transfer of 72-B cask , canister from the upper hot cell, or canister into the facility cask is complete causing the load to drop. 8. Robots move during transfer of a canister and either dislodge the canister from the grapple or puncture the canister. 9. Compressed gas cylinder becomes a missile and damages waste container. 10. Canister or pintle lid failure during canister transfer with hot cell crane or grapple hoist fails. 11. Shuttle car fails causing cask/canister drop.				9. The detension robot is interlocked and cannot be operated unless the upper hot cell shield valve is closed. (Prevents cause 8) 10. Swipe and detension robot motor cannot generate sufficient torque to puncture a 72-B canister. (Prevents cause 8) 11. Mechanical facility canister lid closure is load bearing and includes a mechanical pin/lock. Pintle and associated bolts are designed for the fully loaded canister. (Prevents cause 10) 12. Shuttle car and structural supports for car are designed to handle design loads and remain on the rails in the event of a DBE. (Prevents cause 11) 13. The FCTC mates with the FCRD and is latched in place to prevent FCTC movement during canister transfer (Prevents cause 13) 14. The FCRD is interlocked with the telescoping port shield and grapple hoist shield bell to prevent facility cask rotation during canister transfer. (Prevents cause 12) Administrative: 1. Trained operators (Prevents cause 1, 2, 3, 4, 5, 6, 7, 9, 12, 13) 2. Waste handling restriction to require that the FCTC and FCRD be mated and latched prior to rotating the facility cask. (13)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-3	Loss of confinement in the transfer cell (continued)	12. FCRD rotates facility cask during canister transfer resulting in grapple hoist rope shear and load drop. 13. FCTC moves during transfer of a waste canister.				3. Waste handling restrictions including use of the vision system to confirm the presence or absence of RH waste in the transfer cell prior to introducing additional waste to the transfer cell. Also procedures include use of the vision system prior to closure of shield valves or movement of the shuttle car. (Prevents cause 4, 5, 10, 12, 13) 4. Preventive maintenance program including periodic structural inspections of crane/grapple hoist and structural support. (Prevents cause 1, 2, 3, and 5) 5. Compressed gas cylinder control. (Prevents cause 9) 6. Generator sites must certify that the mechanism for securing the 72-B canister lid will structurally support the canister when lifted with a grapple as required by the RH WAC. (Prevents cause 10) 7. Periodic structural integrity inspection of the transfer cell shuttle car with structural supports and transfer cell ceiling shield valve. (Prevents causes 11) 8. Access control to prohibit personnel access to the transfer cell during waste processing in the cell. (Prevents worker consequences from all causes)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-4	Loss of confinement in the upper hot cell MAR: 2240 PE-Ci worst case in the upper hot cell. Maximum of 6 canisters and 10 drums; 10-160B shipments are drums are limited to 80 PE-Ci Release Mechanism: Impact/puncture/crush and breach Initial Condition: Upper hot cell inventory limited by HWFP to 6 loaded facility canisters and 10 55-gal drums Hazard Source: Radioactive Material/Beryllium	1. Upper hot cell crane or overhead powered manipulator fails and drops, crushes, or punctures waste containers. 2. Grapple or lift fixtures fail and drops 10-16B cask lid, shield plugs, or facility canister on drums or loaded facility canisters. 3. Upper hot cell crane or manipulator knocks shield plug lift fixture into drums. 4. Drum lifting ring and cables fail and drop drum. 5. Overhead powered manipulator arm hook fails and drops drum 6. Facility canister lid or pintle fail and canister drops. 7. Drums are tipped over during removal drum carriage lift fixture. 8. Drum is tipped over with end of arm device during engaging the bail. 9. Crane fails and drops rotating block or grapple on top of waste canister or drum crushing the lid.	A	<u>Radiological</u> Fac Worker - High Site Worker - Moderate Public - Moderate <u>Chemical</u> Fac Worker - High Site Worker - Moderate Public - Moderate	 I I I I I I	<u>Design:</u> 1. Upper hot cell crane/grapple and overhead powered manipulator and lift fixtures designed to handle design basis loads and hold their load during LOP. (Prevents causes 1, 2, 3, 5, 6, 9, 10, 12) 2. The grapple used with the upper hot cell crane is designed with three pivot dogs that move together to hold a canister pintle (Prevents causes 2) 3. Grapple is interlocked with the pintle contact permissive to open the lifting lugs. (Prevents cause 2) 4. Grapple interlock with crane load cell to ensure that the lifting lugs cannot be released while lifting a load. (Prevents cause 2) 5. Overhead powered manipulator has insufficient force to puncture a drum. (Prevents cause 16) 6. The overhead powered manipulator end of arm tool has redundant ball locks to preclude the tool from releasing. The overhead powered manipulator telescoping tube motor is interlocked such that slack in the rope causes the tube hoist motor to stop downward motion. (Prevents cause 5) 7. Shield valve is interlocked such that the valve can only be closed when the upper hot cell crane grapple is in the high position. (Prevents cause 13) 8. Canister storage wells are located over structural beams that support stored canisters containing RH waste and prevent the canisters from falling to the lower hot cell. (Prevents 11)	<u>Design:</u> 1. Hot cell ventilation system maintains a differential pressure with respect to the RH bay with the shield plugs installed. (Mitigates consequences for all causes in upper hot cell) 2. Hot cell complex is built of thick concrete walls, floor and ceiling with lead glass windows to provide shielding and confinement for worker protection. (Reduces consequences to workers for all radiological releases in the upper hot cell) 3. Upper hot cell storage locations are positioned over structural members that support the facility canister in the event of a dropped drum or canister. (Reduces consequences for causes 12, 13) <u>Administrative:</u> 1. Emergency response procedures. (Mitigates consequences for all causes)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-4	Loss of confinement in the upper hot cell (continued)	10. Loaded drum carriage or facility canister falls through deck plate to lower hot cell. 11. Crane fails and drops loaded facility canister through the storage cylinder to the lower hot cell. 12. Drum is dropped into the inspection station cylinder without a canister in place. 13. Upper hot cell shield valve closes on a facility canister. 14. Canister lid or pintle fail while lifting causes canister breach. 15. Puncture of drum by knocking it over onto a sharp edge. 16. Puncture of drum or canister with the end of arm hook on overhead powered manipulator. 17. Puncture of drum with the wall mounted manipulator arm. 18. Compressed gas cylinder missile.				9. Mechanical facility canister lid closure is load bearing and includes a mechanical pin/lock. Pintle and associated bolts are designed for the fully loaded canister. (Prevents cause 6, 15) 10. Wall mounted manipulators transmit the force applied by a human had and have counterweights to limit speed of travel in the event that an operator releases the manipulator. (Prevents cause 17) Administrative: 1. Operator training. (Prevents cause 3, 7, 8, 10, 11, 12, 13, 14, 16, 17) 2. Waste handling procedure. (10, 11, 12, 13, 14, 16, 17) 3. Access to the upper hot cell is prohibited when waste handling is in progress and restricted if waste is stored in the canister storage locations. (Prevents worker consequences for all causes). 4. Generator site must certify installation of the drum lifting ring and cable as required by the RH WAC. (Prevents cause 4) 5. Waste handling restriction requires that the10-160B loaded drum carriages are carried over and stored on the concrete portion of the upper hot cell floor. Facility canisters are only stored in the storage wells or in the wells at the inspection station. (Prevents cause 10,11) 6. Compressed gas cylinder control. (Prevents cause 18)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB3-5	Loss of confinement in the FCLR MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact/puncture/crush and breach Initial Condition: Facility cask holds only one canister Hazard Source: Radioactive Material/Beryllium	1. Grapple hoist or grapple fail and drop loaded canister during transfer to the facility cask. 2. The facility cask shield valves close on grapple hoist ropes, grapple or canister. 3. Canister lid or pintle fail and cause canister to fall and breach. 4. FCTC moves during transfer of a waste canister. 5. FCRD rotates facility cask during canister transfer resulting in grapple hoist rope shear and load drop. 6. Airlock door closes on facility cask during transfer of a loaded canister from the FCLR to the waste shaft conveyance.	A	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - High Site Worker - Low Public - Low	 I III III I III III	Design: 1. Grapple hoist and grapple are designed to handle design basis load and hold load during LOP. (Prevents cause 1) 2. Grapple is interlocked such that the dogs cannot be disengaged unless pintle contact is made and the load cell detects weight no greater than that of the grapple. (Prevents cause 1) 3. Grapple positions are programmed, interlocked, and indicated such that the grapple must be in specific positions for shield valve operation. (Prevents cause 2) 4. FCRD is interlocked with the telescoping port shield and FCLR grapple hoist and shield bell. (Prevents cause 5) 5. FCTC mates with the FCRD and is latched prior to rotating the facility cask. (Prevents cause 4) 6. Torque limiters on the facility cask shield valves. (Prevents cause 2) 7. Torque limiter on the FCLR airlock door. (Prevents cause 6)	Design: 1. RH facility ventilation system. (Mitigates worker consequence for all loss of confinement events in FCLR) Administrative: 1. Emergency response procedures. (Mitigates worker consequence for all loss of confinement events in FCLR) 2. Access to FCLR restricted during waste processing. (Minimizes worker consequence to only those directly involved with waste handling for all loss of confinement causes in the FCLR)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-5	Loss of confinement in the FCLR (continued)	7. Compressed gas cylinder missile impacts the facility cask and impacts waste.				8. Facility canister /pintle is design for maximum load with appropriate safety factors. (Prevents cause 3) Administrative: 1. Trained operators. (Prevents cause 2, 4, 5, 6) 2. Waste handling restrictions to ensure FCTC is latched to the FCRD prior to rotating the facility cask (4) 3. Waste handling procedures. (Prevents cause 2, 4, 5, 6) 3. Preventive maintenance program including structural integrity inspection of grapple and grapple hoist and structural support. (Prevents causes 1) 4. Compressed gas cylinder control (Prevents cause 7) 5. Generator sites must certify that the mechanism for securing the 72-B canister lid will structurally support the canister when lifted with a grapple as required by the RH WAC. (Prevents cause 4)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-6	Loss of confinement in the RH/CH bay MAR: One pallet of CH overpacked drum assemblies for a total of 4800 PE-Ci CH drums Release Mechanism: Impact/puncture/crush and breach Initial Condition: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact with the lid bolts in place. Hazard Source: Radioactive Material/Beryllium	1. During movement of loaded RH trailer into the RH bay the trailer is backed into the common wall between RH and CH and breaches CH waste containers. 2. Vehicle operating in the RH bay near the common wall penetrates the wall and damages CH waste.	A	Radiological Fac Worker - High Site Worker - Moderate Public - Moderate Chemical Fac Worker - High Site Worker - Moderate Public - Moderate	 I I I I I I	Design 1. Rail stops prevent trailer from being backed into the RH/CH common wall. (Prevents cause 1) 2. WHB structural members spacing between RH and CH bay prevents RH shipping cask transport trailer from breaching common wall. (Prevents cause 1) Administrative 1. Trained operators. (Prevents cause 1, 2) 2. Use of a spotter when backing the RH trailers into the RH bay. (Prevents cause 1) 3. Use of a spotter when operating any vehicle within 15 ft of the common RH/CH wall. (Prevents cause 2)	Design: 1. RH and CH ventilation system (Mitigates consequences from causes 1, 2) Administrative: 1. Emergency response procedures. (Mitigates worker consequence for all loss of confinement events in the RH/CH bay)
WHB3-7	Loss of confinement in the service room	1. Contamination on swipe rabbit becomes airborne during canister radiological swipes.	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design 1. Swipe delivery system exhausts to the transfer cell (1) 2. Fume hood ventilation (1) Administrative 1. Trained operators (1) 2. Radiological control procedures require operation of the fume hood during use of the swipe delivery system and removal of swipes from the rabbit to ensure airflow is directed away from the worker (1)	Design: 1. RH ventilation system (Mitigates consequences from causes 1) Administrative: 1. Emergency response procedures (Mitigates worker consequence due to airborne radiation associated with the swipe delivery system)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB3-8	Loss of confinement in the hot cell operating gallery	1. Contamination on swipe becomes airborne during transfer to the operating gallery using the transfer drawer	A	Radiological Fac Worker - Low Site Worker - Low Public - Low Chemical Fac Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design 1. Hot cell ventilation. (1) 2. Transfer drawer design includes one shield plug on hot cell wall and one inside transfer drawer, shield plugs are interlocked such that only one can be opened at a time. (1) Administrative 1. Trained operators. (1) 2. Waste handling procedures require operation of hot cell ventilation in prior to operating the transfer drawer. (1) 3. Waste handling procedure controls operating sequence of the transfer drawer such that only one transfer drawer shield plug is open at a time. (1)	Design: 1. RH ventilation system. Administrative: 1. Emergency response procedures. (Mitigates worker consequence due to airborne radiation associated with the transfer drawer)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB4-1	Radiation exposure in the RH bay, high efficiency particulate air (HEPA) filter gallery, catwalk for use of override tool, or along east aisle adjacent to CUR MAR: NA Release Mechanism: None Initial Conditions: RH waste arrives in the 72-B or 10-160B shipping cask that is designed for 1000 Rem/hr canister or drum. Hazard Source: Ionizing radiation	1. Waste exceeds 1000 rem/hr limit for RH waste as defined by the Land Withdrawal Act[13] 2. 10-160B cask lid becomes dislodged after bolts are loosened due to vehicle or crane impact or natural event. 3. Personnel on override tool catwalk prior to completion of shielding surveys. 4. Personnel access to hot cell HEPA filter gallery.	A	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	Design: 1. Low profile RCTC design keeps car from tipping over. (2) 2. Cask prep station design establishes a standoff distance between the worker and the cask. (1, 2) 3. Hot cell complex shield walls are designed for greater than 1000 Rem/hr. (1, 3) 4. Shielding around elbows at the exhaust exit from the hot cell. Is designed for greater than 1000 Rem/hr. (4) Administrative: 1. Trained operators.(2) 2. Waste handling restriction: - prohibits removal of RH waste containers from the shipping cask outside the hot cell complex. (1) - Requires grapple override port shield plugs to be installed when the grapple override tools are not in use. (3) 3. Work control process. (1, 2, 3, 4) 4. Waste required to not exceed 1000 Rem/hr as implemented at generator sites prior to shipment to the WIPP in accordance with the RH WAC. (1) 5. Access control to the RH facility during waste handling activities, including filter gallery, catwalks. (3, 4) 6. Radiation protection program requires periodic shielding surveys. (1)	Design: 1. Area radiation monitor at cask prep station. 2. Continuous air monitor the cask preparation station. Administrative: 1. Radiation protection program. 2. Emergency response procedure.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB4-2	Direct radiation exposure in the CUR MAR: NA Release Mechanism: NA Initial Condition: RH waste arrives in the 72-B or 10-160B shipping cask that is designed for1000 Rem/hr canister. Hazard Source: Ionizing radiation	1. Personnel are exposed as a result of opening 72-B cask in CUR. 2. Lid/loaded drum carriages is/are removed from the 10-160B shipping cask with the CUR shield door open. 3. Personnel enter the CUR through the man door when waste is being unloaded from the 10-160B cask. 4. CUR floor shield valve is opened with exposed canister in the transfer cell. 5. Upper hot cell shield plugs are removed with the CUR shield door open. 6. Shipping cask transfer car (RCTC) is tipped over with the CUR crane or hot cell crane grapple. 7. CUR shield door is opened during removal of loaded drum carriages from the 10-160B cask.	A	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	Design: 1. The CUR shield door cannot be opened with the upper hot cell shield plugs removed. The hot cell crane grapple position is interlocked with the CUR shield door to prevent removal of the shield plugs with CUR shield door open (grapple will not move up). (Prevents cause 5, 7) 2. CUR shield door is interlocked with the CUR area radiation monitor (ARM) and cannot be opened with a high ARM alarm. (Prevents cause 7) 4. Facility configuration prevents removal of the72-B inner lid in the CUR. (Prevents cause 1) 5. CUR crane configuration cannot lift 10-160B cask lid/drum carriages (Prevents cause 2) 6. Detensioning robot for 72-B inner lid is not under CUR to transfer cell port. (Prevents cause 4) 7. Cameras and transfer cell shuttle car encoder indicate location of transfer car shuttle car. (Prevents cause 4) 8. Low profile RCTC design keeps car from tipping over. (Prevents cause 6) Administrative: 1. Trained operators. (Prevents worker consequences from all causes) 2. Waste handling restriction to prohibit opening the 72-B cask inner lid until cask is in the transfer cell and prohibit removal of the 10-160B cask lid until the CUR shield door is closed. (Prevents causes 1, 2 ,4 ,5 ,7)	Design: 1. CUR man door is annunciated locally with CMR indication of door position to alert person of a high radiation area. (Reduces chance for worker exposure from cause 3) Administrative: 1. Radiation protection program. 2. Emergency response procedure.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB4-2	Direct radiation exposure in the CUR (continued)					3. Access in the CUR is prohibited during 10-160B waste processing. CUR man door is posted and has sign to alert personnel of high radiation. (Prevents worker consequences from all events associated with 10-160B processing) 4. Radiation program includes periodic shielding surveys. (Prevents worker consequences from all events associated with 10-160B processing)	
WHB4-3	Direct radiation exposure in the service room or transfer cell MAR: NA Release Mechanism: NA Initial Condition: RH waste remains in the 72-B or 10-160B Type B shipping cask or in the facility cask except for in the hot cell complex which is a shielded facility designed for 1000 Rem/hr RH canister or drum. Hazard Source: Ionizing radiation	1. Grapple override tool shield plug removed from penetrations through the shield wall.	A	<u>Radiological</u> Fac Worker - High Site Worker - Low Public - Low <u>Chemical</u> Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	<u>Design:</u> 1. Electrical, and piping, penetrations are offset to prevent streaming. (1) 2. Grapple override ports and spare penetrations have shield plugs. (1) 3. Thick concrete walls of the hot cell complex are designed for RH waste greater than 1000 Rem/hr. (1) <u>Administrative:</u> 1. Trained Operators.(1) 2. Waste handling restriction to require the override tool shield plug to be in place except for when tool is in use. (1) 3. Access control to prevent personnel access to the transfer cell when waste is being transferred between the transfer cell and upper hot cell or FCLR. (1) 4. Radiation protection program to including periodic shielding survey. (1)	<u>Design:</u> 1. None <u>Administrative:</u> 1. Radiation protection program. 2. Emergency response procedure.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB4-4	Direct radiation exposure in the hot cell, hot cell operating gallery, catwalk, or crane maintenance room MAR: NA Release Mechanism: NA Initial Condition: None Hazard Source: Ionizing radiation	1. Shielding window(s) are broken with swinging loads in upper hot cell. 2. Shielding window(s) are broken with movable arm on overhead powered manipulator or wall mounted manipulators. 3. Personnel enter the lower hot cell during transfer of a facility canister or when waste is in the upper hot cell. 4. Personnel enter the upper hot cell when waste is present. 5. Personnel are present in the crane maintenance room when waste is present in the upper hot cell and the crane maintenance room shield door is open. 6. Crane override tool penetration plugs are not in place. 7. Shielding windows are over-pressurized causing oil loss and loss of shielding. 8. Both shield plugs on transfer drawer are opened at the same time.	A	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	Design: 1. Hot cell complex has thick concrete walls, floors, ceiling, and shield windows designed for RH waste greater than 1000 Rem/hr. 2. Shield windows include provision for oil expansion from temperature changes. (Prevents cause 7) 3. Hot cell crane and overhead powered manipulator controls limit bridge and trolley motion including a speed limit near the windows. (Prevents cause 1, 2) 4. Counterweights on the wall mounted manipulators limit speed of travel in the event the operator releases the manipulator. (Prevents cause 2) Administrative: 1. Trained operators. (Prevents cause 2) 2. Waste handling procedure including specific instructions for use of the arm on the overhead powered manipulator. (Prevents cause 2) 3. Waste handling restriction to require override port shield plug to be in place except for when tool is in use. (Prevents cause 6) 4. Access control to lower hot cell, cat walk, crane maintenance room, upper hot cell when waste is present in the upper hot cell. (Prevents cause 3, 4, 5) 5. Radiation program includes periodic shielding surveys. 6. Work control process. 7. Waste handling procedure controls operating sequence for the transfer drawer such that only one transfer drawer shield plug is open at a time. (Prevents cause 8)	Design: 1. ARMs in upper hot cell have a readout in the operating gallery. (4) 2. Crane maintenance room shield door is operated with a key locked switch. (Reduces likelihood that door will be operated by unauthorized personnel for cause 5) Administrative: 1. Radiation protection program. 2. Emergency response procedure.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
WHB4-5	Direct Radiation Exposure in the FCLR MAR: NA Release Mechanism: NA Initial Condition: RH waste remains in the 72-B or 10-160B Type B shipping cask or in the facility cask except for in the hot cell complex which is a shielded facility designed for 1000 Rem/hr RH canister or drum. Hazard Source: Ionizing radiation	1. Grapple hoist lifts loaded facility canister and shield bell above the level of the upper facility cask shield valve. 2. The telescoping port shield lowers during canister transfer. 3. Shield bell is not in contact with top shield valve of on the facility cask. 4. Facility cask upper shield valve is open after canister transfer. 5. The FCRD rotates the cask during canister transfer. 6. The FCTC moves during canister transfer. 7. Shield valves on facility cask are not fully closed when cask is rotated.	A	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	Design: 1. Shield bell, grapple, telescoping port shield, and facility cask interlocks ensure shielding during canister transfer. (All) 2. The FCRD is interlocked with the telescoping port shield and FCLR grapple hoist such that the facility cask is not rotated during canister transfer (Prevents cause 4) 3. The FCTC mates with the FCRD and latches prior to rotating the facility cask. (Prevents cause 5) 4. Shield valve limit switches to indicate shield valve position (Prevents cause 4 and 7) 5. Facility cask shield valve latch pins to hold shield valves closed. (Prevents cause 7) 6. Operator console located behind shadow shield. (all) 7. Shielding provided by the facility cask, telescoping port shield and shield bell. 8. Interlocks prevent the FCRD from rotating unless the shield bell is in the fully raised position and the telescoping port shield is lowered prior to rotating the FC from vertical to horizontal (Prevents cause 5)	Design: 1. ARM with annunciation is in the FCLR with CMR indication to alert the operator on high radiation. (all) Administrative: 1. Radiation protection program. 2. Emergency response procedure.

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB4-5	Direct Radiation Exposure in the FCLR (continued)					Administrative: 1. Trained operators. (all) 2. Controlled waste handling procedure specifies sequence of operation. (all) 3. Limited access to FCLR when waste is being transferred to the facility cask. (all) 4. Preventive maintenance program on telescoping port shield, grapple hoist, shield valves, etc. (all) 5. Radiation program includes periodic shielding surveys. 6. Waste handling restriction to ensure FCTC is latched to the FCRD prior to rotating the facility cask. (Prevents cause 5)	

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB5-1	Nuclear Criticality MAR: NA Release Mechanism: NA Initial Condition: None Hazard Source: Ionizing radiation	1. No controls on fissile content in waste	EU	Radiological Fac Worker - High Site Worker - Low Public - Low Chemical Fac Worker - NA Site Worker - NA Public - NA	 II IV IV NA NA NA	Design: None Administrative: 1. Criticality safety program that requires: - Fissile limits of 325 FGE imposed for 72-B RH waste canisters with no single drum exceeding 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - No drum shipped in a 10-160B shipping cask can exceed 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - A loaded facility canister does not exceed 600 FGE with no single drum exceeding 200 FGE. - Special moderator and reflector limits imposed by the criticality safety evaluation for the WIPP are specified in the RH WAC and implemented at generator sites prior to approval for shipment to the WIPP.	Design: 1. Hot cell complex shielding and shielding provided by the facility cask Administrative: 1. Emergency response procedures

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB6-1	Errant vehicle collides with WHB resulting in damage to building and breach of waste containers MAR: 800 PE-Ci from a 10-160B shipping cask. Location: WHB RH bay Release Mechanism: Impact and breach Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact with the lid bolts installed. Hazard Source: Radioactive material, beryllium	1. Operator error 2. Equipment malfunction (e.g., brake failure, stuck accelerator)	A	Radiological Fac. Worker - High Site Worker - Low Public - Moderate Chemical Fac. Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Building and facility design protects the RH bay from impact from areas north and west. The north side of the RH portion of the WHB is partially protected by the thick concrete walls of the hot cell complex and the hot cell HEPA filter gallery. The west side of the RH facility is protected by the CH portion of the WHB. (1, 2) Administrative: 1. Trained operators (1) 2. Waste handling restriction to prohibit removal of a 72-B shipping cask inner lid in the RH bay. (1, 2) 3. The 10-160B shipping cask cannot be left unattended in the RH bay when the lid bolts are loosened. (1, 2)	Design: 1. RH ventilation Administrative: 1. Emergency response procedures

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB6-2	External fire propagates to the WHB MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: WHB RH portion Release Mechanism: Thermal Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lid bolts installed Hazard Source: Radioactive material, beryllium	1. External vehicle fire 2. Fire involving staged equipment fire (e.g., combustible materials) 3. Fire in adjacent facility or structure (e.g., HAZMAT facility) 4. Cigarettes or matches dropped while lit ignite combustible material in vicinity of WHB and fire propagates to WHB 5. Federal agency conducts controlled burn 6. Oil well fire	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. PPA is paved and graveled and provided separation between the WHB and low profile vegetation. (5, 6) 2. Noncombustible construction of the WHB. Thick concrete shield walls, floors and ceiling of the hot cell complex prevent fire from propagating into the hot cell complex. (1, 2, 3, 4, 5, 6) Administrative: 1. Combustible loading control program (2, 4) 2. Waste handling restriction that prevents removal of RH waste containers from shipping casks outside the hot cell complex.	Design: 1. WHB fire suppression system Administrative: 1. Emergency response procedures 2. External agency fire fighting support

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB6-3	Aircraft crash into WHB MAR: Two RH shipping casks in the RH bay for 1600 PE-Ci; 2240 PE-Ci in the upper hot cell (10 drums and 6 facility canisters); 240 PE-Ci in the facility cask in the FCLR; 240 PE-Ci in the transfer cell Location: WHB RH portion Release Mechanism: Impact and thermal Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact and fire Hazard Source: Radioactive material, beryllium	1. Pilot error 2. Aircraft power or control system malfunction	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker -High Site Worker - High Public - High	 I I I I I I	Design: 1. WIPP is in a remote area that is not on a direct flight path for normal air traffic. (1, 2) Administrative: None	Design: None Administrative: 1. Emergency response procedures 2. Alert, notification and protective actions 3. Trained workers 4. WIPP fire brigade and external firefighting support 5. Combustible loading control program

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB6-4	Loss of electrical power MAR: RH waste that can be suspended at the same time 960 PE-Ci - upper hot cell when the crane drops a shield plug on four loaded canisters in storage. 240 PE-Ci - FCLR or the transfer cell 800 PE-Ci - CUR 240 PE-Ci in the RH bay (in cask) Location: WHB RH bay Release Mechanism: None Initial Conditions: RH waste arrives at the WIPP in a closed 72-B or 10-160B shipping cask that are designed to withstand drops. Hazard Source: Radioactive material, beryllium	1. Storm 2. Electrical fire 3. Brownout 4. Utility error	A	Radiological Fac. Worker - High Site Worker - Moderate Public - Moderate Chemical Fac. Worker -High Site Worker - Moderate Public - Moderate	 I I I I I I	Design: 1. RH cranes, grapple hoist, and overhead powered manipulator are designed to hold their load in the event of loss of power. (1, 2, 3, 4) Administrative: 1. Preventive maintenance program (2, 3)	Design: 1. Backup diesel generators to power selected loads. Administrative: 1. Emergency response procedures

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-1	Wildland fire propagates to the WHB MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: WHB RH portion Release Mechanism: Thermal Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand fire with the lid bolts installed Hazard Source: Radioactive material, beryllium	1. Lightning	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. PPA is paved and graveled and provided separation between the WHB and low profile vegetation to reduce the likelihood of fire impacting WHB. (1) 2. Noncombustible construction of WHB. (1) 3. Thick concrete shield walls, floors and ceiling of the hot cell complex prevent fire from propagating into the hot cell complex. (1) Administrative: 1. Combustible loading control program (1)	Design: 1. WHB fire suppression system. Administrative: 1. Emergency response procedures 2. External agency fire fighting response

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-2	Earthquake with fire MAR: Entire inventory of RH facility that is not in a closed shipping cask. 3520 PE-Ci Total: 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened; 2240 PE-Ci in the upper hot cell; 240 PE-Ci in the facility cask; 240 PE-Ci in the transfer cell Location: WHB RH portion Release Mechanism: Thermal release Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact and fire Hazard Source: Radioactive material, beryllium	1. Earthquake results in falling debris which damages electrical equipment generating sparks and arcing that ignite adjacent combustibles	U	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker -High Site Worker - High Public - High	 I I I I I I	Design: 1. WHB including the hot cell complex is designed to withstand the DBE (1) 2. RH bay 140/25-ton crane, CUR crane, upper hot cell bridge crane and overhead powered manipulator, and FCLR grapple hoist hold their load in the DBE. (1) 3. Transfer cell shuttle car is designed to remain on the rails in the event of a DBE (1) 4. Noncombustible construction of the WHB. Thick concrete shield walls, floors and ceiling of the hot cell complex prevent fire from propagating into and within the hot cell complex. (1) Administrative: 1. Combustible Loading Control Program (1)	Design: 1. Fire suppression system in RH bay and FCLR may provide some mitigation if still operating following the event Administrative: 1. Emergency response procedures 2. WIPP fire brigade and external firefighting support 3. Trained workers

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-3	Lightning strike to WHB damages waste containers MAR: Five drums from a 10-160B shipping cask at 80 PE-Ci each for a total of 400 PE-Ci Location: WHB RH portion Release Mechanism: Thermal release Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact and fire Hazard Source: Radioactive material, beryllium	1. Thunderstorms; severe weather	A	Radiological Fac. Worker - High Site Worker - Moderate Public - Moderate Chemical Fac. Worker -High Site Worker - Moderate Public - Moderate	 I I I I I I	Design: 1. WHB grounding and lightning protection system (1) 2. RCTC has non-metal wheels that isolate it from ground when it is not connected to its power supply (1) 3. Rubber tires on the transportation trailer isolate the casks from ground (1) Administrative: 1. Periodic inspection of lightning protection system (1)	Design: 1. RH ventilation Administrative: 1. Procedures designating response to oncoming severe weather 2. Trained workers (workers trained to seek appropriate shelter in the case of severe weather)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-4	Tornado MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: WHB RH facility Release Mechanism: Impact and breach Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact Hazard Source: Radioactive material, beryllium	1. Tornado generates wind driven missiles that damage waste containers 2. Structural damage to WHB damages waste containers	A	Radiological Fac. Worker - High Site Worker - Low Public - Low Chemical Fac. Worker - High Site Worker - Low Public - Low	 I III III I III III	Design: 1. WHB is designed to withstand the DBT (2) 2. Hot cell complex designed to withstand the DBT (2) 3. Hot cell complex has thick concrete walls and floors which will protect waste from missiles. (1) 4. FCLR has thick concrete walls and floor to protect it from missiles generated by a tornado.(1) 5. Facility cask design protects waste canister from missiles.(1) Administrative: 1. Procedures designating response to oncoming severe weather (1, 2)	Design: 1. RH facility and hot cell ventilation . Administrative: 1. Procedures designating response to oncoming severe weather 2. Trained workers (workers trained to seek appropriate shelter in the case of severe weather)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-5	Straight line winds damage WHB structure and produce wind driven missiles that damage waste containers MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: WHB RH facility Release Mechanism: Impact and breach Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact Hazard Source: Radioactive material, beryllium	1. Extreme winds 2. Straight winds generate wind driven missiles that damage waste containers	A	Radiological Fac. Worker - High Site Worker - Low Public - Low Chemical Fac. Worker - High Site Worker - Low Public - Low	 I III III I III III	Design: 1. WHB designed to withstand the 110 MPH wind with a 1000 year return frequency (1) 2. Hot cell complex has thick concrete walls and floors which will protect waste from missiles. (2) 3. FCLR has thick concrete walls and floor to protect it from missiles generated by a tornado. (2) 4. Facility cask design protects waste canister from missiles. (2) Administrative: 1. Procedures designating response to oncoming severe weather (1, 2)	Design: 1. RH facility and hot cell ventilation. Administrative: 1. Procedures designating response to oncoming severe weather 2. Trained workers (workers trained to seek appropriate shelter in the case of severe weather)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-6	Hail impacts WHB causing breach of building and damage to waste containers MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: WHB RH facility Release Mechanism: Impact and breach Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact Hazard Source: Radioactive material, beryllium	1. Severe weather/ hail-producing thunderstorm	A	<u>Radiological</u> Fac. Worker - High Site Worker - High Public - Moderate <u>Chemical</u> Fac. Worker - High Site Worker - High Public - Moderate	 I I I I I I	<u>Design</u>: 1. WHB designed to withstand 27 lb/ft^2 snow loading (1) <u>Administrative</u>: 1. Procedures that specify response to severe winter weather including hail (1)	<u>Design</u>: 1. None <u>Administrative</u>: 1. Emergency response procedures 2. Trained workers (workers trained to seek appropriate shelter in the case of severe weather)

Table A-10 - Hazard Evaluation for RH Waste Handling Building

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
WHB7-7	Snow/ice accumulation on WHB roof causes breakthrough of roof structure and damage to inventory MAR: Entire inventory of RH facility that is not in a closed shipping cask. 800 PE-Ci in the RH bay from a 10-160B shipping cask in the RH bay with the lid bolts loosened. 2240 PE-Ci in the upper hot cell 240 PE-Ci in the facility cask 240 PE-Ci in the transfer cell Location: RH inventory in the upper Hot Cell or RH bay Release Mechanism: Impact and breach Initial Conditions: RH waste arrives at the WIPP in 72-B or 10-160B Type B shipping casks designed and tested to withstand impact Hazard Source: Radioactive material, beryllium	1. Winter storm results in accumulation of snow and ice that causes the roof to collapse and breach waste containers.	A	Radiological Fac. Worker - High Site Worker - High Public - Moderate Chemical Fac. Worker - High Site Worker - High Public - Moderate	 I I I I I I	Design: 1. WHB designed to withstand 27 lb/ft^2 snow loading. (1) Administrative: 1. Procedures that specify response to severe winter weather including hail (1)	Design: None Administrative: 1. Emergency response procedures 2. Trained workers (workers trained to seek appropriate shelter in the case of severe weather)

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Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG1-1	Fire in waste disposal path (includes waste shaft station and transport path to active disposal room) and impacts RH or RH and CH waste in transit One 72-B or facility canister at 240 PE-Ci and one facility pallet of direct loaded drums for a total of 2480 PE-Ci Release Mechanism: Thermal Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Diesel powered or electrical mining equipment catches fire. 2. Diesel fuel or hydraulic fluid fire on RH 41-ton forklift. 3. Electrical fire due to RH 41-ton forklift snagging 13.8 kV cable suspended from the back/rib. 4. Nearby electrical equipment catches fire. 5. Ignition of accumulated combustibles from electrical sparks. 6. Hot work (e.g., welding, cutting torch, grinding). 7. Spontaneous ignition of waste inside canister. 8. Collision between RH and CH waste handling equipment. 9. Fire on non-waste handling equipment impacts RH waste. 10. Fire on RH waste handling equipment impacts CH waste	A	Radiological Fac. Worker - High Site Worker - Moderate Public - Moderate Chemical Fac. Worker - High Site Worker - Moderate Public - Moderate	 I I I I I I	Design: 1. Underground electrical installations comply with 30CFR56 and 57 and NEC. (Prevents 4) 2. Facility cask design protects waste canister from direct flame impingement. (Prevents impact to waste from all causes) 3. Hydraulic fluid on 41-ton forklift does not support combustion. (Prevents 2) 4. Automatic/manual fire suppression system on RH 41-ton, 20-ton, and 6-ton waste handling forklifts. (Prevents 2, 10) Administrative: 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (Prevents 7) 2. Combustible Loading Control Program (prevents 5) including: - only diesel or electric vehicles are used in the underground. - flammable gas and compressed gas cylinder use and storage control (Prevents 5) - no lube truck in the disposal path while waste is in transit (Prevents 9)	Design: 1. Hand held fire extinguishers on underground vehicles. 2. Manual fire suppression system on mining equipment. 3. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG1-1 cont.	Fire in waste disposal path (includes waste shaft station and transport path to active disposal room) and impacts RH or RH and CH waste in transit (continued)					3. Waste handling restrictions require: - minimum 75 ft. separation distance between waste handling vehicles loaded with waste and between non-waste handling vehicles and loaded waste handling vehicles. (Prevents 1, 9) - Access control in E-300 during waste handling. (Prevents consequences from all causes) - Use of a spotter when operating RH waste handling equipment within 75 ft. of the CH waste array. (Prevents 10) 4. Hot work permit. (Prevents 4, 5, 6) 5. Work control. (Prevents 4, 5, 6) 6. Qualified operators(Prevents 3, 8)	

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG1-2	Fire in the waste disposal room that impacts RH waste or RH and CH waste. MAR: One 72-B or facility canister at 240 PE-Ci and 3 columns of waste (9 seven packs of 55-gallon drums) for a total of 5,280 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Diesel fuel or hydraulic fluid fire on RH 41-ton, 20-ton or 6-ton forklift near the CH waste array. 2. Electrical fire in HERE control console or power center for HERE or borehole machine 3 Ignition of accumulated combustibles. 4. Hot work (e.g., welding, cutting torch, grinding). 5. Malfunction of electrical equipment generates a spark and ignites flammable or combustible material. 6. Hydraulic fluid fire on HERE. 7. Collision between RH and CH waste handling equipment. 8. Spontaneous ignition of waste inside canister. 9. Cigarettes or matches ignite combustible material 10. Fire on the 41-ton, 20-ton, or 6-ton RH forklift near the CH waste face.	A	<u>Radiological</u> Fac. Worker - High Site Worker - Moderate Public - High <u>Chemical</u> Fac. Worker - High Site Worker - Moderate Public - High	 I I I I I I	<u>Design:</u> 1. RH waste disposal boreholes and concrete shield plugs. (Prevents impact to RH waste already emplaced from all causes) 2. Facility cask design protects waste canister from direct flame impingement (Prevents impact to RH waste from all causes) 3. Underground electrical installations comply with 30CFR56 and 57 and NEC. (2, 5) 4. Hydraulic fluid on 41-ton forklift does not support combustion. (1) 5. Hydraulic fluid on HERE (40 gallon capacity on alignment fixture and 70 gallon on transfer mechanism) with a flashpoint of 385 - 400 degrees F.(1, 6) 6. Automatic/manual fire suppression system on the RH 41-ton, 20-ton, and 6-ton forklifts and HERE. (1) <u>Administrative:</u> 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.(8) 2. Combustible Loading Control Program (3,9) including the following: - Only diesel or electric vehicles are used in the underground. - Flammable gas and compressed gas cylinder use and storage control - No lube truck in the active disposal room	<u>Design:</u> 1. Hand held fire extinguishers on underground vehicles. 2. Manual fire suppression system on mining equipment. 3. Underground ventilation system . <u>Administrative:</u> 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG1-2 continued	Fire in the waste disposal room that impacts RH waste or RH and CH waste (continued)					3. Waste handling restrictions including: - A spotter is required when operating RH waste handling equipment within 75 ft of the CH disposal array waste face (10) - No non-waste handling vehicles are allowed in the active disposal room during waste handling (7) - A minimum standoff distance of 75 ft. is required between the RH 41-ton waste handling forklift and a CH waste transporter loaded with waste. (7, 10) - A minimum separation distance of 75 ft between non-waste handling vehicles and the RH 41-ton forklift loaded with waste (7) - Electrical equipment associated with the HERE or the borehole machine must be at least 10 ft from the CH waste array face or a fire watch is posted. (2, 5) - Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground. (Prevents worker consequence from all causes) 4. Hot work permit. (4) 5. Work control. (4, 7) 6. Qualified operators (4, 7)	

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG1-3	Fire in construction/ mining ventilation circuit which impacts RH waste MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: None Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Malfunction of electrical equipment generates a spark and ignites flammable or combustible material. 2. Overheating of electrical equipment. 3. Vehicle fire. 4. Cigarettes or matches ignite combustible material. 5. Hot work (e.g., welding, cutting torch, grinding). 6. Spontaneous combustion of oily rags.	A	Radiological Fac. Worker - High Site Worker - Low Public - Low Chemical Fac. Worker - Low Site Worker - Low Public - Low	 I III III I III III	Design: 1. Robust facility cask protects waste canister from fire. (Prevents all causes) 2. Bulkheads, airlocks, and overcasts that segregate the mining/construction area from the disposal area and waste shaft station are made of noncombustible materials. (Prevents all causes) 3. After waste emplacement, RH borehole and shield plug protect waste canister from fire. (Prevents all causes) Administrative: 1. Combustible Loading Control Program requires: - flammable gas and flammable compressed gas cylinder control. (5) - only diesel or electric vehicles are used in underground. (3) 2. Preventive maintenance. (1, 2) 3. Hot work permit. (5)	Design: 1. Hand held fire extinguishers on underground vehicles. 2. Fire suppression at diesel fueling station. 3. Fire suppression on mining equipment. 4. Underground ventilation system. Administrative: 1. First line initial response team. 2. Emergency response procedures. 3. Trained operators. 4. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG1-4	Fire in north ventilation circuit which impacts RH waste MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: None Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground . Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Malfunction of electrical equipment generates a spark and ignites flammable or combustible material. 2. Overheating of electrical equipment. 3. Vehicle fire. 4. Cigarettes or matches ignite combustible material. 5. Hot work (e.g., welding, cutting torch, grinding).	A	Radiological Fac. Worker - High Site Worker - Low Public - Low Chemical Fac. Worker - High Site Worker - Low Public - Low	 I III III I III III	Design: 1. Robust facility cask protects waste canister from fire. (Prevents all causes) 2. Noncombustible bulkheads, airlocks, and overcasts segregate the mining/construction area from the disposal area and waste shaft station. (Prevents all causes) Administrative: 1. Combustible Loading Control Program including: - flammable gas and flammable compressed gas cylinder control. (1) - Only diesel or electric vehicles are used in underground. (3) 2. Preventive/Corrective maintenance. (1, 2, 3) 3. Hot work permit. (5)	Design: 1. Hand held fire extinguisher on underground vehicles. 2. Fire suppression at diesel fueling station. 3. Fire suppression system on some mining equipment. 4. Underground ventilation system. Administrative: 1. First line initial response team. 2. Emergency response procedures. 3. Trained operators. 4. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG1-5	Fire in waste hoist tower results in damage to the waste hoist while RH waste is being loaded onto the waste shaft conveyance causing facility cask to fall to the bottom of the waste shaft. MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each for a total of 5400 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Electrical malfunction generates sparks which ignites flammable or combustible material. 2. Overheating of electrical equipment. 3. Hot work (e.g., welding, cutting torch, grinding. 4. Hydraulic system leak ignited by sparks from electrical short.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design 1. Redundant failsafe brakes. (Prevents all causes) 2. Waste shaft conveyance is supported by six ropes, any two of which can hold the load. (Prevents all causes) 3. Waste hoist tower fire suppression extinguishes fire before ropes or brakes are affected. (Prevents all causes) Administrative: 1. Preventive maintenance - periodic inspections of electrical equipment. (1, 2, 4) 2. Combustible Loading Control Program including flammable gas and flammable compressed gas cylinder use and storage control. (1) 3. Access control to hoist tower when hoist is in operation. (3) 4. Work control. (3) 5. Hot work permit. (3)	Design: 1. None Administrative: 1. Emergency response procedures. 2. WIPP fire brigade and external firefighting support.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG2-1	Explosion followed by fire in waste disposal path (includes waste shaft station and disposal route) and impacts RH/CH waste in transit MAR: One 72-B or facility canister at 240 PE-Ci and one facility pallet of CH waste drums for a total of 2480 PE-Ci. Release Mechanism: Impact and breach Initial Condition: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Ignition of nearby flammable gas or compressed gas. 2. Hot work. 3. Explosion in an RH waste canister.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Robust facility cask design protects waste canister from damage due to impact. (Prevents RH waste damage from all causes) 2. Facility canister has mechanical lid that prevents lid loss and protects drums. (Prevents RH waste damage from all causes) Administrative: 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (3) 2. RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (3) 3. Access control in E-300 during waste handling (Prevents worker consequence from all causes) 4. Combustible Loading Control Program including flammable gas or flammable compressed gas cylinder use and storage control. (1) 5. Hot work permit (2)	Design: 1. Facility cask design protects CH waste from an explosion from an RH waste canister during RH waste transport and emplacement. 2. Underground ventilation system. Administrative: 1. Emergency response procedures 2. First line initial response team 3. Mine rescue team response

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG2-2	Explosion in RH disposal room or explosion followed by fire in disposal room impacts RH or RH and CH waste MAR: MAR: One 72-B or facility canister at 240 PE-Ci and three columns of waste (9 seven packs direct loaded) for a total of 5,280 PE-Ci Release Mechanism: Impact and breach Initial Condition: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. Ignition of nearby flammable gas or compressed gas. 2. Hot work. 3. Explosion in an RH waste canister.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. After waste emplacement, RH borehole and shield plug protect waste canister from explosion/fire. (Prevents RH waste damage from all causes) 2. Robust facility cask design protects waste canister from damage due to impact. (Prevents RH waste damage from all causes) 3. Facility canister has a mechanically pinned lid and protects drums. (Prevents RH waste damage from all causes) 4. HERE shield collar, transfer mechanism and facility cask protect waste prior to emplacement. (Prevents RH waste damage from all causes) Administrative: 1. Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (3) 2. RH waste drums and 72-B waste canisters are required to be vented prior to shipment through adherence to the RH WAC. (3) 3. Combustible Loading Control Program including flammable gas and flammable compressed gas cylinder use and storage control. (3) 4. Access control in E-300 during waste handling. (Prevents worker consequence from all causes) 5. Hot work permit. (2)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG2-3	Battery explosion on the RH waste handling forklifts MAR: One 72-B or facility canister at 240 PE-Ci and three columns of CH waste (9 seven packs of 55-gallon drums) for a total of 5,280 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Battery malfunction. 2. Battery charging malfunction ignites hydrogen generated by the vehicle battery.	A	Radiological Fac. Worker - High Site Worker - Low Public - Moderate Chemical Fac. Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Battery enclosed in vented engine compartment. (1, 2) 2. Facility cask design protects the RH waste canister from impact. (1, 2) 3. Borehole and shield plug protect RH waste canister from impact after emplacement. (1, 2) 4. Automatic/manual fire suppression system on 41-ton, 20-ton, and 6-ton RH forklifts. (1, 2) Administrative: 1. Waste handling equipment preoperational checks. (1, 2) 2. Preventive maintenance program. (1, 2) 3. Combustible Loading Control Program: - prevents RH forklift battery charging within 75 ft of the CH disposal array face (1, 2) - requires RH forklift battery charging to be performed in a cross cut away from the transport path during CH waste handling.(1, 2) 4. Access control in E-300 during waste handling (Prevents worker consequence from all causes)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG2-4	Explosion at battery charging station or involving a battery on nearby vehicle (other than the RH waste handling forklifts) impacts RH waste MAR: MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Battery malfunction. 2. Battery charging malfunction ignites hydrogen generated by the vehicle battery.	A	Radiological Fac. Worker - Low Site Worker - Low Public - Low Chemical Fac. Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Underground ventilation system prevents a flammable gas concentration. (2) 2. Facility cask protects the RH waste canister from impact during waste transport and emplacement. (1, 2) 3. Borehole and shield plug protects waste canister after emplacement. (1, 2) Administrative: 1. Preventive maintenance program. (1, 2) 2. Waste handling restrictions that require a standoff distance greater than 75 ft between the loaded 41-ton forklift and other vehicles in the underground during waste transport in the disposal path, and prohibit non-waste handling vehicles in the active disposal room during waste emplacement. (1, 2)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG2-5	Ignition of explosive hardware used for installation of ventilation barriers (Hilti spad gun cartridges) MAR: MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Open flame or fire involves cartridges and results in explosion.	U	Radiological Fac. Worker - Low Site Worker - Low Public - Low Chemical Fac. Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Facility cask protects waste canister during waste transport and emplacement. (1) 2. The shield plug protects waste canister after canister emplacement. (1) Administrative: 1. Hot work program. (1) 2. Work control program. (1)	Design: 1. Underground ventilation system . Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.
UG2-6	Explosion followed by fire in waste hoist tower results in damage to the waste hoist or conveyance causing loaded facility cask to fall to the bottom of the waste shaft. MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each for a total of 5400 PE-Ci Release Mechanism: Impact and Breach Initial Condition: Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. Explosion of flammable gas or flammable compressed gas cylinders.	A	Radiological Fac Worker - High Site Worker - High Public - High Chemical Fac Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Redundant brakes on waste hoist, one set can hold the load. (1) 2. Waste shaft conveyance is supported by six ropes, any two of which can hold the load. (1) Administrative: 1. Combustible Loading Control Program including flammable gas or flammable compressed gas cylinder control of storage and use. (1) 2. Preventive maintenance program. (1) 3. Hot work program.(1)	Design: WHB fire suppression system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG3-1	Loss of confinement in the underground due to waste hoist failure MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each for a total of 5400 PE-Ci Release Mechanism: Impact and breach Initial Condition: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. Waste hoist structure fails and causes loaded conveyance to fall to the bottom of the shaft. 2. Waste hoist structure fails and falls on top of waste 3. Waste hoist brakes fail and load accelerates to bottom of the waste shaft. 4. Failure of the conveyance structure to support the loaded facility cask.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Waste hoist and structural support is designed to handle design basis load and the hoist is designed to hold load during loss of power. (1, 2, 4) 2. Waste shaft conveyance is supported by six ropes. (1, 2, 4) 3. The waste hoist has redundant brakes. (3) Administrative: 1. Preventive maintenance program and shaft inspection. (1, 2, 3, 4) 2. Structural integrity program for hoist, conveyance, and WHB structural support of the hoist. (1, 2, 4)	Design: 1. Underground ventilation system 2. Waste hoist counterweight offsets RH load such that waste does not free fall. 3. Overtravel arrester crash beams at the bottom of the waste shaft. 4. Underground ventilation system. Administrative: 1. Waste handling restriction to prohibit transport of personnel and waste at the same time. 2. Emergency response procedures.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG3-2	Loss of confinement during RH waste transport from the waste shaft station to disposal room involving RH or RH and CH waste MAR: One 72-B or facility canister at 240 PE-Ci. In addition, one facility pallet payload of CH overpacked waste (worse case) at 4800 PE-Ci Release Mechanism: Impact or puncture and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. Forklift collision with wall, airlocks, or overcast and damages facility cask and impacts waste canister. 2. Compressed gas cylinder or SCSR becomes a missile and impacts waste in transit in the underground. 3. Forklift collides with FCTC and facility cask and either punctures, crushes, or knocks over the facility cask. 4. Forklift drops facility cask due to improper tine engagement. 5. FCTC derails and falls over when moving the facility cask off the waste shaft conveyance due to misalignment of pivot rails, collision with other vehicles, or misalignment of the conveyance with respect to the pivot rails.	A	Radiological Fac. Worker - High Site Worker - Low Public - Moderate Chemical Fac. Worker - High Site Worker - Low Public - Moderate Note: The RH Facility Cask is not damaged by compressed gas cylinder or SCSR missiles.	 I III I I III I	Design: 1. Hoist chairing device, guide ropes, and guides at the station ensures the conveyance rails and the station rails are aligned for off-loading loads. (5) 2. Design of pivot rails and gap between the conveyance and the rails at the station prevent the FCTC from tipping over. (5) 3. FCTC wheels are large in diameter with respect to the gap at the station if the pivot rails are not lowered and prevent the car from falling into the gap. (5) 4. Fork tines are designed with a sufficient safety factor to preclude failure during lifting or transport of the facility cask. (6) 5. Forklift tines are blunt. (3) 6. Facility cask has integral forklift pockets. (3) 7. Facility cask design prevents damage to RH during transit to disposal room. (Prevents RH release from all causes)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team . 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG3-2 Contd	Loss of confinement during RH waste transport from the waste shaft station to disposal room involving RH or RH and CH waste (continued)	6. Structural failure of forklift tines or hydraulics fail and drop load when removing the cask from the FCTC or during transport from the waste shaft station to the active disposal room. 7. Forklift collision with other vehicles (moving or parked) or equipment such as mining equipment, golf cart. 8. Bulkhead doors close on facility cask in transit in the disposal path. 9. RH waste handling forklift collides with CH waste transporter loaded with CH waste				<u>Administrative:</u> 1. Trained operators. (1, 3, 4, 7, 9) 2. Compressed gas cylinder control (2) 3. Waste handling restrictions to require - A standoff distance greater than 75 ft between the 41-ton forklift loaded with waste and the loaded CH waste transporter during waste transport. (9) - When RH waste is in transit, non-waste handling equipment shall be moved to a cross cut and be secured until the waste transporter has passed and is greater than 75 ft. away. Vehicles that may have become disabled (excluding the lube truck) may be in the disposal path but must be secured in a cross cut. (7) - Spotter is required when operating the 41-ton forklift loaded with waste. - Spotter required when operating the RH 41-ton, 20-ton, or 6-ton waste handling forklifts in the active disposal room during waste emplacement or when operating within 75 ft of the CH disposal array face. - Access control in E-300 during waste handling in the underground (Prevents worker consequence from all causes)	

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG3-3	Loss of confinement in the active disposal room involving RH or RH and CH waste disposal room MAR: One 72-B or facility canister at 240 PE-Ci. Four columns of CH waste (12 four packs of drum overpacks) for a total of 14,640 PE-Ci. Release Mechanism: Impact or puncture and breach Initial Condition: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. 41-ton forklift drops the facility cask onto the HERE. 2. 41-ton forklift collides with non-waste handling equipment in the active RH disposal room. 3. Transfer mechanism damages canister during transfer from the facility cask into the borehole. 4. Facility cask shield valves close on RH canister during waste transfer to the borehole 5 Borehole is not deep enough to accommodate the canister and shield plug and the canister is crushed 6. Shield plug installation breaches canister inside the borehole	A	<u>Radiological</u> Fac. Worker - High Site Worker - Moderate Public - Moderate <u>Chemical</u> Fac. Worker - High Site Worker - Moderate Public - Moderate	 I I I I I I	<u>Design:</u> 1. Interlocks on HERE ensure that the transfer mechanism does not operate if staging platform, alignment fixture (shield collar), facility cask and transfer carriage are misaligned. (3) 2. Shield valve torque limiters (4) 3. Shield valve control interlocks prevent closing the shield valve when the transfer mechanism is extended beyond each shield valve. (4) 4. Fork tines are designed with a sufficient safety factor to preclude failure during lifting or transport of the facility cask. (1) 5. Mechanical provision on the transfer mechanism to prevent over-pressurization in the event that the bore hole is too short (5) 6. Facility cask design. Cask also has integral forklift pockets (1) 7. RH canister is designed to be pushed by the transfer mechanism, a shield plug, or another canister into the disposal borehole (5) 8. Physical size of the facility cask on forklift and disposal room height limit the drop distance of the cask to less than four feet. (1) 9. Facility canister has a mechanical or pinned lid. (3)	<u>Design:</u> 1. Underground ventilation system <u>Administrative:</u> 1. Emergency response procedures 2. First line initial response team 3. Mine rescue team response

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG3-3 Contd	Loss of confinement in the disposal room (Continued)	7. Compressed gas cylinder becomes a missile and impacts waste in transit in the underground 8. Facility canister pinned lid or 72-B welded lid comes off due to vibration/ collision. 9. RH waste handling forklift loaded with the facility cask runs into the CH disposal array				<u>Administrative:</u> 1. Waste handling restrictions: Spotter required when using the RH 41-ton, 20-ton, or 6-ton waste handling forklifts in the active disposal room during waste handling or when operating within 75 ft of the CH disposal array face. (1, 9) - Non-waste handling equipment is prohibited in the active disposal room during waste handling. (1) - Access control in E-300 during waste handling in the underground. (Prevents worker consequence from all causes) 2. Survey program to ensure the boreholes are the correct depth/diameter/height off floor and are horizontal within tolerances.(5) 3. Compressed gas cylinder control.(7) 4. Trained operators.(Prevent all causes when initiated by human error) 5. Generator site verify structural integrity of 72-B lid closure (8)	

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG3-4	Objects (e.g., crane load, electrical cables, compressed air piping, ventilation ductwork, roof bolts) fall from ceiling onto facility cask MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Equipment support failure 2. Corrosion 3. Shift in salt layer 4. Operator error	A	Radiological Fac. Worker - Low Site Worker - Low Public - Low Chemical Fac. Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Electrical system design and installation complies with 30 CFR Parts 56/57 and NEC. (1) Administrative: 1. Trained operators. (4) 2. Ground control and geotechnical monitoring. (3) 3. Preventive maintenance program.(2, 3)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.
UG3-5	Roof fall during transport of RH waste or in the active RH disposal room MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Unstable ceiling in underground.	U	Radiological Fac. Worker - High Site Worker - Low Public - Low Chemical Fac. Worker - High Site Worker - Low Public - Low	 I III III I III III	Design: 1. Geologic stability of the repository. (1) 2. RH waste disposed of in boreholes drilled in the walls of disposal rooms. (1) 3. Facility cask design protects RH waste canisters from impact. (1) Administrative: 1. Geotechnical monitoring and ground control program. (1) 2. Underground ground inspections at the start of each shift. (1)	Design: 1. Underground ventilation system . Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG3-6	Loss of confinement due to loaded FCTC falling into shaft and impacting RH waste only or impacting CH waste in transit to the underground. MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each and four 4-packs of CH waste at 1200 PE-Ci each. (10,200 PE-Ci) Release Mechanism: Impact and breach Initial Conditions: RH facility cask transports one RH waste canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive Material/Beryllium	1. The FCTC is driven beyond the conveyance and falls off rails. 2. The loaded FCTC is driven into the waste shaft during CH waste transport on the conveyance.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Pivot rails are interlocked with hoist movement such that when the conveyance is not at the station the pivot rails are vertical which stop the FCTC from entering the shaft. (1, 2) 2. Fence around the shaft collar. (1, 2) Administrative: 1. Trained operators. (1, 2) 2. Spotters used during waste handling operations. (1, 2) 3. Toplander controls the loading and unloading of materials onto the waste shaft conveyance.(1, 2) 4. RH waste handling procedure require verification that waste shaft conveyance is at collar before moving facility cask from FCLR to waste shaft collar. (1, 2)	Design: 1. Underground ventilation system Administrative: 1. Emergency response procedures. 2. First line initial response team. 3. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG4-1	Direct exposure to acute radiation levels MAR: NA Release Mechanism: NA Initial Condition: Facility cask is used to transport one RH canister to and in the underground Hazard Source: Ionizing radiation	1. Waste exceeds 1000 rem/hr limit for RH waste as defined by the Land Withdrawal Act[13] 2. Facility cask shield valves open during transport to the disposal room. 3. Facility cask not mated with the alignment fixture or transfer carriage during waste canister transfer. 4. Inadequate shielding provided by shield plug. 5. Failure to install shield plug after canister emplacement. 6. Streaming around borehole shield plug after shield plug emplacement. 7. Room to room exposure	A	<u>Radiological</u> Fac. Worker - High Site Worker - Low Public - Low <u>Chemical</u> Fac. Worker - NA Site Worker - NA Public - NA	 I III III NA NA NA	<u>Design:</u> 1. Facility cask is designed to provide shielding during transfer of an RH waste canister from the surface to the underground. (1, 7) 2. Facility cask shield valves held closed by lock pins that require air to open and drives are threaded such that the valves require electrical or mechanical force to open. (2) 3. Interlocks between the HERE alignment fixture, the cask, the transfer carriage and transfer mechanism maintain shielding. (3) 4. The facility cask is held on the HERE with lock pins that mate with the shield collar and the transfer mechanism. (3) 5. Underground disposal rooms are separated by 100ft wide salt pillars such that boreholes in adjacent rooms are separated by at least 30 ft of salt. (7) <u>Administrative:</u> 1. Trained operators. (2, 3, 5) 2. Controlled waste handling procedures. (1, 2, 3, 4, 5) 3. Preventive maintenance program (1, 2) 4. Radiological control program. (1) 5. Shield plugs installed after shield plug emplacement reduce streaming around shield plug and bore hole. (6) 6. Waste handling restriction to place boreholes away from corners of salt pillars between disposal rooms. (7) 7. Boreholes are required to be at least 17 ft. deep (4)	<u>Design:</u> 1. None <u>Administrative</u>: 1. Emergency response procedures. 2. Limited access during waste handling in disposal room and transport route during waste handling activities.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG5-1	Criticality MAR: NA Release Mechanism: None Initial Conditions: None Hazard Source: Fissile material - neutron radiation	1. No limits on fissile mass or special moderators or reflectors	EU	<u>Radiological</u> Fac. Worker - High Site Worker - Low Public - Low <u>Chemical</u> Fac. Worker - NA Site Worker - NA Public - NA	 II IV IV NA NA NA	<u>Design:</u> None <u>Administrative:</u> 1. Criticality safety program that requires: - Fissile limits of 325 FGE imposed for 72-B RH waste canisters with no single drum exceeding 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. (1) - No drum shipped in a 10-160B shipping cask can exceed 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. (1) - A loaded facility canister does not exceed 600 FGE with no single drum exceeding 200 FGE. (1) - Waste disposal boreholes are spaced greater than 30 inch center-to-center. (1)	<u>Design:</u> None <u>Administrative:</u> Emergency response procedures.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG6-1	Loss of AC power MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each for a total of 5400 PE-Ci Release Mechanism: Impact and breach Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard: Radioactive material, beryllium	1. Thunderstorm 2. Electrical fire 3. Brownout 4. Utility error	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Redundant electrical feeds to underground from electrical grid. (3, 4) 2. Underground electrical feed and distribution system designed to conform with NEC and 30CFR56/57. (2) 3. Waste hoist is designed to hold its load on a loss of power. (1, 2, 3, 4) Administrative: 1. Preventive maintenance program. (2, 3)	Design: 1. Backup diesel generators provide power for limited loads. 2. UPS system for CMS. Administrative: 1. Emergency response procedures. 2. Preventive maintenance program.
UG6-2	Equipment is dropped down the waste shaft while RH waste is in transit to the underground and breaches RH waste canister MAR: One 72-B or facility canister containing three solidified drums at 1800 PE-Ci each for a total of 5400 PE-Ci Release Mechanism: Impact and breach Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Equipment enter waste shaft collar and drops down shaft with waste conveyance not there.	A	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. Fence around the waste shaft collar.(1) Administrative: 1. Trained toplander whose function is to control access into the conveyance loading area and loading the conveyance.(1) 2. Trained operators (1) 3. Hoist operating procedures (1)	Design: 1. Underground ventilation system. Administrative: 1. Emergency response procedures.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG6-3	Flooding from manmade source goes down waste shaft and impacts waste in transit or at the bottom of the shaft MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: None Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Fire suppression discharge in WHB - water runs into waste shaft 2. Load testing of cranes in WHB with water weights (approximately 140 tons of water)- weights rupture and water flows down waste shaft	U	Radiological Fac. Worker - Low Site Worker - Low Public - Low Chemical Fac. Worker - Low Site Worker - Low Public - Low	 III III III III III III	Design: 1. Waste transported on waste shaft conveyance below the man deck (1, 2) 2. Waste shaft sump over 100 ft deep (1, 2) 3. Facility cask prevents water from impacting the RH waste canister (1, 2) Administrative: 1. Work control process (2)	Design: 1. Two sets of airlock doors around waste shaft Administrative: 1. Emergency response procedures
UG6-4	Loss of underground ventilation MAR: NA Release Mechanism: None Initial Conditions: N/A Hazard Source: Radioactive materials, beryllium	1. Power failure 2. Mechanical failure 3. Operator error	A	Radiological Fac. Worker - NA Site Worker - NA Public - NA Chemical Fac. Worker - NA Site Worker -NA Public - NA Note: Loss of ventilation is not an initiator that results in radiological or hazardous material	 NA NA NA NA NA NA	Design: 1. Redundant fans that support necessary airflow underground (2) Administrative: 1. Preventive and corrective maintenance (1, 2) 2. Trained operators (3)	Design: 1. Backup diesel generators provide power for limited ventilation airflow 2. UPS for CMS Administrative: 1. Emergency response procedures 2. Trained operators (workers are trained to respond to abnormal situations) 3. Diesel generator periodic preventive maintenance

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG7-1	Flooding from rain drainage into the waste shaft while waste is being transported or is at the bottom of the waste shaft in the FC MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: Robust designed facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Severe weather including extreme rainfall	U	Radiological Fac. Worker - NA Site Worker - NA Public - NA Chemical Fac. Worker - NA Site Worker - NA Public - NA Note: This is not an initiator for the release of radiological or hazardous material	 NA NA NA NA NA NA	Design: 1. Berms around site. (1) 2. On-site storm drainage system. (1) Administrative: None	Design: 1. Three sets of airlock doors around waste shaft. 2. Waste is transported on the waste shaft conveyance below the man deck. 3. Waste shaft sump is over 100 ft deep. Administrative: 1. Emergency response procedures

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG7-2	Wildland fire causes combustion products and embers to enter the underground through air intakes and results in damage to waste MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: None Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Lightning 2. Cigarettes or matches dropped outside the WIPP property - igniting vegetation and fire propagates to the WIPP site. 3. Campfire in vicinity of the WIPP ignites vegetation and results in fire that propagates to the WIPP site.	U	<u>Radiological</u> Fac. Worker - Low Site Worker - Low Public - Low <u>Chemical</u> Fac. Worker - Low Site Worker - Low Public - Low	 III III III III III III	<u>Design</u>: 1. The PPA is paved and graveled and surrounded by a gravel road that parallels the security fence provides a fire break. (1, 2, 3) 2. The facility cask design protects the RH waste canister. (1, 2, 3) <u>Administrative</u>: 1. Combustible material control program. (2) 2. Fire department and external agency response extinguish fire before it could reach the facility. (1, 2, 3)	<u>Design</u>: None <u>Administrative</u>: 1. Emergency response procedures. 2. Combustible material control program. 3. Fire brigade response
UG7-3	Earthquake followed by a fire impacts facility cask on waste shaft conveyance or at the bottom of the waste shaft. MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: thermal Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Waste is handled and disposed of 2150 ft underground. Hazard Source: Radioactive material, beryllium	1. Earthquake results in falling debris which damages electrical equipment generating sparks and arcing that ignite adjacent combustibles.	A	<u>Radiological</u> Fac. Worker - High Site Worker - Low Public - Moderate <u>Chemical</u> Fac. Worker - High Site Worker - Low Public - Moderate	 I III I I III I	<u>Design</u>: 1. Waste hoist brakes hold the maximum design load in a DBE. (1) 2. WHB is designed to withstand the DBE. (1) <u>Administrative</u>: 1. No other materials are transported on the waste shaft conveyance when transporting waste. (1) 2. Combustible material control program. (1)	<u>Design</u>: 1. Portable extinguishers. 2. WHB fire suppression system may provide some mitigation . <u>Administrative</u>: 1. First line initial response team. 2. Emergency response procedures. 3. Combustible material control program. 5. Fire brigade response. 6. Mine rescue team response.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
UG7-4	Lightning strikes the waste hoist head frame during waste transit and damages waste MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Electrical arcing Initial Condition: Facility cask transports one facility or 72-B canister at a time to and in the underground Hazard Source: Radioactive material, beryllium	1. Severe weather/ thunderstorm generates lightning that strikes head frame tower and propagates down metal framework	A	Radiological Fac. Worker - High Site Worker - Low Public - Moderate Chemical Fac. Worker - High Site Worker - Low Public - Moderate	 I III I I III I	Design: 1. Lightning dissipation system on the waste hoist tower. (1) 2. WHB and waste hoist tower steel frame structure is grounded. (1) Administrative: 1. Periodic inspection of lightning protection system. (1)	Design: None Administrative: 1. Emergency response procedures. 2. First line initial response team.
UG7-5	Design basis tornado missiles breach facility cask on the waste conveyance at the waste shaft collar. MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: None Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Hazard Source: Radioactive material, beryllium	1. Tornado generates wind driven missiles.	U	Radiological Fac. Worker - Moderate Site Worker - Low Public - Low Chemical Fac. Worker - Moderate Site Worker - Low Public - Low	 II III III II III III	Design: 1. Waste shaft is protected by waste shaft tower, and CH and RH side of the WHB such that a missile would have to enter the shaft vertically to impact the facility cask. (1) 2. Facility cask protects the RH waste canister during transport. (1) 3. Waste is transported below the man deck. (1) Administrative: None	Design: None Administrative: 1. Emergency response procedures. 2. First line initial response team.

Table A-11 - Hazard Evaluation for RH Waste Handling Underground

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
UG7-6	Straight line wind missiles breach facility cask on the waste conveyance at the waste shaft collar. MAR: One 72-B or facility canister at 240 PE-Ci Release Mechanism: Impact and breach Initial Conditions: Facility cask transports one facility or 72-B canister at a time to and in the underground Hazard Source: Radioactive material, beryllium	1. Extreme winds generate missiles	U	Radiological Fac. Worker - Moderate Site Worker - Low Public - Low Chemical Fac. Worker - Moderate Site Worker - Low Public - Low	 II III III II III III	Design: 1. Waste shaft is protected by waste shaft tower, and CH and RH side of the WHB such that a missile would have to enter the shaft vertically to impact the facility cask. (1) 2. Facility cask protects the RH waste canister during transport. (1) 3. Waste is transported below the man deck. (1) Administrative: None	Design: None Administrative: 1. Emergency response procedures 2. First line initial response team

Table A-12 - RH Waste Handling Process - Building General

Event No.	Event Description	Causes	Freq. Level	Consequence Level	Risk Bin	Potential Preventive Features	Potential Mitigative Features
			Unprev	Unmitigated	Unmit		
BG6-1	Aircraft crashes into the WIPP and impacts the parking area on the south side of the WHB, the WHB, and the waste hoist head frame engulfing the areas impacted with aircraft fuel including burning fuel spilling down waste shaft impacting waste in transit or waste on a loaded transporter at the bottom of the shaft Location: Outside area, RH bay, Underground Release Mechanism: Impact and thermal MAR: 14400 PE-Ci - 11200 PE-Ci in outside area from 14 RH shipping casks; 480 PE-Ci, two 72-B casks at 240 PE-Ci each in the RH bay; 2240 PE-Ci, six 10-160B facility canisters and ten drums in the upper hot cell; 240 PE-Ci, one 72-B cannister with 3 drums at 80 PE-Ci on the waste hoist or in the FCLR and 240 PE-Ci in transfer cell Initial Conditions: RH waste arrives at the WIPP in RH shipping casks either 72-B or 10-160B that are designed to withstand impact, breach and fire. Hazard Source: Radioactive material, beryllium	1. Pilot error 2. Aircraft power or control system malfunction	U	Radiological Fac. Worker - High Site Worker - High Public - High Chemical Fac. Worker - High Site Worker - High Public - High	 I I I I I I	Design: 1. WIPP is in a remote area that is not on a direct flight path for normal air traffic. (1, 2) Administrative: None	Design: 1. Fire suppression system in WHB may provide some mitigation if still operating following the event 2. Paved parking area (limits extent of follow-on fire) Administrative: 1. Emergency response procedures 2. Trained operators (facility workers trained to evacuate in emergency situations) 3. WIPP fire brigade and external agency fire fighting support.

Table A-12 - RH Waste Handling Process - Building General

Event No.	Event Description	Causes	Freq. Level Unprev	Consequence Level Unmitigated	Risk Bin Unmit	Potential Preventive Features	Potential Mitigative Features
BG7-1	Earthquake impacts facility, results in damage to waste containers and breach Location: RH portion of WHB, Underground Release Mechanism: Impact and Breach MAR: 3520 PE-Ci total: 800 PE-Ci in the RH bay from a 10-160B cask with the lid bolts loosened; 2240 PE-Ci, six 10-160B facility canisters and ten drums in the upper hot cell; 240 PE-Ci, one 72-B cannister with 3 drums at 80 PE-Ci on the waste hoist or FCLR or on the hoist; 240 PE-Ci in the transfer cell Initial Conditions: RH waste arrives at the WIPP in RH shipping casks either 72-B or 10-160B that are designed to withstand impact and breach Hazard Source: Radioactive material, beryllium	1. Seismic activity	A	Radiological Fac. Worker - High Site Worker - High Public - Moderate Chemical Fac. Worker - High Site Worker - High Public - Moderate Note: This event assumes that the earthquake will impact all of the areas addressed in the area-specific tables to some degree and is not followed by a fire. Seismic events followed by fires are addressed in area-specific tables.	 I I I I I I	Design: 1. The WHB is designed to withstand the DBE. The Support Building is designed to withstand the lateral forces of the DBE to prevent damage to the WHB. (1) 2. The waste hoist, the 140/25-ton crane, the upper hot cell crane and overhead powered manipulator, the CUR crane , and grapple hoist are designed to hold the maximum design load in a DBE. (1) 3. The shuttle car is designed to stay on the rails during a DBE. (1) Administrative: None	Design: 1. The RH facility and hot cell complex ventilation system if it is still operating following the event. 2. The DOT Type B RH shipping casks and DOT Type 7A or equivalent waste containers expected to limit release. Administrative: 1. Emergency response procedures.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
OA6-3 Aircraft Crash	EU	High	See comment.	NA	NA	NA	NA	Aircraft crash not credible as discussed in Section 3.4.2.7
WHB1-1 Fire in the RH bay impacts RH waste containers	A	Moderate	Design Feature: Noncombustible construction of the WHB. The RH bay is segregated from the hot cell complex by thick concrete walls and floors (SSC) - WHB fire suppression system (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC (AC) - Combustible loading control program including controls that prohibit storage of flammable gas or flammable compressed gas cylinders in the WHB and prevents their use in the RH bay when the lid bolts on the a 10-160B shipping cask containing RH waste are loosened.	Prevents fire propagation from the RH bay to the hot cell complex. Extinguishes fires before they become large enough to impact waste. Eliminates ignition sources in waste containers. Prevents fires by controlling the amount of combustible material in the WHB.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-1 Fire in the RH bay impacts RH waste containers cont.			(AC) - Waste handling restrictions: - prohibit removal of RH waste drums or canisters from the shipping cask outside the hot cell complex - 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed if left unattended. (AC) - Emergency Response	Prevents fires in the RH bay from impacting RH waste. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-2 Fire in Upper Hot Cell	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell has thick concrete walls, floors, ceiling, shield plugs, lead glass windows, steel doors and steel shield valves. Metal facility canister with bolted or pinned lid Upper hot cell canister storage wells (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas or flammable compressed gas cylinders in the upper hot cell and prevents use of flammable gas and flammable compressed gas in the upper hot cell when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell when waste is present the CUR or transfer cell unless the upper hot cell shield plugs are installed and the upper hot cell floor shield valve is closed. (AC) - Emergency Response	Prevents fire propagationinto the upper hot cell. Prevents lid ejection and direct flame impingement on canisterized drums. Prevents direct flame impingement on canisters. Eliminates ignition sources in waste containers. Prevents fires by controlling the amount of combustible material in the upper hot cell. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-6 Fire in the crane maintenance room impacts waste in upper hot cell	A	High	Design Feature: Noncombustible construction of the WHB. Crane maintenance room is segregated from the upper hot cell by a 3 ft high concrete wall and a shield door. (SSC) - WHB fire suppression system in crane maintenance room. (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas and flammable compressed gas in the crane maintenance room and prevents use of flammable gas and flammable compressed gas in the crane maintenance room when waste is present in the upper hot cell unless the crane maintenance room shield door is closed. (AC) - Crane maintenance room shield door is required to be closed except when transferring the upper hot cell crane into the room for maintenance and back to the upper hot cell. (AC) - Emergency Response	Prevents propagation of fires into the upper hot cell. Extinguishes fires in the crane maintenance room. Prevents fires in the crane maintenance room by controlling the amount of combustible material and prevents fire propagation to the upper hot cell. Prevents fire propagation to the upper hot cell. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-7 Fire in the hot cell operating gallery	A	Moderate	Design Feature: Noncombustible construction of WHB. Operating gallery is segregated from the upper hot cell by thick concrete walls and lead glass windows, and steel doors. (SSC) - WHB fire suppression system in the hot cell operating gallery (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas and flammable compressed gas in the hot cell operating gallery, and prevents use of flammable gas and flammable compressed gas in the operating gallery when waste is present in the upper hot cell. (AC) - Emergency response	Prevents fire propagation into the upper hot cell. Extinguishes fires in the hot cell operating gallery. Prevents fires by controlling the amount of combustible material in the hot cell operating gallery. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-8 Fire in the RH bay near the common RH/CH wall impacts RH waste or RH and CH waste	A	High	Design Feature Noncombustible construction of the WHB. (SSC) WHB fire suppression system (AC) Combustible Loading Control Program including controls that require at least 15 ft standoff distance for diesel vehicles operating in the RH bay near the RH/CH common wall when waste is stored in the NE corner of the CH bay or posting a fire watch. Also prohibits storage of flammable gas and flammable compressed gas in the RH bay and prohibits storage of combustibles in the RH bay within 4 ft of the common RH/CH wall. (AC) Waste handling restrictions: - prohibit removal of RH waste containers from shipping casks outside the hot cell complex. - require that the 10-160B cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed to be left unattended. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Emergency Response	Prevents fire propagation. Extinguishes fire before sufficient heat is generated to breach the common RH/CH wall. Prevents fires in the RH bay from impacting waste in the CH bay by controlling the amount of combustible material in the RH bay and prevents fires associated with diesel powered equipment in the RH bay from impacting waste in the CH bay. Prevents fires from impacting RH waste in the in the RH bay Eliminates ignition sources in waste containers. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB1-9 Fire in the CUR	A	High	Design Feature: Noncombustible construction of the WHB. CUR separated from upper hot cell, transfer cell, and RH bay by thick concrete floors, ceilings, shield plugs, shield valves and doors. (AC) - Waste handling restriction requires that the CUR shield door to be closed when a 10-160B shipping cask loaded with waste is in the CUR. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Combustible Loading Control Program including controls that prohibit storage of flammable gas or flammable compressed gas cylinders in the WHB and prevents their use in the CUR when waste is present. (AC) - Emergency Response	Prevents fire propagation. Prevents fire propagation to RH bay Eliminates ignition sources in waste containers. Prevents fires by controlling the amount of combustible material in the CUR. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-1 Explosion followed by fire in the RH bay	A	High	Design feature: Noncombustible construction of the WHB. The RH bay is separated from the hot cell complex by thick concrete walls and floors. (AC) - Pyrophoric and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC. (AC) - Combustible loading control program including controls that prohibit storage of flammable gas or flammable compressed gas cylinders in the WHB and prevents their use in the RH bay when the lid bolts on a 10-160B shipping cask containing RH waste are loosened. AC) - Waste handling restrictions: - prohibit removal of RH waste drums or canisters from the shipping cask outside the hot cell complex - 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed if left unattended. (AC) - Emergency Response	Prevents fire propagation. Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the RH bay. Prevents explosions in the RH bay from impacting RH waste. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-2 Explosion followed by fire in the CUR	A	High	Design feature: Noncombustible construction of the WHB. The CUR is segregated from the upper hot cell and transfer cell by thick concrete walls, floors, ceilings, shield plugs and shield valves. (AC) - Pyrophoric and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC. (AC) - Combustible loading control program including flammable gas and flammable compressed gas cylinder control that prohibits their storage in the WHB and prevents their use in the CUR when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell or transfer cell when waste is in the CUR unless the upper hot cell floor shield plugs are installed and the CUR floor shield valve is closed. (AC) - Emergency Response	Prevents fire propagation Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the CUR and propagation from the CUR to other areas. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-3 Explosion followed by fire in the upper hot cell	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell is segregated from the transfer cell and CUR with thick concrete floors, shield plugs, and a steel shield valve.	Prevents fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			(AC) - Pyrophoric and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources in waste containers.				
			(AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) - Combustible Loading Control Program including flammable gas or flammable compressed gas cylinder control that prohibits their storage in the WHB and prevents their use in the upper hot cell when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the CUR when waste is present in the upper hot cell unless the upper hot cell shield plugs are installed.	Prevents explosions/fires in the upper hot cell and propagation to other areas.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-4 Explosion followed by fire in the service room or transfer cell	A	High	Design Feature: Noncombustible construction of the WHB. Transfer cell is segregated from other areas of the hot cell complex with thick concrete ceiling, and steel shield valves.	Prevents fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC	Eliminates ignition sources in waste containers.				
			(AC) - RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) - Combustible Loading Control Program including flammable compressed gas cylinder control such that they are not stored in the service room or transfer cell and are not used in the transfer cell when waste is present. Also flammable compressed gas cylinders are not used in the upper hot cell or CUR when waste is in the transfer cell transfer cell unless the upper hot cell floor shield valve and the CUR shield valve are closed.	Prevents explosions/fires from impacting waste and propagating to other areas of the hot cell complex where waste may be present.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-5 Explosion followed by fire in the FCLR	A	High	Design Feature: Noncombustible construction of the WHB. FCLR is segregated from other areas of the hot cell complex, the RH bay, and the transfer cell with thick concrete walls and floors. Facility cask design Telescoping port shield and shield bell (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC (AC) - RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC. (AC) -Combustible Loading Control Program including flammable gas and flammable compressed gas cylinder control that prohibits their storage in the WHB and prevents their use in the FCLR when waste is present. (AC) - Emergency Response	Prevent fire propagation. Thick walls and shield valves protect waste canister from the effects of an explosion. Protects waste canister from the effects of an explosion. Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the transfer cell and propagation to other areas. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-6 Explosion followed by fire in the crane maintenance room	A	High	Design Feature: Noncombustible construction of the WHB. Crane maintenance room is segregated from upper hot cell by 3 ft raised concrete wall and a shield door. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC. (AC) - Combustible Loading Control Program including flammable compressed gas cylinder control such that they are not stored in the WHB maintenance room and are not used in the crane maintenance room when waste is present in the upper hot cell without door between the crane maintenance room and the upper hot cell being closed.. (AC) - Waste handling restriction requires that the door between the crane maintenance room and upper hot cell is closed except when transferring the upper hot cell crane to and from the crane maintenance room. (AC) - Emergency Response	Prevents fire propagation. Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the crane maintenance room from impacting waste in the upper hot cell. Prevents propagation of fires or explosions. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB2-7 Explosion followed by fire in the upper hot cell operating gallery	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell operating gallery is segregated from the waste in the hot cell complex by thick concrete walls, floors and ceilings, lead glass windows, and steel doors (AC) - Combustible loading control program including flammable gas or flammable compressed gas cylinder control that prohibits storage in the WHB and prevents use in the hot cell operating gallery when waste is present in the upper hot cell. (AC) - Emergency response	Prevents fire propagation. Prevents explosions/fires in the hot cell operating gallery or service room and propagation to other areas. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB3-4 Loss of confinement in the upper hot cell	A	Moderate	Design Features: Upper hot cell crane and overhead powered manipulator is designed for design basis loads including the DBE and will hold its load on loss of power The upper hot cell crane grapple has three pivot dogs that move together to hold a lift fixture or canister pintle. (SSC) - Grapple pintle contact proximity switch interlock with pivot dogs. (AC) - Compressed Gas Cylinder Control Program that prevents storage of compressed gas cylinders in the hot cell and prevents their use in the upper hot cell when waste is present. (AC) - Lifting bails installed on drums shipped in a 10-160B are required to be verified to be load bearing as implemented at generator sites in accordance with the RH WAC prior to shipment of drums in a 10-160B shipping cask. (AC) - Use of Qualified Operators (AC) - Emergency Response	Prevents dropping shield plugs, 10-160B shipping cask lid, drum carriages, or waste containers. Prevents the pivot dogs from opening while a load is suspended from the grapple. Prevents breach of waste containers from gas cylinder missile Prevents dropping drums during loading into a facility canister. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequences prevented by the specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB3-6 Loss of confinement in the RH/CH bay	A	Moderate	(AC) - Waste handling restrictions requires use of a spotter when backing the RH transportation trailers into the RH bay (AC) - Work control to require use of a spotter when operating any vehicle within 15 ft of the common RH/CH wall when waste is present in the NE corner of the CH bay (AC) - Emergency Response	Prevents breaching the common RH/CH wall and impacting CH waste Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event ans consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB6-2 External fire propagates to the WHB	A	High	Design Feature: PPA is paved and graveled and surrounded by a dirt road Noncombustible construction of the WHB (SSC) - WHB fire suppression system (AC) - Waste handling restriction to prohibit removal of waste canisters or drums from shipping containers outside the hot cell complex. (AC) - Combustible Loading Control Program (AC) - Emergency response	Provides separation between the WHB and low profile vegetation surrounding the WIPP site. Prevents propagation of fires that could impact waste. Extinguishes fires before they become large enough to impact waste outside of a closed shipping cask. Prevents external fires from impacting waste containers. Minimizes potential for and size of fires by controlling the amount of combustible material in and around the outside of the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	EU	Low	IV	
WHB6-3 Air Craft crash into WHB	EU	High	See comment.	NA	NA	NA	NA	See Section 3.4.2.7 - aircraft crash not credible
WHB6-4 Loss of electrical power	A	Moderate	(SSC) - RH cranes, grapple hoist, overhead powered manipulator are designed to hold their load on loss of power. (AC) - Emergency Response	Prevents uncontrolled drop and breach of waste containers. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB7-1 Wildland fire propagates to the WHB	A	High	Design Feature: PPA is paved and graveled and surrounded by a dirt road Noncombustible construction of the WHB (SSC) - WHB fire suppression system (AC) - Waste handling restriction to prohibit removal of waste canisters or drums from shipping containers outside the hot cell complex. (AC) - Combustible Loading Control Program (AC) - Emergency response	Provides separation between the WHB and low profile vegetation surrounding the WIPP site. Prevents propagation of fires that could impact waste. Extinguishes fires before they become large enough to impact waste outside of a closed shipping cask. Prevents external fires from impacting waste containers. Minimizes potential for and size of fires by controlling the amount of combustible material in and around the outside of the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	EU	Low	III	

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
WHB7-2 Earthquake with fire	U	High	Design Features: - WHB designed to withstand DBE - RH bay 140/25-ton crane, CUR crane, upper hot cell bridge crane and overhead powered manipulator, and CLR grapple hoist hold their load in a DBE - Shuttle car is designed to remain on the rails in the event of a DBE - Noncombustible construction of the WHB. Thick concrete shield walls, floors, ceiling, lead glass windows, and steel doors of the hot cell complex (AC) - Combustible Loading Control Program (AC) - Emergency Response Program	Prevents structural failure during a DBE Prevents propagation of fires Prevents fires in the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Consequences prevented by specified controls. WIPP has no gas pipelines or other passive sources of fuel that could create large fires following a seismic event.
WHB7-3 Lightning strikes the WHB	A	Moderate	Design Feature: WHB grounding and lightning dissipation system	Prevents damage to building or waste from lightning.	Prevented	NA	NA	Consequences prevented by specified control
WHB7-6 Hail impacts WHB causing breach of building and waste containers	A	High	Design Feature: WHB is designed to withstand a 27 lb/ft^2 snow loading	Prevents damage to building or waste	Prevented	NA	NA	Event and consequences prevented by specified controls.
WHB7-7 Snow/ice accumulation on WHB roof breaches roof and waste containers	A	High	Design Feature: WHB is designed to withstand a 27 lb/ft^2 snow loading	Prevents damage to building or waste	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG1-1 Fire in the disposal path (includes waste shaft station and transport path to active disposal room) affects RH or RH and CH waste	A	Moderate	Design Feature: Facility cask design (SSC) - Automatic/manual fire suppression system on RH 41-ton, 20-ton, and 6-ton forklifts (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Combustible Loading Control Program including: - Only diesel or electric powered vehicles are allowed in the underground. - No storage of combustibles or flammable gas or flammable compressed gas cylinders in the disposal path - No use of flammable gas or flammable compressed gas cylinders in the disposal path during waste handling. - The lube truck is prohibited from the disposal path while waste is in transit	Protects the RH waste canister from direct flame impingement Prevents small fires on diesel powered waste handling equipment from becoming large fires that can impact waste. Prevents fires and explosions in waste containers by eliminating ignition sources and flammable material in the waste containers Prevents fires in the disposal path.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG1-1 Fire in the disposal path (includes waste shaft station and transport path to active disposal room) affects RH or RH and CH waste continued			(AC) - Waste handling restrictions: - A minimum standoff distance of 75 ft. shall be maintained between the 41-ton RH waste handling forklift and a loaded CH waste transporter. - When RH waste is in transit, non-waste handling equipment shall be moved to a crosscut and be secured until the RH 41-ton forklift transporting waste has passed and is greater than 75 ft away. Vehicles that may have become disabled (excluding the lube truck) may be in the disposal path but must be secured along the wall of the disposal path. - A spotter is required when operating RH waste handling equipment within 75 ft of the CH disposal array waste face.	Prevents vehicle collisions that could result in fires with the potential to impact CH waste from RH waste handling operations.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG1-2 Fire in the active disposal room affects RH or RH and CH waste	A	Moderate	Design feature: Facility cask, borehole shield collar, and HERE transfer mechanism Disposal borehole and shield plug (SSC) - Automatic/manual fire suppression system on RH 41-ton, 21-ton, and 6-ton waste handling forklifts AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Combustible Loading Control Program including: - Only diesel or electric powered vehicles are allowed in the underground. - No storage of combustibles or flammable gas or flammable compressed gas cylinders in the active disposal room - No use of flammable gas or flammable compressed gas cylinders in the active disposal room during waste handling - The lube truck is prohibited from the active disposal room	Prevents RH waste canister from direct flame impingement during waste emplacement. Protects RH waste canister from a fire in the active disposal room after emplacement. Prevents fires associated with waste handling equipment including fuel or hydraulic leaks or the engine from becoming large fires that can impact waste. Prevents fires and explosions in waste containers. Prevents fires by controlling combustible material in the disposal path.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG1-2 Fire in the active disposal room affects RH or RH and CH waste continued			(AC) - Waste handling restrictions: - A spotter is required when operating RH waste handling equipment within 75 ft of the CH disposal array waste face - A minimum standoff distance of 75 ft. is required between the RH 41-ton waste handling forklift and a CH waste transporter loaded with waste. - No non-waste handling vehicles in the active disposal room during waste handling. - A minimum separation distance between non-waste handling vehicles and the RH 41-ton forklift loaded with waste - Electrical equipment associated with the HERE or the borehole machine must be at least 10 ft from the CH waste array face or a fire watch is posted.	Prevents collisions that could result in fires with the potential to breach waste containers.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG1-5 Fire in waste hoist tower	A	High	Design feature Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower Design Feature and (SSC) - Waste hoist brakes (SSC) - WHB fire suppression system (AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB and prohibits its use in the waste hoist tower during waste transport using the waste shaft conveyance. (AC) - Emergency Response	Prevents uncontrolled movement of loaded waste conveyance down the waste shaft. Prevents uncontrolled movement of the waste conveyance. Extinguishes fire before ropes or brakes are damaged. Prevents fires in the waste hoist tower. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and consequences prevented by specified controls. No consequences are expected from the fire alone, but if not extinguished the fire could be an initiator for UG3-1.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG2-1 Explosion followed by fire in disposal path affects RH or RH and CH waste	A	Moderate	Design Feature: Facility cask design (AC) - Combustible Loading Control Program including: - No storage of flammable gas or flammable compressed gas cylinders in the disposal path. - No use of flammable gas or flammable compressed gas cylinders in the disposal path during waste handling (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) -Drums shipped in a 10-160B cask and 72-B canisters approved for disposal at the WIPP must be vented as implemented at generator sites through adherence to the RH WAC (AC) - Use of Qualified Operators (AC) - Emergency Response	Prevents direct flame impingement on the waste container and protects waste from explosion external to the facility cask. Prevents explosions and fires. Prevents fires and explosions in waste containers Prevents pressurization of waste containers due to gas generation. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG2-2 Explosion followed by fire in active RH disposal room that affects RH or RH and CH waste	A	High	Design Feature: Facility cask design	Protects the RH waste canister from impact and direct flame impingement and minimizes the effects of a waste container explosion	Prevented	NA	NA	Event and consequences prevented by specified controls.
			(AC) - Combustible Loading Control Program including: - No storage of flammable gas or flammable compressed gas cylinders in the active disposal room - No use of flammable gas or flammable compressed gas cylinders in the active disposal room during waste handling	Prevents explosions/fires.				
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Prevents fires and explosions in waste containers.				
			(AC) -Drums shipped in a 10-160B cask and 72-B canisters approved for disposal at the WIPP must be vented as implemented at generator sites through adherence to the RH WAC	Prevents pressurization of waste containers due to gas generation.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG2-6 Explosion in the waste hoist tower results in damage to the waste hoist or conveyance causing loaded facility cask to fall to the bottom of the waste shaft	A	High	Design feature Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower Waste hoist brakes (AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB and prohibits its use in the waste hoist tower during waste transport using the waste shaft conveyance. (AC) - Emergency Response	Prevents uncontrolled drop of the waste shaft conveyance Prevents uncontrolled drop of a loaded waste conveyance down the shaft. Prevents fires in the waste hoist tower when transporting waste. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG3-1 Loss of confinement due to waste hoist failure	A	High	Design Feature: Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower	Prevents uncontrolled drop of loaded waste conveyance down the shaft. The head frame and hoist drum support the counterweight, waste shaft conveyance and ropes. The structural support for the waste hoist head frame is provided by the waste hoist tower. Counterweight may off set RH load such that waste and counterweight balance or waste slowly accelerates to bottom of shaft	Prevented	NA	NA	Event and consequences prevented by specified controls.
			Design Feature and (SSC) - Waste hoist brakes	Prevents uncontrolled drop of a loaded waste conveyance down the shaft.				
			(AC) - Waste Hoist Structure and Structural Support Integrity Program	Ensures integrity of the load bearing components associated with the waste hoist.				
			(AC) - Waste handling restriction verify: S prior to moving the facility cask loaded with RH waste onto the waste shaft conveyance, the weight of the loaded canister. If the weight the weight of a RH waste canister exceeds 3220 lbs, the loaded facility cask shall not be moved onto the waste shaft conveyance until the maintenance platform has been removed.	Prevents overloading the rated capacity of the waste hoist.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized				

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG3-3 Loss of confinement in an active disposal room from RH and CH waste	A	Moderate	(SSC) - Facility cask (AC) - Waste handling restriction: - A spotter is required when operating the RH 41-ton, 20-ton, or 6-ton forklift within 75 ft. of the CH disposal array waste face. (AC) - Compressed gas cylinder control that prevents storage in the active disposal room and prevents use during RH waste handling in the active disposal room. (AC) - Use of Qualified Operators (AC) - Emergency Response	Protects RH waste canister from impact Prevents RH waste handling equipment from colliding with the CH waste face Prevents waste container breach due to compressed gas cylinders becoming a missile. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.	Prevented	NA	NA	Event and consequences prevented by controls specified.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
UG3-6 Loss of confinement due to driving loaded FCTC into waste shaft	A	High	Design feature Fence around the waste shaft collar (AC) -Toplander control of waste shaft access (AC) - Waste handling restriction requires that prior to moving the FCTC loaded with the facility cask from the FCLR to the waste shaft collar area, the waste shaft conveyance is verified to be at the collar of the waste shaft. (AC) - Use of Qualified Operators	Prevents a load from inadvertently entering the waste shaft. Prevents a load from inadvertently entering waste shaft Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG6-1 Loss of AC Power	A	High	Design Feature and (SSC) - Waste hoist brakes	Prevents uncontrolled drop of a loaded waste conveyance down the shaft	Prevented	NA	NA	Event and consequences prevented by specified controls
UG6-2 Equipment or Materials Dropped Down the Waste Shaft While RH Waste in Transit to UG	A	High	Design Features: Fence around the waste shaft at the collar (AC) - Toplander control of waste shaft access.	Defined restricted area bounding waste shaft and prevents uncontrolled access to the shaft Prevents a load from inadvertently entering waste shaft	Prevented	NA	NA	Event and consequences prevented by specified controls.
BG6-1 Aircraft Crash	EU	High	None	NA	NA	NA	NA	Aircraft crash not credible as discussed in Section 3.4.2.7.

Table A-13 - Site Worker MHE Summary For Risk Rank I and II Events (evaluated at 100 m)

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq	Conseq			Freq	Conseq	Risk Bin	
BG7-1 Earthquake impacts facility resulting in breach of waste containers	A	High	Design feature: - WHB designed to withstand DBE - RH bay 140/25-ton crane, CUR crane, upper hot cell bridge crane and overhead powered manipulator, and CLR grapple hoist hold their load in a DBE - Shuttle car is designed to remain on the rails in the event of a DBE - Noncombustible construction of the WHB. Thick concrete shield walls, floors, ceiling, lead glass windows, and steel doors of the hot cell complex (AC) - Combustible Loading Control Program (AC) - Emergency Response Program	Prevents structural failure during a DBE Prevents propagation of fires Prevents fires in the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Event and consequences prevented by the controls specified.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
OA4-1 Direct Radiation Exposure	U	High	(AC) - RH waste can only be shipped to WIPP in a 72-B or 10-160B shipping cask. (AC) -Generator site characterization program must ensure that RH waste does not exceed 1000 Rem/hr on contact as required by the RH WAC	72-B and 10-160B shipping casks are designed to provide shielding for up to 1000 Rem/hr RH waste drums and canisters Generator site characterization program must ensure that RH waste canisters and drums do not exceed 1000 Rem/hr prior to shipment as required by the RH WAC	BEU	High	III	
OA5-1 Criticality	EU	High	(AC) -Criticality Safety Program that establishes the FGE and special moderator/reflector limits for RH waste.	Protects assumptions for NCSE that shows criticality in transport containers not credible	BEU	High	III	See DSA Chapter 6
OA6-3 Aircraft Crash	EU	High	See comment.	NA	NA	NA	NA	Aircraft crash not credible as discussed in Section 3.4.2.7
WHB1-1 Fire in the RH bay impacts RH waste containers	A	High	Design Feature: Noncombustible construction of the WHB. The RH bay is segregated from the hot cell complex by thick concrete walls and floors (SSC) - WHB fire suppression system (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC (AC) - Combustible loading control program including controls that prohibit storage of flammable gas or flammable compressed gas cylinders in the WHB and prevents their use in the RH bay when the lid bolts on the a 10-160B shipping cask containing RH waste are loosened.	Prevents fire propagation from the RH bay to the hot cell complex. Extinguishes fires before they become large enough to impact waste. Eliminates ignition sources in waste containers. Prevents fires by controlling the amount of combustible material in the WHB.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-1 Fire in the RH bay impacts RH waste containers cont.			(AC) - Waste handling restrictions: - prohibit removal of RH waste drums or canisters from the shipping cask outside the hot cell complex - 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed if left unattended. (AC) - Emergency Response	Prevents fires in the RH bay from impacting RH waste. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-2 Fire in Upper Hot Cell	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell has thick concrete walls, floors, ceiling, shield plugs, lead glass windows, steel doors and steel shield valves. Metal facility canister with bolted or pinned lid Upper hot cell canister storage wells (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) -Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas or flammable compressed gas cylinders in the upper hot cell and prevents their use in the upper hot cell when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell when waste is present the CUR or transfer cell unless the upper hot cell shield plugs are installed and the upper hot cell floor shield valve is closed. (AC) - Emergency Response	Prevents fire propagation. Prevents lid ejection in a fire and direct flame impingement on canisterized drums. Prevents direct flame impingement on canisters. Eliminates ignition sources in waste containers. Prevents worker from being in immediate area and exposure in event of a release during RH waste handling. Prevents fires by controlling the amount of combustible material in the upper hot cell. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-3 Fire in Transfer Cell	A	High	Design Feature: Noncombustible construction of the WHB. Transfer cell has thick concrete walls, floors, ceiling, and steel shield valves	Prevents fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			Metal facility canister with bolted or pinned lid	Prevents direct flame impingement on canister and prevents lid ejection in a fire.				
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources in waste containers.				
			(AC) - 72-B waste canister is required to have a welded or mechanical lid as implemented at generator sites through adherence to the RH WAC.	Prevents lid ejection in a fire.				
			(AC) -Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling.	Prevents worker from being in immediate area and exposure in event of a release during RH waste handling.				
			(AC) - Combustible Loading Control Program including controls that prohibit storage of flammable gas and flammable compressed gas in the WHB and prevents its use in the transfer cell when waste is present.	Prevents fires by controlling the amount of combustible material in the transfer cell.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-4 Fire in FCLR	A	High	Design Feature: Noncombustible construction of the WHB. FCLR has thick concrete walls, floors, ceiling, and steel doors.	Prevents fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			Facility cask	Prevents direct flame impingement on a canister.				
			Telescoping port shield	Prevents direct flame impingement on a canister.				
			Metal facility canister with bolted or pinned lid	Prevents lid ejection in a fire.				
			(SSC) - WHB fire suppression system in the FCLR	Extinguishes fires before they become large enough to impact waste.				
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources in waste containers.				
			(AC) - 72-B waste canister is required to have a welded or mechanical lid implemented at generator sites as required by the RH WAC	Prevents lid ejection in a fire.				
			(AC) - Combustible Loading Control Program including controls that prohibit storage of flammable gas and flammable compressed gas in the WHB and prevents its use in the FCLR when waste is present.	Prevents fires by controlling the amount of combustible material in the FCLR.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-5 Fire in Service Room	A	High	Design Feature: Noncombustible construction of the WHB. Service room is segregated from the transfer cell by thick concrete walls and shield plugs and steel doors (AC) - Waste handling restriction that requires grapple override port shield plug are installed except when grapple override tool is in use. (AC) - Combustible Loading Control Program including controls that prohibit storage of flammable gas and flammable compressed gas in the WHB and prevents its use in the service room when waste is present in the transfer cell. (AC) - Emergency Response	Prevents fire propagation. Prevents fire propagation between transfer cell and service room. Minimize potential and size of fires by controlling the amount of combustible material in the Service Room Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-6 Fire in the crane maintenance room impacts waste in the upper hot cell	A	High	Design Feature: Noncombustible construction of the WHB. Crane maintenance room is segregated from upper hot cell by 3 ft raised thick concrete wall and a metal shield door (SSC) - WHB fire suppression system in the crane maintenance room. (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas and flammable compressed gas in the crane maintenance room and prevents use of flammable gas and flammable compressed gas in the crane maintenance room when waste is present in the upper hot cell unless the crane maintenance room shield door is closed. (AC) - Crane maintenance room shield door is required to be closed except when moving the upper hot cell crane to and from the room for repair. (AC) - Emergency Response	Prevents fire propagation. Extinguishes fires in the crane maintenance room. Prevents fires in the crane maintenance room by controlling the amount of combustible material and prevents fire propagation to the upper hot cell. Prevents fire propagation to upper hot cell. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-7 Fire in the hot cell operating gallery	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell operating gallery is segregated from the hot cell complex by thick concrete walls, floors, and ceilings, lead glass windows, and steel doors (SSC) - WHB fire suppression system in hot cell operating gallery (AC) - Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas and flammable compressed gas in the hot cell operating gallery, and prevents use of flammable gas and flammable compressed gas in the operating gallery when waste is present in the upper hot cell. (AC) - Emergency Response	Prevents fire propagation. Extinguishes fires in the hot cell operating gallery. Prevents fires by controlling the amount of combustible material in the operating gallery. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-8 Fire in the RH bay near the common RH/CH wall impacts RH waste or RH and CH waste	A	High	Design Feature: Noncombustible construction of the WHB (SSC) - WHB fire suppression system (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) Combustible Loading Control Program including controls that require at least 15 ft standoff distance for diesel vehicles operating in the RH bay near the RH/CH common wall when waste is stored in the NE corner of the CH bay or posting a fire watch. Also prohibits storage of flammable gas and flammable compressed gas in the RH bay and prohibits storage of combustibles in the RH bay within 4 ft of the common RH/CH wall. (AC) Waste handling restrictions: - prohibit removal of RH waste containers from shipping casks outside the hot cell complex. - require that the 10-160B cask cannot be left unattended in the RH bay with the lid bolts loosened - it must either have the lid bolts installed or be in the CUR with the shield door closed to be left unattended. (AC) - Emergency Response	Prevents fire propagation. Extinguishes fires before sufficient heat generated to breach common RH/CH wall Eliminates ignition sources in waste containers. Prevents fires in the RH bay from impacting waste in the CH bay by controlling the amount of combustible material in the RH bay and prevents fires associated with diesel powered equipment in the RH bay from impacting waste in the CH bay. Prevents fires from impacting RH waste in the RH bay. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB1-9 Fire in the CUR	A	High	Design Feature: Noncombustible construction of the WHB. CUR separated from upper hot cell, transfer cell, and RH bay by thick concrete floors, ceilings, shield plugs and steel shield valves and steel doors. (AC) - Waste handling restriction requires that the CUR shield door be closed when a 10-160B shipping cask loaded with waste is in the CUR. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) -Combustible Loading Control Program including controls that prohibit storage of combustible material, flammable gas and flammable compressed gas in the CUR, and prevents use of flammable gas and flammable compressed gas in the CUR when waste is present in the CUR. (AC) -Emergency Response (AC) - Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling.	Prevents fire propagation. Prevents fire propagation to the RH bay. Eliminates ignition sources in waste containers. Prevents fires in the CUR by controlling the amount of combustible material in the CUR. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized. Prevents personnel exposure.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-1 Explosion followed by fire in the RH Bay	A	High	Design feature: Noncombustible construction of the WHB. The RH bay is separated from the hot cell complex by thick concrete walls and floors.	Prevents fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			(AC) - Pyrophoric and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources in waste containers.				
			(AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) - Combustible loading control program including controls that prohibit storage of flammable gas or flammable compressed gas cylinders in the WHB and prevents their use in the RH bay when the lid bolts on a 10-160B shipping cask containing RH waste are loosened.	Prevents explosions/fires in the RH bay.				
			AC) - Waste handling restrictions: - prohibit removal of RH waste drums or canisters from the shipping cask outside the hot cell complex - 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened. It must either have the lid bolts installed or be in the CUR with the shield door closed if left unattended.	Prevents explosions in the RH bay from impacting RH waste.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-2 Explosion followed by fire in the CUR	A	High	Design feature: Noncombustible construction of the WHB. The CUR is segregated from the upper hot cell and transfer cell by thick concrete walls, floors, ceilings, shield plugs and shield valves. (AC) - Pyrophoric and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC. (AC) - Combustible loading control program including flammable gas and flammable compressed gas cylinder control that prohibits their storage in the WHB and prevents their use in the CUR when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell or transfer cell when waste is in the CUR unless the upper hot cell floor shield plugs are installed and the CUR floor shield valve is closed. (AC) - Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling. (AC) - Emergency Response	Prevents fire propagation Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the CUR and propagation from the CUR to other areas. Prevents worker exposure in event of a release during RH waste handling. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-3 Explosion followed by fire in the upper hot cell	A	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell is segregated from the CUR, transfer cell, and other areas of the RH facility by thick concrete floors, walls, ceiling, shield plugs, lead glass windows, and steel shield valves and doors.	Prevents propagation of fires.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources and flammable material in waste containers.				
			(AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) - Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling	Prevents worker exposure in event of a release during RH waste handling				
			(AC) - Combustible Loading Control Program including flammable compressed gas cylinder control such that they are not stored in the upper hot cell and are not used in the upper hot cell when waste is present. Also flammable compressed gas cylinders are not used in the CUR when waste is present in the upper hot cell unless the upper hot cell shield plugs are installed.	Prevents explosions/fires in the upper hot cell and propagation to other areas.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-4 Explosion followed by fire in the service room or transfer cell	A	High	Design Feature: Noncombustible construction of the WHB. Transfer cell is segregated from the service room and other areas of the hot cell complex by thick concrete walls, floor, ceiling, shield plugs, and steel shield valves.	Prevents fire propagation.	U	Low	III	
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC.	Eliminates ignition sources and flammable material in waste containers.				
			(AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) - Access control to ensure areas where waste is outside the shipping cask are unoccupied during RH waste handling	Protects workers from radiological exposure				
			(AC) - Combustible Loading Control Program including flammable compressed gas cylinder control such that they are not stored in the service room or transfer cell and are not used in the transfer cell when waste is present. Also flammable compressed gas cylinders are not used in the upper hot cell or CUR when waste is in the transfer cell unless the upper hot cell floor shield valve and the CUR shield valve are closed.	Prevents explosions/fires from impacting waste and propagating to other areas of the hot cell complex where waste may be present				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-5 Explosion followed by fire in the FCLR	A	High	Design Feature: Noncombustible construction of the WHB. FCLR is segregated from other areas of the hot cell complex, the RH bay, and the transfer cell with thick concrete walls and floors.	Prevent fire propagation.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			Facility cask design	Thick walls and shield valves protect waste canister from the effects of an explosion.				
			Telescoping port shield and shield bell	Protects waste canister from the effects of an explosion.				
			(AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC	Eliminates ignition sources in waste containers.				
			(AC) - RH waste containers are required to be vented at the generator sites prior to shipment to the WIPP in accordance with the RH WAC.	Prevents pressurization of the waste containers due to gas generation.				
			(AC) -Combustible Loading Control Program including flammable gas and flammable compressed gas cylinder control that prohibits their storage in the WHB and prevents their use in the FCLR when waste is present.	Prevents explosions/fires in the transfer cell and propagation to other areas.				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-6 Explosion followed by fire in the Crane Maintenance Room	U	High	Design Feature: Noncombustible construction of the WHB. Crane maintenance room is segregated from upper hot cell by 3 ft raised concrete wall and a shield door. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - RH waste containers are required to be vented prior to shipment to the WIPP in accordance with the RH WAC. (AC) - Combustible Loading Control Program including flammable compressed gas cylinder control such that they are not stored in the WHB maintenance room and are not used in the crane maintenance room when waste is present in the upper hot cell without door between the crane maintenance room and the upper hot cell being closed.. (AC) - Waste handling restriction requires that the door between the crane maintenance room and upper hot cell is closed except when transferring the upper hot cell crane to and from the crane maintenance room. (AC) - Emergency Response	Prevents fire propagation. Eliminates ignition sources in waste containers. Prevents pressurization of the waste containers due to gas generation. Prevents explosions/fires in the crane maintenance room from impacting waste in the upper hot cell. Prevents propagation of fires. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB2-7 Explosion followed by fire in the hot cell operating gallery	U	High	Design Feature: Noncombustible construction of the WHB. Upper hot cell operating gallery is segregated from the waste in the hot cell complex by thick concrete walls, floors and ceilings, lead glass windows, and steel doors (AC) - Combustible loading control program including flammable gas or flammable compressed gas cylinder control that prohibits storage in the WHB and prevents use in the hot cell operating gallery when waste is present in the upper hot cell. (AC) - Emergency response	Prevents fire propagation. Prevents explosions/fires in the hot cell operating gallery or service room and propagation to other areas. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-1 Loss of confinement in the RH Bay	A	High	Design Features: RH Bay 140/25 -ton crane designed to handle design basis loads including during a DBE and LOP (AC) - Waste containers are prohibited from being removed from a shipping cask until inside the hot cell complex. (AC) - Waste handling restriction to prevent non-waste handling vehicles from the RH bay when the 10-160B lid bolts are loosened. (AC) - Compressed Gas Cylinder Control Program limiting the RH bay to no more than 4 compressed gas cylinders when CH waste is stored in the NE corner of the CH bay. (AC) - Use of qualified operators (AC) - Emergency Response	Prevents dropping loaded shipping casks in RH Bay Protects waste containers from impacts, punctures, and breaches Prevents dislodging the 10-160B shipping cask from the RCTC when the lid bolts are loosened. Minimizes the potential for a compressed gas cylinder to become a missile and impact CH waste through the common RH/CH wall Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-2 Loss of confinement in the CUR	A	High	Design Features: CUR crane, upper hot cell crane, overhead powered manipulator, and lift fixtures are designed to handle design basis loads including DBE and loss of power. The grapples used with the upper hot cell crane and in the FCLR are designed with three pivot dogs that move together to hold a canister pintle (SSC) - Grapple pintle contact proximity switch interlock with pivot dogs. (AC) - Compressed Gas Cylinder Control Program prevents storage of compressed gas cylinders in the CUR and their use when RH waste is present. (AC) - Use of qualified operators (AC) - Access control to prohibit personnel access to the CUR when removing the upper hot cell shield plugs, 10-160B shipping cask lid or loaded drum carriages. (AC) - Emergency Response	Prevents failure of building, cranes, or lift fixtures and dropping or crushing waste Prevents dropping the 10-160B shipping cask lid and loaded drum baskets when moving waste containers to the upper hot cell. Prevents pivot dogs from opening while a load is suspended from the grapple. Prevents breach of 10-160B drums from gas cylinder missile Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Protects facility worker from radiological exposure in the event of a breached drum Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-3 Loss of confinement in the Transfer Cell	A	High	Design Features: Shuttle car is designed to remain on its rails during a DBE	Prevents drop of a waste cask/canister	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls
			Upper hot cell crane, CUR crane, and FCLR grapple hoist is designed for design basis loads including the DBE and will hold its load on loss of power	Prevents dropping loaded 72-B shipping cask or waste canisters				
			The grapples used with the upper hot cell crane and in the FCLR are designed with three pivot dogs that move together to hold a canister pintle	Prevents dropping a canister from the upper hot cell or FCLR to the transfer cell				
			The FCTC mates with the FCRD and latches.	Prevents movement of the FCTC during canister transfer that could result in crushing a canister or the grapple hoist ropes resulting in a canister drop				
			(SSC) - Grapple pintle contact proximity switch interlock with pivot dogs.	Prevents pivot dogs from opening while a load is suspended from the grapple.				
			The facility canister has a mechanical or pinned lid and pintle	Structurally supports the canister when lifted with the upper hot cell crane grapple.				
			(SSC) - Interlock that prevents transfer cell shuttle car movement unless the CUR floor shield valve, the upper hot cell shield valve and the transfer cell ceiling shield are all closed.	Prevents crushing a canister or severing the ropes associated with upper hot cell grapple, the FCLR grapple, or the CUR crane during transfer of a canister into the transfer cell or from the transfer cell to the facility cask.				
			(SSC) - Interlock between the FCLR grapple hoist and shield bell, telescoping port shield, facility cask, and transfer cell ceiling shield valve.	Prevents the transfer cell ceiling shield valve and facility cask shield valves from crushing a canister during transfer or severing the grapple hoist cables and dropping a canister.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-3 Loss of confinement in the Transfer Cell cont			(SSC) - The FCRD is interlocked with the telescoping port shield and FCLR grapple hoist	Prevents rotation of the facility cask during transfer of a canister from the transfer cell to the facility cask and prevents crushing the canister or severing the grapple hoist rope.				
			(AC)- Waste handling restriction to require the FCRD and FCTC to be mated and latched prior to rotating the facility cask.	Prevents movement of the FCTC during canister transfer and prevents crushing the canister of severing the grapple hoist rope.				
			(AC) - Access to transfer cell is prohibited during waste handling	Protects workers in the event of a release				
			(AC) - Compressed Gas Cylinder Control Program to prevent storage of compressed gas cylinders in the transfer cell and prevent their use when waste is present.	Prevents breach of waste containers from gas cylinder missile				
			(AC) - 72-B canister lid is welded or mechanically pinned and an installed pintle that structurally support the canister when lifted by the pintle. This is implemented at the generator site as required by the RH WAC prior to shipment.	Prevents drop of a 72-B canister during transfer into the facility cask from the transfer cell.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-4 Loss of confinement in the upper hot cell	A	High	Design Features: Upper hot cell crane and overhead powered manipulator is designed for design basis loads including the DBE and will hold its load on loss of power The grapple used with the upper hot cell crane is designed with three pivot dogs that move together to hold a lift fixture or canister pintle The facility canister has a mechanical or pinned lid and pintle The storage wells in the upper hot cell Canister storage wells are located over a WHB structural beam (SSC) - Grapple pintle contact proximity switch interlock with pivot dogs. (AC) - Compressed Gas Cylinder Control Program that prevents storage of compressed gas cylinders in the hot cell and prevents use of compressed gas cylinders in the upper hot cell when waste is present. No more than two compressed gas cylinders shall be stored in the hot cell operating gallery to support radiological swipe evaluation.	Prevents dropping waste containers or crushing waste containers from crane or overhead powered manipulator structural failure. Prevents dropping shield plugs, 10-160B shipping cask lid, drum carriages, or waste containers. Structurally supports the canister when lifted with the upper hot cell crane grapple. Provide support to keep a stored facility canister upright and protects canister from dropped objects. Prevents RH waste containers from falling to the lower hot cell. Prevents pivot dogs from opening while a load is suspended from the grapple. Prevents breach of waste containers from gas cylinder missile .	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-4 Loss of confinement in the upper hot cell cont.			(AC) - Lifting bails installed on drums shipped in a 10-160B are required to be verified to be load bearing as implemented at generator sites in accordance with the RH WAC prior to shipment of drums in a 10-160B shipping cask. (AC) - Access control to upper hot cell to prohibit workers from the upper hot cell when waste is present. (AC) - Waste handling restriction requires that the10-160B loaded drum carriages are carried over and stored on the concrete portion of the upper hot cell floor. Facility canisters are only stored in the storage wells or in the wells at the inspection station. (AC) - Use of Qualified Operators (AC) - Emergency Response	Prevents dropping drums during loading into a facility canister. Prevents worker exposure in the event of a radiological release. Prevents RH waste containers from falling to the lower hot cell and breaching. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-5 Loss of confinement in the FCLR	A	High	Design Features: WHB and Hot Cell complex structural design FCLR grapple hoist is designed for design basis loads including the DBE and will hold its load on loss of power. The grapple used with the FCLR grapple hoist is designed with three pivot dogs that move together to hold a canister pintle. The facility canister has a mechanical or pinned lid and pintle. Facility cask FCTC mates with FCRD and latches. (AC) - Compressed Gas Cylinder Control Program to prohibit storage of compressed gas cylinders in the FCLR and to prevent their use during waste handling in the FCLR. (AC) - 72-B canister lid is welded or mechanically pinned and an installed pintle that structurally support the canister when lifted by the pintle. This is implemented at the generator site as required by the RH WAC prior to shipment.	Seismically qualified to prevent collapse of Hot Cell complex Prevents dropping a waste canister. Prevents dropping waste canisters and the 72-B shipping cask inner lid during canister transfer from the transfer cell to the facility cask. Interfaces with the grapple. Pinned lid and pintle structurally support the canister during transfer from the transfer cell to the facility cask. Protects waste containers from impacts, punctures, and breach. Prevents movement of the FCTC during canister transfer that could result in crushing a canister or the grapple hoist ropes resulting in a canister drop. Prevents breach of waste containers from gas cylinder missile. Prevents drop of a 72-B canister during transfer into the facility cask from the transfer cell.	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-5 Loss of confinement in the FCLR cont			(SSC) -Grapple pintle contact proximity switch interlock with pivot dogs.	Prevents grapple from releasing a waste container during lifting.				
			(SSC) - Facility cask shield valve interlocks with the grapple hoist	Prevent facility cask shield valves from crushing a waste container or hoist ropes.				
			.(SSC) - The transfer cell shuttle car cannot move unless the CUR floor shield valve, the upper hot cell shield valve and the transfer cell ceiling shield are all closed.	Prevents crushing a canister or severing the ropes associated with upper hot cell grapple, the FCLR grapple, or the CUR crane during transfer of a canister into the transfer cell or from the transfer cell to the facility cask.				
			(SSC) - The FCRD is interlocked with the telescoping port shield and FCLR grapple hoist	Prevents rotation of the facility cask during canister transfer that could result in crushing a canister or the grapple hoist ropes resulting in a canister drop.				
			(AC) Waste handling restriction to require the FCTC and FCRD to be mated and latched prior to rotating the facility cask.	Prevents movement of the FCTC during canister transfer that could result in crushing a canister or the grapple hoist rope and dropping a canister.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB3-6 Loss of confinement in the RH/CH bay	A	High	(AC) - Waste handling restrictions requires use of a spotter when backing the RH transportation trailers into the RH bay (AC) - Work control to require use of a spotter when operating any vehicle within 15 ft of the common RH/CH wall when waste is present in the NE corner of the CH bay (AC) - Emergency Response	Prevents breaching the common RH/CH wall and impacting CH waste Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive material is minimized	Prevented	NA	NA	Event and radiological consequence is prevented by the specified controls

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-1 Radiation exposure in RH bay, HEPA filter gallery, aisle adjacent to CUR or catwalk for hot cell override tool use	A	High	Design Features: Hot cell complex thick concrete walls, floors, ceilings, shield door and shield valves including shield plugs (AC) - Access control to filter gallery and catwalks when waste is present in the hot cell complex. (AC) - Waste handling restriction requires the grapple override port shield plugs to be installed when the override tools are not in use (AC) - Waste handling restriction to prohibit removal of waste canisters/drums from shipping casks outside of the hot cell complex (AC) - Waste handling restriction to prohibit removal of drums from the 10-160B shipping cask without the CUR door being closed (AC) - Use of Qualified Operators	Prevents exposure from RH waste being handled inside the hot cell complex. Prevents worker exposure Prevents worker exposure Prevents worker exposure Prevents worker exposure Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by specified controls.

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-2 Direct radiation exposure in CUR	A	High	Design Features: Thick concrete walls, floors, ceilings, shield door and shield valves including shield plugs (SSC) - Interlocks between the upper hot cell crane, the CUR shield door, and the upper hot cell shield plugs (AC) - Access control to CUR during waste handling operations involving a loaded 72-B or 10-160B waste container or when waste is present in the upper hot cell or transfer cell. Access is prohibited when the upper hot cell floor shield plugs are removed and waste is in the upper hot cell. (AC) - Waste handling restriction requires the hot cell shield plugs be in place with the CUR door open, prohibit removal of waste canisters or drums from shipping casks outside of the hot cell complex, and prohibit removal of drums from the 10-160B shipping cask without the CUR door being closed (AC) - Use of Qualified Operators	Reduces exposure from RH waste to levels comparable to CH waste. Interlocks are designed to preserve shielding and prevent worker exposure Prevents worker exposure Prevents worker exposure Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by the specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-3 Direct radiation exposure in the Service Room or Transfer Cell	A	High	Design Features: Thick concrete shield walls, floors, ceilings and grapple override tool shield plugs segregate the service room from the transfer cell. (AC) - Waste handling restriction requires grapple override port shield plug to be installed except when grapple override tool is in use. (AC) - Access control prevents personnel access to the transfer cell when waste is being transferred between the upper hot cell or FCLR and the transfer cell. (AC) - Use of Qualified Operators	Provides shielding from waste containers in the transfer cell. Prevents possible radiation streaming from Transfer Cell. Prevents worker exposure when waste is outside a shipping cask or the shielded insert. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-4 Direct radiation exposure in the upper hot cell, upper hot cell operating gallery, catwalk, or crane maintenance room	A	High	Design Features: Hot cell complex has thick concrete shield walls, floors, ceilings, shield plugs, lead glass shield windows, and steel doors Upper hot cell wall mounted manipulators have counterweights to limit speed of travel in the event that an operator releases the manipulator Crane maintenance room is segregated from upper hot cell by 3 ft raised, thick concrete wall and a shield door (AC) - Crane maintenance room shield door is maintained normally closed except when transferring the upper hot cell crane to and from the crane maintenance room when waste is present in the upper hot cell. (AC) -Waste handling restriction requires the grapple override port shield plugs to be installed when the override tools are not in use. (AC) - Access control to prohibit access to the upper hot cell when waste is present in the upper hot cell, to prevent worker access to the crane maintenance room unless the crane maintenance room shield door is closed. (AC) - Use of Qualified Operators	 Provides shielding for worker protection when waste is in the upper hot cell. Prevents breaking the shield windows with the manipulators. Provides shielding for worker protection when waste is in the upper hot cell. Prevent worker exposure. Prevents worker exposure. Prevents worker exposure. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-5 Direct radiation exposure in FCLR	A	High	Design Features: Facility cask Shield bell and telescoping port shield	Prevents worker exposure	Prevented	NA	NA	Event and consequences prevented by specified controls.
			Thick concrete floors, transfer cell ceiling shield valves, telescoping port shield	Provides radiation shielding, protects Facility worker from radiation exposure.				
			The FCTC mates with the FCRD and latches.	Prevents movement of the FCTC during canister transfer and prevents crushing the canister or the grapple hoist rope and dropping a canister.				
			(SSC) - Interlocks between the transfer cell ceiling shield valve, the facility cask shield valves, the telescoping port shield, the grapple hoist and shield bell	Prevents worker exposure by ensuring a shielded path for transfer of a waste canister from the transfer cell to the FCLR and prevents closure of shield valves on a canister being transferred.				
			(SSC) - Interlocks prevent the FCRD from rotating unless the shield bell is in the fully raised position and the telescoping port shield is lowered prior to rotating the FC from vertical to horizontal	Prevents horizontal rotation of the facility cask during transfer of a canister from the transfer cell to the facility cask and prevents crushing the canister or severing the grapple hoist rope and prevents loss of shielding				
			(AC) - Waste handling restrictions require that facility cask shield valves are normally closed except when transferring a waste canister from the transfer cell to the facility cask and to specify sequence of operation.	Prevents worker exposure				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB4-5 Direct radiation exposure in FCLR continued			(AC) - Waste handling restriction requires the FCTC to be mated to the FCRD and latched prior to rotating the facility cask. (AC) - Use of Qualified Operators (AC) - Emergency Response	Prevents movement of the FCTC during transfer of a canister from the transfer cell to the facility cask and prevents crushing the canister or the grapple hoist rope. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Ensures worker is trained to respond to abnormal events such as a high radiation alarm from the ARM located in the FCLR to prevent exposure to a high gamma field. Ensures worker is trained to respond to abnormal events such as a high radiation alarm from the ARM located in the FCLR to prevent exposure to a high gamma field.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated Freq.	Unmitigated Conseq	Credited SSC or AC	Safety Functions	Mitigated Freq.	Mitigated Conseq.	Risk Bin	Comments
WHB5-1 Criticality	A	High	(AC) -Criticality Safety Program that requires: - Fissile limits of 325 FGE imposed for 72-B RH waste canisters with no single drum exceeding 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - No drum shipped in a 10-160B shipping cask can exceed 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - A loaded facility canister does not exceed 600 FGE with no single drum exceeding 200 FGE. - Special moderator and reflector limits imposed by the criticality safety evaluation for the WIPP are specified in the RH WAC and implemented at generator sites prior to approval for shipment to the WIPP.	Protects assumptions for NCSE that shows criticality not credible	BEU	High	III	See DSA Chapter 6
WHB6-1 Vehicle Crash into WHB and breaches waste containers.	U	High	(AC) - Waste handling restriction prohibits removal of waste canisters or drums from shipping containers outside the hot cell complex. (AC) - Use of Qualified Operators	Protects waste containers from breaches/punctures caused by collisions Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	U	Low	III	

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB6-2 External Fire Propagates to WHB	U	High	Design Feature: PPA is paved and graveled and surrounded by a dirt road Noncombustible construction of the WHB (SSC) - WHB fire suppression system (AC) - Waste handling restriction prohibits removal of waste canisters or drums from shipping containers outside the hot cell complex. (AC) - Combustible Loading Control Program (AC) - Emergency Response	Provides separation between the WHB and low profile vegetation surrounding the WIPP site. Prevents propagation of fires that could impact waste. Extinguishes fires before they become large enough to impact waste outside of a closed shipping cask. Prevents external fires from impacting waste containers. Minimizes potential for and size of fires by controlling the amount of combustible material in and around the outside of the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	U	Low	III	
WHB6-3 Aircraft Crash	EU	High	None	NA	NA	NA	NA	See Section 3.4.2.7 - Aircraft crash is not credible
WHB6-4 Loss of electrical power	A	Moderate	(SSC) - RH cranes, grapple hoist, overhead powered manipulator are designed to hold their load on loss of power.	Prevents uncontrolled drop and breach of waste containers.	Prevented	NA	NA	Event and consequences prevented by the specified controls.

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB7-1 Wildland Fire Propagates to WHB	U	High	Design Feature: PPA is paved and graveled and surrounded by a dirt road Noncombustible construction of the WHB (SSC) - WHB fire suppression system (AC) - Waste handling restriction to prohibit removal of waste canisters or drums from shipping containers outside the hot cell complex. (AC) - Combustible Loading Control Program (AC) - Emergency Response	Provides separation between the WHB and low profile vegetation surrounding the WIPP site. Prevents propagation of fires that could impact waste. Extinguishes fires before they become large enough to impact waste outside of a closed shipping cask. Prevents external fires from impacting waste containers. Minimizes potential for and size of fires by controlling the amount of combustible material in and around the outside of the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	EU	Low	IV	

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB7-2 Earthquake with Fire	U	High	Design Features: - WHB and Hot Cell complex designed to withstand DBE - RH bay 140/25-ton crane, CUR crane, upper hot cell bridge crane and overhead powered manipulator, and CLR grapple hoist hold their load in a DBE - Shuttle car is designed to remain on the rails in the event of a DBE S Noncombustible construction of the WHB. Thick concrete shield walls, floors, ceiling, lead glass windows, and steel doors on the hot cell complex (AC) - Combustible loading program (AC) - Emergency Response Program	Building, cranes, hoists, and shuttle car designed to withstand a DBE Prevents propagation of fires Minimizes potential for and size of fires by controlling the amount of combustible material in the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Consequences prevented by specified controls. WIPP has no gas pipelines or other passive sources of fuel that could create large fires following a seismic event.
WHB7-3 Lightning Strike to WHB Damages Waste Containers	A	High	Design Feature: WHB grounding and lightning protection system	Prevents lightning strike from impacting o waste containers in the WHB	Prevented	NA	NA	Event and consequences prevented by the specified controls.

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Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB7-4 Tornado	U	High	Design Features: WHB and hot cell complex designed to withstand DBT Facility cask (AC) - Emergency Response	Prevents WHB and hot cell complex collapse if subjected to DBT. Minimum three ft. thick concrete hot cell complex walls protect waste containers from missiles. Protects waste containers from tornado missiles Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Consequences prevented by the specified controls.
WHB7-5 Straight line winds damage WHB structure and produce wind driven missiles that damage waste containers	U	High	Design Features: WHB and hot cell complex designed to withstand DBT Facility cask (AC) - Emergency Response	Prevents WHB and hot cell complex collapse if subjected to DBT. Minimum three ft. thick concrete hot cell complex walls protect waste containers from missiles. Protects waste containers from tornado missiles Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized. Prevents building collapse due to high winds. WHB is not qualified for missiles generated by high winds.	Prevented	NA	NA	Consequences prevented by the specified controls.
WHB7-6 Hail impacts WHB causing breach of building and waste containers	A	High	Design Feature: WHB is designed to withstand a 27 lb/ft^2 snow loading	Prevents damage to building or waste	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
WHB7-7 Snow/ice accumulation on WHB roof breaches roof and waste containers	A	High	Design Feature: WHB is designed to withstand a 27 lb/ft^2 snow loading	Prevents damage to building or waste	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG1-1 Fire in disposal path (includes waste shaft station and transport path to active disposal room) impacts RH waste or RH and CH waste	A	High	Design Features: Facility cask (SSC) - Automatic fire suppression system on the RH waste handling 41-ton, 20-ton, and 6-ton waste handling forklift (SSC) - Underground ventilation (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) - Combustible Loading Control Program: - Only diesel or electrically powered vehicles are used in the underground - Prohibits storage of flammable gas or flammable compressed gas cylinders in disposal path and prevents their use in the disposal path during waste handling. - The lube truck is prohibited from the disposal path while waste is in transit.	Protects waste canister from direct flame impingement Prevents fires on diesel powered waste handling equipment from becoming large fires that can impact waste. Directs airflow away from the worker Prevents ignition sources in waste containers Prevents fires in the disposal path.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-1 Fire in disposal path impacts RH waste or RH and CH waste continued			(AC) - Waste handling restrictions that impose the following: - When waste is in transit, non-waste handling equipment shall be moved to a crosscut and be secured until the RH 41-ton forklift transporting waste has passed and is greater than 75 ft. away. Vehicles that may have become disabled (excluding the lube truck) may be in the disposal path but must be secured along the wall of the disposal path. - A spotter is required when operating RH waste handling equipment within 75 ft of the CH disposal array waste face. - A minimum standoff distance of 75 ft. is required between the 41-ton waste handling forklift and a loaded CH waste transporter. - Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground.	Prevents vehicle collision that could result in fires with the potential to impact CH waste from RH waste handling operations. Reduces consequences to workers in the event of a radiological release				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations				
			(AC) - Emergency Response	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations. Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-2 Fire in disposal room affects RH or RH and CH waste	A	High	Design Features: Disposal boreholes and shield plugs Facility cask, borehole shield collar, and HERE transfer mechanism (SSC) - Automatic fire suppression system on the RH 41-ton, 20-ton, and 6-ton diesel powered waste handling forklifts and the HERE (SSC) - Underground Ventilation (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC (AC) -Combustible Loading Control Program that requires the following: - Only diesel and electric powered vehicles are used in the underground - No lube truck in active disposal panel - No storage of flammable gas or flammable compressed gas in the active disposal room and no use of flammable gas or flammable compressed gas cylinders in the active disposal room during waste handling.	Protects the RH waste canister from explosion/fire in the disposal room after emplacement Prevents direct flame impingement on waste canister Prevents fires associated with waste handling equipment including fuel or hydraulic leaks or the engine from becoming large fires that can impact waste containers Directs airflow away from the worker Eliminates ignition sources in the waste containers Prevents fires in the disposal room	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-2 Fire in disposal room affects RH or RH and CH waste continued			(AC) - Waste handling restrictions that require: - A spotter is required when operating RH waste handling equipment within 75 ft of the CH disposal array waste face - A minimum standoff distance of 75 ft. is required between the RH 41-ton waste handling forklift and a CH waste transporter loaded with waste. - No non-waste handling vehicles in the active disposal room during waste handling. - A minimum separation distance of 75 ft between non-waste handling vehicles and the RH 41-ton forklift loaded with waste - Electrical equipment associated with the HERE or the borehole machine must be at least 10 ft from the CH waste array face or a fire watch is posted.	Prevents collisions that could result in fires with the potential to breach waste containers.				
			- Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground.	Reduces consequences to workers in the underground in the event of a radiological release.				
			(AC) - Use of Qualified Operators	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations.				
			(AC) - Emergency Response	Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-3 Fire in construction (mining) ventilation circuit	A	High	Design Features: Non-flammable construction of underground bulkheads, overcasts, and airlocks RH boreholes and shield plugs Facility cask (AC) - Combustible Loading Control Program including: - No storage of flammable gas or flammable compressed gas cylinders at bulkhead 309 and no use of flammable gas or flammable compressed gas cylinders at bulkhead 309 during waste handling operations - No storage of flammable gas or flammable compressed gas cylinders between the AIS and South 1000 in West 30 or within 100 ft of bulkhead 303 on the north ventilation side and no use of flammable gas or flammable compressed gas cylinders at those locations during waste handling operation in the underground.	Provides separation between construction and waste handling areas Protects the waste canister from effects of fire after emplacement. Prevents direct flame impingement to waste canisters Prevents introduction of fire sources to disposal areas from construction areas.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-4 Fire in north ventilation circuit	A	High	Design Features: Non-flammable construction of underground bulkheads, overcasts, and airlocks Facility cask (AC)- Combustible Loading Control Program including: - No storage of flammable gas or flammable compressed gas cylinders at bulkhead 309 and no use of flammable compressed gas cylinders at bulkhead 309 during waste handling in the underground. - No storage of flammable gas or flammable compressed gas cylinders within 100 ft of bulkhead 303 on the north ventilation side and no use of flammable gas or flammable compressed gas cylinders at that location during waste handling in the underground.	Provides separation between north circuit and waste shaft station Prevents damage to the waste canister from the effects of fires Prevents introduction of fire sources adjacent to the transport path.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG1-5 Fire in waste hoist tower	A	High	Design feature Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower Design Feature and (SSC) - Waste hoist brakes (SSC) - WHB fire suppression system (AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB and prohibits its use in the waste hoist tower during waste transport using the waste shaft conveyance. (AC) - Emergency Response	Prevents uncontrolled movement of loaded waste conveyance down the waste shaft. Prevents uncontrolled movement of the waste conveyance. Extinguishes fire before ropes or brakes are damaged. Prevents fires in the waste hoist tower. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized.	Prevented	NA	NA	Event and consequences prevented by specified controls. No consequences are expected from the fire alone, but if not extinguished the fire could be an initiator for UG3-1.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG2-1 Explosion followed by fire in disposal path affects RH or RH and CH waste	U	High	Design Features: Facility cask design (SSC) - Underground Ventilation (AC) -Waste handling restriction: Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground. (AC) - Combustible Loading Control Program including: - No storage of flammable gas and flammable compressed gas in the disposal path and no use of flammable gas or flammable compressed gas in the disposal path during waste transport in the disposal path. (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) -Drums shipped in a 10-160B cask and 72-B canisters approved for disposal at the WIPP must be vented as implemented at generator sites through adherence to the RH WAC. (AC) - Use of Qualified Operators	Prevents direct flame impingement on the waste canister and protects the canister from and explosion external to the facility cask. Directs airflow away from the worker Reduces consequences to workers in the event of a radiological release. Prevents explosions/fires in the disposal path. Eliminates ignition sources in waste containers. Prevents pressurization of waste containers due to gas generation. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG2-1 Explosion followed by fire in disposal path affects RH or RH and CH waste continued			(AC) - Emergency response	Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations.				
UG2-2 Explosion followed by fire in active disposal room affects RH waste or RH and CH waste	A	High	Design Features: Disposal boreholes and shield plugs (SSC) - Underground Ventilation Facility cask, borehole shield collar, and HERE transfer mechanism (AC) - Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC. (AC) -Drums shipped in a 10-160B cask and 72-B canisters approved for disposal at the WIPP must be vented as implemented at generator sites through adherence to the RH WAC. (AC) -Combustible Loading Control Program that requires the following: - No storage of flammable gas or flammable compressed gas cylinders in the active disposal room and no use of flammable compressed gas or flammable compressed gas cylinders in the active disposal room during waste handling.	Protects the waste canister from explosion/fire in the disposal room and protects CH waste from an explosion/fire in an RH canister after emplacement Directs airflow away from the worker Protects the waste canister from an explosion/fire in the disposal room during emplacement. Eliminates ignition sources in waste containers Prevents pressurization of waste containers due to gas generation. Prevents explosions/fires in the disposal room.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG2-2 Explosion followed by fire in active disposal room affects RH waste or RH and CH waste Contd			(AC) - Waste handling restriction: Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground. (AC) - Use of Qualified Operators (AC) - Emergency Response	Prevents worker consequence in the event of a radiological release. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations. Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.				
UG2-3 Battery Explosion on the RH waste handling forklifts	A	High	Design Feature: Disposal boreholes and shield plugs Facility cask, borehole shield collar, and HERE transfer mechanism (SSC) - Underground Ventilation (AC) - Battery charging for the RH 41-ton, 20-ton, or 6-ton waste handling forklifts shall not be done within 75 ft of the CH waste face. Battery charging for the RH waste handling forklifts shall not be done in the disposal path during CH waste transport. Charging must be performed in a crosscut or in an unused room in the disposal circuit.	Protects the waste canister from explosion/fire in the disposal room and protects CH waste from an explosion/fire in an RH canister after emplacement Protects the waste canister from an explosion/fire in the disposal room during emplacement. Directs airflow away from the worker Prevents missiles with the potential to impact CH waste.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG2-6 Explosion in the waste hoist tower results in damage to the waste hoist or conveyance causing loaded facility cask to fall to the bottom of the waste shaft	A	High	Design feature Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower Waste hoist brakes (AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB and prohibits its use in the waste hoist tower during waste transport using the waste shaft conveyance. (AC) - Emergency Response	Prevents uncontrolled drop of the waste shaft conveyance Prevents uncontrolled drop of a loaded waste conveyance down the shaft. Prevents fires in the waste hoist tower when transporting waste. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG3-1 Loss of confinement due to waste hoist failure	A	High	Design Feature: Waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower Design Feature and (SSC) - Waste hoist brakes (AC) - Waste Hoist Structure and Structural Support Integrity Program (AC) - Waste handling restriction verify: prior to moving the facility cask loaded with RH waste onto the waste shaft conveyance, the weight of the loaded canister. If the weight the weight of a RH waste canister exceeds 3220 lbs, the loaded facility cask shall not be moved onto the waste shaft conveyance until the maintenance platform has been removed. (AC) - Emergency Response	Prevents uncontrolled drop of loaded waste conveyance down the shaft. The head frame and hoist drum support the counterweight, waste shaft conveyance and ropes. The structural support for the waste hoist head frame is provided by the waste hoist tower. Counterweight may off set RH load such that waste and counterweight balance or waste slowly accelerates to bottom of shaft Prevents uncontrolled drop of a loaded waste conveyance down the shaft. Ensures integrity of the load bearing components associated with the waste hoist. Prevents overloading the rated capacity of the waste hoist. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG3-2 Loss of confinement during RH waste transport from the waste shaft station to disposal room involving RH or RH and CH waste	A	High	Design feature Facility cask (SSC) - Underground Ventilation (AC) - Waste handling restrictions require: - a minimum 75 ft standoff distance between the RH waste handling forklift and a loaded CH waste transporter - use of a spotter when operating the 41-ton forklift loaded with waste. - the use of a spotter when operating the 41-ton, 20-ton, or 6-ton waste handling forklifts are operated within 75 ft of the CH disposal array waste face. - Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground. . (AC) - Compressed Gas Cylinder Control Program prevent storage of compressed gas cylinders in the active disposal room and prevent their use during waste handling activities. (AC) - Use of Qualified Operators (AC) - Emergency Response	Protects RH waste canister during transit from waste shaft station to disposal room from impacts and breaches. Directs airflow away from the worker Prevents collisions between waste handling vehicles that could result in a breach of waste containers and prevents a collision with the waste face. Minimizes the number of people in the release flow path reducing potential for radiological exposure. Prevents breach of waste containers from gas cylinder missile Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations. Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG3-3 Loss of confinement in the disposal room	A	High	Design Feature Facility cask design (SSC) - Interlocks between the Facility cask and HERE ensure the transfer mechanism does not operate if there is any misalignment between the HERE and th borehole and the facility cask. (SSC) - Facility cask shield valve interlock with the HERE transfer mechanism. (SSC) - Underground Ventilation (AC) - Waste handling restrictions: - No non-waste handling vehicles are allowed in active disposal room during waste handling - Personnel access shall be restricted in E-300 from the exit of the active disposal room to the underground ventilation exhaust shaft during waste handling operations in the underground. (AC) - Compressed Gas Cylinder Control Program prevent storage of compressed gas cylinders in the active disposal room and prevent their use during waste handling activities. (AC) - Use of Qualified Operators (AC) - Emergency Response	Protects canister from drops or impacts. Prevents crushing a canister due to misalignment of the HERE and facility cask with the borehole. Prevents shield valves from closing when the transfer mechanism is extended beyond either shield valve and crushing a canister. Directs airflow away from worker Prevents collision in the disposal room that could result in breaching a waste canister. Minimizes the number of people in the release flow path reducing potential for radiological exposure. Prevents breach of waste containers from gas cylinder missile Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations Mitigates event by ensuring prompt reporting of event to CMR and appropriate actions commenced to minimize personnel exposure to the release.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG3-5 Loss of confinement due to roof fall during transport to or in the active disposal room	U	High	(AC) - Ground control program to require weekly inspections (AC) - Ground Control Program	Prevents roof fall event in an active disposal room by detecting conditions that indicate instability and initiating action to repair or close the room	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG3-6 Loss of confinement due to driving loaded FCTC into waste shaft	A	High	Design feature Fence around the waste shaft collar (AC) -Toplander control of waste shaft access (AC) - Waste handling restriction requires that prior to moving the FCTC loaded with the facility cask from the FCLR to the waste shaft collar area, the waste shaft conveyance is verified to be at the collar of the waste shaft. (AC) - Use of Qualified Operators	Prevents a load from inadvertently entering the waste shaft. Prevents a load from inadvertently entering waste shaft Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position. Ensures operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG4-1 Direct radiation exposure	A	High	Design Feature: Facility cask HERE borehole shield collar and transfer mechanism. Shield plug (SSC) - Interlocks between the HERE transfer carriage, shield collar, including tilt sensors, and facility cask to provide shielding (AC) - Generator site characterization program must ensure that RH waste to be disposed of at the WIPP does not exceed 1000 Rem/hr on contact as required by the RH WAC. (AC) - Waste handling restriction to: - require placement of a shield plug in the disposal borehole before removing the facility cask from the HERE after canister emplacement - require boreholes to be 17 ft deep (-0/+2 ft.) and .to be placed nominally 34 ft. from the corner of salt pillars along the short axis of the pillar that separate the disposal rooms and nominally 26 ft .from the corners of the of the salt pillar along the long axis.	Provides shielding to prevents direct radiation exposure to worker from RH waste canister up to 1000 Rem/hr. Ensures that shielding is maintained during canister transfer Limits radiation levels to that authorized as RH waste Prevents direct radiation exposure to workers.	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG5-1 Criticality	EU	High	(AC) -Criticality Safety Program Criticality Safety Program that requires: - Fissile limits of 325 FGE imposed for 72-B RH waste canisters with no single drum exceeding 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - No drum shipped in a 10-160B shipping cask can exceed 200 FGE for waste approved for disposal at the WIPP, as implemented at generator sites prior to shipment, as required by the RH WAC. - A loaded facility canister does not exceed 600 FGE with no single drum exceeding 200 FGE. - Special moderator and reflector limits imposed by the criticality safety evaluation for the WIPP are specified in the RH WAC and implemented at generator sites prior to approval for shipment to the WIPP. (AC) - Waste disposal configuration requires disposal bore holes to be placed greater than 30 inch center-to center boreholes	Protects assumptions for NCSE that shows criticality in underground not credible	BEU	High	III	See RH DSA Chapter 6
UG6-1 Loss of AC Power	A	High	Design Feature and (SSC) - Waste hoist brakes	Prevents uncontrolled drop of a loaded waste conveyance down the shaft	Prevented	NA	NA	Event and consequences prevented by specified controls
UG6-2 Equipment or Materials Dropped Down the Waste Shaft While RH Waste in Transit to UG	A	High	Design Features: Fence around the waste shaft at the collar (AC) - Toplander control of waste shaft access.	Defined restricted area bounding waste shaft and prevents uncontrolled access to the shaft Prevents a load from inadvertently entering waste shaft	Prevented	NA	NA	Event and consequences prevented by specified controls.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
UG7-3 Earthquake followed by fire impacts facility cask on waste shaft conveyance or at the bottom of the waste shaft.	U	High	Design Feature: Waste hoist is designed for design basis loads including the DBE. WHB is designed for design basis loads including the DBE (AC) - Combustible Loading Control Program prohibits storage of flammable gas and flammable compressed gas in the WHB including the waste hoist tower and prevents its use in the waste hoist tower during waste transport on the waste shaft conveyance.	Prevents uncontrolled drop of the waste hoist or load and prevents structural collapse of the building from a DBE. Prevents fires in the WHB and waste hoist tower.	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG7-4 Lightning Strike to Waste Hoist impacts Waste in Transit	A	High	Design: Lightning dissipation system on the waste hoist tower Steel frame WH structure is grounded	Prevents lightning from damaging building and waste. Shunts electrical voltage surge to ground preventing damage to structure	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG7-5 Tornado missiles impact waste in transit on waste shaft conveyance	EU	High	Design Feature: Conveyance is designed such that waste is transported below the man deck	Prevents wind born missiles from impacting waste	Prevented	NA	NA	Event and consequences prevented by specified controls.
UG7-6 High wind missiles impact waste in transit on waste shaft conveyance	EU	High	Design Feature: Conveyance is designed such that waste is transported below the man deck	Prevents wind born missiles from impacting waste	Prevented	NA	NA	Event and consequences prevented by specified controls.
BG6-1 Aircraft Crash	EU	High	None	NA	NA	NA	NA	Aircraft crash is not credible as discussed in Section 3.4.2.7.

Table A-14 - Facility Worker MHE Summary

Event	Unmitigated		Credited SSC or AC	Safety Functions	Mitigated			Comments
	Freq.	Conseq			Freq.	Conseq.	Risk Bin	
BG7-1 Earthquake impacts facility resulting in breach of waste containers	A	High	Design Features: - WHB and Hot Cell complex designed to withstand DBE - RH bay 140/25-ton crane, CUR crane, upper hot cell bridge crane and overhead powered manipulator, and FCLR grapple hoist hold their load in a DBE - Shuttle car is designed to remain on the rails in the event of a DBE S Noncombustible construction of the WHB. Thick concrete shield walls, floors, ceiling, lead glass windows, and steel doors on the hot cell complex (AC) - Combustible loading program (AC) - Emergency Response Program	Building, cranes, hoists, and shuttle car designed to withstand a DBE Prevents propagation of fires Minimizes potential for and size of fires by controlling the amount of combustible material in the WHB. Ensures worker is trained to respond to abnormal events such as fires, spills, or other waste container breaches, such that inhalation of radioactive of material is minimized Prevents structural failure of the WHB.	Prevented	NA	NA	Event and consequences prevented by the controls specified.

SAFETY STRUCTURES, SYSTEMS, and COMPONENTS

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SAFETY STRUCTURES, SYSTEMS, and COMPONENTS

4.1 Introduction

This chapter provides details on those system, structures, and components (SSCs) that are designated as Safety Class (SC) or Safety Significant (SS) for the WIPP remote handled (RH) waste handling process. The purpose of selecting SC and SS SSCs is to provide protection to the public and workers by identifying those SSCs that are most important to preventing or mitigating postulated events. The selection of SC and SS SSCs was made in the Chapter 3. SC SSCs are discussed in Section 4.3 and SS SSCs are discussed in the remaining sections and listed in Table 4.4-1 of this chapter.

The scope of this chapter includes the following:

- Description of the SC and SS SSCs for the WIPP including the required safety functions
- Identification of the functional requirements necessary for the safety SSCs to perform their safety functions and the general conditions caused by postulated accidents under which the safety SSCs must operate
- Identification of the performance criteria necessary to provide reasonable assurance that the functional requirements will be met
- Identification of initial conditions that are SSCs and require technical safety requirement (TSR) coverage

4.2 Requirements

This chapter was prepared in accordance with the format, content, and graded approach guidelines for identifying safety SSCs in accordance with Title 10 CFR Part 830, Subpart B, "Safety Basis Requirements"[1]; U.S. DOE Standard (STD) *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis* (DOE-STD-3009-94)[2]; and DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*.[3]

4.3 Safety-Class Systems, Structures, and Components

SC SSCs are those SSCs whose preventive and/or mitigative function is necessary to keep radiological exposure to the public from challenging the off-site evaluation guideline. The guideline specifies a value of 25 rem total effective dose equivalent to a maximally exposed member of the public be used as the threshold for identifying SC SSCs and, as explained in Section 3.4.1.5, greater than 15 rem has been used as the unmitigated consequence level which is considered to challenge the off-site evaluation guideline. The following SSCs are designated SC.

4.3.1 Waste Handling Building Structure

4.3.1.1 Safety Function

The noncombustible construction of the Waste Handling Building (WHB) prevents fire propagation within the building. For the RH portion of the WHB, the rooms within the hot cell complex includes thick concrete walls, floors, ceilings, and steel doors and shield valves that segregate the rooms from each other and the entire hot cell complex from the RH bay and the rest of the WHB.

The WHB is designed and constructed to withstand a design basis earthquake (DBE) and prevents the building from structural failure and collapsing on waste containers outside closed shipping casks.

4.3.1.2 System Description

The WHB is designed and constructed in accordance with the requirements for National Fire Protection Association (NFPA) 220, *Standard on Types of Building Construction*,[4] Type II construction. The WHB is described in Sections 2.4.1 and 2.6.1.

The hot cell complex includes the following: the cask unloading room (CUR), lower hot cell, and facility cask loading room (FCLR) are on the ground floor, the transfer cell is on the floor below the CUR and FCLR, the upper hot cell is on the second floor above the CUR and transfer cell, while the crane maintenance room are on the third floor. The walls, floor, and ceilings that separate the rooms and cells that comprise the hot cell complex and the walls that separate the hot cell complex from the rest of the WHB are constructed of concrete with a minimum 36 inch thickness. The construction also includes thick steel shield doors, shield valves, concrete shield plugs, and shield windows. The hot cell complex is further described in Sections 2.4.1.2 through 2.4.1.7.

The WHB is designed for the DBE of .1 g (acceleration of gravity) peak acceleration with a 1,000-year return interval.

The WHB design is further discussed in Chapter 2 of this documented safety analysis (DSA). The design and performance requirements for the WHB is documented in the System Design Description (SDD) CF00-GC00, *Plant Buildings, Facilities, and Miscellaneous Equipment*.[5]

4.3.1.3 Functional Requirements

The WHB is required to meet NFPA 220,[4] Type II construction such that fires outside the building or within the building do not propagate and damage waste containers outside of closed shipping casks.

The WHB is required to withstand the DBE postulated for the WIPP of .1 g peak acceleration with a 1,000-year return interval such that the building structure does not collapse in a DBE and damage waste containers.

4.3.1.4 System Evaluation

The design requirements for the hot cell complex are specified in SDD CF00-GC00.[5] Since the hot cell complex is also designed to provide shielding when RH waste containers are outside of a shipping cask, the walls, floors, and ceilings are constructed of concrete and are not only sufficiently thick to provide the necessary shielding, but provide segregation between rooms within the hot cell complex such that fires do not propagate between rooms and additionally, prevents fire propagation from the RH bay into the hot cell complex and from the hot cell complex to the RH bay.

The CUR is separated from the upper hot cell by a 54 in. thick concrete ceiling and two concentric 54 in. thick shield plugs. The thickness of the concrete ceiling and shield plugs prevents a fire in the CUR from propagating to the upper hot cell when the shield plugs are installed. The CUR is separated from the RH bay by 54. in thick concrete wall and a steel concrete filled 140-ton shield door. The CUR shield door is 18.2 ft. long by 22.0 ft. high by 4.0 ft. thick. The CUR shield door is open when a 72-B shipping cask is being processed in the CUR, and closed when a 10-160B shipping cask is being processed in the CUR. The shield plugs are removed when transferring items between the upper hot cell and the CUR.

The upper hot cell is separated from the operating gallery by 54 in. thick concrete wall and six shielding windows The operating gallery side of the shielding windows consists of a tempered cover glass and three 5 inch thick lead shielded glasses. The upper hot cell side consists of a 1 ½ inch thick non-browning cover glass. The space between the sides is filled with mineral oil. The shield wall and windows will prevent fire propagation between the operating gallery and the upper hot cell.

The upper hot cell is separated from the transfer cell by 54 inch thick concrete floor and an 8 in thick steel shield valve and a vertical distance of over 28 ft. The upper hot cell shield valve is open only when transferring a waste canister between the two areas. The thickness of the floor and shield valve and vertical separation prevent fire propagation between the transfer cell and the upper hot cell.

The transfer cell is separated from the FCLR by a 54 inch thick concrete floor and a steel shield valve in the ceiling of the transfer cell. The transfer cell ceiling shield valve is normally closed and is only opened when processing waste from a 72 B shipping cask or transferring a facility canister into the facility cask. The concrete floor and shield valve prevent fire propagation between the FCLR and the transfer cell.

The upper hot cell is separated from the RH bay by a 54 inch thick concrete wall. The concrete wall will prevent fire propagation between the RH bay and the upper hot cell.

The FCLR is separated from the RH bay by a concrete wall, minimum thickness of 24 inch and thick steel doors. The doors are required to be closed during RH waste handling in either area. The wall and doors will prevent fire propagation between the FCLR and the RH bay.

The crane maintenance room is separated from the upper hot cell by a 4 ft. high 54 inch thick concrete shield wall and a ceiling mounted 2 inch thick steel shield door. The crane maintenance room shield door is normally closed and is only opened when moving the upper hot cell crane into the room for repair. The shield wall and door prevent fire propagation between the crane maintenance room and the upper hot cell when the door is closed.

The transfer cell service room is separated from the transfer cell by a 54 inch thick concrete shield wall and a shield plug is installed in the grapple override ports. The shield plugs are installed unless the grapple override tool is being used. The concrete shield wall and shield plugs prevent fire propagation between the transfer cell and the transfer cell service room.

The WHB is constructed as designed for the DBE of .1 g (acceleration of gravity) peak acceleration with a 1,000-year return interval. The TRUPACT Maintenance Facility (TMF) shares a common wall with the WHB on the west end of the contact handled (CH) bay. The Support Building is located directly north of the CH portion of the WHB. While the RH portion of the WHB is segregated from both the TMF and Support Building by the CH portion of the WHB, the main lateral force resisting structural members of the TMF and Support Building are designed to withstand the DBE to prevent those structures from collapsing on the adjacent WHB.

4.3.1.5 Controls (TSRs)

The WHB constructed design and non-combustible construction of the WHB and hot cell complex structure are passive design features. There are no TSR controls required except the configuration and change control process that invokes the unreviewed safety question (USQ) process for a review of any changes to those structures. Programmatic controls include configuration management and the USQ process for any design change.

4.3.2 Waste Hoist Brakes

4.3.2.1 Safety Function

The waste hoist brakes prevent the uncontrolled movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure that could result in a breach of waste containers.

4.3.2.2 System Description

The waste hoist brakes are described in Section 2.4.4.2. There are two sets of brakes mounted approximately 180 degrees apart on each braking flange of the hoist wheel. The brake calipers are mounted to provide a braking surface on both sides of the friction wheel brake discs. The brake material is held against the wheel disc by a series of cupped washer springs. The brakes are normally engaged except when the conveyance is in motion. The brakes are released by applying hydraulic pressure to a piston that compresses the springs which in turn moves the brake pads away from the brake disc. The brake pads return to the "set" position when the hydraulic pressure is released from the piston. The springs set the brakes.

4.3.2.3 Functional Requirements

The waste hoist brakes are required to stop movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure under all hoist operations including maximum speed and maximum load at any location along the shaft. The waste hoist brakes can stop the fully loaded waste shaft conveyance under all emergency stop conditions. The redundant brakes are designed so that either set is capable of stopping the waste shaft conveyance when the conveyance carries the maximum payload at the maximum hoisting depth.

4.3.2.4 System Evaluation

The waste hoist brake system must be energized to release both independent sets of brakes. During loss of power, the brakes fail safe to the engaged position. Either set of brakes is capable of holding the fully loaded waste shaft conveyance.

A series of tests are performed on the waste hoist brakes at the beginning of each shift before the hoist is put into service. The emergency stop test verifies that the hoist motor shuts down and the brakes remain set. A static brake test ensures that the brakes are fully engaged by increasing amps on the hoist drive motor and verifying that the drum does not move. The brake dump valves test is also performed to ensure operation of the normal emergency braking system. Testing is accomplished with the hoist initially reset and stopped. The push button is depressed and held, and hoist movement is attempted. If the system is operating properly, the brakes will set soon after the brake fluid pressure rises above 1,200 psi during brake release. The motor torque will then operate against the brakes, similar to the action of a static brake test. When the brake dump valves test push button is released after a successful test, the hoist will trip off-line.

The emergency brake valves test push button is used to perform a static test of the operation of the emergency brake solenoid valves. This test is similar to the static brake test.

4.3.2.5 Controls (TSRs)

The TSRs require an administrative control to perform preoperational checks on the waste hoist brakes at the beginning of each shift, prior to placing the waste hoist in service.

4.3.3 Waste Hoist Structure and Structural Support

4.3.3.1 Safety Function

The waste hoist structure and structural support ensure that the waste shaft conveyance will not fall into the waste shaft in an uncontrolled manner, during normal operations and seismic events, that could result in breaching a RH waste container.

4.3.3.2 System Description

These waste hoist structure and structural support are described in Section 2.4.4 and consist of the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and structural support provided by the waste hoist tower. The loaded RH facility cask is the maximum load that the hoist was designed for. SDD UH00, Underground Hoisting,[15] discusses the design and performance requirements for the waste hoist.

4.3.3.3 Functional Requirements

The waste hoist load bearing components are designed to ensure that the hoist will not fail under maximum loading conditions coincident with design basis natural events. The loaded RH facility cask is the maximum load that the hoist is designed to support.

4.3.3.4 System Evaluation

The hoist head frame structure, the conveyance, the conveyance ropes, and counterweight are designed and constructed to withstand the loads associated with normal operations, emergency conditions, and the design basis natural events. The ropes have at least a 5.9 factor of safety against maximum design payload and a minimum endurance of 400,000 cycles.

The conveyance is constructed in accordance with the design for the vertical load combination of dead load, maximum payload, and forces transmitted from the hoisting ropes and tail ropes during normal operation. The allowable stress for all the steel members and connections is limited to 25 percent of American Institute for Steel Construction-allowable stresses to allow for accelerations, decelerations, impact loading and fatigue.

The ropes are designed and constructed to remain intact in the event that the brakes fail allowing the counterweight to propel the conveyance into the over travel arresters in the hoist head frame.

The counterweight is sized to minimize the torque required to control the system across the range of payloads the conveyance will carry. When carrying RH waste, the conveyance is slightly heaver than the counterweight to ensure that in case of power and brake failure, the conveyance will tend to slowly fall in the waste shaft when loaded with the maximum allowed RH load.

The waste hoist was load tested to its design load after initial installation. Subsequently, weekly rope and attachment inspections, periodic electro-magnetic testing of the ropes to detect rope degradation, and the static brake test ensure the continued integrity of the waste hoist system. Periodic waste shaft conveyance inspections are performed to monitor any degradation for structural integrity.

4.3.3.5 Controls (TSRs)

The TSRs include programmatic controls for the configuration management and the USQ process for any design change. In addition, the TSRs require that a waste hoist structure and structural integrity support program shall be established and shall determine the periodic inspections, tests, and/or maintenance activities and periodicity for those activities that are needed to maintain the integrity of the load bearing components associated with the waste hoist.

4.3.4 Waste Shaft Conveyance

4.3.4.1 Safety Function

The waste shaft conveyance sized to support transport of only one RH canister to the underground in a facility cask, at a time, which limits the MAR in the waste shaft. The material deck is located below the man deck such that RH waste is protected from falling objects and tornado missiles.

4.3.4.2 System Description

The waste shaft conveyance is described in Section 2.4.4.2. The waste shaft conveyance is designed such that the height, width, and length of the materials deck can hold only RH facility cask loaded with one waste canister and cannot accommodate both RH waste in a facility cask and CH waste at the same time. The RH waste canister can weigh up to 8,000 lbs. The rails on the material deck of the conveyance interfaces with the rail-mounted facility cask transfer car (FCTC). The material deck is located below the man deck.

4.3.4.3 Functional Requirements

The waste shaft conveyance, by passive design, is sized to carry one RH facility cask loaded with one waste canister.

4.3.4.4 System Evaluation

The waste shaft conveyance in conjunction with the waste hoist is constructed in accordance with the design to support transport of either one RH facility cask or one facility pallet of CH waste at a time. The RH facility cask containing an RH waste canister of up to 8,000 lbs. is the maximum load handled at the WIPP. The waste shaft conveyance structurally support the FCTC on rails mounted on the material deck. The material deck height accommodates the facility cask in a horizontal position on the FCTC. The conveyance is equipped with a maintenance platform located on the top of the conveyance that is used for personnel performing shaft inspections. The maintenance platform must be removed if an RH waste canister to be transported to the underground weighs more than 3220 lbs. to avoid exceeding the capacity of the waste hoist.

4.3.4.5 Controls (TSRs)

This structure is a passive design feature. TSR controls include the configuration and change controls processes that invoke the USQ process for a review of any design changes to the waste shaft conveyance. The TSRs will also contain a waste handling restriction to remove the maintenance platform on the conveyance prior to moving the loaded facility cask onto the conveyance if a RH waste canister to be transported to the underground exceeds 3,220 lbs.

4.3.5 Underground RH Waste Handling Equipment Automatic/Manual Fire Suppression System

4.3.5.1 Safety Function

The underground RH waste handling equipment automatic/manual fire suppression system prevents small fires associated with waste handling equipment including fuel or hydraulic leaks or the engine from becoming large fires with the potential to impact waste containers.

4.3.5.2 System Description

The underground RH waste handling equipment automatic/manual fire suppression system provides a dry chemical fire suppressant available to extinguish vehicle fires associated with fuel and hydraulic leaks and the vehicle engine. The RH 41-ton, 20-ton, and 6-ton forklifts and the alignment fixture assembly of the horizontal emplacement retrieval equipment (HERE) are each equipped with an automatic/manual fire suppression system.

A general description of the system is described in Section 2.5.4.6. The system is comprised of electric powered detection capability, and a compressed nitrogen gas cartridge that, when actuated, fluidizes the fire suppressant powder and forces the powder to the distribution network. The system is also equipped with a control module that includes system status lights to indicate normal and trouble conditions, and a provision to test the status lights. On the forklifts the fire suppressant is directed towards the engine compartment. On the alignment fixture assembly of the HERE, the system has four discharge nozzles aimed at the hydraulic power unit and hydraulic jacks.

The system automatically actuates when the detection circuit shorts due to heat generated by fire causing current to a squib. The squib is an electrically actuated component containing a small charge of powder which forces a pin to puncture the cap/seal on the compressed nitrogen gas cartridge. The gas is directed via tubing to the fire suppressant container where the suppressant is fluidized and dispersed into the distribution piping. The system also has a manual capability that bypasses the electrical squib, such that the manual actuator forces the pin to break the cap/seal on the compressed nitrogen gas cartridge.

The control module includes status lights that indicate that the system is not discharged and that the detection circuit is functioning properly. The control module is mounted such the operator of the RH waste handling equipment can see the system status indication.

4.3.5.3 Functional Requirements

The underground RH waste handling equipment shall be equipped with a fire suppression system that automatically actuates and provides fire suppression sufficient to prevent a fire associated with the fuel or hydraulic leaks and the engine from developing into a large fire. The system is required to also have manual capability to actuate the system. This includes the RH 41-ton, 20-ton, and 6-ton forklifts and the HERE.

4.3.5.4 System Evaluation

The underground waste handling vehicles automatic/manual fire suppression system and the alignment fixture assembly of the HERE automatic fire suppression system are designed, installed, tested, and maintained according to the NFPA Standards NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.[6] The guidance provided in DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for use with DOE O 420.1, Facility Safety*,[7] does not specify requirements for dry chemical extinguishing systems. The installed system on each piece of diesel powered waste handling equipment meets the requirements for mobile equipment described in NFPA 17. The design requirements for the RH waste handling equipment is documented in SDD WH00, RH TRU Waste Handling Equipment Requirements, Design, and Operation.[16]

4.3.5.5 Controls (TSRs)

The TSRs contain limiting conditions of operation (LCO) with respect to underground RH waste handling equipment automatic/manual fire suppression system availability to prevent damage to waste containers in the underground disposal path or active disposal room. Periodic surveillance will be performed to ensure system operability. Should underground RH waste handling equipment automatic/manual fire suppression become unavailable, the TSRs define the necessary actions to reduce the risk of fires with the potential to breach waste containers in the underground.

4.4 Safety-Significant Structures, Systems, and Components

The SS SSCs are specified in Chapter 3 in Tables A-13 and A-14, and discussed in the following sections. The SS SSCs are summarized in Table 4.4-1, including the safety functions, accident events from Chapter 3 upon which the SS designation is based, functional requirements, and performance criteria judged to require TSR coverage.

4.4.1 Fire Water Supply and WHB Fire Suppression Systems

4.4.1.1 Safety Function

The safety function of the fire water supply and WHB fire suppression systems is to extinguish fires within the WHB before they become large enough to impact RH waste, propagate to areas containing RH waste outside of a closed shipping cask, or propagate from the RH portion of the WHB to the CH bay and impact CH waste.

4.4.1.2 System Description

The portion of the fire water supply and WHB fire suppression systems addressed here are those that support the WHB, including the waste hoist tower.

A general description of the fire water supply system is contained in Section 2.7.3. The SS portion of the water distribution system includes a 180,000-gallon water storage tank dedicated to supplying fire water. The SS portion of the fire water supply system includes one electric and one diesel fire pump each rated for 1,500 gallons per minute at greater than 105 psi, a jockey pump to maintain system pressure, and a yard distribution system. The SS portion of the system also includes the supply risers and valving up to the flange after the piping enters the WHB. The WHB is supplied by three risers, one in the overpack and repair room, one in the RH bay and one in the CH bay. The TMF receives its fire water supply from the CH bay suppression portion of the WHB. The waste hoist tower and a portion of the CH bay receives fire water from the WHB supply in the overpack and repair room. The RH bay, the upper hot cell operating gallery, the FCLR, and the crane maintenance room receives its fire water from the RH bay fire water supply riser.

The SS portion of the fire suppression system inside the WHB includes the main drains, instrumentation, alarm valves, water flow detection devices, water motor gongs, isolation valves, fire department connections, distribution piping with installed fusible sprinklers, valving, and inspectors test connections. The TMF, supplied from the suppression system in the WHB, is equipped with distribution piping with installed fusible sprinklers, valving, a flow switch, an inspectors test connection, and an isolation valve and associated drain. The suppression system includes pressure relief valves to protect the piping from high pressures due to pressure surges and thermal expansion of the trapped water. There are no specific requirements for the TMF portion of the WHB fire suppression system applicable to RH waste handling. This is because of the distance between the TMF and the RH portion of the facility and the thick concrete non-combustible construction of the hot cell complex that protects RH waste containers when they are outside of the RH shipping casks or the facility cask.

Sprinkler systems are maintained full of water and pressurized by the fire water distribution system. When a fire occurs, the heat produced will cause one or more sprinklers in the area to actuate causing water to flow. The sprinkler system will continue to flow until it is shut off manually.

4.4.1.3 Functional Requirements

The fire water supply and WHB fire suppression system must automatically actuate and provide fire suppression sufficient to keep any fire from developing into a large fire that impacts RH or CH waste. The design requirements for this system are documented in SDD FP00, *Fire Protection System*.[8]

4.4.1.4 System Evaluation

The fire water supply is designed, installed, tested, and maintained according to the NFPA Standards NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*[9]; NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*[10]; and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.[11] The automatic wet pipe sprinkler systems are designed, installed, tested, and maintained in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*[12] and NFPA 25.[11]

The fire suppression system is capable of performing its safety function in the absence of electric power due to the heat-rated fusible-link actuation of the sprinkler heads in the facilities and the diesel driven pump. The fire suppression system and the fire water supply and distribution system are not designed to withstand the effects of a DBE or design basis tornado (DBT).

4.4.1.5 Controls (TSRs)

The TSRs will contain LCOs with respect to fire water supply and WHB fire suppression availability to prevent damage to RH waste containers the WHB. The specific areas of the WHB that include sprinklers necessary to protect RH waste includes the RH bay, the FCLR, the crane maintenance room, the hot cell operating gallery and the waste hoist tower. Periodic surveillance and maintenance in accordance with NFPA 25[11] will be performed to ensure system reliability, including pressure checks, flow testing, water supply level, interlock testing, control of valve lineups, diesel fuel quantity, and verification of automatic functions.

Should the fire water supply to the WHB or the fire suppression system in the WHB become unavailable, the TSRs define the necessary actions to provide a reduced risk of fires with the potential to breach RH waste containers in the WHB.

4.4.2 Waste Handling Building

The WHB is functionally classified as SC in Section 4.3 for the those features that prevent radiological consequences to the public. Those WHB design features that provide a SS function for worker protection are discussed below.

4.4.2.1 Safety Function

The WHB (including the waste hoist tower) is designed and constructed to withstand snow/ice loading, high winds and the DBT, and dissipates lightning to prevent damage to the RH waste containers within it. The hot cell complex of the WHB is designed and constructed to provide shielding for worker protection with its thick concrete walls, floors, ceilings; upper hot cell, CUR, and transfer cell shield valves, CUR and crane maintenance room shield doors; upper hot cell floor shield plugs and grapple override port shield plugs; and upper hot cell lead glass shield windows. The structural beams in the upper hot cell under the canister storage wells supports facility canisters to prevent a waste canister from falling to the lower hot cell.

4.4.2.2 System Description

Those features of the WHB that provide a SC function for public protection are described in Section 4.3.1.2.

The WHB including the waste hoist tower is primarily constructed of concrete and steel. The hot cell complex of the WHB is designed and constructed to provide shielding for worker protection with its thick concrete walls, floors, ceilings; upper hot cell, CUR, and transfer cell shield valves, CUR and crane maintenance room shield doors; upper hot cell floor shield plugs and grapple override port shield plugs; and upper hot cell lead glass shield windows. Further details of the hot cell complex are provided in Section 4.3.1.4.

The WHB is grounded and has a lightning protection system.

The WHB is designed to withstand a 27 lb/per square foot (ft^2) snow load. The WHB is designed to withstand (1) a tornado with a 183-mile-per-hour (mph) wind speed at a 1,000,000-year return frequency, (2) straight winds with a wind speed of 110 mph with a 1,000-year return frequency. The WHB including the waste hoist tower is designed to withstand the DBT with 183 miles per hour and a translational velocity of 41 miles per hour, a maximum rotational velocity radius of 325 ft, a pressure drop of 0.5 pounds per square inch ($lb/in.^2$) and a pressure drop rate of 0.09 $lb/in.^2/s$. The WHB is not designed to withstand wind or tornado driven missiles.

The structural beams in the upper hot cell under the canister storage wells supports facility canisters and prevent a waste canister from falling to the lower hot cell.

The WHB is described in Sections 2.4.1 and 2.6.1. The lightning protection and grounding system for the WHB is described in Section 2.8.1.4.

4.4.2.3 Functional Requirements

The WHB must withstand the design basis snow and ice loads postulated for the WIPP without resulting in a roof collapse that could impact RH waste. The WHB is required to withstand high winds and the DBT postulated for the WIPP site without resulting in structural failure that could impact RH waste. The WHB must withstand lightning strikes associated with inclimate weather at the WIPP such that the WHB and waste containers within the WHB are not breached. The hot cell complex within the WHB shall be designed to provide shielding for worker protection when RH waste is outside of a closed shipping cask or the facility cask. The WHB structural beams in the upper hot cell are required under the canister storage wells to support facility canisters and prevent a waste canister from falling to the lower hot cell.

4.4.2.4 System Evaluation

The WHB including the waste hoist tower is primarily constructed of concrete and steel. The hot cell complex of the WHB is constructed to provide shielding for worker protection with its thick concrete walls, floors, ceilings; upper hot cell, CUR, and transfer cell shield valves, CUR and crane maintenance room shield doors; upper hot cell floor shield plugs and grapple override port shield plugs; and upper hot cell lead glass shield windows. The robust hot cell complex construction prevents fires/explosions in areas outside the hot cell complex from propagating to areas inside the hot cell complex, from fires or explosions within one part of the complex from propagating to another within the hot cell complex or to areas outside the hot cell complex.

The structural beams in the upper hot cell under the canister storage wells supports facility canisters and prevent a waste canister from falling to the lower hot cell.

The WHB is constructed to withstand a 27 lb/per square foot (ft^2) snow load, which exceeds the100-year recurrence maximum snow pack for the WIPP region of 10 lb/ft^2. Although the TMF shares a common wall with the WHB at the west end of the CH bay and is also designed to withstand a snow load of 27 lb/ft^2, there are no specific requirements with respect to the TMF to support RH waste handling.

The WHB including the waste hoist tower is designed to withstand the DBT with 183 miles per hour and a translational velocity of 41 miles per hour, a maximum rotational velocity radius of 325 ft, a pressure drop of 0.5 pounds per square inch (lb/in.^{2}) and a pressure drop rate of 0.09 lb/in.^{2}/s. Although the TMF shares a common wall with the WHB at the west end of the CH bay and the common wall is designed to withstand the DBT, there are no specific requirements with respect to the TMF to support RH waste handling.

The WHB structure is grounded and the building includes a lightning protection system on the roof of the WHB including the waste hoist tower. The lightning protection system transfers the energy from a lightning strike by dissipating the charge associated with a strike to the surrounding air through point discharge. The system is also connected to ground. While the proprietary dissipation array used at the WIPP is not reflected in NFPA 780[13] as a recognized lightning protection system, the system lays claim to a 99.7% success ratio (http://lightningeliminators.com).

4.4.2.5 Controls (TSRs)

The design of the WHB is passive and includes no active components to ensure that it can withstand the natural phenomena events anticipated to occur at the WIPP. TSR controls require the configuration and change controls processes that invoke the USQ process for a review of all structural design changes to the WHB. TSR controls will also contain a SAC to ensure that drum carriages loaded with RH waste shall be carried over and stored on the concrete portion or the upper hot cell floor. Facility canisters loaded with RH waste are carried over the concrete portion of the upper hot cell floor and are only stored in the upper hot cell canister storage wells.

4.4.3 RH Bay Crane, Upper Hot Cell Crane and Overhead Powered Manipulator, CUR crane, FCLR Grapple Hoist, and Waste Hoist

The waste hoist is already designated SC in the CH DSA based on the CH material at risk (MAR) when CH waste is transported on the waste shaft conveyance. The maximum operating load for the waste hoist is the loaded RH facility cask. Based on only the RH MAR of one RH facility cask, the waste hoist provides a SS function. The remaining hoists and cranes associated with RH waste provide a SS function discussed below.

4.4.3.1 Safety Function

The RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and waste hoist shall be designed to hold their loads during the DBE or loss of power.

4.4.3.2 System Description

The RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and the waste hoist are described in Chapter 2 of this DSA. The waste hoist brakes are also discussed in Section 4.4.3. The waste hoist structure and structural support are further discussed in Section 4.4.11.

4.4.3.3 Functional Requirements

The RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and the waste hoist shall be designed to hold their loads during the DBE or loss of power.

4.4.3.4 System Evaluation

The RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and waste hoist are constructed in accordance with the design to hold their respective loads in the event of a DBE or loss of power. Each piece of equipment has been load tested and will be load tested following any modification or repair to load bearing members or change out of ropes. Each piece of equipment is supported by the WHB structure. The waste hoist structure and structural support is further discussed in Section 4.4.11.

4.4.3.5 Controls (TSRs)

The TSRs that require configuration and change control processes to invoke the USQ process for any design changes to the RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and waste hoist. To ensure the RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and waste hoist operate as required, the TSRs additionally require that preoperational checks are performed prior to performing waste handling operations with the RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, FCLR grapple hoist, and waste hoist. The maintenance program also ensures the equipment continues to operate as designed. The waste hoist is further discussed Section 4.4.3 and 4.4.11.

4.4.4 Upper Hot Cell Crane Grapple and FCLR Grapple Hoist Grapple

4.4.4.1 Safety Function

The safety function of the hot cell crane and FCLR grapple hoist grapples is to structurally support a canister or lift fixtures associated with moving shield plugs or drum carriages and prevent dropping waste or dropping items on waste during a DBE or loss of power that could result in a waste container breach . The grapple pintle contact interlock with the pivot dogs of the grapple ensures that the pivot dogs cannot be opened when a load is suspended.

4.4.4.2 System Description

The grapple used with the FCLR grapple hoist or with the upper hot cell crane is described in Section 2.5.4.3. Grapples used with the FCLR grapple hoist or the upper hot cell crane are designed to engage a RH pintle for lifting or moving a RH waste canister or the lift fixtures used to move upper hot cell shield plugs or drum carriages. It has a lift capacity of 21,000 pounds. The grapple has an axially mounted electrically operated actuator that rotates a drive gear that drives three pivot dogs (lifting lugs) into or out of engagement under the pintle. The grapples are equipped with a switch that when During lifting there is sufficient space between the pintle and the switch such that the permissive provided by switch contact with the pintle is absent and the pivot dogs cannot be rotated. In the event of a power failure or seismic event, the three lifting lugs remain engaged under the pintle by the gear drive.

4.4.4.3 Functional Requirements

The upper hot cell crane and FCLR grapple hoist facility grapple are required to engage a pintle associated with an RH waste canister or lift fixtures used to move shield plugs or drum carriages. The grapple is required to remain engaged on a suspended load and support that load during a loss of power or DBE. The grapple pivot dogs are required to move together such that they cannot be opened when a load is suspended.

4.4.4.4 System Evaluation

The grapple has three pivot dogs that rotate together to engage a pintle. In the event of a power failure or seismic event, the three lifting lugs remain engaged under the pintle by the gear drive. The grapple is also equipped with a proximity switch interlock with the drive motor that only allows the pivot dogs to be rotated by the drive motor when the switch is in contact with a pintle. During lifting there is sufficient space between the pintle and the switch such that the permissive provided by switch contact with the pintle is absent and the pivot dogs cannot be rotated. There is an indication on the associated control consoles for the FCLR and upper hot cell grapples to show not only the position of the pivot dogs, but also whether there is pintle contact. The grapples have been load tested and will be load tested following any change that would impact the load bearing portions of the grapple.

4.4.4.5 Controls (TSRs)

The TSRs that require configuration and change control processes to invoke the USQ process for any design changes to the upper hot cell grapple or the FCLR grapple. The TSRs contain an LCO that requires surveillance testing of the grapples and associated pintle contact interlock on each grapple. Should the interlock be unavailable, the TSRs define the necessary actions to ensure that waste containers are not dropped and objects being lifted with either grapple are not dropped on waste containers.

4.4.5 PPA Paved or Graveled and Surrounded By Gravel Road

4.4.5.1 Safety Function

The paved and graveled property protection area (PPA) that is surrounded by a gravel road maintains a physical separation between WHB and the indigenous low profile vegetation surrounding the WIPP site to prevent wildland fires from propagating to the WHB.

4.4.5.2 System Description

These features are described in Sections 2.3.1 and 2.7.3. The gravel and pavement surfaces maintain a physical separation greater than 200 ft between the WHB and the indigenous low profile vegetation surrounding the site, which minimizes the likelihood of a wildfire spreading to the WHB.

4.4.5.3 Functional Requirements

The PPA is required to provide separation (fire break) between the vegetation outside the PPA and the WHB inside the PPA.

4.4.5.4 System Evaluation

The PPA is surrounded by fencing to prevent public intrusion. The gravel and pavement surfaces maintain a physical separation greater than 200 ft between the WHB and the indigenous low profile vegetation surrounding the site, which prevents a wildfire spreading from outside the PPA into the PPA and to the WHB. This feature also provides a fire break for fires external to the WHB and prevents them from propagating to the WHB.

4.4.5.5 Controls (TSRs)

This design feature is passive. There are no TSR controls required except the configuration and change controls processes that invoke the USQ process for a review of design changes that affect the PPA.

4.4.6 Upper Hot Cell Canister Storage Wells

4.4.6.1 Safety Function

The upper hot cell canister storage wells provide structural support for facility canisters in the upper hot cell such that a canister does not topple onto other waste containers. The canister storage wells also prevent direct flame impingement on facility canisters containing waste and protects the canister from dropped objects.

4.4.6.2 System Description

The canister storage wells in the upper hot cell are described in Section 2.4.1.4. There are nine storage wells, six on the east side of the hot cell, one at the northeast inspection station and two at the northwest inspection station. The wells are steel cylinders that extend nominally the length of a waste canister. The facility canisters are 121 in. The wells are located below the operating deck of the upper hot cell and are situated over structural members of the hot cell to support the weight of loaded facility canisters.

4.4.6.3 Functional Requirements

The upper hot cell facility canister storage wells are required to provide structural support for the facility canisters in the upper hot cell such that they do not topple and do not allow a canister to fall to the lower hot cell if dropped. The canister well prevents direct flame impingement on a stored facility canister loaded with waste and protect the canister from dropped objects.

4.4.6.4 System Evaluation

The facility canister storage wells are designed such that a facility canister is stored in a vertical position in a location below the operating deck of the upper hot cell. The design ensures that stored canisters do not topple over and do not interfere with operation of the upper hot cell crane or overhead powered manipulator. The storage wells are cylindrical and fabricated of steel. The structural beams under the storage well are anchored to the hot cell walls and do not collapse in a DBE and do not allow a canister to fall to the lower hot cell if dropped. The noncombustible construction that is nominally the length of a canister, excluding the canister pintle, protects stored canisters from direct flame impingement.

4.4.6.5 Controls (TSRs)

The upper hot cell facility canister storage wells are passive design features. There are no TSR controls required except the configuration and change controls processes that invoke the USQ process for a review of all structural design changes to the upper hot cell facility canister storage wells.

4.4.7 Underground Ventilation

4.4.7.1 Safety Function

The underground ventilation system ensures that there is sufficient airflow for waste handling activities and directs airflow away from workers in the event of a waste container breach. The system also provides fresh air for worker evacuation in the event of a fire.

4.4.7.2 System Description

Because the disposal area at the WIPP is in a mine with vertical shaft access, the WIPP is required to meet 30CFR56/57/58 and Part 62, Federal Mine Safety and Health Regulations for Metal/Nonmetal Mines.[14] Without ventilation, waste handling operations do not start or resume until ventilation is operating.

As discussed in Section 2.6.3.7, underground ventilation is divided into four separate flow paths supporting the waste disposal area, the construction area, north area, and the waste shaft station. The waste disposal, construction and north areas receive their air supply from common sources, the air intake shaft and the salt handling shaft. The waste disposal area receives its supply air from the construction supply air. The waste shaft station receives its air supply from the waste shaft and an associated auxiliary air intake and is separated from the other three circuits by bulkheads and airlocks. All four air circuits combine near the exhaust shaft, which acts as the common discharge from the underground.

Various combinations of fans can be used to achieve the required airflow to support activities in the underground as described in Section 2.6.3.7. Under normal operating conditions, the ventilation system functions continuously. If the normal flow is not available, underground operations may proceed, but the number of activities that can be performed in parallel may be limited depending on the quantity of air available. For RH waste handling in the underground to occur, a minimum of 42,000 actual cubic feet per minute (acfm) airflow is required in the active waste emplacement room and a minimum of 20,000 acfm is needed in the waste shaft ventilation circuit.

Air is routed through the active disposal room within a panel using underground bulkheads and air regulators. Once a disposal room is filled, it is closed against entry and isolated from the mine ventilation system by constructing barricades at each end. Filled rooms are not ventilated. The ventilation path for the waste disposal circuit is separated from the construction side by means of bulkheads, overcasts, and airlocks.

4.4.7.3 Functional Requirements

The underground ventilation system is required to provide sufficient airflow to direct airflow away from workers during waste handling in the event of a waste container breach. Sufficient airflow must also be maintained to facilitate evacuation of underground workers in the event of underground fires. The underground ventilation system is required to provide at least 20,000 scfm at the base of the waste shaft and 42,000 scfm in the active disposal room.

4.4.7.4 System Evaluation

The underground ventilation system is designed, installed, tested, and maintained to meet 30CFR56/57/58 and Part 62.[14] The underground ventilation system provides directional airflow to the areas of the underground sufficient to operate the diesel powered RH waste handling equipment needed to support RH waste handling and such that airflow is directed away from the worker in the event of a waste container breach. Underground ventilation provides fresh air for worker evacuation in the event of a fire. The system operates as designed such that the any leakage from other areas of the underground is into the waste transport path.

4.4.7.5 Controls (TSRs)

The TSRs require the configuration and change controls processes that invoke the USQ process for a review of design changes. The maintenance program ensures that the system continues to operate as designed. The TSRs also contain LCO which specifies the minimum airflow requirements to support RH waste handling and address actions that are required should underground ventilation become inoperable. Periodic surveillance will be performed to ensure system operability.

4.4.8 Transfer Cell Shuttle Car

4.4.8.1 Safety Function

The shuttle car supports its maximum design load and remains on its rails in the event of a DBE such that a RH waste container in the shuttle car is not breached. It accommodates only one RH waste canister at a time.

4.4.8.2 System Description

The transfer cell shuttle car is discussed in Section 2.5.4.4. The transfer cell shuttle car is a steel frame structure with a single basket designed to support 56,000 pounds such that it accommodates either a RH 72-B shipping cask loaded with a single 8000 pound 72-B canister, or a shielded insert with a single facility canister. The shuttle car, approximately 22 ft. long, 10 ft. deep and 6 ft. wide, is suspended from four steel wheels that ride on rails mounted on support trestles in the transfer cell, and is provided with restraints that keep the car on its rails in the event of a DBE. The shuttle car is capable of being positioned under the CUR, the upper hot cell, or the FCLR to support processing a RH waste canister for disposal. The position of the shuttle car is determined by an encoder that ensures the car is correctly positioned for transfer of a waste container either into or out of the shuttle car.

4.4.8.3 Functional Requirements

The shuttle car is required to support the maximum design load and remain on its rails in the event of a DBE.

4.4.8.4 System Evaluation

The transfer cell shuttle car is constructed in accordance with the design such that it will stay on its rails in a DBE and support the maximum design load. The basket of the shuttle car is sized to accommodate either a RH 72-B shipping cask loaded with with a single 8000 pound 72-B canister, or a shielded insert with a single facility canister. The car is rail-mounted and is provided with restraints that keep the car on its rails in the event of a DBE.

4.4.8.5 Controls (TSRs)

The transfer cell shuttle car structure and restraints that ensure it stays on its rails in a DBE is a passive design feature. The TSR controls include the configuration and change controls processes that invoke the USQ process for any design changes to or that affect the transfer cell shuttle car structure or restraints.

4.4.9 Upper Hot Cell Wall Mounted Manipulators

4.4.9.1 Safety Function

The upper hot cell wall mounted manipulators have counterweights to limit speed of travel in the event that an operator releases the manipulator to prevent breaking the upper hot cell lead glass shield windows resulting in a loss of shielding when RH waste is in the upper hot cell.

4.4.9.2 System Description

There are four wall mounted manipulators in the upper hot cell located at two inspection stations. The manipulators are mounted in the wall of the upper hot cell using a thru-tube and shielding. The manipulators are equipped with mechanical linkages to transfer the motion of the human hand on the manipulator outside the hot cell to the portion of the manipulator inside the hot cell to allow waste handling personnel to take radiological swipes and move objects inside the hot cell to support processing RH waste for disposal. The manipulator control is located below the hot cell penetration and allows waste handling personnel to operate the manipulator and see the resultant movement of the portion of the manipulator inside the hot cell. The hot cell portion of the manipulator can be extended at least 6 ft. beyond the inside surface of the shielded window. The manipulators have counterweights that limit the speed of travel in the event the operator releases the manipulator control to prevent breaking the shield windows. The wall mounted manipulators are also discussed in Section 2.5.4.3.

4.4.9.3 Functional Requirements

The wall mounted manipulators require counterweights to limit speed of travel in the event the operator releases a manipulator to prevent breaking the lead glass shield windows.

4.4.9.4 System Evaluation

The wall mounted manipulators are located near the shield glass windows at two of the upper hot cell inspection stations to allow waste handling personnel to take radiological swipes and move objects in the upper hot cell in support of processing RH waste. The through tubes that support the wall mounted manipulators are located above the shield windows and are provided with shielding for worker protection. The manipulators have sufficient range of motion to touch the hot cell lead glass window that they are mounted near, however, the counterweights on the manipulators have demonstrated through actual operation to limit the speed of travel in the event that an operator releases the manipulator such that it does not hit the window with any significant force.

4.4.9.5 Controls (TSRs)

The wall mounted manipulators counterweights are a passive design feature. TSR controls include the configuration and change controls processes that invoke the USQ process for any design changes to or that affect the wall mounted manipulators.

4.4.10 Underground Bulkheads, Overcasts, and Airlocks

4.4.10.1 Safety Function

The noncombustible construction of the underground bulkheads, overcasts, and airlocks in the underground prevent fires from propagating from the construction and north areas of the underground to the disposal areas.

4.4.10.2 System Description

These features are described in the Section 2.6.3.7.

4.4.10.3 Functional Requirements

Underground bulkheads, overcasts, and airlocks shall be constructed of noncombustible material.

4.4.10.4 System Evaluation

The underground bulkheads, overcasts, and airlocks used to segregate the underground ventilation circuits are made of fire resistant material and can support the maximum pressure differential that could occur under normal operating conditions. These structures are designed, installed, and maintained in such a manner to accommodate ground deformation due to salt creep.

4.4.10.5 Controls (TSRs)

These components are passive design features. There are no TSR controls required except the configuration and change controls processes that invoke the USQ process for a review of design changes that affect bulkheads, overcasts, and airlocks and their locations.

4.4.11 Boreholes and Borehole Shield Plugs

4.4.11.1 Safety Function

The RH disposal boreholes and borehole shield plugs provide shielding after RH waste canister disposal for protection of workers in the active disposal room. Borehole placement ensures shielding for worker protection and protects spacing assumptions in the RH disposal criticality safety evaluations. The shield plug length and material protects workers from radiological exposure associated with RH waste and protects assumptions in the criticality safety evaluation for disposed RH waste. The shield plug also protects the disposed RH waste canister from the effects of an explosion/fire in the active waste disposal room.

4.4.11.2 System Description

The underground RH shield plugs are described in Section 2.4.5.6. The borehole is approximately 17 ft. long and 30 in. in diameter. The boreholes are placed on nominal 8 ft. center to center spacing and located a distance away from the corners of salt pillars that separate disposal rooms, nominally 34 ft. from the projected corner (corners are mitered) along the short axis and 26 ft. from the projected corner along the long axis of salt pillars. The shield plug is approximately 69 in. long and 29 in. in diameter and constructed of concrete with a steel shell and a removable pintle. The shield plug is inserted into the borehole after the waste canister has been emplaced. Each shield plug weighs approximately 3,900 lbs.

4.4.11.3 Functional Requirements

The RH disposal boreholes and borehole shield plugs shall provide radiological shielding for protection of the workers and protect disposed RH waste canisters from fires/explosions in the disposal room. canisters. The borehole placement shall ensure criticality between RH canisters remains incredible. Shield plugs shall be made of concrete with a steel sleeve and shall be at least 4 ft. long. The length of the shield plug ensures neutronic isolation of the RH waste with respect to CH waste. Boreholes shall be placed in the walls of the disposal rooms to ensure that shielding near salt pillar corners and on opposite sides of the salt pillar is maintained. Shield plugs shall be sized and constructed of material to protect workers and that the assumptions in the criticality safety analysis for RH waste are maintained.

4.4.11.4 System Evaluation

The borehole is drilled into the walls of a disposal room or access drift. The boreholes are spaced approximately 8 ft. on centers and are 17 (-0, +2) ft. deep, which is deep enough to accommodate the length of the waste canister and the shield plug. The boreholes are placed on nominal 8 ft. center to center spacing and located a distance away from the corners of salt pillars that separate disposal rooms, nominally 34 ft. from the projected corner along the short axis and 26 ft. from the projected corner along the long axis of salt pillars. The 8 ft. center-to-center spacing exceeds the minimum 30 in. of salt between disposal boreholes and any two RH waste canisters to keep RH canisters neutronically isolated from each other. The placement away from the corners of salt pillars separating disposal rooms ensures that canisters have greater than the 6 ft. of salt thickness to provide shielding for worker protection and that any part of two boreholes exceeds the assumptions in the criticality analysis. The shield plug is inserted into the borehole after emplacement of the waste canister before the facility cask is removed from the HERE. The shield plug provides the necessary shielding for the exposed end of the borehole. The shield plug also protects the waste canister from any damage resulting from the effects of fire or explosion in the disposal area where it is located.

4.4.11.5 Controls (TSRs)

The boreholes and borehole shield plugs are passive design features that require configuration and change controls processes that invoke the USQ process for a review of any design changes to the boreholes or shield plugs. Additionally, the TSRs administrative controls require that boreholes for disposal of RH waste canisters are 17 ft. deep (-0/+2 ft.) and are nominally 34 ft. from the projected corner of salt pillars along the short axis of the pillar that separates the disposal rooms and nominally 26 ft. from the projected corners of the salt pillar along the long axis. An administrative control will also be required to install a shield plug in a borehole containing an RH waste canister before removing the facility cask from the HERE.

4.4.12 WHB Shielding Interlocks - CUR Shield Door, Upper Hot Cell Shield Plugs, and Upper Hot Cell Crane

4.4.12.1 Safety Function

The shielding interlocks between the CUR shield door, the upper hot cell shield plugs, and upper hot cell crane provide shielding for worker in the CUR when processing a 72-B waste canister in the CUR and waste is in the upper hot cell. The shielding interlocks also provide shielding for workers when waste is being removed from a 10-160B shipping cask in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell.

4.4.12.2 System Description

The shielding interlocks between the CUR shield door, the upper hot cell shield plugs, and upper hot cell crane are described in Section 2.4.1.3 and 2.5.4.2.

4.4.12.3 Functional Requirements

The CUR shield door, the upper hot cell shield plugs, and upper hot cell crane interlocks must prevent the CUR shield door from opening when a 10-160B shipping cask is open in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell, and prevent the hot cell shield plugs from being removed when a 72-B shipping cask is being processed through the CUR.

4.4.12.4 System Evaluation

The design of the interlocks between the CUR shield door, the upper hot cell shield plugs, and the upper hot cell crane are documented in the SDD WH00-WH03, RH TRU Waste Handling Equipment Requirements, Design, and Operation.[16]

4.4.12.5 Controls (TSRs)

The TSRs contain LCOs with respect to operable conditions of the shielding interlocks between the CUR shield door, the upper hot cell shield plugs, and the upper hot cell crane availability to provide worker shielding to prevent direct radiation exposure. Periodic surveillance will be performed to ensure system operability and verification of automatic functions.

4.4.13 FCLR Telescoping Port Shield and Grapple Hoist Shield Bell

4.4.13.1 Safety Function

The FCLR telescoping port shield and grapple hoist shield bell provide shielding for worker protection by mating with the facility cask when positioned vertically over the transfer port between the transfer cell and FCLR.

4.4.13.2 System Description

The telescoping port shield and shield bell are discussed in Section 2.5.4.5. The telescoping port shield is a cylindrical structure that is stored in the retracted position in the floor of the FCLR at port between the FCLR and transfer cell. It is raised by motor driven jack screws such that it mates with the facility cask when the cask is positioned over the port between the transfer cell and the FCLR.

The shield bell is supported by the FCLR grapple hoist such that the grapple can move independent of the shield bell once the shield bell is mated with the facility cask when the cask is positioned vertically over the transfer port between the transfer cell and the FCLR.

These items are further discussed in SDD WH00-WH03.[16]

4.4.13.3 Functional Requirements

The shield bell and telescoping port shield are required to provide shielding for worker protection by mating with the facility cask when positioned vertically over the transfer port between the FCLR and the transfer cell. The shield bell, telescoping port shield, and facility cask provide a shielded path for transferring a RH waste canister into the facility cask.

4.4.13.4 System Evaluation

The telescoping port shield and FCLR grapple hoist shield bell provide sufficient shielding to ensure that a RH waste canister at up to 1000 Rem/hr on contact provides less than 200 mrem/hr on contact of the surface of the telescoping port shield, facility cask, or the shield bell when transferring a canister into the facility cask. The shielding is passive but interlocks are necessary to ensure that the facility cask shield valves and the transfer cell ceiling shield valve cannot be opened unless the telescoping port shield is raised and the shield bell is lowered to make contact with the facility cask positioned vertically over the transfer port between the FCLR and transfer cell.

4.4.13.5 Controls (TSRs)

The shielding provided by the telescoping port shield and the FCLR grapple hoist shield bell are passive design features that are protected by configuration control and the USQ process. The TSRs contain LCOs associated with the interlocks between the telescoping port shield, the shield bell, the facility cask, and the facility cask rotating device (FCRD). These interlocks are discussed in Section 4.4.17 and 4.4.18.

4.4.14 WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, and Transfer Cell Ceiling Shield Valve

4.4.14.1 Safety Function

The interlocks between the FCLR grapple hoist shield bell and grapple, telescoping port shield, facility cask, and transfer cell ceiling shield valve ensure that a shielded path is established before initiating transfer of a facility canister or 72-B canister loaded with RH waste from the transfer cell to the facility cask in the FCLR. These interlocks ensure that a RH waste canister cannot be raised into the FCLR using the FCLR grapple hoist unless the facility cask is located over the transfer port between the transfer cell and the FCLR, and positioned in a vertical configuration such that the FCLR grapple hoist shield bell can mate with the top of the facility cask and the telescoping port shield can mate with the lower part of the facility cask. The interlocks also prevent closure of the facility cask shield valves or transfer cell ceiling shield valve on the grapple hoist ropes or a waste canister to prevent dropping or crushing a waste canister that could result in a breach.

4.4.14.2 System Description

The FCLR grapple hoist supports the grapple and shield bell. The shield bell is a steel casting that not only houses the grapple but is designed to rest on the upper part of the facility cask when the cask is vertically positioned over the transfer port in the FCLR. The shield bell provides shielded when the facility cask upper shield valve is opened. The facility cask upper shield valve must be in the open position for the grapple to be lowered though the facility cask and through the transfer port in the floor of the FCLR to engage a RH waste canister in the transfer cell. The FCLR grapple hoist position is calculated by a microprocessor in the FCLR control console that receives its signal from the grapple hoist position transmitter. Each grapple position corresponds to a physical grapple location. The grapple positions important to shielding are as follows:

Position A	Grapple in the maximum up position
Position B	Shield bell in contact with the top of the facility cask
Position C	Grapple slightly above the pintle of the RH canister in the facility cask or canister is slightly raised above the facility cask bottom shield valve.
Position D	RH canister resting on the closed bottom shield valve of the facility cask
Position E	FCLR grapple/shield bell in contact with the top of the telescoping port shield
Position F	72-B shipping cask inner lid above the transfer cell ceiling shield valve

The facility cask is a thick walled cylindrical container made of steel and lead with powered gate shield valves on either end. The shield valves have air operated locking pins that ensure the valves stay shut when a RH waste canister is inside the facility cask. Compressed air is required to retract the locking pins that are held normally closed with spring pressure. The cask includes two trunnions that allow it be supported with the FCTC and two pivot pins at the top shield valve housing that are used to rotate the cask from horizontal to vertical using the FCRD.

The telescoping port shield is a cylindrical ring that is over 2 ft. tall with an outer diameter of 54 in. and an inner diameter of 36 in. The telescoping port shield is located in the floor of the FCLR at the transfer port between the FCLR and the transfer cell. The telescoping port shield is raised and lowered using motor driven jack screws. After the facility cask is vertically aligned over the transfer port between the FCLR and the transfer cell, the telescoping port shield is raised to mate with the bottom of the facility cask.

The transfer cell ceiling shield valve is located at the transfer port between the transfer cell and the FCLR. The transfer cell ceiling shield valve is normally closed and is opened only for removal or replacement of the 72-B shipping cask inner lid or to transfer a RH waste canister from the transfer cell to the facility cask.

The transfer cell ceiling shield valve cannot be opened unless either the facility cask is in contact with the telescoping port shield or the FCLR grapple hoist shield bell is in contact with the telescoping port shield at Position E. This ensures that shielding is present so that personnel in the FCLR cannot be exposed to a waste canister in the transfer cell. Further the transfer cell ceiling shield valve cannot be closed when lifting a waste canister unless the grapple hoist is at position B, C, or D. This ensures that the cables associated with lifting a canister and the canister cannot be crushed.

The facility cask top shield valve cannot be opened unless the grapple is at Position B. This ensures that the shield bell is in contact with the top of the facility cask. The facility cask lower shield valve cannot be opened unless the transfer cell ceiling shield valve is closed and the grapple hoist is at position D. This ensures that if the telescoping port shield is not raised personnel in the FCLR will not be exposed to an RH waste canister. The facility cask lower shield valve cannot be closed unless the grapple hoist is at position B or C. This ensures that both the grapple hoist ropes and a RH waste canister are above the facility cask lower shield valve and cannot be crushed when the valve is closed.
The facility cask top shield valve cannot be closed unless the grapple is at position A or B and the grapple is open. This ensures that the RH waste canister is either not in the facility cask or the the canister is in the cask and resting on the closed bottom shield valve, and that the grapple hoist ropes and grapple are above the top shield valve.

The equipment is further described in Chapter 2 of the RH DSA.

4.4.14.3 Functional Requirements

Interlocks between the FCLR grapple hoist and shield bell, the telescoping port shield, the facility cask and the facility cask shield valves and the transfer cell ceiling shield valve are required to ensure that the telescoping port shield is mated to the bottom shield valve of the facility cask and the shield bell is mated to the top of the facility cask prior to the FCLR grapple hoist lifting a RH waste canister from the transfer cell into the facility cask to provide shielding for worker protection, and to prevent closure of the facility cask shield valves or the transfer cell ceiling shield valve on a waste canister or the grapple hoist ropes when lifting a waste canister.

4.4.14.4 System Evaluation

The design of the interlocks between the FCLR grapple hoist and shield bell, the telescoping port shield, the facility cask, and transfer cell ceiling shield valve is documented in the SDD WH00-WH03.[16] There are several additional interlocks that support processing a RH waste canister from the transfer cell to the facility cask, including removal of the 72-B shipping cask inner lid and those associated with the swipe robot that require it to be positioned such that it does not interfere with lifting a canister. Only those interlocks that ensure shielding and prevent crushing a canister or the grapple hoist ropes are designated SS.

4.4.14.5 Controls (TSRs)

The TSRs contain LCOs with respect to operable conditions of the shielding interlocks between the FCLR grapple hoist and shield bell, the facility cask and shield valves, the telescoping port shield, and the transfer cell ceiling shield valve to protect worker from radiation exposure during canister transfer and to prevent crushing a waste canister or the grapple hoist ropes during canister transfer. Periodic surveillance will be performed to ensure system operability and verification of automatic functions.

4.4.15 WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, Facility Cask Rotating Device

4.4.15.1 Safety Function

The interlocks between the FCLR grapple hoist and shield bell, telescoping port shield, facility cask, and FCRD prevent the vertically positioned facility cask from rotating until transfer of a canister is complete and the telescoping port shield is retracted and the shield bell and grapple are fully retracted.

4.4.15.2 System Description

These interlocks are described in Section 2.5.4.5.

4.4.15.3 Functional Requirements

The grapple hoist, telescoping port shield, facility cask, FCRD, and the FCTC interlocks must ensure that the FCTC cannot move while the facility cask is in the vertical position, the FCRD cannot rotate the facility cask to the horizontal position while the telescoping port shield is in contact with the facility cask bottom shield valve, the telescoping port shield cannot retract while the grapple hoist is not at its fully retracted position, and the grapple hoist cannot go to its fully retracted position until the RH waste canister is resting on the facility cask bottom shield valve.

4.4.15.4 System Evaluation

The design of the interlocks between the grapple hoist, telescoping port shield, FCRD and the FCTC are documented in the SDD WH00-WH03[16]

4.4.15.5 Controls (TSRs)

The TSRs contain LCOs with respect to operable conditions of the interlocks between the grapple hoist, telescoping port shield, FCRD and the FCTC availability to provide worker shielding to prevent direct radiation exposure, and to prevent breaching of a RH waste canister from crushing or dropping. Periodic surveillance will be performed to ensure system operability and verification of automatic functions.

4.4.16 WHB Interlocks - Transfer Cell Shuttle Car, CUR Shield Valve, Upper Hot Cell Shield Valve, and Transfer Cell Ceiling Shield Valve

4.4.16.1 Safety Function

The interlocks between the transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve prevent a RH waste canister from being breached as a result of a drop due to shuttle car movement shearing the ropes of the crane or grapple performing the transfer. The interlocks also prevent crushing the waste canister during transfer between the CUR and the transfer cell or transfer cell and facility cask in the FCLR as a result of the transfer cell shuttle car moving.

4.4.16.2 System Description

The interlocks between the transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and the transfer cell ceiling shield valve ensure that the shuttle car cannot move unless all three shield valves are closed. The interlocks prevent movement of the shuttle car during transfer of a RH waste canister from the CUR to the transfer cell, the upper hot cell to the transfer cell, to the transfer cell to the facility cask in the FCLR. Movement of the shuttle car could result in crushing a RH waste canister or shearing the ropes associated with the CUR crane, the upper hot cell crane, or the FCLR grapple hoist resulting in a drop of a RH waste canister.Interlocks are further described in Sections 2.5.4.2., 2.5.4.3. and 2.5.4.4.

4.4.16.3 Functional Requirements

The transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve interlocks are required to ensure that the transfer cell shuttle car cannot move during transfer of a waste canister between rooms within the hot cell complex where RH waste is processed to prevent breaching a canister either by crushing a waste canister or shearing the grapple/crane ropes that are supporting the canister.

4.4.16.4 System Evaluation

The design of the interlocks between the transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve are documented in the SDD WH00-WH03.[16] Additional interlocks exist at each transfer port between areas of the hot cell complex where waste is processed. The shuttle car is equipped with a position encoder that ensures the shuttle car is positioned under a shield valve transfer port before the shield valves can be opened. Only the interlocks associated the shield valve position and movement of the shuttle car with the potential to breach a waste canister are selected as SS.

4.4.16.5 Controls (TSRs)

The TSRs contain LCOs with respect to operable conditions of the interlocks between the transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve availability to prevent breaching of a RH waste canister from either crushing the canisters or drops due to crushing/severing the ropes associated with the grapples or cranes. Periodic surveillance will be performed to ensure system operability and verification of automatic functions.

4.4.17 HERE and Shield Collar

4.4.17.1 Safety Function

The HERE transfer mechanism and shield collar provide shielding for worker protection when mated with the facility cask during transfer of a RH waste canister from the facility cask into a disposal borehole, prevents direct flame impingement on the waste canister, and protects the canister from explosions.

4.4.17.2 System Description

The HERE transfer mechanism and shield collar are described in Section 2.5.4.6. The HERE and shield collar are further discussed in the SDD WH00-WH03.[16] The HERE and shield collar are aligned on a disposal borehole and mate with the facility cask such that the HERE is aligned with the borehole and allows a RH waste canister to be pushed into the disposal borehole with the HERE transfer mechanism. The exposed part of the transfer mechanism, the shield collar, and the facility cask provide a shielded path for transfer of the canister. The shielding is a passive feature when the components are properly mated. Interlocks are provided to detect the position of the facility cask with respect to the transfer mechanism and the shield collar and to detect any tilt in the HERE with respect to the borehole. The shield collar as shown in Figure 2.5-24 is attached to the alignment fixture and inserted into the counterbore in the borehole to provide shielding during emplacement operations.

4.4.17.3 Functional Requirements

The HERE transfer mechanism and shield collar are required to mate with the RH facility cask to provide a shielded path for transfer of a RH canister into a disposal borehole and subsequent installation of a shield plug before the facility cask is removed and the HERE and shield collar removed from a disposal borehole.

4.4.17.4 System Evaluation

The design and construction of the HERE transfer mechanism and shield collar sufficient to provide shielding for worker protection when mated with the facility cask such that radiation levels for a RH waste canister up to 1000 Rem/hr on contact are reduced to less than 200 mrem/hr on contact of the surface the shield collar and exposed portion of the transfer mechanism. Interlocks are provided to detect the position of the facility cask with respect to the transfer mechanism and the shield collar and to detect any tilt in the HERE with respect to the borehole. These interlocks are further discussed in Section 4.4.21.

4.4.17.5 Controls (TSRs)

The TSRs require configuration management and the USQ process for any design changes that would change the materials and construction of the HERE transfer mechanism or shield collar. The TSR also contain a LCO with respect to operable conditions of the shielding interlocks between the HERE transfer mechanism, the facility cask, and the shield collar availability to provide worker shielding to prevent direct radiation exposure. This is further discussed in Section 4.4.21.

4.4.18 Underground Interlocks - HERE, Facility Cask, and Shield Collar

4.4.18.1 Safety Function

The interlocks between the HERE, the facility cask, and shield collar is to ensure shielding for worker protection during transfer of a RH waste canister from the facility cask into a disposal borehole and prevent crushing a canister by detecting any misalignment of the HERE with respect to the disposal borehole and any gap in the shielding provided by the transfer mechanism and shield collar mating with the facility cask. The interlocks between the facility cask shield valves and HERE transfer mechanism prevents closing a shield valve on a canister resulting in a breach by closure of a shield valve when the canister is within the open valve.

4.4.18.2 System Description

The HERE transfer mechanism, facility cask, and shield collar and interlocks are described in Section 2.5.4.6.

4.4.18.3 Functional Requirements

The HERE and facility cask interlocks must ensure the facility cask front or rear shield valve cannot be opened unless the HERE tilt sensors show the transfer mechanism is aligned with the alignment fixture, the alignment fixture proximity switches detect the facility cask, and the transfer mechanism proximity switches detect the facility cask. Further, the shield valves on the facility cask cannot be closed if the HERE transfer mechanism is extended beyond either shield valve.

4.4.18.4 System Evaluation

The design of the interlocks on the HERE transfer mechanism, the facility cask, and the shield collar are documented in the SDD WH00-WH03, RH TRU Waste Handling Equipment Requirements, Design, and Operation.[16]

4.4.18.5 Controls (TSRs)

The TSRs contain LCOs with respect to operable conditions of the interlocks between the HERE, the facility cask, and the shield collar availability to provide worker shielding to prevent direct radiation exposure and crushing a RH waste canister. The LCO will also apply to the operable condition of the interlocks between the facility cask shield valves and HERE transfer mechanism. Periodic surveillance will be performed to ensure system operability and verification of interlock functions.

4.4.19 RH Metal Facility Canisters

4.4.19.1 Safety Function

The RH metal facility canisters include a mechanical or pinned lid such that when the canister is lifted by the pintle on the lid, the lid structurally supports the canister and prevents lid ejection during a fire. The canister also prevents direct flame impingement on RH drums that have been loaded into a facility canister for disposal.

4.4.19.2 System Description

The facility canisters are described in Section 2.5.3.1. The facility canister is an approximately 0.25 in. thick steel container with an outside diameter of 28.5 in. and a overall length of approximately 117.5 in. It is designed to hold three 55-gallon drums of RH waste. The lid, with an integral pintle used for lifting, is attached to the shell with three locking pins designed to support the fully loaded weight of 3,980 lbs.

4.4.19.3 Functional Requirements

The facility canister lid is required to structurally support the loaded facility canister when lifted by its pintle by the upper hot cell crane or FCLR grapple hoist. The lid is required to be mechanical or pinned to prevent the lid from becoming disengaged from the canister when being lifted by the pintle.

4.4.19.4 System Evaluation

The facility canister lid is attached to the facility canister shell by three locking pins, any one of which has sufficient mechanical strength to keep the lid attached to the facility canister during the lifts required to transfer the facility canister from the upper hot cell into the facility cask. The metal facility canister contains up to three 55-gallon drums of RH waste. Once the drums are in the canister with the lid installed, any fire in the upper hot cell would not result in direct flame impingement on the RH waste drums.

4.4.19.5 Controls (TSRs)

The facility canister lid locking pins and mating structure on the facility canister shell are passive design features. There are no TSR controls required except the configuration and change controls processes that invoke the USQ process for a review of all structural design changes to the facility canister.

4.4.20 RH Facility Cask

4.4.20.1 Safety Function

The facility cask provides shielding of an RH waste canister for worker protection, prevents direct flame impingement on a waste canister from fires, and provides protection to the RH waste canister in the event explosions or if the facility cask is dropped.

4.4.20.2 System Description

The facility cask is described in Section 2.5.3.3. The facility cask is a double end loading shielded container approximately 165 in. long and 98 in. high. It consists of two concentric steel cylinders with the 4.75 in. thick annulus between them filled with lead. The internal cylinder is approximately 0.50 in. thick, while the outer cylinder is approximately 0.625 in. thick. The robustness of the facility cask protects the RH waste canister from the effects of fire and explosions as well as drops. The facility cask is designed such that it maintains its shielding integrity when dropped from a height of 102 inch The equivalent impact load is 1g horizontal and 13g vertical.[16] The facility cask has two support trunnions located approximately mid length at 180° from each other. The trunnions are the support points of the FCTC. The facility cask has a motor operated approximately 8.5 in. thick steel shield valve at each end used for loading and unloading RH waste canisters. Both shield valves are electrically operated, have spring loaded pins that lock the valve gates closed, and are designed to support the weight of a fully loaded RH waste canister when they are closed and the cask is vertical. Compressed air is used to release the locking pins. The facility cask has two sets of forklift pockets, the lower set used for transport and placement on the HERE.

The facility cask is provided with interlocks between it, the grapple hoist shield bell and the telescoping port shield when positioned vertically over the port between the transfer cell and the FCLR such that a shielded path must be present before the canister transfer can begin and must remain in place until transfer is complete. The facility cask is also provided with interlocks between it and the HERE transfer mechanism and the shield collar to ensure a shielded path is maintained during transfer of a RH waste canister into a disposal borehole.

4.4.20.3 Functional Requirements

The facility cask is required protect to provide shielding for worker protection when loaded with a RH waste container. The facility cask shield valves must remain closed when transporting a RH waste canister.

4.4.20.4 System Evaluation

The facility cask robust construction provides shielding protection for workers in its immediate area and protects its RH waste canister from the effects of drops, impacts, fires and explosions. The facility cask shield valves are held closed by lock pins when transporting a RH waste canister. The facility cask is designed to provide shielding for a RH waste canister such that the cask surface dose rate is less than 200 mrem/hr when the waste canister surface dose rate is 7,000 Rem/hr. This design exceeds the shielding required for a 1,000 Rem/hr RH waste canister.

4.4.20.5 Controls (TSRs)

The facility cask is a passive design feature. There are no TSR controls required except the configuration and change controls processes that invoke the USQ process for a review of all structural design or operational changes to the facility cask.

4.4.21 Facility Cask Transfer Car

4.4.21.1 Safety Function

The FCTC structurally supports the facility cask during transfer of a RH waste container from the transfer cell to the facility cask and subsequent transfer to the underground on the waste shaft conveyance. The FCTC mates with the FCRD and latches to prevent the FCTC from moving during canister transfer that could result in crushing the RH waste canister or the FCLR grapple hoist ropes and dropping a canister. This feature also prevents loss of shielding in the FCLR.

4.4.21.2 System Description

The FCTC is a rail-mounted car that supports the facility cask weight for transfer of a RH waste canister from the transfer cell to the facility cask when positioned vertically over the transfer cell port. The FCTC has two A-frame supports for the trunnions on the facility cask that allow the cask to be rotated by the FCRD. The FCTC mates with the FCRD. The FCRD has pins that extend into the FCTC to latch it to the FCRD so that the car cannot move during cask rotation or during canister transfer. The FCTC car supports the facility cask not only supports the facility cask for canister transfer but also supports the cask during transport from the FCLR to the waste shaft conveyance, traverse of the waste shaft and to the underground where the cask is removed from the FCTC by the 41-ton RH waste handling forklift. The FCTC is further described in Section 2.5.4.5.

4.4.21.3 Functional Requirements

The FCTC is required to support the facility cask during canister transfer and during transport from the WHB to the underground on the waste shaft conveyance. It is required to be rail mounted to interface with the material deck rails on the waste shaft conveyance. It is required to interface with the FCRD such that it does not move during transfer of a RH waste canister.

4.4.21.4 System Evaluation

The FCTC and FCRD are constructed in accordance with the design and have demonstrated through testing and subsequent operation to interface and latch such that the FCTC does not move during canister transfer. The FCRD and FCTC also remain securely latched during rotation of the facility cask either from horizontal to vertical or vertical to horizontal. The FCTC supports the facility cask during transfer from the WHB to the underground via the waste shaft conveyance.

4.4.21.5 Controls (TSRs)

The TSRs require preoperational checks of the transfer car prior to use consistent with the conduct of operations program. The programmatic configuration and change control process ensures that a USQ determination is performed for design changes to the FCTC. The TSRs contain a waste handling restriction to ensure that the FCTC and FCRD are mated and latched prior to facility cask rotation .

4.4.22 Fence Around Waste Shaft Collar

4.4.22.1 Safety Function

The fence around the waste shaft collar defines a restricted area around the waste shaft and prevents uncontrolled access to the shaft.

4.4.22.2 System Description

Waste shaft collar fencing is discussed in Section 2.5.5.4. Fencing with gates are located at the shaft collar and the waste shaft station to prevent inadvertent access to the shaft. The gates are interlocked such that the conveyance cannot move with a gate open, and if the conveyance is in motion when a gate is opened, the emergency stop is actuated

4.4.22.3 Functional Requirements

The fence around the waste shaft collar is required to provide a barrier to prevent inadvertent access to the waste shaft.

4.4.22.4 System Evaluation

According to Section 2.5.5.4, the collar area of the waste shaft is surrounded with fencing that prevents unauthorized entry and minimizes the chance for items falling into the shaft.

4.4.22.5 Controls (TSRs)

Operating practices include daily inspections and verification of proper operation consistent with the conduct of operations program. The programmatic configuration and change control process ensures that a USQ determination is performed for design changes to the waste shaft collar fencing.

References for Chapter 4

1. 10 CFR Part 830, Subpart B, "Safety Basis Requirements," 2001.

2. DOE-STD-3009-94, Change 2, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*, 2002.

3. DOE G 421.1-2, *Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B of 10 CFR 830*, 2001.

4. NFPA 220, *Standard on Types of Building Construction*.

5. SDD CF00-GC00, Plant Buildings, Facilities, and Miscellaneous Equipment.

6. NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, National Fire Protection Association.

7. DOE G 420.1-1, *Non-reactor Nuclear Safety Design Criteria and Explosive Safety Criteria for use with DOE 420.1, Facility Safety*, 2000.

8. SDD FP00, Waste Isolation Pilot Plant Fire Protection System.

9. NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, National Fire Protection Association.

10. NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, National Fire Protection Association.

11. NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, National Fire Protection Association.

12. NFPA 13, *Standard for the Installation of Sprinkler Systems*, National Fire Protection Association

13. NFPA 780, Standard for the Installation of Lightning Protection Systems, National Fire Protection Association

14. 30 CFR 56, 57, 58, and 62, *Federal Mine Safety and Health Regulations for Metal and Nonmetal Mines*.

15. SDD UH00, Underground Hoisting System Design Description.

16. SDD WH00-WH03, RH TRU Waste Handling Equipment Requirements, Design, and Operation.

Table 4.4-1 Safety Significant SSCs

Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
4.4.1	Fire Water Supply and WHB Fire Suppression Systems	WHB1-1, 1-4, 1-6, 1-7, 1-8, WHB7-1, UG1-5	The safety function of the water supply and WHB fire suppression systems is to extinguish fires within the WHB before they become large enough to impact RH waste, propagate to areas containing RH waste outside of a closed shipping cask, or propagate from the RH portion of the WHB to the CH bay and impact CH waste.	The fire water supply and WHB fire suppression system must automatically actuate and provide fire suppression sufficient to keep any fire from developing into a large fire that impacts RH or CH waste.	Surveillance and maintenance in accordance with NFPA 25.[11]

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.2	Waste Handling Building (Already classified SC in Section 4.3 based on noncombustible construction and designed and constructed to withstand the DBE to prevent accidents WHB7-1 and7-2)	WHB4-1, 4-2, 4-3, 4-4, 4-5, WHB7-3, 7-4, 7-5, 7-6, 7-7, BG7-1, UG7-4	The WHB (including the waste hoist tower) is designed and constructed to withstand snow/ice loading, high winds and the DBT, and dissipates lightning to prevent damage to the RH waste containers within it. The hot cell complex of the WHB is designed and constructed to provide shielding for worker protection with its thick concrete walls, floors, ceilings; upper hot cell, CUR, and transfer cell shield valves, CUR and crane maintenance room shield doors; upper hot cell floor shield plugs and grapple override port shield plugs; and upper hot cell lead glass shield windows. The structural beams in the upper hot cell under the canister storage wells supports facility canisters to prevent a waste canister from falling to the lower hot cell.	The WHB must withstand the design basis snow and ice loads postulated for the WIPP without resulting in a roof collapse that could impact RH waste. The WHB is required to withstand high winds and the DBT postulated for the WIPP site without resulting in structural failure that could impact RH waste. The WHB must withstand lightning strikes associated with inclimate weather at the WIPP such that the WHB and waste containers within the WHB are not breached. The hot cell complex within the WHB shall be designed to provide shielding for worker protection when RH waste is outside of a closed shipping cask or the facility cask. The WHB structural beams in the upper hot cell are required under the canister storage wells to support facility canisters and prevent a waste canister from falling to the lower hot cell.	The WHB construction including the shielding provided by the thick concrete walls, floors, ceilings, shield plugs, shield doors, and lead glass shield windows are passive design features. The TSRs contain administrative controls to ensure that shield plugs are normally installed, shield valves are normally closed except when transferring items between locations in the hot cell complex, the crane maintenance room shield door is closed except when transferring the upper hot cell crane to and from the crane maintenance room and the CUR shield door is closed when transferring items to and from the upper hot cell when waste is in the upper hot cell or when transferring waste to the upper hot cell from the CUR. Waste handling restriction also requires that drum carriages loaded with RH waste shall be carried over and stored on the concrete portion or the upper hot cell floor. Facility canisters loaded with RH waste are carried over the concrete portion of the upper hot cell floor and are only stored in the upper hot cell canister storage wells.
2	4.4.3	RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane, and FCLR grapple hoist (The waste hoist is already classified SC in the CH DSA based on the CH MAR)	WHB3-1, 3-2, 3-3, 3-4, 3-5, WHB6-4, UG7-3	The cranes overhead powered manipulator and grapple hoist hold their load during the DBE or loss of power.	The RH bay crane, upper hot cell crane, overhead powered manipulator, CUR crane and FCLR grapple hoist shall be designed to withstand loss or power or a DBE event without dropping their load.	To ensure the RH bay crane, upper hot cell crane and overhead powered manipulator, CUR crane and FCLR grapple hoist will continue to perform their safety function, periodic maintenance, inspections and pre-operational testing shall be performed.

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.4	Hot cell & FCLR grapples	WHB3-2, 3-3, 3-4, 3-5	Structurally support a canister or lift fixtures associated with moving shield plugs or drum carriages and prevent dropping waste or dropping items on waste during a DBE or loss of power that could result in a waste container breach . The grapple pintle contact interlock with the pivot dogs of the grapple ensures that the pivot dogs cannot be opened when a load is suspended.	The upper hot cell crane and FCLR grapple hoist facility grapple is required to engage a pintle associated with an RH waste canister or lift fixtures used to move shield plugs or drum carriages. The grapple is required to remain engaged during a loss of power or DBE.	The TSRs contain a LCO that requires surveillance testing of the grapples and associated pintle contact interlock on each grapple. Should the interlock be unavailable, the TSRs define the necessary actions to ensure that waste containers are not dropped.
2	4.4.5	PPA is paved or graveled and surrounded by a gravel road	WHB6-2, WHB7-1	Maintains a physical separation between the WHB and the indigenous low profile vegetation around the site.	Provides a separation between the vegetation outside the PPA and the WHB inside the PPA.	None requiring TSR coverage.
3	4.4.6	Upper hot cell canister storage wells	WHB1-2, WHB3-4	The storage wells prevent facility canisters from toppling onto other waste containers and protects the canister from dropped objects. The wells also prevent direct flame impingement on facility canisters containing waste.	The upper hot cell facility cask storage wells are required to provide structural support for the facility canisters in the upper hot cell such that they do not tip over. The canister wells prevent direct flame impingement on a stored facility canister loaded with waste and protect the canister from dropped objects.	None requiring TSR coverage.
4	4.4.7	Underground Ventilation	UG1-1, 1-2, UG2-1, 2-2, UG3-2	Ensures airflow is directed away from workers and towards the disposal array, and that there is sufficient airflow to facilitate evacuation of the underground workers in the event of a fire.	Required to provide sufficient airflow to direct airflow away from workers during waste handling in the event of a waste container breach. Sufficient airflow must also be maintained to facilitate evacuation of underground workers in the event of underground fires. The underground ventilation system is required to provide at least 20,000 scfm at the base of the waste shaft and 42,000 scfm in the active disposal room.	The TSRs require daily check of the minimum airflow in active disposal room and in the waste shaft ventilation circuit

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.8	Transfer cell shuttle car	WHB3-3, BG7-1	The shuttle car supports its maximum design load and remains on its rails in the event of a DBE such that a RH waste container in the shuttle car is not breached. It accommodates only one RH waste canister at a time.	The transfer cell shuttle car shall be designed to withstand a DBE event and remain on its rails to prevent a waste canister from being dropped or breached.	None requiring TSR coverage
2	4.4.9	Upper hot cell wall mounted manipulators	WHB4-4	Equipped with counterweights to limit the speed of travel in the event that an operator releases the manipulators to prevent breaking prevent breaking upper hot cell lead glass shield windows.	The wall mounted manipulators require counterweights to limit speed of travel in the event the operator releases a manipulator to prevent breaking the lead glass shield windows.	None requiring TSR coverage
3	4.4.10	Underground Bulkheads, Overcasts, and Airlocks	UG1-3, 1-4	The noncombustible construction of the underground bulkheads, overcasts, and airlocks in the underground prevent fires from propagating from the construction and north areas to the disposal area.	Underground bulkheads, overcasts, and airlocks shall be constructed of non combustible material	None requiring TSR coverage.
4	4.4.11	Boreholes and borehole shield plugs	UG1-2, 1-3, UG2-2, 2-3, UG4-1, UG5-1	Provide shielding after RH waste canister disposal for protection of workers in the active disposal room. The shield plug length and material protects assumptions in the criticality safety evaluation for disposed RH waste such that RH waste is neutronically isolated from CH waste. The shield plug also protects the disposed RH waste canister from the effects of an explosion/fire in the active waste disposal room.	The RH disposal boreholes and borehole shield plugs shall provide radiological shielding for protection of the workers and protect disposed RH waste canisters from fires/explosions in the disposal room. canisters. The borehole placement shall ensure criticality between RH canisters remains incredible. Borehole shield plugs shall be made of concrete with a steel sleeve and shall be at least 4 ft. long. Boreholes shall be placed in the walls of the disposal rooms to ensure that shielding near salt pillar corners and on opposite sides of the salt pillar is maintained. Shield plugs shall be sized and constructed of material to protect workers and that the assumptions in the criticality safety analysis for RH waste are maintained.	TSRs require an administrative control to require that boreholes for disposal of RH waste are 17 ft. (-0, +2) deep and are nominally 34 ft. from the projected corner of salt pillars along the short axis of the pillar that separates the disposal rooms and nominally 26 ft. from the projected corners of the salt pillar along the long axis. An administrative control will also be required to install a shield plug in a borehole containing an RH waste canister before removing the facility cask from the HERE.

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.12	WHB Shielding Interlocks - CUR Shield Door, Upper Hot Cell Shield Plugs, and Upper Hot Cell Crane	WHB4-2	Provide shielding for worker in the CUR when processing a 72-B waste canister in the CUR and waste is in the upper hot cell. Provides shielding for workers when waste is being removed from a 10-160B shipping cask in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell.	The CUR shield door, the upper hot cell shield plugs, and upper hot cell crane interlocks must prevent the CUR shield door from opening when waste is being removed from a 10-160B in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell, and prevent the hot cell shield plugs from being removed when a 72-B shipping cask is being processed through the CUR.	LCO demonstrates operability quarterly
2	4.4.13	FCLR Telescoping Port Shield and Grapple Hoist Shield Bell	WHB1-4, WHB2-5, WHB4-5	Provide shielding for worker protection. The telescoping port shield also prevents direct flame impingement or the effects of an explosion in the FCLR on the RH waste canister during transfer.	The shield bell and telescoping port shield are required to provide shielding for worker protection by mating with the facility cask when positioned vertically over the transfer port between the FCLR and the transfer cell. In addition to providing shielding, the telescoping port shield protects a waste canister during transfer from the effects of fires or explosions in the FCLR.	In addition to configuration management and the USQ process, the TSRs require interlock operability described in 4.4.17 and 4.4.18.
3	4.4.14	WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, and Transfer Cell Ceiling Shield Valve	WHB3-3, 3-5 WHB4-3, 4-5	Ensure that a shielded path is established before initiating transfer of a facility canister or 72-B canister loaded with RH waste from the transfer cell to the facility cask in the FCLR. The interlocks also prevent closure of the facility cask shield valves or transfer cell ceiling shield valve on the grapple hoist ropes or a waste canister.	Ensure that the telescoping port shield is mated to the bottom shield valve of the facility cask and the shield bell is mated to the top of the facility cask prior to the FCLR grapple hoist lifting a RH waste canister from the transfer cell into the facility cask to provide shielding for worker protection, and to prevent closure of the facility cask shield valves on the grapple hoist ropes or a waste canister.	LCO demonstrates operability quarterly

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.15	WHB Interlocks - Grapple Hoist, Telescoping Port Shield, Facility Cask, Facility Cask Rotating Device, and Facility Cask Transfer Car	WHB3-3, 3-5, 4-5	The interlocks between the FCLR grapple hoist and shield bell, telescoping port shield, facility cask, FCRD and the FCTC prevent the vertically positioned facility cask from rotating or the FCTC from movement until transfer of a canister is complete and the telescoping port shield is retracted and the shield bell and grapple are fully retracted.	The grapple hoist, telescoping port shield, facility cask, FCRD, and the FCTC interlocks must ensure that the FCTC cannot move while the facility cask is in the vertical position, the FCRD cannot rotate the facility cask to the horizontal position while the telescoping port shield is in contact with the facility cask bottom shield valve, the telescoping port shield cannot retract while the grapple hoist is not at its fully retracted position, and the grapple hoist cannot go to its fully retracted position until the RH waste canister is resting on the facility cask bottom shield valve.	LCO demonstrates operability quarterly
2	4.4.16	WHB Interlocks - Transfer Cell Shuttle Car, CUR Shield Valve, Upper Hot Cell Shield Valve, and Transfer Cell Ceiling Shield Valve	WHB3-5	Prevents a RH waste canister from being breached as a result of a drop due to shuttle car movement shearing the ropes of the crane or grapple performing the transfer. The interlocks also prevent crushing the waste canister during transfer between the CUR and the transfer cell or transfer cell and facility cask in the FCLR as a result of the transfer cell shuttle car moving.	The transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve interlocks are required to ensure that the transfer cell shuttle car cannot move during transfer of a waste canister between rooms within the hot cell complex where RH waste is processed to prevent breaching a canister either by crushing a waste canister or shearing the grapple/crane ropes that are supporting the canister.	LCO demonstrates operability quarterly
3	4.4.17	HERE and Shield Collar	UG1-2, UG2-2, UG4-1	The HERE transfer mechanism and shield collar provide shielding for worker protection when mated with the facility cask during transfer of a RH waste canister from the facility cask into a disposal borehole, prevents direct flame impingement on the waste canister, and protects the canister from explosions.	Required to mate with the RH facility cask to provide a shielded path for transfer of a RH canister into a disposal borehole and subsequent installation of a shield plug before the facility cask is removed and the HERE and shield collar removed from a disposal borehole.	In addition to configuration management and the USQ process, the TSRs require interlock operability in 4.4.21.

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.18	Underground Interlocks - HERE , Facility Cask, and Shield Collar	UG3-3, 4-1	The interlocks between the HERE, the facility cask, and shield collar is to ensure shielding for worker protection during transfer of a RH waste canister from the facility cask into a disposal borehole and prevent crushing a canister by detecting any misalignment of the HERE with respect to the disposal borehole and any gap in the shielding provided by the transfer mechanism and shield collar mating with the facility cask. The interlocks between the facility cask shield valves and HERE transfer mechanism prevents closing a shield valve on a canister resulting in a breach by closure of a shield valve when the canister is within the open valve.	Interlocks must ensure the facility cask front or rear shield valve cannot be opened unless the HERE tilt sensors show the transfer mechanism is aligned with the alignment fixture, the alignment fixture proximity switches detect the facility cask, and the transfer mechanism proximity switches detect the facility cask. Further, the shield valves on the facility cask cannot be closed if the HERE transfer mechanism is extended beyond either shield valve.	LCO demonstrates operability quarterly
2	4.4.19	RH Metal Facility Canisters	WHB1-2, 1-3, 1-4, WHB3-3, 3-4, WHB3-5	Structurally supports the canister and prevents lid ejection during a fire. The canister also prevents direct flame impingement on RH drums that have been loaded into a facility canister for disposal.	Required to structurally support the loaded facility canister when lifted by its pintle by the upper hot cell crane or FCLR grapple hoist. The lid is required to be mechanical or pinned to prevent the lid from becoming disengaged from the canister when being lifted by the pintle.	None requiring TSR coverage.
3	4.4.20	RH Facility Cask	WHB1-4, WHB2-5, WHB3-5, WHB4-5, WHB7-4, 7-5 UG1-1, 1-2, 1-3, UG2-1, 2-2, 2-3, UG3-3, 3-5 UG4-1	Provides shielding of an RH waste canister for worker protection and prevents direct flame impingement on a waste canister from fires and provides protection to the RH waste canister in the event explosions or if the facility cask is dropped. Also protect an RH waste canister from tornado and wind generated missiles.	Required to provide shielding for worker protection when loaded with a RH waste container. The facility cask shield valves must remain closed when transporting a RH waste canister.	In addition to configuration management and the USQ process, the TSRs require interlock operability in 4.4.17 and 4.4.18.

Table 4.4-1 Safety Significant SSCs

	Chapter 4 Section	Safety Significant SSC	Chapter 3 Accident/ Rationale	Safety Function	Functional Requirements	Performance Criteria that requires TSR coverage
1	4.4.21	Facility Cask Transfer Car	WHB3-3, WHB3-5, WHB 4-5	The FCTC structurally supports the facility cask during transfer of a RH waste container from the transfer cell to the facility cask and subsequent transfer to the underground on the waste shaft conveyance. The FCTC mates with the FCRD and latches to prevent the FCTC from moving during canister transfer that could result in crushing the RH waste canister or the FCLR grapple hoist ropes and dropping a canister. This feature also prevents loss of shielding in the FCLR.	The FCTC is required to support the facility cask during canister transfer and during transport from the WHB to the underground on the waste shaft conveyance. It is required to be rail mounted to interface with the material deck rails on the waste shaft conveyance. It is required to interface with the FCRD such that it does not move during transfer of a RH waste canister.	Change control process and USQ process for design changes. Preoperational checks prior to use. The TSRs will also require a waste handling restriction to require the FCTC and FCRD to be latched prior to facility cask rotation.
2	4.4.22	Fence around the waste shaft collar	UG3-6, 6-2,	Defines restricted area around the waste shaft and prevents uncontrolled access to the shaft.	A barrier to prevent inadvertent access to the waste shaft .	Visually inspect for proper operation and ensure the configuration and change control processes that invoke the USQ process for a review of all design changes.

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DERIVATION OF THE TECHNICAL SAFETY REQUIREMENTS

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DERIVATION OF THE TECHNICAL SAFETY REQUIREMENTS

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5.1 Introduction

The purpose of this chapter is to derive the technical safety requirements based upon the control functions determined to be essential in Chapter 3, Hazard and Accident Analysis; and Chapter 4, Safety Structures, Systems, and Components (SSCs). This chapter consists of summaries and references to pertinent sections of this RH documented safety analysis (DSA) in which design features (DFs) and administrative controls (ACs) are needed to prevent and/or mitigate the consequences of a postulated event. The limiting conditions for operation (LCOs), surveillance requirements (SRs), and necessary ACs determined in this chapter form the basis for the facility technical safety requirements (TSRs) and provide the logical link between the TSRs and the DSA.

Expected products of this chapter, as applicable and based on the graded approach, include the following information with a sufficient basis to derive, as appropriate, any of the following TSR parameters for individual TSR controls:

- Safety limits (SLs)
- Limiting control settings (LCSs)
- LCOs
- SRs
- Information with a sufficient basis to derive TSR ACs and specific administrative controls (SACs) for specific control features or to specify programs necessary to perform institutional safety functions
- Identification of TSR controls for all passive DFs addressed in the DSA
- Identification of TSR controls from other facilities that affect the WIPP safety basis
- Derivation of facility modes

5.2 Requirements

The content, format, and graded-approach guidelines for identifying TSRs in this chapter have been specifically developed in accordance with requirements of the following codes, standards, and regulatory document:

- Title 10 CFR 830.205, "Technical Safety Requirements".[1]
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*.[2]
- DOE-STD 1186-2004, *Specific Administrative Controls*.[3]
- DOE Guide 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements.*[4]

5.3 TSR Coverage

This section provides assurance that TSR coverage for the WIPP is complete. The TSR controls ensure that the safety functions outlined in Chapters 3 and 4 of the DSA are operational when required, and preserve the Initial Conditions. Chapter 3 identifies the controls necessary to prevent and/or mitigate potential hazardous events evaluated in this DSA. Chapter 4 identifies which SSCs are SC and SS and systematically evaluates the credited SSCs identified in Chapter 3 for protection of the public and the worker. The SSCs and ACs identified in Chapter 3 are required to prevent and/or mitigate postulated events within the WIPP and, therefore, they are evaluated for TSR coverage.

Section 5.5 and Table 5-1 provides a listing of controls (SSCs and ACs) along with the type of operating limit required, the safety function performed, and the related hazard analysis (HA) events. The selected passive DFs that have a significant effect on the safe operation of the WIPP, if altered or modified, are described in Section 5.6.

All SSCs and ACs credited with prevention and/or mitigation in the accident analysis for protection of the public, those required for worker protection, and significant items that provide defense in depth have been incorporated into the TSRs.

5.4 Derivation of Facility Modes

To aid in compliance with the WIPP LCOs, operational modes are established to provide a safe, structured approach to facility operation. Modes reflect the relative hazards associated with different facility or process configurations; categorize the requirements placed on the facility as a convenience for operator control; and aid the operations staff in determining when the LCO is applicable. Also, modes provide a convenient way to ensure availability of all pertinent safety functions during the current process area/system configuration because not all safety functions are required in each mode. If equipment performs a safety function, but the safety function is not required in certain modes, it would be inefficient to require the equipment to be operable when it is not needed.

The three RH modes defined in the TSRs for the WIPP are RH waste handling, RH waste storage, and RH standby. The hierarchy of modes from the highest to the lowest in relation to hazards is waste handling, waste storage, and standby. Mode designations and changes are an administrative declaration made by the WIPP facility shift manager or designee. There are certain requirements and characteristics that will be present during each mode. The mode definition addresses the actual performance or the capability of the WIPP facility to conduct its intended function(s).

RH Waste Handling Mode

RH waste handling mode is used for the RH portion of the waste handling building (WHB) when moving RH shipping casks loaded with RH waste, when moving RH waste canisters or drums, preparing shipping casks for removal of RH waste containers, placing RH waste drums into facility canisters, transferring waste between portions of the hot cell complex, processing a 72-B or facility canister with RH waste in the transfer cell or facility cask, transporting waste to the underground on the waste shaft conveyance, transporting the facility cask to the active disposal room and emplacing the waste canister into a disposal borehole in the wall of the active waste emplacement room using the horizontal emplacement retrieval equipment (HERE). RH waste handling also includes installation of the borehole shield plug into the borehole after emplacing the waste canister. While in this mode all LCOs for operation(s) have been met and the facility is performing or is capable of performing its intended function(s). Other actives that are allowed in this mode are maintenance, repair, and inspections as long as these activities are not in conflict with the requirements set forth in this document.

RH Waste Storage Mode

RH waste storage mode is a mode that is used for the RH portion of the WHB including the RH bay, the transfer cell, the cask unloading room (CUR), the upper hot cell, and the facility cask loading room (FCLR). While in this mode, RH waste can not be physically handled, but will be temporarily stored. Other activities, such as maintenance, repair, and inspections are allowed as long as these activities do not conflict with the requirements set forth in this document.

RH Standby Mode

RH standby mode is a mode used for the RH portion of the facility. While in this mode, RH waste is on the transporter or on a road cask transfer car (RCTC) with no lid bolts loosened.

The RH standby mode is the safest mode for the RH portion of the facility due to the fact that while in this mode no waste will be present outside of a closed 72-B or 10-160B shipping container, therefore, the postulated events involving waste can not occur. This mode only applies to the RH bay portion of the WHB. The rooms in the RH portion of the facility where waste is outside of a closed shipping cask, or the outer lid bolts of the shipping cask are detensioned, and the underground portion of the facility can never be in the RH standby mode.

5.5 TSR Derivation

The derivation of the TSRs is organized by specific design or administrative feature identified in Section 5.3. Each subsection includes the specific feature, relevant modes of operation, LCO, SRs, and ACs. The WIPP facility has no SLs or LCSs derived for TSRs.

5.5.1 Fire Water Supply and WHB Fire Suppression System

The safety function of the fire water supply and WHB fire suppression systems is to extinguish fires within the WHB before they become large enough to impact RH waste, propagate to areas containing RH waste outside of a closed shipping cask, or propagate from the RH portion of the WHB to the CH bay and impact CH waste. The suppression system is required to be operational when the WIPP is waste handling or waste storage mode. Chapter 4 provides (1) system description and system functionality, (2) system evaluation, and (3) justification for the TSR.

5.5.1.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of the fire suppression system would not result in a release of material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the two LCOs with their accompanying definitive parameters are presented below.

Fire Suppression System for the WHB

An LCO shall be required, along with the appropriate conditions for an operable fire suppression system, for the WH:

- The static pressure as measured at each riser to the WHB and Support Building shall be greater than or equal 125 pounds per square inch gauge (psig).
- The main primary or alternate isolation valves at riser shall be locked in the open position
- All other sSystem isolation valves FW-411-V-072 and FW-411-V-073 shall be locked in the open position
- The post indicator valve shall be locked in the open position
- Main drain test results are less than or equal to 20 percent pressure change
- Water flow indication when the inspector's test valve is opened

Fire Water Supply System

An LCO shall be required along with the appropriate conditions for an operable fire water supply system::

- The system shall maintain a water capacity of ≥135,000 gallons
- The system shall have two operable fire pumps

5.5.1.2 Surveillance Requirements

Fire Suppression System

Water Supply Pressure

In order for the fire suppression system to operate properly, the static water supply pressure at the WHB supply risers must be greater than or equal to 125 psig. This SR verifies on a monthly basis that the water supply pressure is adequate.

Primary and Alternate Main Isolation Valves

The main primary or alternate isolation valves for each riser is are required to be locked open. This SR verifies that these valves are locked open on a monthly basis.

Other Isolation Valves

The other isolation valves in the system are required to be locked open. This SR verifies that these valve are locked open on a monthly basis.

Post Indicator Valves

The post indicator valve associated with each system is required to be locked open. This SR verifies that this valve is locked open on a monthly basis.

Inspector's Test Valve Flow

The fire suppression system requires indication of water flow when the inspector's test valve is opened. This SR opens the inspector's test valve and verifies water flow through the associated system on a quarterly basis.

Main Drain Test

In order for the fire suppression system to be operable, the main drain test results must be less than or equal to 20 percent pressure change. This SR performs this test annually and verifies that the results are within the required parameters.

Fire Water System

Fire Water Capacity

The fire water supply system is required to have a minimum of 135,000 gallons of water available for fire protection. This SR verifies that the required amount of water is present each shift.

Isolation Valve

In order for the fire water supply system to provide water to individual sprinkler systems, the isolation valve is required to be locked open. This SR verifies that the valve is open prior to each shift.

Diesel Fuel

To maintain the diesel pump operable, there is required to be greater than 125 gallons of diesel fuel in the diesel fire pump fuel tank. This SR verifies that the required amount of fuel is present prior to each shift.

Automatic Start Test

An automatic start test is required to be performed on the fire pumps weekly. This SR ensures that each pump can automatically start at the proper pressure parameters.

Pump Output

To provide the necessary amount of water to the sprinkler systems, each fire pump must be capable of pumping greater than 1500 gpm at 105 psi net discharge. This SR verifies annually that the pumps can perform this function.

5.5.2 Underground RH Waste Handling Equipment Automatic/Manual Fire Suppression System

The safety function of the automatic/manual fire suppression system on RH waste handling equipment is to prevent a small fire associated with fuel or hydraulic leaks (forklifts or HERE) or the RH waste handling forklift engine (41-ton, 20-ton, and 6-ton) from developing into a large fire. The automatic fire suppression system is required to be operable while handling waste in the underground. Chapter 4 provides (1) system description and system functionality, (2) system evaluation, and (3) justification for the TSR.

5.5.2.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of RH waste handling equipment fire suppression system would not result in a release of material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with the accompanying definitive parameters is presented below.

Underground RH Waste Handling Equipment Automatic/Manual Fire Suppression System

An LCO shall be required, along with the appropriate conditions for an operable automatic/manual fire suppression system on RH waste handling equipment used in the underground. An operable automatic fire suppression system consists of the following:

- System status lights are functioning properly and no trouble lights are illuminated on the automatic fire suppression system control module.
- The system shall be verified as charged

An operable manual fire suppression system consists of the following element:

- A charged fire suppressant system on the RH waste handling equipment.

5.5.2.2 Surveillance Requirements for Underground RH Waste Handling Equipment Automatic/Manual Fire Suppression System

Control Module

The automatic/manual fire suppression system control module system status lights shall be verified as functioning properly and that no trouble lights are illuminated for the selected waste handling equipment. This SR is performed every 48 hours and ensures that the automatic portion of the system is functioning.

Fire Suppression System Charge

The automatic fire suppression system shall be visually verified to have not discharged. This SR is performed every 12 hours when the equipment is in use and ensures that the automatic and manual initiation portion of the system is available. A semi-annual verification of the system charge is also performed to support both automatic and manual initiation of the suppressant.

System Controls

The automatic/manual fire suppression system control shall be verified as functioning. This SR verifies the system is operable on a semi-annual basis.

5.5.3 Underground Ventilation System

The safety function of underground ventilation system is to ensure that there is sufficient airflow for waste handling activities and to direct airflow away from workers in the event of a waste container breach. The system also provides fresh air for worker evacuation in the event of a fire. The ventilation system is required to be operable for waste handling operations. Chapter 4 provides (1) system description and system functionality, (2) system evaluation, and (3) justification for the TSR.

5.5.3.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of the underground ventilation system would not result in a release of material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

Underground Ventilation System

An LCO shall be required, along with the appropriate conditions for an operable underground ventilation system:

- The underground ventilation system shall be verified to provide a minimum of 42,000 actual cubic per minute (acfm) airflow in the active disposal room
- The underground ventilation system shall be verified to provide a minimum of 20,000 acfm airflow in the waste shaft ventilation circuit as measured on the waste shaft side of regulator 74-B-308.
- Underground ventilation fan(s) running to achieve the required airflow.

5.5.3.2 Surveillance Requirements Underground Ventilation System

Airflow

The underground ventilation system shall be verified as providing the required airflow through the active waste disposal room; and in the waste shaft ventilation circuit as measured on the waste shaft side of regulator 74 B-308. This SR verifies the required airflow on a daily basis.

5.5.4 WHB Shielding Interlocks - CUR Shield Door, Upper Hot Cell Shield Plugs and Upper Hot Cell Crane

The safety function of the shielding interlocks between the CUR shield door, the upper hot cell shield plugs and upper hot cell crane is to protect workers from direct radiation exposure. During processing of RH waste in a 72-B shipping cask, workers are present in the CUR and the CUR shield door is open. The interlocks prevents removal of the upper hot cell shield plugs when the CUR shield door is open. During processing of RH waste from a 10-160B shipping cask in the CUR, workers are not present and the CUR shield door is closed. The interlocks prevent removal of the upper hot cell shield plugs until the CUR shield door is closed.

5.5.4.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of the interlocks does not result in a release of radioactive material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

<u>WHB Shielding Interlocks - CUR Shield Door, Upper Hot Cell Shield Plugs and Upper Hot Cell Crane</u>

An LCO shall be required along with the appropriate conditions for operable interlocks between the CUR shield door, upper hot cell shield plugs and the upper hot cell crane.

- The CUR shield door must be closed before the upper hot cell crane grapple can be raised when positioned over the upper hot cell floor shield plugs.
- When the upper hot cell shield plugs are removed and the CUR shield door is closed, the CUR shield door cannot be opened

5.5.4.2 Surveillance Requirements WHB Shielding Interlocks - CUR Shield Door, Upper Hot Cell Shield Plugs, Upper Hot Cell Crane

The surveillance requires the following be verified:

> The CUR shield door cannot be opened with the upper hot cell shield plugs removed.
>
> The upper hot cell crane grapple cannot be raised when centered over the upper hot cell floor shield plugs unless the CUR shield door is closed

This SR verifies the required interlocks are operable quarterly and after maintenance on the CUR shield door, the upper hot cell crane, or the associated controls.

5.5.5 WHB Interlocks - Upper Hot Cell Crane and FCLR Grapple Pintle Contact Interlock with Pivot Dogs

The safety function of the upper hot cell crane and FCLR grapple hoist grapples is to structurally support a canister or a lift fixture and prevent dropping waste or dropping items on waste. The grapple pintle contact interlock with the pivot dogs of the grapple ensures that the pivot dogs cannot be opened when a load is suspended.

5.5.5.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of the shielding interlocks does not result in a release of material. Therefore, no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

Upper Hot Cell and FCLR Grapple Pintle Contact Interlock with Pivot Dogs

An LCO shall be required , along with the appropriate conditions for operable interlocks for the grapple pintle contact with the pivot dogs for the upper hot cell crane grapple and the FCLR grapple hoist grapple.

- The FCLR grapple pivot dogs cannot be rotated open unless the grapple pintle contact proximity switch contact is closed as indicated by the green pintle contact indicating light on Panel 411-CP-264-04.
- The upper hot cell crane grapple pivot dogs cannot be rotated open unless the grapple pintle contact proximity switch is closed as indicated by the green pintle contact indicating light on the hot cell crane control panel.

5.5.5.2 Surveillance Requirements for Grapple Pintle Contact Interlock with Pivot Dogs

The surveillance requires the following be verified:

The FCLR grapple pivot dogs cannot be rotated open unless the grapple pintle contact proximity switch contact is closed as indicated by the green pintle contact indicating light on Panel 411-CP-264-04.

The upper hot cell grapple pivot dogs cannot be rotated open unless the grapple pintle contact proximity switch is closed as indicated by the green pintle contact indicating light on the hot cell crane control panel.

This SR verifies the required interlocks are operable quarterly and after maintenance on the upper hot cell crane grapple and the FCLR grapple hoist grapple.

5.5.6 WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, and Facility Cask, and Transfer Cell Ceiling Shield Valve

The interlocks between the FCLR grapple hoist shield bell and grapple, telescoping port shield, facility cask, and transfer cell ceiling shield valve ensure that a shielded path is established before initiating transfer of a facility canister or 72-B canister loaded with RH waste from the transfer cell to the facility cask in the FCLR. These interlocks ensure that a RH waste canister cannot be raised into the FCLR using the FCLR grapple hoist unless the facility cask is located over the transfer port between the transfer cell and the FCLR, and positioned in a vertical configuration such that the FCLR grapple hoist shield bell can mate with the top of the facility cask and the telescoping port shield can mate with the lower part of the facility cask. The interlocks also prevent closure of the facility cask shield valves or transfer cell ceiling shield valve on the grapple hoist ropes or a waste canister.

5.5.6.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. Inoperability of the shielding interlocks does not result in a release of material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

<u>WHB Shielding Interlocks- FCLR Grapple Hoist, Telescoping Port Shield, and Facility Cask</u>

An LCO shall be required, along with the appropriate conditions for operable interlocks between the FCLR grapple hoist, telescoping port shield, and facility cask.

- The facility cask top shield valve cannot be opened unless the grapple is at Position B as indicated by the Position B white light on control panel 411-CP-264-04. The facility cask top shield valve cannot be closed unless the grapple is at position A or B as indicated by the associated position white lights on control panel 411-CP-264-04 and the grapple is open.

- The transfer cell ceiling shield valve cannot be opened unless the telescoping port shield is in contact with the facility cask lower shield valve. If the facility cask is not present, the transfer cell ceiling shield valve cannot be opened unless the FCLR grapple hoist shield bell is in contact with the telescoping port shield at Position E as indicated by the white Position E indicating light on control panel 411-CP-264-04. The transfer cell ceiling shield valve cannot be closed when lifting a waste canister unless the grapple hoist is at position B, C, or D as indicated by the associated position white lights on control panel 411-CP-264-04.

- The facility cask lower shield valve cannot be opened unless the transfer cell ceiling shield valve is closed and the grapple hoist is at position D as indicated by the Position D white light on control panel 411-CP-264-04. The facility cask lower shield valve cannot be closed unless the grapple hoist is at position B or C as indicated by the associated position white lights on control panel 411-CP-264-04.

The grapple positions are described in Chapter 2 and in Chapter 4, Section 4.4.17.

5.5.6.2 Surveillance Requirements for WHB Shielding Interlocks - FCLR Grapple Hoist, Telescoping Port Shield, and Facility Cask

The surveillance requires the following be verified:

- The facility cask top shield valve cannot be opened unless the grapple is at Position B as indicated by the Position B white light on control panel 411-CP-264-04. The facility cask top shield valve cannot be closed unless the grapple is at position A or B as indicated by the associated position white lights on control panel 411-CP-264-04 and the grapple is open.
- The transfer cell ceiling shield valve cannot be opened unless the telescoping port shield is in contact with the facility cask lower shield valve. If the facility cask is not present, the transfer cell ceiling shield valve cannot be opened unless the FCLR grapple hoist shield bell is in contact with the telescoping port shield at Position E as indicated by the white Position E indicating light on control panel 411-CP-264-04. The transfer cell ceiling shield valve cannot be closed when lifting a waste canister unless the grapple hoist is at position B, C, or D as indicated by the associated position white lights on control panel 411-CP-264-04.
- The facility cask lower shield valve cannot be opened unless the transfer cell ceiling shield valve is closed and the grapple hoist is at position D as indicated by the Position D white light on control panel 411-CP-264-04. The facility cask lower shield valve cannot be closed unless the grapple hoist is at position B or C as indicated by the associated position white lights on control panel 411-CP-264-04.

This SR verifies the required interlocks are operable quarterly and after maintenance on the FCLR grapple hoist or shield bell, the telescoping port shield, the facility cask, the transfer cell ceiling shield valve, or the associated controls.

5.5.7 WHB Interlocks - Transfer Cell Shuttle Car, CUR Shield Valve, Upper Hot Cell Shield Valve, and Transfer Cell Ceiling Shield Valve

The interlocks between the transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve prevent a RH waste canister from being breached as a result of a drop due to shuttle car movement shearing the ropes of the crane or grapple performing the transfer. The interlocks also prevent crushing the waste canister during transfer between the CUR and the transfer cell or transfer cell and facility cask in the FCLR as a result of the transfer cell shuttle car moving.

5.5.7.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. The consequence of a release from inoperability of the interlocks does not result in consequences that challenge the evaluation guideline (EG). Therefore, no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

<u>WHB Interlocks - Transfer cell shuttle car and CUR shield valve, Upper Hot Cell shield valve, and Transfer Cell ceiling shield valve</u>

An LCO shall be required, along with the appropriate conditions for operable interlocks between the transfer cell shuttle car, upper hot cell shield valve, the transfer cell shield valve and the CUR shield valve.

- The transfer cell shuttle car cannot be moved unless the upper hot cell shield valve, the CUR shield valve, and the transfer cell ceiling shield valve are closed.

5.5.7.2 Surveillance Requirements for Shielding Interlocks - Transfer Cell Shuttle Car and CUR Shield Valve, Upper Hot Cell Shield Valve, and Transfer Cell Ceiling Shield Valve

The surveillance requires the following be verified:

- The transfer cell shuttle car cannot be moved unless the upper hot cell shield valve, the CUR shield valve, and the transfer cell ceiling shield valve are closed

This SR verifies the required interlocks are operable quarterly and after maintenance on the transfer cell shuttle car, the upper hot cell shield valve, the CUR shield valve, the transfer cell ceiling shield valve, or the associated controls.

5.5.8 WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, Facility Cask Rotating Device

The safety function of the interlocks between the grapple hoist, the telescoping port shield, and the facility cask rotating device (FCRD) is to ensure shielding for worker protection. These interlocks also prevent crushing a waste canister if the rotating device or the transfer car were to move before a RH waste canister is fully inside the facility cask. The interlocks also prevent crushing the grapple hoist cables during canister transfer which prevents a canister drop.

5.5.8.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. The consequence of a release from inoperability of the interlocks does not result in consequences that challenge the EG. Therefore, no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

<u>WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, and Facility Cask Rotating Device</u>

An LCO shall be required, along with the appropriate conditions for operable interlocks between the grapple hoist, telescoping port shield, and the FCRD.

- The FCRD cannot rotate the facility cask from vertical to horizontal unless the grapple hoist is in the highest position and the telescoping port shield is retracted.

5.5.8.2 Surveillance Requirements for WHB Interlocks - FCLR Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, and Facility Cask Rotating Device

The surveillance requires the following be verified:

- The FCRD cannot rotate the facility cask from vertical to horizontal unless the grapple hoist is in the highest position and the telescoping port shield is retracted.

This SR verifies the required interlocks are operable quarterly and after maintenance on the FCLR grapple hoist and shield bell, the telescoping port shield, the facility cask, and the FCRD, or the associated controls.

5.5.9 Underground Interlocks - HERE, Facility Cask, and Shield Collar

The interlocks between the HERE, the facility cask, and shield collar is to ensure shielding for worker protection during transfer of a RH waste canister from the facility cask into a disposal borehole and prevent crushing a canister by detecting any misalignment of the HERE with respect to the disposal borehole and any gap in the shielding provided by the transfer mechanism and shield collar mating with the facility cask. The interlocks between the facility cask shield valves and HERE transfer mechanism prevents crushing a canister by closure of a shield valve when the transfer mechanism is extended beyond either shield valve.

5.5.9.1 Safety Limits, Limiting Control Settings, and Limiting Conditions for Operation

SLs are limits on process variables associated with those physical barriers that, if exceeded, could directly cause the failure of one or more barriers that prevent the uncontrolled release of radioactive or other hazardous materials, with the potential of consequences to the public above specified guidelines. The consequence of a release from inoperability of the interlocks does not result in a release of radiological material. Therefore no SLs are required.

LCSs are settings on safety systems that control process variables to prevent exceeding SLs. Because no SLs are identified for the WIPP, no LCSs are required.

LCOs are selected to detail the operability requirements for the given equipment and to ensure that the practical definitive parameter limits are included in the LCO statement. As identified in Chapter 4, the LCO with accompanying definitive parameters is presented below.

<u>Underground Shielding Interlocks - HERE Transfer Mechanism, Facility Cask, and Shield Collar</u>

An LCO shall be required, along with the appropriate conditions for operable interlocks between HERE transfer mechanism, facility cask, and shield collar.

- The front shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture as indicated by green lights on the tilt status array on the control console for the waste transfer machine, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism detect the facility cask.
- The rear shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture as indicated by green lights on the tilt status array on the control console for the waste transfer machine, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism must detect the facility cask.

- The front shield valve on the facility cask cannot be closed if the transfer mechanism is extended through the rear shield valve greater than 33 inches and the grapple detects a pintle as indicated on the control console for the waste transfer machine.
- The rear shield valve on the facility cask cannot be closed unless the transfer mechanism is retracted to less than 14 inches and the grapple is open as indicated on the control console for the waste transfer machine.

5.5.9.2 Surveillance Requirements Underground Shielding Interlocks - HERE Transfer Mechanism, Facility Cask, and Shield Collar

The surveillance requires the following be verified:

- The front shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture as indicated by green lights on the tilt status array on the control console for the waste transfer machine, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism detect the facility cask.
- The rear shield valve on the facility cask cannot be opened unless the tilt sensors on the HERE indicate that the waste transfer machine is aligned with the alignment fixture as indicated by green lights on the tilt status array on the control console for the waste transfer machine, the proximity switches on the alignment fixture detect the facility cask, and the proximity switches on the transfer mechanism must detect the facility cask.
- The front shield valve on the facility cask cannot be closed if the transfer mechanism is extended through the rear shield valve greater than 33 inches and the grapple detects a pintle as indicated on the control console for the waste transfer machine.
- The rear shield valve on the facility cask cannot be closed unless the transfer mechanism is retracted to less than 14 inches and the grapple is open as indicated on the control console for the waste transfer machine.

This SR verifies the required interlocks are operable quarterly and after maintenance on the facility cask, the alignment fixture, or the transfer mechanism, the proximity switches, or the tilt sensors, or the associated controls.

5.5.10 Administrative Controls

This section of the TSRs addresses the administrative functions required to meet facility safety criteria as identified within the RH DSA. These include minimum facility staffing requirements, programmatic administrative controls (PACs) and SACs required for safe operation of the facility. PACs are designed to provide broad programmatic support for safety management programs supporting defense-in-depth or worker safety. SACs provide specific preventive or mitigative functions for accident scenarios identified in Chapter 3 where the safety function has importance similar to, or the same as, the safety function of a safety SSC. SACs are developed consistent with the requirements of DOE-STD-1186-2004.[3] Both the PACs and the SACs are delineated in Table 5.1-1.

Minimum Facility Staffing

RH Waste Storage, Standby, or Waste Handling Mode

RH waste handling operations take place on the surface outside the WHB, inside the WHB, and in the underground. Even if waste handling operations are not in progress, the minimum required operating staff to maintain the WIPP in a safe condition is specified below.

1. Facility shift manager (FSM)
2. Central monitoring room operator (CMRO)
3. Surface roving watch

This minimum staffing assumes no personnel are in the WIPP underground. The FSM is responsible for overall facility operation and operation of the facility in accordance with approved TSRs. The FSM acts as the central point for release of work, control of physical changes in facility configuration, and coordination of the activities of work groups within the facility. The FSM ensures that all facility operations are performed under a trained supervisor. This does not require the supervisor to be present at the work location. This means that the supervisor is trained to perform the tasks commensurate with management expectation for the associated facility operations. The FSM also ensures that personnel performing surveillance, maintenance testing, or other activities that could affect SSCs as credited in the facility safety basis meet established training requirements for the activity/activities being performed.

The CMRO is responsible for monitoring plant operating equipment that reports to the CMR through the central monitoring system, making plant announcements, and providing a central point for communication during emergency situations. As specified in the specific administrative control for qualified operators, only operators trained in the appropriate response to underground fires are authorized to man the CMR during waste handling operations.

The surface roving watch is responsible for monitoring equipment conditions in the field, recording data as necessary, and operation of plant equipment.

The RH waste handling operations on the surface and in the WHB involve two different shipping casks, the 72-B and the 10-160B. As discussed in Chapter 2 of this DSA, waste from a 72-B is transferred from the 72-B shipping cask into the facility cask and then from the transfer cell to the FCLR. Waste from the 10-160B shipping cask must first be transferred from the 10-160B to the upper hot cell where it is subsequently placed into a facility canister. The facility canister is later transferred to the transfer cell where the process is the same as the transfer of 72-B waste. Because some activities associated with the 10-160B and 72-B waste can occur concurrently, staffing is specified by process area.

RH Waste Handling Mode in the WHB

For RH waste handling operations on the surface and in the WHB, the staffing includes the following:

a. FSM, CMRO, and roving watch as specified above

b. One RH waste handling engineer

c. Radiological control technician - see discussion below for duties in the WHB

d. Two RH waste handling technicians - see discussion below for duties in the WHB

In the RH bay, CUR, and upper hot cell, one waste handling technician operates the crane(s) and the other waste handling technician acts as a spotter. The spotter is near the 72-B shipping cask in the RH bay and CUR and can directly see the movement of the cask. When removing waste containers from a 10-160B cask in the CUR, the spotter uses camera images to monitor waste movement. In the upper hot cell the spotter can see some movement of waste through the shield windows but must also rely on camera images for loading waste drums into the facility canister. In the FCLR, one waste handling technician operates the shuttle car and grapple at the control panel and the spotter monitors the camera images as the canister moves from the transfer cell in to the facility cask. In the RH bay the radiological control technician is required to obtain and analyze a radiological assessment filter in conjunction with preparing the loaded shipping cask for subsequent movement into the CUR. When waste containers are being moved in the upper hot cell, the radiological control technician analyzes swipes of the underside of the 10-160B shipping cask lid, and swipes of the exterior surface of the waste drums and drum carriages. When waste is being processed in the transfer cell, the radiological control technician processes swipes of the underside of the 72-B inner containment vessel lid and the external surface of the waste canister during transfer from the transfer cell to the facility cask. The RH waste handling engineer support the overall RH WH process and resolves issues should they arise. The RH waste handling engineer can also serve in the capacity of a RH waste handling technican.

Since waste handling operations can occur in the RH bay, upper hot cell, and transfer cell simultaneously, each processing location must have the radiological control technician and the two waste handling technicians. If waste is processed sequentially in one location at a time, then the same waste handling technicians and radiological control technician can be used in each location. If RH waste handling operations are not being conducted on the surface or in the WHB, the radiological control technician and waste handling technicians are not required.

<u>RH Waste Handling Mode in the Underground</u>

The minimum staffing to support waste handling operations in the WIPP underground includes the following:

a. FSM, CMRO, and roving watch as specified above

b. Waste hoist operator for operation of the waste hoist controls during loading, transport, and offloading RH waste on the waste shaft conveyance

c. Toplander at the waste shaft for operation of the gate in the fence at the waste shaft collar during, loading, transport, and offloading the waste shaft conveyance

d. Bottom lander at the bottom of the waste shaft during loading, transport, and offloading the waste shaft conveyance

e. Waste handling engineer (this can be the same engineer as the one that supports RH Waste Handling Mode in the WHB)

f. Radiological control technician - to monitor RH waste handling operations during transport from the waste shaft station to the active RH disposal room and during emplacement of an RH waste canister into a disposal borehole. Following installation of the shield plug after the canister is emplaced and after removal of the facility cask and RH emplacement equipment from the borehole, the radiological control technician takes radiation measurements to determine if additional radiological control measures are necessary.

g. Two RH waste handling technicians (one to operate the FCTC and a spotter, or one to operate the 41-ton forklift and a spotter, or one to operated the HERE and a spotter, or one to operate the 20-ton forklift and a spotter). The RH waste handling engineer can simultaneously serve in the capacity of a RH waste handling technician.

h. Underground facility operations engineer to control work in the underground and communicate with the CMRO during normal and abnormal conditions.

i. Underground roving watch to ensure adequate ventilation for underground activities, to monitor other underground parameters as assigned by the underground facility operations engineer

The toplander at the waste shaft is also addressed in a specific administrative control to prevent a load from inadvertently entering the waste shaft or being dropped down the shaft causing a radiological release from waste.

If RH waste handling operations are occurring on the surface in the WHB and in the underground, the number of radiological control technicians and waste handling technicians must meet the minimum for each process area.

Programmatic Administrative Controls

Initial Testing, In-Service Inspection and Test, Configuration Management, and Maintenance Program

The programmatic control for initial testing, in-service inspection and test, configuration management, and maintenance program ensures SSCs supporting safe operation of the WIPP and DFs subject to degradation perform their intended functions.

Document Control

The programmatic control for document control establishes minimum review and approval requirements, change control, and minimum record retention requirements for the WIPP facility.

Quality Assurance Program

The programmatic control for quality assurance includes required elements including work planning; training and personnel development; preparing, reviewing, approving, and verifying designs; qualifying suppliers; preparing, reviewing, approving, and issuing instructions, procedures, schedules, and procurement documents; purchasing; verifying supplier work; identifying and controlling hardware and software; manufacturing; managing and operating facilities; calibrating and controlling measuring and test equipment; conducting investigations and acquiring data; performing maintenance, repair, and improvements; performing assessments; tracking non-conformances and corrective actions; and controlling records.

Training

The programmatic control for training ensures operators are trained to properly operate the waste handling equipment during normal RH waste handling operations and to properly respond to off-normal operations.

Conduct of Operations

The programmatic control for conduct of operations contains elements of organization and administration of facility operations to ensure that operations activities are controlled to be consistent with assumptions in the RH DSA. The basic elements of the conduct of operations includes: operations organization and administration; shift routines and operating practices; control area activities; communications; control of on-shift training; control of equipment and system status; lockouts and tagouts; independent verification; log keeping; operations turnover; timely orders to operators; operations procedures; operator aid postings; and component and piping labeling. **Preoperational checks** shall be performed to ensure that equipment performing RH waste handling operates as required prior to RH waste handling.

Emergency Response

The programmatic control for emergency response provides preparedness, training, and operational response capabilities (including notification, evacuation, and direct responses to events) to minimize consequences to workers and the public from accidents involving WIPP operations.

Radiation Protection

The programmatic control for radiation protection ensures personnel radiation protection for any WIPP operations involving personnel radiation exposure. The radiation protection program, as specified in WP 12-5, WIPP Radiation Safety Manual,[5] includes considerations and general facility DFs employed to maintain radiation exposures as low as reasonable achievable; radiological control zoning and access control; radiation shielding; ventilation systems; differential pressure; radiation monitoring equipment, and effluent monitoring and sampling systems.

Access control ensures that personnel do not enter areas where RH waste is outside of a closed shipping cask or facility cask in the WHB including the upper and lower hot cell and the transfer cell. The CUR is required to be unoccupied with the CUR shield door closed when removing drums from a 10-160B shipping cask or when waste is in the upper hot cell and the shield plugs are removed.

Unreviewed Safety Questions

The programmatic control to maintain an unreviewed safety question program ensures that the WIPP remains consistent with this DSA and credited DFs as proposed modifications to the facility or activities that affect waste handling are considered prior to making the change.

Fire Protection Program

The programmatic control for the WIPP fire protection program is established to, at a minimum, provide for periodic inspection and testing of fire suppression, detection and alarm equipment to meet the requirements of NFPA. The program includes combustible loading control for structures or areas of the facility with the potential to impact RH waste at the WIPP and ensures that combustible loading is maintained such that small fires will not propagate into larger fires with sufficient heat to cause a significant release from waste containers in close proximity to the fire. The fire protection program also includes periodic updates to the site fire hazards analysis.

Ground Control and Geotechnical Monitoring Program

A ground control and geotechnical monitoring program shall be established, implemented and maintained to initiate remedial action for unstable salt and to characterize, monitor, and trend salt behavior to minimize the likelihood of falling objects from the overhead and prevent a roof fall event in the underground. The program shall include periodic ground control inspections as a specific control in addition to the programmatic control.

Waste Hoist Structure and Structural Support Integrity Program

The programmatic control for the structural integrity of load bearing components of the waste hoist and structural support includes periodic inspections, tests and maintenance activities. These activities include cable lubrication, cable and cable attachment inspections and/or nondestructive testing, verification of proper load sharing of all the ropes, and inspections of the headframe, conveyance and counterweight and the structural support provided by the waste hoist tower.

Specific Administrative Controls

Criticality Safety Program

The SAC to ensure waste meets the fissile mass and reflector/moderator mass limits by container type prior to being approved for disposal at the WIPP ensures that criticality remains incredible at the WIPP. Limits are determined through nuclear criticality safety evaluations and are imposed in the RH TSRs and in the DOE/WIPP-02-3122, Rev. 5 (draft), Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant,[6] referred to in this DSA as the RH WAC. A waste characterization/certification program at each generator site ensures that only RH waste that meets the requirements in the RH WAC[6] is disposed of at the WIPP, and that any exceptions are evaluated against all applicable baseline documents prior to their authorization for shipment.

Waste Characteristics Control

This SAC ensures that only waste that meets the specified curie content by waste container type, surface dose rate and hazardous constituent restrictions is approved for disposal at the WIPP. The waste characteristics are imposed in the RH TSRs and in the RH WAC.[6] A waste characterization/certification program at each generator site ensures that only RH waste that meets the requirements in the RH WAC[6] is disposed of at the WIPP, and that any exceptions are evaluated against all applicable baseline documents prior to their authorization for shipment.

Combustible Loading Control Program - Waste Handling Building

The SAC for a combustible loading control program, as it applies to the WHB, controls the amount of combustible materials in the WHB such that fires in the WHB will not produce sufficient heat to cause a release from waste containers in close proximity to the fire. Use of flammable gas or flammable compressed gas cylinders(except for those cylinders covered by Department of Transportation (DOT) Exemption DOT-E-7607) is prohibited in any specific room within the hot cell complex when waste is present in that room. Use of flammable gas and flammable compressed gas cylinders is also restricted in rooms adjacent to rooms with waste unless rooms are separated by closed shield doors, shield plugs are installed or shield valves are closed as specified in Table 5.1-1.

Storage of flammable gas and flammable compressed gas cylinders is prohibited in the WHB. Transient combustible material shall not be stored in the hot cell complex, the service room, the hot cell operating gallery, the crane maintenance room, the FCLR, or within 15 ft. of the common RH/CH wall. Any diesel powered equipment operating in the RH bay within 15 ft of the common RH/CH wall requires a fire watch when waste is present in the NE corner of the CH bay.

Combustible Loading Control Program - Disposal Path

The SAC for a combustible loading control program, as it applies to the disposal path, places limits on the amount and location of flammable material in order to reduce the likelihood of a fire in the disposal path in the underground area. The program prohibits storage of flammable gas and flammable compressed gas cylinders in the disposal path and prevents their use during waste handling. This also includes prohibitions on the storage or use flammable gas in construction areas that are close to the waste transport path including bulkhead 309 in West 30 ~~and between the disposal panel supply overcast and the construction bulkhead to the south in East 300 during waste transit from the waste shaft station to the active disposal room,~~ and between the Air Intake Shaft and South 1000 in West 30 and within 100 ft of bulkhead 303 on the north ventilation side. This program is supplemented by waste handling restrictions that imposing standoff distances and other controls to prevents collisions between waste handling equipment and non-waste handling equipment during waste handling operations and the automatic/manual fire suppression system on RH waste handling equipment.

Combustible Loading Control Program - Disposal Room

The SAC for a combustible loading control program, as it applies to the disposal room, prohibits storage of flammable gas and flammable compressed gas cylinders in the active RH disposal room and prohibits their use during waste handling in the active disposal room and prohibits the lube truck from the active RH disposal room. The program also limits equipment used in the underground to be powered either electrically or by diesel. This program is supplemented by waste handling restrictions that impose standoff distances and use of a spotter to prevent collisions with the CH disposal array that could result in fire with the potential to breach RH or RH and CH waste.

Waste Handling Restrictions

Waste handling restrictions limit the amount of RH waste stored within the RH portion of the WHB (see Table 5.1 for the specifics), specifies that loaded 10-160B shipping cask cannot be left unattended in the RH bay with the lid bolts loosened and shall only be stored in the CUR with the CUR shield door closed when the lid bolts are removed, restricts the removal of RH waste from a shipping cask to be performed only within the shielded hot cell complex, and ensures that RH waste is only transported to the underground using the waste hoist and is not moved outside the disposal path in the underground. Additional restrictions requires use of a spotter when backing the RH transportation trailers into the RH bay, requires use of a spotter when operating any vehicle within 15 ft of the common RH/CH wall when waste is present in the NE corner of the CH bay, requires a verification of canister weight to determine whether the maintenance platform may be left on the waste shaft conveyance prior to loading the facility cask onto the conveyance to prevent overloading the waste hoist, restricting worker access from E-300 in the underground during waste handling, requiring a spotter when operating the 41-ton forklift loaded with waste, and requiring a spotter when operating the 41-ton, 20-ton, or 6-ton RH waste handling forklifts near the CH disposal array. Waste handling restrictions also specifies the distance boreholes are placed from the corners of salt pillars that separate the disposal room, that they are placed on 8 ft. center-to-center spacing, and requires placement of a shield plug in a borehole prior to removal of the facility cask from the HERE when a waste canister is already in the borehole. Waste handling restrictions will also require that drum carriages loaded with RH waste shall be carried over and stored on the concrete portion or the upper hot cell floor. Facility canisters loaded with RH waste are carried over the concrete portion of the upper hot cell floor and are only stored in the upper hot cell canister storage wells. A full listing of the restrictions is included in Table 5.1-1 with the safety function provided and the associated hazard event that it prevents.

Ground Control Program

The SAC for weekly ground control inspections in the underground waste handling is to detect conditions that indicate instability and initiate corrective action. This prevents objects from falling on waste during transport or disposal operations.

Waste Hoist Brake Performance

The SAC for pre-operational tests of the waste hoist brake system are performed on each shift prior to transporting waste to ensure that the hoist brakes are working properly.

Nonflammable Compressed Gas Cylinder Control

The SAC for nonflammable compressed gas cylinder control limits the number of compressed gas cylinders in the RH bay of the WHB to a maximum of four DOT Type 3AA, style K or larger cylinders (except for hand held fire extinguishers) and prohibits storage of compressed gas cylinders in the WHB, at the base of the waste shaft, in the disposal path, or in the active disposal room to minimize the potential for improper handling or storage of compressed gas cylinders which could result in damage to waste containers and a subsequent release.

Qualified Operators

The SAC for qualified operators ensures that only operators who are trained in the operational evolutions and qualified on the applicable equipment are authorized to operate plant equipment for waste handling operations. This ensures operators are qualified to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations. Additionally, only operators who are trained in the appropriate response to fires in the underground are authorized to man the CMR or to operate plant equipment for RH waste handling operations. This ensures that the central monitoring room (CMR) operator(s) and operations personnel in the underground performing RH waste handling operations communicate and take the appropriate actions in the event of a fire in the underground that the CMR operators(s) block the automatic shift to filtration of underground ventilation until personnel are out of danger. This requirement also ensures that operations personnel in the underground take the necessary immediate actions to notify the CMR and proceed to a safe location.

Toplander Control

The SAC for the toplander control at the waste shaft collar ensures that loads are supervised during loading of the waste shaft conveyance. No items may enter the waste shaft collar area without the approval of the toplander. The purpose of this requirement is to prevent a load from inadvertently entering the waste shaft.

5.6 Design Features

DFs are normally passive characteristics of the facility not subject to change by operations personnel (e.g., shielding, structural walls, relative locations of major structures and components, or physical dimensions and interfaces). Any change to a DF could affect the safe handling of RH waste and will be analyzed for safety implications and approved at the appropriate level prior to making the modification.

The DFs credited in the safety analysis are passive components, configuration and/or physical arrangement as part of the facility design. DFs are controlled to the engineering drawings and specifications. DFs are controlled to ensure that if the SSC is modified or replaced, the modification or new SSC has essentially the same feature, form, fit and function as the original SSC. Typically, the material, construction or the actual physical dimensions of the item are controlled as a DF. As such, the

ACs of the configuration management, quality assurance, initial testing, in-service surveillance and maintenance, and USQ programs apply to these DFs. DFs are listed in Table 5-1.

The following DFs are credited as performing a safety function:

Property Protection Area Is Paved or Graveled and Surrounded by a Gravel Road

The paved and graveled property protection area (PPA) maintains a physical separation of greater than 200 feet between the WHB and the indigenous low profile vegetation surrounding the site, which prevents a wildland fire from propagating to the WHB.

Underground Bulkheads, Overcasts, and Airlocks

The bulkheads, overcasts, and airlocks are of non-combustible construction and provide segregation between the construction ventilation circuit and the disposal ventilation circuit and waste shaft station and prevents fires outside the waste disposal path from propagating into the disposal path or disposal area or the underground.

RH Bay Crane, Upper Hot Cell Crane and Overhead Powered Manipulator, FCLR Grapple Hoist, and Waste Hoist

(Note: The waste hoist is already classified as safety class in the CH DSA)

The RH bay crane, CUR crane, upper hot cell crane and overhead powered manipulator, lift fixtures, FCLR grapple hoist, and waste hoist are designed to hold their load during the design basis earthquake (DBE) or loss of power. This prevents dropping a waste container that could result in a breach.

Waste Handling Building

The WHB includes the waste hoist tower. The WHB is required to withstand the DBE postulated for the WIPP of .1 g peak acceleration with a 1,000-year return interval such that the building structure does not collapse in a DBE and damage waste containers.

The WHB is required to meet National Fire Protection Association (NFPA) 220, *Standard on Types of Building Construction*,[7] Type II construction such that fires outside the building or within the building do not propagate and damage waste containers outside of closed shipping casks. For the RH portion of the WHB, the rooms within the hot cell complex includes thick concrete walls, floors, ceilings, and steel doors and shield valves that segregate the rooms from each other and the entire hot cell complex from the RH bay and the rest of the WHB such that fires do not propagate and provides shielding for worker protection.

The WHB is designed to withstand a roof loading of 27 lb/sq ft. This protects the waste inside from design basis snow and ice loading. The WHB is grounded and has a lightning protection system. This requirement reduces the potential for direct lightning strikes to waste containers in the WHB.

The WHB is designed to withstand (1) a tornado with a 183-mile-per-hour (mph) wind speed at a 1,000,000-year return frequency, and (2) straight winds with a wind speed of 110 mph with a 1,000-year return frequency. The WHB including the waste hoist tower is designed to withstand the DBT with 183 miles per hour and a translational velocity of 41 miles per hour, a maximum rotational velocity radius of 325 ft, a pressure drop of 0.5 pounds per square inch (lb/in.^{2}) and a pressure drop rate of 0.09 lb/in.^{2}/s. The WHB is not designed to withstand wind or tornado driven missiles.

The structural beams in the upper hot cell under the canister storage wells supports facility canisters and prevent a waste canister from falling to the lower hot cell.

Upper Hot Cell Canister Storage Wells

The upper hot cell canister storage wells prevent facility canisters from toppling onto other RH waste containers and protects the canister from dropped objects. The wells also prevent direct flame impingement on facility canisters containing RH waste.

Transfer Cell Shuttle Car

The transfer cell shuttle car is designed to remain on its support rails in a DBE. It accommodates only one RH waste canister at a time.

Upper Hot Cell Crane Grapple and FCLR Grapple Hoist Grapple

The hot cell crane and FCLR grapple hoist grapples structurally support a canister or lift fixtures associated with moving shield plugs or drum carriages and prevent dropping waste or dropping items on waste during a DBE or loss of power that could result in a waste container breach . The grapples used with the upper hot cell crane and the FCLR are designed with three pivot dogs that move together to hold a pintle on a waste canister or lift fixtures for moving the upper hot cell shield plugs or drum carriages and prevents the grapple from releasing a RH waste canister or other loads that could be dropped on RH waste.

FCLR Telescoping Port Shield and Grapple Hoist Shield Bell

The FCLR telescoping port shield and grapple hoist shield bell provide shielding for worker protection by mating with the facility cask when positioned vertically over the transfer port between the transfer cell and FCLR.

Facility Cask Transfer Car

The facility cask transfer car (FCTC) structurally supports the facility cask during transfer of a RH waste container from the transfer cell to the facility cask and subsequent transfer to the underground on the waste shaft conveyance. The FCTC mates with the FCRD and latches to prevent the FCTC from moving during canister transfer that could result in crushing the RH waste canister or the FCLR grapple hoist ropes and dropping a canister. This feature also prevents loss of shielding in the FCLR.

Metal Facility Canister

The facility canister has a mechanical or pinned lid and pintle that structurally supports the canister when lifted with the upper hot cell crane grapple and the FCLR grapple hoist and prevents the canister from being dropped. The lid design also prevents lid loss in the event of a fire. The facility canister also protects the RH waste drums once the drums have been placed into the canister.

Upper Hot Cell Wall Mounted Manipulators

Wall mounted manipulators have counterweights to limit speed of travel in the event that an operator releases the manipulator to prevent breaking the upper hot cell lead glass shield windows when RH waste is in the upper hot cell.

Waste Shaft Conveyance

The waste shaft conveyance is designed such that only one facility cask can be transported at a time, RH waste and CH waste cannot be transported at the same time, and that the material deck is below the man deck such that waste is protected from falling objects and tornado missiles. This design limits the RH inventory that can be transferred on the waste shaft conveyance and protects waste in the facility cask from falling objects.

Waste Hoist Brakes

The waste hoist brakes prevents the uncontrolled movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure. The brake system must be energized to release both independent sets of brakes. During loss of power, the brakes fail safe to the engaged position.

Waste Hoist Structure and Structural Support

(Note that the waste hoist structure and structural support is designated SC in the CH DSA)

The design of the waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and waste hoist tower prevents an uncontrolled drop of the waste shaft conveyance loaded with waste down the shaft.

Fence Around Waste Shaft Collar

The fence around the waste shaft collar defines the restricted area surrounding the waste shaft and prevents uncontrolled access to the shaft. This prevents dropping a load down the shaft that could result in a breach of waste containers.

RH Facility Cask

The RH facility cask holes only one RH canister. The cask mates with the FCTC for transport of and RH waste canister to the underground. The cask can be rotated on trunnions such that the cask is vertical over the transfer port between the FCLR and the transfer cell. The RH facility cask is also mates with the forks on the 41-ton forklift used to transfer the cask from the transfer car to the active waste emplacement room. The cask also mates with the HERE for transfer of a loaded RH canister into an RH borehole. The cask is equipped with two shield valves that can be opened from the control console in the FCLR or the control console for the HERE. This design limits the amount of RH waste at risk and protects the waste canister from fires and explosions or drops and provides shielding for worker protection.

Boreholes and Borehole Shield Plugs

The RH disposal boreholes and borehole shield plugs provide shielding after RH waste canister disposal for protection of workers in the active disposal room. Borehole placement ensures shielding for worker protection and protects spacing assumptions in the RH disposal criticality safety evaluations. The shield plug length and material protects workers from radiological exposure associated with RH waste and protects assumptions in the criticality safety evaluation for disposed RH waste. The shield plug also protects the disposed RH waste canister from the effects of an explosion/fire in the active waste disposal room. The borehole shield plugs are required to be made of concrete at least 4 ft. in length.

HERE and Shield Collar

HERE transfer mechanism and shield collar mate with either end of the facility cask to protect an RH waste canister from fires and explosions external to the cask during transfer of a waste canister into a disposal borehole and provides shielding for worker protection.

5.7 Interface with TSRs from Other Facilities

The RH WAC[6] specifies the waste fissile and special moderator/reflector content mass limits, the waste characteristics including content restrictions, the acceptable container types and that the waste containers must be vented. The RH WAC[6] requires the generator sites to prepare a waste certification program that lists the methods and techniques for determining compliance with the RH WAC[6] and associated quality criteria. The generator site program must meet the requirements found in the Hazardous Waste Facility Permit (HWFP) Waste Analysis Plan. The RH WAC[6] imposes the limits, controls, and restrictions from the HWFP and the RH TRAMPAC and is the implementing requirements document at generator sites for RH TSRs. Generator sites are responsible for meeting the requirements imposed by the RH WAC[6] prior to shipment of waste to the WIPP. Violation of the stated limits is a violation of the TSRs by the WIPP only if the generator site certification documentation included characterization data that was not in compliance with the stated limits, but the waste was accepted by the WIPP.

References for Chapter 5

1. 10 CFR §830.205, Subpart B, "Technical Safety Requirements."

2. DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, dated July 1994, Change Notice 2, dated April 2002.

3. DOE-STD 1186-2004, *Specific Administrative Controls*, 2004.

4. DOE Guide 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*, dated October 24, 2001.

5. WP 12-5, WIPP Radiation Safety Manual.

6. DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, 2005.

7. NFPA 220, *Standard on Types of Building Construction*.

8. WSMS-WIPP-00-003, Rev. 1, *Waste Isolation Pilot Plant Nuclear Criticality Safety Evaluation Remote Handled Waste*, December 20, 2001.

9. CS-2003-003, *Determination of Beryllium Mass Limit for the 72-B Direct Loaded Canister with Beryllium Reflection*, January 2004.

10. CS-2003-001, Revision 1, *Waste Isolation Pilot Plant Nuclear Criticality Safety Evaluation for Contact Handled Transuranic Waste Storage*, August 2003.

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Fire Water Supply and WHB Fire Suppression Systems	LCO	Minimizes the release by reducing WHB temperature during large fire such that minimal damage to waste containers occurs and/or prevents spread of fire from adjacent areas.	WHB1-4, 1-6, 1-7, 1-8, WHB6-2, WHB7-1 UG1-5
Underground RH Waste Handling Equipment Automatic/Manual Fire Suppression System	LCO	Prevents a small fire associated with fuel or hydraulic leaks (forklifts or HERE) or the RH waste handling forklift engine (41-ton, 20-ton, and 6-ton) from developing into a large fire.	UG1-1, 1-2
Underground Ventilation System	LCO	The underground ventilation system ensures that there is sufficient airflow for waste handling activities and directs airflow away from workers in the event of a waste container breach. The system also provides fresh air for worker evacuation in the event of a fire.	UG1-1, 1-2, UG2-1, 2-2, 2-3, UG3-3
WHB Shielding Interlocks - Upper hot cell shield plugs, the CUR shield door and the upper hot cell crane	LCO	The interlocks provide shielding for workers in the CUR when processing a 72-B waste canister in the CUR and waste is in the upper hot cell. Also provides shielding for workers when waste is being removed from a 10-160 shipping cask in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell.	WHB4-2
Upper Hot Cell Grapple and FCLR Grapple Hoist Grapple - Grapple Pintle Contact Interlock	LCO	The grapple pintle contact interlock with the pivot dogs of the grapple ensures that the pivot dogs cannot be opened when a load is suspended.	WHB3-2, 3-3, 3-4, 3-5

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
WHB Interlocks- FCLR grapple hoist and shield bell, telescoping port shield, facility cask, and transfer cell ceiling shield valve	LCO	The shielding interlocks between the FCLR grapple hoist, shield bell, facility cask, telescoping port shield, and transfer cell ceiling shield valve ensure that a shielded path is established before initiating transfer of a facility canister or 72-B canister loaded with RH waste from the transfer cell to the facility cask in the FCLR. The interlocks also prevent closure of the facility cask shield valves or transfer cell ceiling shield valve on the grapple hoist ropes or a waste canister.	WHB3-3, 3-5 WHB4-5
WHB Interlocks - Transfer cell shuttle car and CUR shield valve, upper hot cell shield valve, and transfer cell ceiling shield valve	LCO	The interlocks between the transfer cell shuttle car, the upper hot cell shield valve, the CUR shield valve, and the transfer cell ceiling shield valve ensure that the transfer cell shuttle car cannot be moved unless all three shield valves are closed. This prevents damaging RH waste canisters or the cables/ropes associated with the upper hot cell crane, the CUR crane, or the FCLR grapple hoist during canister transfer. Damaging a canister or damaging the ropes could lead to a waste container breach or a drop of a waste container that could result in breach.	WHB3-3, 3-5

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
WHB Interlocks - Grapple hoist, telescoping port shield, facility cask shield valves, the facility cask rotating device.	LCO	The interlocks between the grapple hoist, telescoping port shield, and the FCRD prevent the FCRD from rotating the facility cask from vertical to horizontal during a canister transfer from the transfer cell into the facility cask. The grapple hoist must be in the highest position and the telescoping port shield must be retracted before the cask can be rotated and or movement of the transfer car is initiated. The facility cask shield valve must be closed before the cask is rotated or the transfer car can move when loaded with the cask. The interlocks prevent movement of the FCRD during canister transfer that could result in either breaching a canister or compromising shielding and impacting workers.	WHB3-3, WHB3-5, WHB 4-5
Underground Interlocks - HERE, facility cask, and shield collar	LCO	Ensure shielding for worker protection during transfer of a RH waste canister from the facility cask into a disposal borehole and prevent crushing a canister by detecting any misalignment of the HERE with respect to the disposal borehole and any gap in the shielding provided by the transfer mechanism and shield collar mating with the facility cask. The interlocks between the facility cask shield valves and HERE transfer mechanism prevents closing a shield valve on a canister resulting in a breach by closure of a shield valve when the canister is within the open valve.	UG4-1, UG3-3

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Initial Testing, In-Service Inspection and Test, Configuration Management and Maintenance Program An initial testing, in-service inspection and test, configuration management, and maintenance program shall be established, implemented, and maintained to ensure SSCs supporting safe operation of the WIPP and DFs subject to degradation perform their intended functions. This shall ensure the DFs of equipment remain consistent with those assumed in the RH DSA.	PAC	Minimizes the likelihood of an accident resulting in the release of radioactive material or worker injury caused by equipment failure, through programs requiring maintenance, testing, and inspection of equipment to confirm proper configuration, operation and continued reliability.	Applicable to all HA events.
Document Control A document control program and associated procedures shall be established, implemented, and maintained to control WIPP documents. The program shall establish minimum review and approval requirements, change control, and minimum record retention requirements for the WIPP.	PAC	Ensures the facility is operated and maintained in an approved, prescribed manner consistent with the assumptions of the facility safety basis	Applicable to all HA events.
Quality Assurance Program A quality assurance program and associated procedures shall be established, implemented, and maintained. The basic elements of the quality assurance program include work planning; training and personnel development; preparing, reviewing, approving, and verifying designs; qualifying suppliers; preparing, reviewing, approving, and issuing instructions, procedures, schedules, and procurement documents; purchasing; verifying supplier work; identifying and controlling hardware and software; manufacturing; managing and operating facilities; calibrating and controlling measuring and test equipment; conducting investigations and acquiring data; performing maintenance, repair, and improvements; performing assessments; tracking non-conformances and corrective actions; and controlling records.	PAC	Minimizes the likelihood and consequences of events through a program that ensures commitments made in the safety analysis are properly implemented.	Applicable to all HA events.

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Training A training program for the WIPP facility operation staff and technical support personnel shall be established and maintained to ensure that operators are trained to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations.	PAC	Minimizes likelihood of an accident by ensuring that workers can successfully and safely execute actions defined by programs and supporting procedures. Training reduces the frequency of human error by improving awareness of hazards that could lead to worker injury or release of radioactive waste.	Applicable to all HA events.
Conduct of Operations The Conduct of Operations program shall contain elements of organization and administration of facility operations to ensure that operations activities are controlled to be consistent with assumptions in the RH DSA.[6] Effective implementation and control of operating activities are primarily achieved through established written standards for operations, periodic monitoring and performance assessment, and holding personnel accountable for their performance. The basic elements of the Conduct of Operations program include, as applicable, guidance for: operations organization and administration; shift routines and operating practices; control area activities; communications; control of on-shift training; control of equipment and system status; lockouts and tagouts; independent verification; log keeping; operations turnover; timely orders to operators; operations procedures; operator aid postings; and equipment and piping labeling. **Preoperational checks** shall be performed to ensure that equipment performing waste handling operations operates as required prior to waste handling operations.	PAC	Ensure operation of the facility is in accordance with the assumptions of the facility safety basis.	Applicable to all HA events.
Emergency Response Program An emergency response program and associated procedures shall be established, implemented, and maintained that provides preparedness, training, and operational response capabilities (including notification, evacuation, and direct responses to events) to minimize consequences to workers from accidents involving WIPP operations. It will provide emergency response actions for events such as fires or flammable gas explosions in the WHB and underground and other events resulting in a breach of waste containers at the WIPP.	PAC	Provide protection for workers providing preparedness, training, and operational response capabilities for abnormal events to ensure workers are removed from the area of hazardous material release and initiate mitigating actions as appropriate.	Applicable to all HA events

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Radiation Protection Program A radiation protection program and associated procedures shall be established, implemented, and maintained to ensure personnel radiation protection for all operations involving personnel radiation exposure. The radiation protection program shall include considerations and general facility DFs employed to maintain radiation exposures as low as reasonably achievable (ALARA); radiological control zoning and access control; radiation shielding; ventilation systems; differential pressure; radiation monitoring equipment, and effluent monitoring and sampling systems. **Access control ensures that personnel do not enter areas where RH waste is outside of a closed shipping cask or facility cask in the WHB. Access control is required for the upper and lower hot cell when waste is present in the upper hot cell . Access control is required for the transfer cell when waste is in the transfer cell and during transfer to the FCLR or during transfer from the upper hot cell. Access to the crane maintenance room is prohibited unless the crane maintenance room shield door is closed when waste is in the upper hot cell. The CUR is required to be unoccupied with the CUR shield door closed when removing drums from a 10-160B shipping cask or when waste is in the upper hot cell and the shield plugs are removed. Access to the CUR is limited during 72-B waste processing to only waste handling personnel and radiological control personnel.** The radiation protection program shall ensure consistency with the assumptions in Chapter 5 of the RH DSA.	PAC	Reduce the likelihood and minimizes exposure of workers and the public to radiation and radioactive material. Prevents worker exposure in the WHB when waste is outside a closed shipping cask or the facility cask.	All HA events that result in direct radiation exposure or release of radioactive materials.
Unreviewed Safety Question A USQ program and associated procedures shall be established, implemented, and maintained that ensures the WIPP remains consistent with the RH DSA[6] and credited DFs.	PAC	Ensures all proposed facility changes or new activities are reviewed for impact on the facility safety basis.	Applicable to all HA events.

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Fire Protection Program The WIPP fire protection program shall be established to, at a minimum, provide for periodic inspection and testing of fire suppression, detection and alarm equipment to meet the requirements of NFPA. The program includes combustible loading control for structures or areas of the facility with the potential to impact RH waste at the WIPP and ensures that combustible loading is maintained such that small fires will not propagate into larger fires with sufficient heat to cause a significant release from waste containers in close proximity to the fire.	PAC	Minimizes the likelihood of fire by controlling the sources of ignition and reduces the spread and consequences of fires by limiting the quantities of combustibles and maintaining the operability of fire suppression systems.	WHB1-1, WHB1-2, WHB1-3, WHB1-4, WHB1-5, WHB1-6, WHB1-7, WHB1-8, WHB1-9, WHB2-1, WHB2-2, WHB2-3, WHB2-4, WHB2-5, WHB2-6, WHB2-7 UG1-1, UG1-2, UG1-3, UG1-4. UG1-5, UG2-1. UG2-2, UG2-3, UG2-4, UG2-5, UG2-6
Ground Control and Geotechnical Monitoring Program A ground control and geotechnical monitoring program shall be established, implemented and maintained to initiate remedial action for unstable salt and to characterize, monitor, and trend salt behavior. The program shall include periodic ground control inspections as a specific control in addition to the programmatic control.	PAC	Minimize the likelihood of falling objects from the overhead and prevent a roof fall event in the underground.	UG3-5
Waste Hoist Structure and Structural Support Integrity Program The programmatic control for the structural integrity of load bearing components of the waste hoist and structural support includes periodic inspections, tests and maintenance activities. These activities include cable lubrication, cable and cable attachment inspections and/or nondestructive testing, verification of proper load sharing of all the ropes, and inspections of the headframe, conveyance and counterweight and the structural support provided by the waste hoist tower.	PAC	Maintains the integrity of the waste hoist which prevents uncontrolled drop of loaded waste conveyance down the waste shaft.	UG3-1

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Criticality Safety Program - A waste characterization/certification program at each generator site ensures that only RH waste that meets the WIPP RH WAC[6] is disposed of at the WIPP, and that any exceptions are evaluated against all applicable baseline documents prior to their authorization for shipment. The following criticality safety requirements shall be met before waste is approved for disposal at the WIPP (including WIPP site-derived waste): The maximum fissile loading shall not exceed 325 FGE, including measurement uncertainty, for a 72-B RH waste canister. If beryllium is present with the RH waste, the direct loaded 72-B canister is limited to a maximum beryllium content of 25 kg.[8, 9] The maximum fissile loading for any 55-gallon drum shipped in a 10-160B shipping cask shall not exceed 200 FGE, including measurement uncertainty, and a maximum beryllium content of 5 kg. If greater than 5 kg up to a maximum of 100 kg beryllium is present in any 55-gallon drum containing RH waste, fissile mass shall not exceed 100 FGE, including measurement uncertainty.[10] The maximum fissile loading for any 30-gallon drum shipped in a 10-160B shipping cask shall not exceed 200 FGE, including measurement uncertainty, with no beryllium or graphite.[8]	SAC	Through control of fissile mass and moderator/reflector mass by waste container type at the generator sites and the waste handling configurations at the WIPP, criticality is incredible at the WIPP.	OA5-1, WHB5-1, UG5-1

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Criticality Safety Program - Requirements Implemented at WIPP Drums are stored in the upper hot cell such they are not stacked prior to being emplaced in a facility canister. No more than 10 drums are in the upper hot cell outside of a facility canister.[8] Loaded canisters are stored in the upper hot cell storage wells. No more than 6 fully loaded facility canisters are stored in the upper hot cell.[8] Facility canisters are loaded such that no more than three 30- or 55-gallon drums are placed in a canister. The FGE content of the fully loaded facility canister containing only 55-gallon drums is limited to 600 FGE, including measurement uncertainty, with no single drum exceeding 200 FGE, including measurement uncertainty.[10] 30-gallon drums shall be loaded into the facility canisters such that each canister is administratively limited to a maximum of 325 FGE, including measurement uncertainty.[8] The RH waste canisters are to be emplaced in horizontal positions in the walls of the underground disposal area within an analyzed minimum center-to-center spacing of greater than 30 inches.[8, 9] The shield plugs in the boreholes will be at least 4 feet long to ensure that RH waste is at least 4 feet from the contact handled waste containers.	SAC	Through control of fissile mass and moderator/reflector mass by waste container type at the generator sites and the waste handling configurations at the WIPP, criticality is incredible at the WIPP.	OA5-1, WHB5-1, UG5-1

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Combustible Loading Control Program - WHB			
Use of flammable gas or flammable compressed gas cylinders is prohibited in the following areas of the RH portion of the WHB when waste is as specified below. – RH bay when a 10-160B shipping cask is loaded with RH waste and the lid is unbolted.(except for those cylinders covered by DOT Exemption DOT-E-7607) – Hot cell operating gallery when waste present in the upper hot cell. – Crane maintenance room when waste is present in the upper hot cell unless the crane maintenance room shield door is closed. – Transfer cell when waste is present. – Upper hot cell when waste is present. Also flammable gas and flammable compressed gas cylinders are not used in the upper hot cell when waste is present in the CUR or transfer cell unless the upper hot cell shield plugs are installed and the upper hot cell floor shield valve is closed. – CUR when waste is present. Also prohibits us of flammable gas or flammable compressed gas cylinders in the CUR when waste is present in the upper hot cell unless the upper hot cell shield plugs are installed. – FCLR when waste is present	SAC	Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.	All HA WHB1 and WHB2 Events WHB6-2 and WHB7-1, WHB7-2 UG1-5, UG2-6, UG 7-3 BG7-1
– Waste hoist tower during waste transport on the waste shaft conveyance		Prevents fire or explosions/fire in the waste hoist tower that could result in damage to the waste hoist resulting in damage to RH waste containers	
Storage of flammable gas and flammable compressed gas cylinders is prohibited in the WHB.		Prevents explosions/fires from flammable gas or flammable compressed gas cylinders from impacting RH waste when it is outside a closed shipping cask.	
Any diesel powered vehicles operating in the RH bay within 15 ft of the common RH/CH wall requires a fire watch.		Prevents fires in the RH portion of the WHB from impacting CH waste near the common RH/CH wall.	
Transient combustible material shall not be stored within the hot cell complex, FCLR, crane maintenance room or hot cell operating gallery, and shall not be stored within 15 ft of the common RH/CH wall.		Prevents small fires from becoming large fires with the potential to impact RH or RH and CH waste	

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Combustible Loading Control Program - Disposal Path			
Only diesel or electric powered vehicles are allowed in the underground.	SAC	Reduce the frequency of and severity of fires in the disposal path.	HA Events UG1-1, UG1-2, UG1-3, UG1-4, UG2-1,UG2-2
No storage of combustibles, flammable gas or flammable compressed gas cylinders in the waste disposal path from the waste shaft station to the active disposal room.		Prevents fires and explosion/fires in the disposal path	
No use of flammable gas cylinders in the disposal path during waste handling. No use of flammable compressed gas cylinders in the construction area at bulkhead 309 in West 30 ~~and between the disposal panel supply overcast and the bulkhead to the south in East 300 during waste handling in the underground.~~ No flammable gas or flammable gas cylinders stored between the Air Intake Shaft and South 1000 in West 30 or within 100 ft of bulkhead 303 on the north ventilation side during waste handling. No storage of flammable gas or flammable compressed gas cylinders in those areas.		Prevents introduction of fire sources and explosives to disposal areas from construction areas.	
The lube truck is not allowed in the waste transport path circuit during waste handling.		Prevents fire source in the disposal path	

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Combustible Loading Control Program - Disposal Room The lube truck shall not be allowed in the active RH disposal room. No flammable gas and flammable gas cylinders shall be stored in the active RH disposal room. No use of flammable gas or flammable compressed gas cylinders in the active RH disposal room during RH waste handling. No flammable gas or flammable compressed gas cylinders shall be used in the active RH disposal room without a fire watch being posted.	SAC	Reduces the frequency and severity of fires that could impact RH waste containers being emplaced or after emplacement and prevents missiles and collisions that could compromise shielding.	HA Events UG1-2, 2-2
Ground Control and Geotechnical Monitoring Weekly ground control inspections in the underground RH waste handling areas shall be performed and documented.	SAC	Minimizes the likelihood of falling objects from the overhead and prevent a roof fall event in the underground RH waste handling areas. The program is designed to detect conditions that indicate instability and initiate corrective action.	HA Event UG3-5
Nonflammable Compressed Gas Cylinder Control No more than four compressed gas cylinders (no larger than DOT Type 3AA, style K) shall be in the RH bay when waste is outside of a closed shipping cask; no more than two compressed gas cylinders shall be in the hot cell operating gallery to support radiological swipe evaluation. This limit does not apply to hand held fire extinguishers. No compressed gas cylinders shall be stored in the hot cell complex, the crane maintenance room, the FCLR, at the bottom of the waste shaft, in the disposal path or active disposal room. No use of nonflammable compressed gas cylinders in the upper hot cell, the CUR, the transfer cell, or the FCLR when RH waste is present. No use in the disposal path or the active RH disposal room during RH waste handling. These restrictions do not apply to fire extinguishers, SCSRs or oxygen bottles in trauma kits.	SAC	Minimize the potential for improper handling or storage of compressed gas cylinders which could result in missiles with the potential to breach shielding or and impact RH waste containers.	HA Events WHB3-2, 3-3, 3-4, 3-5, and UG3-2, 3-3

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Qualified Operators Only operators who are trained in the operational evolutions and qualified on the applicable equipment are authorized to operate plant equipment for waste handling operations. Additionally, only operators who are trained in the appropriate response to fires in the underground are authorized to man the CMR or to operate plant equipment for RH waste handling operations.	SAC	This ensures operators are qualified to properly operate the waste handling equipment during normal operations and to properly respond to off-normal operations. Ensures that the CMR operator(s) and operations personnel in the underground performing RH waste handling operations communicate and take the appropriate actions in the event of a fire in the underground that the CMR operators(s) block the automatic shift to filtration of underground ventilation until personnel are out of danger. This requirement also ensures that operations personnel in the underground take the necessary immediate actions to notify the CMR and proceed to a safe location.	All movement of waste requires trained operators.
Toplander Control Control of waste shaft access	SAC	Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position. Also prevents any load from being dropped down the waste shaft or a load from inadvertently entering the waste shaft.	HA Events UG3-6, UG6-2

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Characteristics Control Program*			
≤ 80 PE-Ci/55-gallon drum shipped in a 10-160B shipping cask	SAC	Protect inventory assumptions	HA assumption
≤ 240 PE-Ci/direct loaded RH waste canister	SAC	Protect inventory assumptions	HA assumption
≤ 1800 PE-Ci/waste container of solidified/vitrified waste	SAC	Protect inventory assumptions	HA initial condition and protects assumptions in WIPP RH NCSEs
Limit acceptable containers to metal 30- or 55-gallon drums and metal 72-B canisters that meet DOT Type 7A or equivalent.	SAC	Robust waste containers minimize the release of radioactive material.	
Pyrophorics and explosives are prohibited in RH waste approved for disposal at the WIPP as implemented at generator sites through adherence to the RH WAC	SAC	Eliminates ignition sources and explosive material in the waste.	WHB1-1 thru 4, 8, 9, All WHB2 (except 2-7) and UG1-1,1-2, UG2-1, 2-2
All waste containers are vented	SAC	Prevents buildup of pressure due to gas generation inside the waste container.	All WHB2 (except 2-7), UG2-1, 2-2 HA assumption
Surface Dose Rate on RH waste containers shall not exceed 1000R/hr.	SAC	Protect basic inventory assumptions.	WHB1-1 thru 4, 8,9, All WHB2 except 2-7, WHB3-3,3-5
72-B canisters have a welded or mechanical lid and pintle that structurally supports the canister when lifted by the pintle	SAC	Prevents container breaches resulting from drops and prevents lid ejection during fires	WHB3-4
30- or 55-gallon drums shipped in a 10-160B shipping cask shall have the lids secured and drum lifting bails installed such that the drum is structurally supported by the bails when lifting the drums at the WIPP.	SAC	Prevents drop of drum in the upper hot cell during canisterization.	HA assumption
RH waste can only be shipped to the WIPP in a 72-B or a 10-160B shipping cask.	SAC	Design provides shielding for up to 1000 Rem/hr RH waste drums and canisters.	

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Handling Restrictions			
The RH waste inventory, allowed storage locations, and configuration in the RH portion of the WHB shall be as follows: - Two loaded shipping casks in the RH bay (on the transportation trailers or on a RCTC) - Six loaded waste canisters and ten 30- or 55-gallon drums in the upper hot cell (one canister per storage well and drums on the concrete portion of the upper hot cell) - One loaded shipping cask in the CUR (on a RCTC) - One canister in the transfer cell (in the 72-B shipping cask or shielded insert in the shuttle car basket) - One canister in the facility cask in the FCLR (in the facility cask with the facility cask shield valves closed. RH waste containers are only removed from the shipping container within the shielded portions of the RH facility.	SAC	Protects inventory assumptions	Basis HA and Chapter 3 assumption
A loaded10-160B shipping cask shall not be left unattended in the RH bay with the lid bolts loosened and shall only be stored in the CUR with the CUR shield door closed when the lid bolts are removed.	SAC	Reduces the likelihood of breaching the10-160B cask when the lid bolts are loosened.	WHB1-1, 1-8, WHB2-1, WHB3-1
RH waste containers shall not be removed from shipping casks outside the hot cell complex in the WHB. RH 72-B canisters with waste shall not be removed from shipping casks outside transfer cell. Drums containing RH waste shall only be removed from the 10-160B shipping cask inside the CUR with the CUR shield door closed.	SAC	Ensures shielding for worker protection.	WHB1-1, 1-8, WHB2-1, WHB3-1, WHB4-1, 4-2, WHB6-1, 6-2, WHB7-1
The crane maintenance room shield door is closed except when transferring the upper hot cell crane into and from the crane maintenance room.	SAC	Prevents propagation of fires and explosions/fires and provides shielding to workers in the crane maintenance room when waste is in the upper hot cell	WHB1-6, WHB2-6, WHB4-4
The waste shaft conveyance shall be verified to be at the waste shaft collar before moving the FCTC loaded with the facility cask containing RH waste from the FCLR to the waste shaft collar area.	SAC	Prevents a loaded FCTC from entering the waste shaft with the waste shaft conveyance out of position.	UG3-6

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Handling Restrictions - continued			
Prior to moving the FCTC loaded with the facility cask from the FCLR to the waste shaft collar area, the waste shaft conveyance is verified to be at the collar of the waste shaft.	SAC	Prevents a load from inadvertently entering the waste shaft with the waste shaft conveyance out of position.	UG3-1
Prior to moving the facility cask loaded with RH waste onto the waste shaft conveyance, the weight of the loaded canister shall be verified to not exceed 3220 lbs. If the weight exceeds 3220 lbs, the facility cask shall not be moved onto the waste shaft conveyance until the maintenance work platform has been removed from the conveyance.	SAC	Ensures that the rated capacity of the waste hoist is not exceeded	WH3-4
Drum carriages loaded with RH waste shall be carried over and stored on the concrete portion or the upper hot cell floor. Facility canisters loaded with RH waste are carried over the concrete portion of the upper hot cell floor and are only stored in the upper hot cell canister storage wells.	SAC	Prevents RH waste containers from falling to the lower hot cell and breaching.	WHB1-5, WHB4-1, 4-3, 4-4
Grapple override port shield plugs are installed except when the grapple override tool is in use. (Includes ports in the service room, RH bay on catwalk, and hot cell operating gallery on catwalk.)	SAC	Prevents fires in the service room from propagating to the transfer cell. Provides shielding for worker protection when RH waste is in the transfer cell and upper hot cell.	

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Handling Restrictions - continued			
Require a standoff distance greater than 75 ft between the 41-ton forklift loaded with waste and the loaded CH waste transporter during waste transport. No non-waste handling vehicles in the active disposal room during waste handling.	SAC	Prevents collisions between the RH waste handling equipment and the HERE, the CH disposal array waste face, and prevents collisions from non-waste handling equipment with the HERE and facility cask aligned on a borehole and prevents collisions with the walls of the room that could hit the shield plug and compromise shielding. Also prevents collisions between waste handling equipment, and between waste handling equipment and non-waste handling equipment and with the CH waste face that could result in fires.	UG1-1, 1-2, UG3-2, 3-3
A spotter is required when operating the RH 41-ton waste handling forklift loaded with the facility cask and operating the RH 41-ton, 20-ton, or 6-ton waste handling forklifts within 75 ft. of the CH disposal array face.	SAC		
When RH waste is in transit, non-waste handling equipment shall be moved to a cross cut and be secured until the waste transporter has passed and is greater than 75 ft. away. Vehicles that may have become disabled (excluding the lube truck) may be in the disposal path but must be secured in a cross cut.	SAC		
RH waste shall be transported to the underground by way of the waste shaft only. No other shaft to the underground may be used for transportation of waste.	SAC	Protects HE assumptions.	
In the underground, no RH waste shall be moved to a location outside the disposal path.	SAC	Protects HE assumptions.	
Personnel access in E-300 shall be restricted from the exit of the active RH disposal room to the underground ventilation exhaust shaft during RH waste handling.	SAC	Protects workers from radiological exposure in the event of a waste container breach.	UG1-1, 1-2, UG2-1, 2-2, UG3-2, 3-3

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Handling Restrictions - continued			
Requires use of a spotter when backing the RH transportation trailers into the RH bay	SAC	Prevent breaching the common RH/CH wall and impacting CH waste.	WHB3-6
Require use of a spotter when operating any vehicle within 15 ft of the common RH/CH wall when waste is present in the NE corner of the CH bay	SAC	Prevents breaching the common RH/CH wall and impacting CH waste.	WHB3-6
Requires the upper hot cell shield plugs to be in place with the CUR door open when RH waste is in the upper hot cell.	SAC	Prevents worker exposure	WHB4-2
Requires the facility cask shield valves to be closed except when transferring a RH waste container from the transfer cell to the facility cask or when transferring a RH waste canister into a disposal borehole.	SAC	Prevents worker exposure	WHB4-5, UG4-1
Requires that the FCTC is mated to the FCRD and latched prior to rotating the facility cask.	SAC	Prevents the FCTC from moving during canister transfer and crushing the RH waste container or the grapple hoist ropes resulting in a container drop. Also prevents loss of shielding.	WHB4-5, WHB3-3, 3-5
Requires electrical equipment associated with the HERE or the borehole machine must be at least 10 ft. from the CH waste array face, or a fire watch is posted.	SAC	Prevents electrical fires associated with RH waste handling equipment from impacting CH waste	UG1-2
Requires that battery charging for the RH 41-ton, 20-ton-6-ton waste handling forklifts shall not be done within 75 ft. of the CH waste face. Battery charging for the RH waste handling forklifts shall not be done in the disposal path during CH waste transport. Charging must be performed in a cross-cut or in an unused room in the disposal circuit.	SAC	Prevents missiles with the potential to breach CH waste containers.	UG2-3
Requires boreholes for disposal of RH waste to be 17 ft. deep (-0/+2 ft.) and nominally 34 ft. from the projected corner of salt pillars along the short axis of the pillar that separates the disposal rooms and nominally 26 ft. from the projected corners of the salt pillar along the long axis.	SAC	Prevents direct radiation exposure to workers.	UG4-1

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Hoist Brake Performance Procedures shall be established, implemented, and maintained to ensure that the preoperational tests of the waste hoist brake system shall be performed on each shift prior to transporting waste.	SAC	Prevent the uncontrolled movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure which could lead to a drop and breach of an RH waste canister.	HA Events UG1-5, UG3-1
Fence Around Waste Shaft Collar Defines restricted area surrounding the waste shaft	DF	Prevents uncontrolled access to the shaft which could lead to an inadvertent drop of waste or loads into the waste shaft.	HA Events UG3-6 and UG6-2.
Facility Cask The facility cask is designed to interface with the FCTC, the FCRD, the shield bell and the HERE and shield collar to provide shielding for transfer of an RH waste canister from the transfer cell to the cask, for transport of the canister to the underground and for emplacement of a canister into an RH disposal borehole and also to provide shielding during emplacement of the shield plug into the borehole after the canister has been emplaced.	DF	Provides shielding of an RH waste canister for worker protection, protects a waste canister in the event of fires and explosions in the underground or dropping the facility cask when loaded with a RH waste canister. Protects RH canister from tornado and wind generated missiles.	WHB1-4, WHB2-4 WHB3-3, WHB4-5, WHB7-4, WHB7-5, UG1-1, 1-2, 1-3, 1-4, UG2-1, 2-2, 2-3, UG3-2, UG3-3, UG4-1
Metal Facility Canister The facility canister has a mechanical or pinned lid and pintle that structurally supports the canister when lifted with the upper hot cell crane grapple and the FCLR grapple hoist.	DF	Prevents the canister from being dropped during movement in the upper hot cell, transfer of a facility canister with RH waste from the upper hot cell to the transfer cell, and transfer of a canister from the transfer cell to the facility cask. Also prevents lid loss in the event of fires or explosions followed by fire. Facility canister also protects waste drums from impact.	WHB1-2, 1-3, 1-4, WHB3-3, 3-4, 3-5
PPA is paved or graveled and surrounded by a gravel road.	DF	Maintain a physical separation greater than 200 ft between the WHB and the indigenous low profile vegetation surrounding site, which minimizes the likelihood of a wild fire spreading to the WHB.	WHB6-2, WHB7-1

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
140/25-ton RH bay crane, CUR crane, upper hot cell crane and overhead powered manipulator, shuttle car, FCLR grapple hoist, and lift fixtures	DF	Designed to hold their load during the DBE or loss of power to prevent dropping and breaching RH waste containers.	WHB3-1, WHB3-2, WHB3-3, WHB3-4, WHB3-5, WHB7-2, BG7-1
Underground bulkheads, overcasts, and airlocks	DF	Nonflammable construction provide separation between construction ventilation circuit and disposal circuit and waste shaft station and minimize the effects to RH waste from fires outside the disposal path.	UG1-3, UG1-4
FCLR Telescoping Port Shield and Grapple Hoist Shield Bell	DF	Provide shielding for worker protection by mating with the facility cask when positioned vertically over the transfer port between the transfer cell and FCLR.	WHB1-4, WHB2-5, WHB4-5
Facility Cask Transfer Car	DF	The FCTC structurally supports the facility cask during transfer of a RH waste container from the transfer cell to the facility cask and subsequent transfer to the underground on the waste shaft conveyance. The FCTC mates with the FCRD and latches to prevent the FCTC from moving during canister transfer that could result in crushing the RH waste canister or the FCLR grapple hoist ropes and dropping a canister. This feature also prevents loss of shielding in the FCLR.	WHB3-3, 3-4, WHB4-5

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Handling Building			
The WHB includes the waste hoist tower. The WHB is designed to withstand the DBE postulated for the WIPP of .1 g peak acceleration with a 1,000-year return interval	DF	Prevents collapse of the building and breaching waste containers.	WHB3-5, WHB7-2, UG7-3, BG7-1
The WHB is required to meet NFPA 220, *Standard on Types of Building Construction*,[7] Type II construction The hot cell complex is comprised of rooms that are segregated from each other and the remainder of the RH portion of the WHB with thick concrete walls, floors, ceilings, shield plugs, shield valves, oil filled shield windows, and shield doors such that the nonflammable robust construction not only provides shielding for worker protection but prevents propagation of fire from one portion of the complex from propagating to another portion of the complex or to the RH bay.		Prevents external or wildland fires from propagating within the WHB to the hot cell complex and damaging waste containers outside of a shipping cask. Also hot cell complex provides shielding for worker protection.	WHB1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9, WHB2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, WHB4-1, 4-2, 4-3, 4-4, 4-5, WHB6-2, WHB7-1, 7-2
The WHB is grounded, and has a lightning protection system.		Prevents direct lightning strikes from impacting waste containers in the WHB.	WHB 7-3, 7-4
The WHB is designed to withstand a roof loading of 27 lb/sq ft.		Prevents the roof from collapsing and impacting waste in the WHB.	WHB7-6, 7-7
The WHB is designed to withstand (1) a tornado with a 183-mile-per-hour (mph) wind speed at a 1,000,000-year return frequency, (2) straight winds with a wind speed of 110 mph with a 1,000-year return frequency. The WHB including the waste hoist tower is designed to withstand the DBT with 183 miles per hour and a translational velocity of 41 miles per hour, a maximum rotational velocity radius of 325 ft, a pressure drop of 0.5 pounds per square inch (lb/in.^{2}) and a pressure drop rate of 0.09 lb/in.^{2}/s. The WHB is not designed to withstand wind or tornado driven missiles.		The WHB must withstand the DBA high wind and tornado loading to prevent structural failure and damage to the waste containers.	WHB7-4, 7-5
The structural beams in the upper hot cell under the canister storage wells supports facility canister.		Prevents a RH waste canister from falling to the lower hot cell.	WHB3-4

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Waste Shaft Conveyance The waste shaft conveyance is designed such that the height, width, and length of the materials deck can hold only one facility cask containing RH waste. The conveyance is not sized to accommodate both RH and CH waste at the same time. The material deck is located below the man deck. The waste shaft conveyance is designed such that a facility cask can only be loaded using the rail mounted FCTC.	DF	Limits the RH inventory that can be transferred on the waste shaft conveyance to only one RH waste canister. RH waste and CH waste cannot be transported at the same time. The waste is protected from falling objects and tornado missiles as the material deck is located below the man deck.	UG7-5, 7-6
Waste Hoist Structure and Structural Support The waste hoist structure and structural support including the waste hoist head frame, waste shaft conveyance, counter weight, ropes, waste hoist drum, and waste hoist tower are designed for design basis loads.	DF	Prevent uncontrolled drop of loaded waste conveyance down the waste shaft.	UG1-5, UG2-6, UG3-1, UG7-3
Waste Hoist Brakes	DF	Prevent the uncontrolled movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure.	UG1-5, UG2-6, UG3-1
Transfer Cell Shuttle Car	DF	The shuttle car supports its maximum design load and remains on its rails in the event of a DBE such that a RH waste container in the shuttle car is not breached. It accommodates only one RH waste canister at a time.	WHB3-3, WHB7-2, BG7-1
Upper Hot Cell Canister Storage Wells	DF	The upper hot cell canister storage wells prevent facility canisters from toppling onto other RH waste containers and protects the canister from dropped objects. The wells also prevent direct flame impingement on facility canisters containing RH waste.	WHB1-2, WHB1-6, WHB2-3, WHB3-4

Table 5-1 Summary of TSR Controls and Design Features

Control	Operating Limits Required	Safety Function	Selection Basis
Upper Hot Cell Crane Grapple and FCLR Grapple Hoist Grapple The grapples used with the upper hot cell crane and the FCLR are designed with three pivot dogs that move together to hold a canister pintle.	DF	Prevents the grapple from releasing a RH waste canister or other loads that could be dropped on RH waste.	WHB3-2, WHB3-3, WHB3-4, WHB3-5
Upper Hot Cell Wall Mounted Manipulators Wall mounted manipulators have counterweights to speed of travel in the event that an operator releases the manipulator.	DF	Prevents breaking the shield windows with the manipulators	WHB4-4
HERE and Shield Collar	DF	The HERE transfer mechanism and shield collar provide shielding for worker protection when mated with the facility cask during transfer of a RH waste canister from the facility cask into a disposal borehole, prevents direct flame impingement on the waste canister, and protects the canister from explosions.	UG1-2, UG2-2, UG4-1
Boreholes and Borehole Shield Plugs Boreholes for disposal of RH waste are 17 ft. (-0, +2) deep and are nominally 34 ft. from the projected corner of salt pillars along the short axis of the pillar that separates the disposal rooms and nominally 26 ft. from the projected corners of the salt pillar along the long axis. Borehole shield plugs shall be made of concrete with a steel sleeve and shall be at least 4 ft. long.	DF	The RH disposal boreholes and borehole shield plugs provide shielding after RH waste canister disposal for protection of workers in the active disposal room. Borehole placement ensures shielding for worker protection and protects spacing assumptions in the RH disposal criticality safety evaluations. The shield plug length and material protects workers from radiological exposure associated with RH waste and protects assumptions in the criticality safety evaluation for disposed RH waste. The shield plug also protects the disposed RH waste canister from the effects of an explosion/fire in the active waste disposal room.	UG1-2, 1-3, UG2-2, 2-3, UG4-1, UG5-1

* Waste characteristics are ensured by a waste characterization/certification program at each generator site that ensures that only RH waste that meets the RH WAC[6] is disposed of at the WIPP, and that any exceptions are evaluated against all applicable baseline documents prior to their authorization for shipment.

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PREVENTION OF INADVERTENT CRITICALITY

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PREVENTION OF INADVERTENT CRITICALITY

6.1 Introduction

The objective of this chapter is to describe essential elements of the Waste Isolation Pilot Plant (WIPP) Nuclear Criticality Safety program for remote handled (RH) waste. The WIPP Nuclear Criticality Safety program, documented in WP 12-NS.04, *WIPP Nuclear Criticality Safety Program,*[1] requires that Nuclear Criticality Safety Evaluations (NCSEs) be developed to analyze the activities involved in the handling and disposal of RH transuranic waste. The waste accepted for disposal at the WIPP is required to be characterized/certified to meet the requirements of DOE/WIPP-DRAFT 22-3123, *Remote-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant,*[2] (RH WAC) and DOE/WIPP 03-3178, *WIPP Remote-Handled (RH) Technical Safety Requirements* [TSRs],[3] prior to being approved for shipment to the WIPP. The RH WAC [2] applies to all generator sites that ship RH waste to the WIPP for disposal.

The RH WAC [2] and TSRs[3] specify fissile mass limits, special reflector/moderator mass limits, RH waste container types, and waste characteristics that have been approved for disposal at the WIPP. The limits are derived from NCSEs specific to the WIPP RH waste handling, storage, and disposal configurations. The fissile material and moderator/reflector mass limits for each container type and the RH waste handling storage and disposal configuration at the WIPP ensures that the probability of a criticality is less than 10^{-6} per year for all normal and credible abnormal conditions.

6.2 Requirements

The WIPP nuclear criticality safety program is based on the requirements of Title 10 CFR Part 830, Subpart B, *Safety Basis Requirements*;[4] DOE-STD-3009-94, *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports*;[5] DOE STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*;[6] DOE O 420.1A, *Facility Safety*;[7] and the ANSI/American Nuclear Society (ANS) standards.

The ANSI/ANS standards applicable to the WIPP include ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*;[8] ANSI/ANS-8.7, *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials*;[9] ANSI/ANS-8.15, *Nuclear Criticality Control of Special Actinide Elements*;[10] and ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety*.[11]

6.3 Criticality Concerns

Because the WIPP is a waste repository for the disposal of transuranic and mixed defense related waste, the surface WHB and underground disposal rooms may contain a significant accumulation of fissile material. The primary fissile material of concern is plutonium (**^{239}Pu**). While other transuranic isotopes may be in the RH waste, they are identified in terms of fissile gram equivalent (FGE) of **^{239}Pu**. In the underground, the facility cask is transported by a forklift into the waste disposal room. In the disposal room, the waste canister (facility canister or 72-B canister) is removed from the facility cask, emplaced in a horizontal borehole and then a shield plug is installed in the borehole. To ensure that the probability of a criticality remains less than10^{-6} per year, fissile mass and reflector/moderator mass limits are specified for container types acceptable for disposal at the WIPP, and are imposed as administrative controls in the WIPP RH TSRs.[3] The RH TSRs [3] for criticality limits are implemented at the waste generator sites through adherence to the RH WAC.[2]

6.4 Criticality Controls

The primary criticality control for the WIPP is that RH waste approved for disposal meet the RH TSRs [3] and RH WAC.[2] In compliance with DOE O 420.1A,[7] NCSEs **were performed to ensure that no credible criticality accident can occur at the WIPP. The analyses consider ^{239}Pu** fissile mass, geometry, moderation and reflection conditions in addition to storage and disposal configurations. Controls include fissile and reflector/moderator mass limits, container types, storage and disposal configurations. Both engineered and administrative controls result from the analyses.

6.4.1 Engineering Controls

The primary criticality control for RH waste are fissile mass limits imposed at the generator sites which are verified prior to shipment to the WIPP through the characterization process. As discussed in Chapter 2 of this documented safety analysis (DSA), RH TRU waste will be shipped to the WIPP in Nuclear Regulatory Commission Type B certified shipping packages (72-B and 10-160B road casks). Because of the shielding required for handling of RH waste, the 72-B shipping cask holds only one RH waste canister. The 72-B waste canister can either be direct loaded or contains up to three 30- or 55-gallon drums. The 10-160B shipping container holds ten 30- or 55-gallon waste drums that remain in the shipping cask until the cask is moved to a shielded facility within the RH portion of the WHB.

The RH waste handling process is limited by passive engineered design to handle only one shipping cask at a time in the RH Bay or the cask unloading room. The transfer cell can accommodate only one waste canister at a time as the shuttle car in the transfer cell is sized to hold one 72-B shipping cask or a shielded insert that has outer dimensions similar to the 72-B shipping cask. Either the 72-B cask or the shielded insert can accommodate only one canister. The facility cask loading room provides sufficient space for the facility cask and its transfer car to mate above an opening into the transfer cell. The 72-B RH waste canister remains in the 72-B road cask until it is transferred directly to the facility cask from the transfer cell as described in Chapter 2 of this DSA.

For the 10-160B process, waste drums remain in the cask until the cask has been moved into the cask unloading room of the hot cell complex. The cask contains two drum carriages with up to five 30- or 55-gallon drums each. Each carriage is removed from the 10-160B cask and raised into the upper hot cell. In the upper hot cell, three drums are loaded into a facility canister. The facility canister is then lowered into a shielded insert in the transfer cell shuttle car. Once in the shuttle car, the waste canister is transferred to the facility cask in a manner similar to the 72-B canister. Due to the length of canisters, the hot cell includes storage locations that extend below the floor of the upper hot cell into the lower hot cell. Facility canisters that have been loaded with waste drums are stored in one of **nine** locations in the upper hot cell until each canister is processed out of the upper hot cell to the transfer cell. The storage locations are permanently installed and are designed with sufficient spacing to ensure that reactivity remains safely subcritical. Due to space limitations in the upper hot cell no more than two loaded drum carriages can be in the upper hot cell at a time.

There is only one facility cask to transfer RH waste from the surface to the underground disposal room. The facility cask is designed to carry only one RH waste canister.

Based on analysis, a minimum center-to-center spacing of 30 inches for RH waste canisters has been shown to be safely subcritical. For ease of drilling and to minimize the effects of salt creep on the borehole shape, boreholes will be drilled on 8 ft center-to-center spacing. This spacing further neutronically isolates one waste canister from an adjacent waste canister. The shield plug that is placed in the disposal borehole to provide shielding for radiological protection of the worker, also neutronically isolates RH waste canisters from the CH disposal array that is emplaced after the walls of the disposal room are filled with RH waste. Shield plugs constructed of concrete inside a steel shell, are approximately 29 inches in diameter and 70 inches long. The plugs weigh approximately 3,950 pounds.

The Engineering Change Order document, described in WP 09-CN3007, *Engineering and Design Document Preparation and Change Control*,[12] controls modifications to the WIPP Structures, Systems and Components. The RH waste processing for 72-B and 10-160B road cask are controlled by WP 05-WH1710, *72-B RH Processing*[13] and WP 05-WH1722, *10-160B RH Processing*[14] procedures, respectively. New equipment designs, changes in the waste disposal room dimensions, changes to waste containers, or borehole spacing are required by WP 09-CN3007[12] to be evaluated for unreviewed safety question (USQ) determination through procedure WP 02-AR3001, *Unreviewed Safety Question Determination*.[15]

At the RH waste disposal location, the 41-ton forklift places the facility cask on the horizontal emplacement/retrieval equipment (HERE) waste transfer machine, which will have been previously aligned with the horizontal borehole. The facility cask is moved forward to mate with the shield collar and the transfer carriage is advanced to mate with the rear facility cask shield valve. Both facility cask shield valves are opened and the transfer mechanism extends to push the canister into the hole. After retracting the transfer mechanism into the facility cask, the forward shield valve is closed, and the transfer mechanism is further retracted to allow space for a shield plug and shield plug carriage to placed, using a forklift, onto the transfer carriage. The transfer mechanism pushes the shield plug into the facility cask. The front shield valve is opened and the shield plug is pushed into the hole. This completes the disposal process. The transfer mechanism is retracted, the shield valves on the facility cask are closed, the shield plug carriage and facility cask are removed from the HERE so that the HERE can be positioned on the next disposal borehole, and the facility cask is returned to the surface to receive a new RH waste canister for disposal.

6.4.2 Administrative Controls

A Waste Characterization/Certification Program at each generator site ensures that only RH waste that meets the RH WAC[2] is disposed of at the WIPP, and that any exceptions are evaluated against all applicable baseline documents prior to their authorization for shipment. The following criticality safety requirements are met before RH waste is approved for disposal at the WIPP:

- The maximum fissile loading shall not exceed 325 FGE, including measurement uncertainty, for a 72-B RH waste canister. If beryllium is present with the RH waste, the direct loaded 72-B canister is limited to a maximum beryllium content of 25 kg.[16, 17]
- The maximum fissile loading for any 55-gallon drum shipped in a 10-160B shipping cask shall not exceed 200 FGE, including measurement uncertainty, and a maximum beryllium content of 5 kg. If greater than 5 kg up to a maximum of 100 kg beryllium is present in any 55-gallon drum containing RH waste, fissile mass shall not exceed 100 FGE, including measurement uncertainty.[18]
- The maximum fissile loading for any 30-gallon drum shipped in a 10-160B shipping cask shall not exceed 200 FGE, including measurement uncertainty, with no beryllium or graphite.[16]

The following administrative controls are met during the RH waste disposal process at the WIPP:

- Drums are stored in the upper hot cell such they are not stacked prior to being emplaced in a facility canister. No more than 10 drums are in the upper hot cell outside of a facility canister.[16]
- Loaded canisters are stored in the upper hot cell storage wells. No more than 6 fully loaded facility canisters are stored in the upper hot cell.[16]
- Facility canisters are loaded such that no more than three 30- or 55-gallon drums are placed in a canister. The FGE content of the fully loaded facility canister containing only 55-gallon drums is limited to 600 FGE, including measurement uncertainty, with no single drum exceeding 200 FGE, including measurement uncertainty.[18] 30-gallon drums shall be loaded into the facility canisters such that each canister is administratively limited to a maximum of 325 FGE, including measurement uncertainty.[16]
- The RH waste canisters are to be stored in horizontal positions in the walls of the underground disposal area within an analyzed minimum center-to-center spacing of 30 inches.[16, 17]
- The shield plugs in the boreholes will be at least 4 feet long to ensure that RH waste is at least 4 feet from the contact handled waste containers.[16]

Changes to RH waste containers, RH waste characteristics, fissile content, moderator or reflector content in the waste container or external to the containers that would alter assumptions in the NCSEs are evaluated through NCSEs and WP 02-AR3001, Unreviewed Safety Question Determination,[15] with new or updated limits or controls specified in a change to the RH TSRs[3] and the RH WAC.[2]

6.4.3 Application of Double Contingency Principle

The NCSEs contain analysis that documents that there are sufficient factors of safety to establish that the probability of an inadvertent criticality is at least 10^{-6}. No single credible event or failure results in the potential for a criticality accident. RH waste and waste containers proposed for disposal at the WIPP must meet the RH WAC[2] prior to being approved to ship to the WIPP. Contingencies include overmassing the waste container, flooding the waste container, loss of geometry due to failure of the waste hoist brakes and subsequent breach of waste containers. In all cases analysis showed that results to be safely subcritical such that additional controls are not required.

For underground disposal, configurations shown to be safely subcritical included either one or two tiers of boreholes, one or two canisters per borehole, and with no spacing between boreholes other than the impracticality of placing them closer together than 30 inches center-to-center. While an administrative limit of 325 FGE has been placed on both the 72-B canister and the facility canister, 410g FGE has been shown to be **subcritical** for 72-B canisters, and 450g FGE has been shown to be **subcritical** for each 10-160B drum in a facility canister provided a minimum borehole spacing is maintained. NCSE WSMS-WIPP-00-003, *Waste Isolation Pilot Plant Nuclear Criticality Safety Evaluation Remote Handled Waste*,[16] documents that the current waste acceptance limit of 200 FGE per drum as sufficient to ensure criticality safety even if one of the drums shipped are double batched by the waste generator. NCSE CS-2003-003, *Determination of Beryllium Mass Limit for the 72-B Direct Loaded Canister with Beryllium Reflection*,[17] also examines the effects on the criticality eigenvalue of this canister containing beryllium metal in kilogram quantities in addition to 325 FGE. The results presented in the evaluation shows that a direct loaded 72-B canister may contain up 25kg of beryllium with up to 325 FGE and maintain a $k_{eff}+2\sigma$ below the upper subcritical limit.

6.5 Criticality Protection Program

The criticality safety program at the WIPP, described in WP 12-NS.04,[1] is structured to meet the requirements of DOE O 420.1A[7] and complies with the mandatory ANSI/ANS nuclear criticality safety standards applicable to the WIPP.

6.5.1 Criticality Safety Organization

ANS 8.1[8] and ANS 8.19[11] require management to clearly establish responsibility for nuclear criticality safety. The following defines the WIPP management and organizational responsibilities with respect to criticality safety:

The WTS General Manager ensures that personnel who identify the necessary criticality safety requirements are, to the extent practicable, administratively independent of process supervisors. The WTS General Manager ensures that the Nuclear Safety group is staffed with personnel skilled in the interpretation of data pertinent to criticality safety and familiar with facility operation.

The WIPP Waste Handling Operations ensures that the RH waste handling procedures reflect the applicable criticality controls identified in the most current NCSE and approved RH TSRs, ensures that personnel access to areas where fissile material is handled, processed, stored or disposed of is controlled, and ensures that the waste containers received for disposal at the WIPP match the waste approved for receipt as identified in the WIPP Waste Information System (WWIS). Waste Handling Operations also ensures that waste handling personnel and their supervision receive criticality safety training.

The Nuclear Safety group performs annual assessments to verify that controls that ensure criticality safety at the WIPP are being implemented, ensures that criticality safety-related deficiencies and corrective actions are addressed, and maintains the WIPP Nuclear Criticality Safety Program. The group also ensures that personnel who prepare and independently review NCSEs for the WIPP have the appropriate education/experience and are trained in accordance with a documented training program that emphasizes parameters important to nuclear criticality safety. The Nuclear Safety group also reviews changes to the WIPP safety analysis reports for packaging, RH WAC,[2] WWIS,[19] procedures for RH waste handling at the WIPP, and facility design changes for criticality impact. Nuclear Safety assists Training in the development of criticality training for the WIPP personnel. Any necessary limits or controls identified in NCSEs are included in the RH TSRs.[3]

The NCSEs implemented at the WIPP are prepared and independently reviewed by personnel knowledgeable in nuclear criticality safety as evidenced by documented experience and training. NCSEs are performed by individuals with the training and qualification consistent with DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification*,[20] which includes formal education requirements, classroom training, site specific knowledge, and demonstrated expertise in the use of the computer codes used. The WIPP personnel who prepare and independently review NCSEs are trained in accordance with NCS-01, *WIPP Safety Analysis Nuclear Criticality Safety Specialist Authorization Card*[21] and NCS-02, *WIPP Safety Analysis Senior Nuclear Criticality Safety Specialist Authorization Card*.[22] Subcontractors who prepare NCSEs for the WIPP are required to supply evidence of training and qualification consistent with DOE-STD-1135-99.[20]

The Design and/or Engineering organizations ensure that engineered items important to criticality safety, as identified in the RH TSRs,[3] are under configuration management and ensure that design for or modification to the surface RH waste storage locations, disposal area configuration, backfill material and RH waste handling equipment are reviewed through the USQ process prior to implementing the change.

The WIPP Quality Assurance assesses site organizations to ensure that nuclear criticality safety program requirements are being implemented.

Technical Training maintains a criticality safety training program for the WIPP personnel who review or implement criticality controls.

There are no institutionalized committees at the WIPP that address criticality safety issues. The Transportation and Packaging and Nuclear Safety groups interface frequently with the Carlsbad Field Office (CBFO) to address any concerns or additional controls for new RH waste forms.

6.5.2 Criticality Safety Plans and Procedures

Adherence to the fissile mass and moderator/reflector limits and RH waste containers approved for disposal at the WIPP, specified in the RH WAC[2] and RH TSRs,[3] is the primary method for ensuring criticality safety at the WIPP. Each generator site has a program for characterization and certification of the RH waste proposed for disposal at the WIPP and demonstrates compliance with the RH WAC[2] through the Performance Demonstration Program described in DOE/CBFO-01-3107, *Performance Demonstration Program Management Plan*.[23] WIPP does not accept any RH waste container shipments for disposal if the RH waste container information has not been submitted into the WWIS and approved by the WWIS data administrator. The process for submitting waste information into the WWIS is described in DOE/CBFO 97-2273, *WIPP Waste Information System User's Manual*.[19] The WWIS is programmed to include the limits for each container type from the RH WAC[2] such that the requirements for each container type are verified prior to shipment to the WIPP.

Once waste arrives at the WIPP, the containers are checked to verify that the containers that shipped match those approved for shipment in the WWIS. The WIPP does not perform any additional verifications of fissile content and has no assay equipment on site to do so. Because NCSEs WSMS-WIPP-00-003[16], and CS-2003-003[17] have shown that the probability of a criticality is less than 10^{-6} per year, no criticality accident alarm systems are necessary at the WIPP. All controls and limits are incorporated and embedded in the operational procedures. No criticality safety postings are used or are necessary. There are no evacuation plans specific to an inadvertent criticality. In the event that an unusual event happens during waste handling, personnel are trained to stop and evacuate the area.

There are no restrictions on fire fighting associated with RH waste handling and disposal activities. There is a wet pipe sprinkler system in the WHB and waste hoist tower. There are sprinklers in the crane maintenance room and the hot cell operating gallery, but not in other areas of the hot cell complex. The facility cask loading room has sprinklers available to extinguish a fire. There is 3 foot high retaining wall in the crane maintenance room that prevents water from flowing into the upper hot cell. If the sprinklers initiate and water overflows the retaining wall, water will drain to a sump in the lower hot cell with minimal impact to waste containers as there is an open floor grate between the upper hot cell and lower hot cell. Should sprinklers initiate in the facility cask loading room, the water may drain to the transfer cell sump. Water will not be retained in the shuttle car as the bottom of the basket has openings that allow any water to drain. There are no fire suppression systems in the disposal path and disposal rooms in the underground other than the installed chemical fire suppression system and hand-held fire extinguishers on the underground waste handling equipment. The likelihood of fires is minimized through a combustible loading control program for both the WHB and underground disposal transport path and active disposal rooms. The combustible loading control program is implemented through WP 12-FP3003, *Combustible Loading Controls for the Waste Handling Building and Underground*,[24] and is further discussed in Chapter 11 of this DSA.

Changes to the WIPP facility including designs that may impact criticality safety are controlled through the WP 09-CN3007.[12] Changes to procedures that impact nuclear safety or change facility processes described in this DSA are reviewed through the USQ process.[15]

6.5.3 Criticality Safety Training

The WIPP has established procedures that reflect the requirements for personnel who perform and independently review NCSEs.

Qualification and training of criticality safety engineering personnel is addressed in Section 6.5.1 of this Chapter.

Technical Training maintains a criticality safety training program for the WIPP personnel who review or implement criticality controls.

The WIPP also has a criticality training module for the WIPP personnel. Waste handling personnel are required to take the training module which explain criticality fundamentals including fissile mass, geometry, reflection and moderation, the administrative limits translated into the RH WAC[2] and RH TSRs,[3] and the relevance of the storage and disposal configuration to criticality safety.

6.5.4 Determination of Operational Nuclear Criticality Limits

The NCSEs[16,17] for the WIPP are developed in accordance with the requirements of DOE-STD-3007-93.[6] Calculations performed in the current NCSEs[16,17] for the WIPP have been prepared using both Monte Carlo N-Particle (MCNP) and Standardized Computer Analyses for Licensing Evaluation (SCALE) computer codes. The software used for NCSEs or calculations is controlled and includes bias validation as required by DOE O 420.1A.[7] The analytical process includes establishing the upper subcritical limit for the proposed operation and demonstrating that the operation remains subcritical for all credible normal and abnormal operations. The NCSEs[16,17] consider fissile mass and geometry, moderation and reflection, RH waste container types, storage and disposal configurations, and material properties.

The NCSEs[16,17] evaluate normal and credible abnormal operations including exceeding fissile or moderator/reflector mass limits in a RH waste container and identify the minimum subcritical margin for the RH waste storage and disposal operations. To ensure that the probability of a criticality remains less than 10^{-6} per year for the WIPP, the fissile and reflector/moderator limits for each container type and the WIPP handling, storage, and disposal configurations described in Section 6.4.2 above are imposed as administrative controls in the RH TSRs[3] and incorporated into the RH WAC.[2]

The WIPP procedure WP 12-NS.05, *Preparation, Review, and Approval of Nuclear Criticality Safety Evaluations*,[25] is based on DOE-STD-3007-93[6] and describes the necessary content for analyses. Evaluation documentation also includes bias development and validation for the computer code and hardware used in the preparation of the analysis.

6.5.5 Criticality Safety Inspections/Audits

RH waste is certified to meet the RH WAC [2] prior to being approved for shipment to and disposal at the WIPP. The approval for waste to be disposed of at the WIPP is documented in the WWIS as discussed in Section 6.5.2. Programs are in place to verify adherence to the RH WAC,[2] which includes data validation and reviews of characterization documentation. At the WIPP, QA audits and departmental assessments are performed to verify adherence to the RH waste handling, the design change control, and the USQ procedures, and adherence to the RH TSRs.[3] Waste handling operations are reviewed periodically to verify that hot cell storage and underground disposal configurations have not been altered such that assumptions in the NCSEs[16,17] have been compromised. There are no specific criticality safety inspections identified for the WIPP as the audits and assessments are sufficient to ensure criticality safety.

Characterization records are retained by the WIPP organizations that characterize RH waste and are ultimately transferred to the WIPP records center for long term retention. Waste profiles, container types, fissile mass, disposal location, and other parameters are documented in the WWIS database, which is a living document that changes as new RH waste is approved for disposal and disposed at the WIPP. Audit and assessment records are retained as specified on each implementing group's records identification document.

6.5.6 Criticality Infraction Reporting and Follow-Up

While the probability of an inadvertent criticality at the WIPP is less than 10^{-6} per year, items that would constitute a criticality infraction include receipt, handling and disposal of waste that exceeded the fissile and special reflector/moderator limits as specified in the RH TSRs[3] and associated RH WAC [2] limits.

Infractions, should they occur, are reported in accordance with WP 12-ES3918, *Reporting Occurrences in Accordance with DOE Order 231.1A*.[26] Event recoveries at the WIPP are controlled by procedure WP 12-ER3903, *Event Recovery*.[27] Recovery from a criticality infraction may include performing an analysis based on the actual RH waste content, container type, and disposal location to determine whether container is bounded by the contingency analysis. Recovery could also include returning the container to the generator site for remediation or correcting the stacking arrangement.

Corrective action following recovery from a criticality limit violation may include, but are not limited to changes to the WWIS, changes in criticality safety training , or changes to oversight of generator sites. The WIPP utilizes occurrence reports generated under WP 12-ES3918 [26] to incorporate lessons learned into training and future safety analyses. The lessons learned program is controlled by WP 15-MD3100, *Lessons Learned Program*.[28] Additional information concerning corrective action is contained in Chapter 11 of this DSA.

6.6 Criticality Instrumentation

The WIPP NCSEs[16,17] conclude that no credible criticality hazard exists at the WIPP for RH waste handling and disposal. The analyses further conclude that because no credible criticality scenarios exist for the WIPP, there is no need for a criticality accident alarm system or criticality detection system. There is currently no functionally operational criticality related instrumentation at the WIPP.

References for Chapter 6

1. WP 12-NS.04, *WIPP Nuclear Criticality Safety Program*.

2. DOE/WIPP-02-3122, Revision 5 (Draft), *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*.

3. DOE/WIPP 03-3178 , *WIPP Remote-Handled Technical Safety Requirements*.

4. Title 10 *Code of Federal Regulations* Part 830, Subpart B, Safety Basis Requirements.

5. DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis Reports* (Change 2, April 2002).

6. DOE-STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*.

7. DOE O 420.1A, *Facility Safety*.

8. ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*.

9. ANSI/ANS-8.7, *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials*.

10. ANSI/ANS-8.15, *Nuclear Criticality Control of Special Actinide Elements*.

11. ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety*.

12. WP 09-CN3007, *Engineering and Design Document Preparation and Change Control*

13. WP 05-WH1710, *72-B RH Processing*.

14. WP 05-WH1722, *10-160B RH Processing*.

15. WP 02-AR3001, *Unreviewed Safety Question Determination*.

16. WSMS-WIPP-00-003, Rev.1, *Waste Isolation Pilot Plant Nuclear Criticality Safety Evaluation Remote Handled Waste*, December 20, 2001.

17. CS-2003-003, *Determination of Beryllium Mass Limit for the 72-B Direct Loaded Canister with Beryllium Reflection*, January 2004.

18. CS-2003-001, Revision 1, *Waste Isolation Pilot Plant Nuclear Criticality Safety Evaluation for Contact Handled Transuranic Waste Storage*, August 2003.

19. DOE/CBFO 97-2273, *WIPP Waste Information System User's Manual*.

20. DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification*, September 1999.

21. NCS-01, *WIPP Safety Analysis Nuclear Criticality Safety Specialist Authorization Card*.

22. NCS-02, *WIPP Safety Analysis Senior Nuclear Criticality Safety Specialist Authorization Card*.

23. DOE/CBFO-01-3107, *Performance Demonstration Program Management Plan*.

24. WP 12-FP3003, *Combustible Loading Controls for the Waste Handling Building and Underground*.

25. WP 12-NS.05, *Preparation, Review, and Approval of Nuclear Criticality Safety Evaluations*.

26. WP 12-ES3918, *Reporting Occurrences in Accordance with DOE Order 231.1A.*

27. WP 12-ER3903, *Event Recovery*.

28. WP 15-MD3100, *Lessons Learned Program*.

RADIATION PROTECTION

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RADIATION PROTECTION

7.1 Introduction

This section discusses (1) the Waste Isolation Pilot Plant (WIPP) radiological protection program and organization, (2) the radiological hazards to the worker and off-site public as a result of remote-handled (RH) waste handling and disposal at the WIPP, (3) the WIPP ALARA (as low as reasonably achievable) policy and program, (4) radiological protection instrumentation, and (5) radiological protection record keeping. The scope of this chapter includes a description of the overall radiological protection program and organization, the practices and design features for keeping exposures ALARA, the administrative limits, dosimetry and respiratory protection, radiological monitoring and the program for maintaining radiation records.

7.2 Requirements

The radiological protection program was established to ensure the exposure of employees and the general public to radiation and radioactive materials is within the requirements of Title 10 *Code of Federal Regulations* (CFR) Part 835, "Occupational Radiation Protection"[1]; U.S. Department of Energy (DOE) Standard (STD) DOE-STD-1098-99, *Radiological Control*[2]; DOE G-441.1-2, *DOE Occupational ALARA Program Guide*[3]; 40 CFR Part 191, Subpart A,"Environmental Standards for Management and Storage";[4] 40 CFR Part 61, Subpart H, "National Emission Standard for Radionuclide Emissions from Department of Energy (DOE) Facilities";[5] and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.[6] The radiological protection program for the WIPP is described in WP 12-5, WIPP Radiation Safety Manual.[7]

7.3 Radiation Protection Program and Organization

7.3.1 Radiation Protection Program

WP 12-5[7] describes the radiological protection program for the WIPP. To ensure the objectives of the program are met, the program requires that:

- ALARA design reviews are conducted to ensure facility changes comply with 10 CFR Part 835, Subpart K, "Design and Control."[8]
- Shipments of radioactive materials to the WIPP meet the requirements of the WIPP RH waste acceptance criteria, as set forth in DOE/WIPP-02-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant,[9] referred to in this DSA as the RH WAC.
- Access control and posting are used to reduce direct radiation exposure to the WIPP employees.
- Shielding is required to support RH waste handling and disposal activities.
- Shielding verification surveys are performed during RH waste receipt and processing to ensure shielding integrity of the hot cell complex.
- Containment and ventilation design and controls minimize the potential for internal exposures during normal operations.

1 • Continuous air monitors are used to monitor for airborne radioactivity in areas where the shipping container is vented and in areas where waste containers are removed from the shipping container.

2 • Radiation protection training is provided for personnel appropriate to their assignments.

3 • Access is restricted to the RH waste handling areas when waste handling is in progress and prohibited in areas within the hot cell complex when waste is not in a shipping cask.

4 • Radiological surveys of personnel and equipment to prevent the spread of external contamination.

5 • A source control program is in place to minimize the potential for the spread of contamination, unnecessary exposure to personnel, loss, theft, sabotage, or improper disposal of radioactive sources.

6 • A respiratory protection program is in place, and respiratory protective equipment will be used during abnormal activities where personnel could be exposed to high surface contamination and/or airborne radioactivity.

7 • Instruments and equipment used to detect radiation or radioactive materials are calibrated so that accurate radiation, contamination, and airborne radioactivity surveys can be performed.

8 • Radiological work procedures and instructions provide for an ALARA review prior to commencement of work, for jobs in which radiation and/or radioactive contamination are expected to exceed site limits established by the WP 12-5.[7]

9 • Personnel dosimetry devices are supplied and are appropriate to the work being performed. A radiation exposure record system is maintained.

10 • An internal dose-assessment program that includes whole-body counting and bioassay is in place.

11 • Management responsible for radiological protection is notified of any unusual or unexpected radiological conditions.

12 • Every radiological worker at the WIPP has the authority to stop radiological work if there is evidence that radiological controls are being compromised.

13 • An effluent and environmental monitoring and/or sampling program is in place to detect releases to the environment, and to verify that facility releases are maintained at a minimum.

14 • The radiological control program is conducted in accordance with written and approved procedures.

15 **7.3.2 Radiation Protection Organization**

16 The radiation protection program at the WIPP includes the following organizational responsibilities:

17 The Safety & Health Department is responsible for developing and maintaining the WIPP programs for
18 industrial safety and radiation protection of employees and the general public. The Safety & Health

Manager is responsible for development, maintenance and oversight of the radiation protection program, the training of radiation workers and radiological control technicians (RCTs), emergency planning, and the ALARA program. This programmatic responsibility is delegated to the Radiation Safety and Emergency Management (RS&EM) Manager, who reports to the Safety & Health Manager and has a direct line of communication to the General Manager in matters of radiation safety.

The RS&EM Manager establishes training programs for qualification and requalification of RCTs. The RS&EM Manager is responsible for establishing and implementing the Radiological Safety Training Program, and reviewing and approving all radiological safety training. The RS&EM Manager reviews and approves radiological procedures. The ALARA coordinator and radiological engineering activities are also directed by the RS&EM Manager.

The RS&EM Manager is responsible for operating and maintaining a dosimetry program to determine external radiation exposure to employees and visitors. In addition, the RS&EM Manager is responsible for implementing and operating the internal dosimetry program. The RS&EM Manager has the authority to remove from further exposure, employees who have either reached or exceeded the established administrative radiation exposure limits or have not demonstrated their continuing understanding of, or compliance with, the WIPP radiological control program.

Operational radiation safety associated with all waste handling activities at the WIPP is the responsibility of the manager of Integrated Waste Operations and is delegated to the Radiological Control Manager, who reports to the manager of Integrated Waste Operations. The Radiological Control Manager maintains the radiological safety of the facility by regularly evaluating and assessing surface contamination, radiation levels, and airborne radioactivity levels in the radiological work areas with respect to approved limits. The Radiological Control Manager directs operational health physics activities, ensures the performance monitoring of routine and special WIPP operations, and is responsible for approval of radiological work permits (RWPs). The Radiological Control Manager ensures appropriate training for the WIPP RCTs is maintained effective and current. All waste handling and disposal activities are performed in accordance with procedures that ensures worker exposures are maintained ALARA.

The Technical Training Manager is responsible for ensuring that all radiological safety training instructors are qualified and have the technical knowledge, experience, and instructional skills to conduct radiological training. The Technical Training Manager is also responsible for maintaining, preparing, and grading written examinations, and maintaining question banks and radiological safety training records for all WIPP personnel. Technical Training is responsible for coordinating the radiological safety training programs including RCT training and qualification, Radiological Worker I training, Radiological Worker II training, General Employee Training (GET), visitor orientation, and ALARA training for supervisory, job planning personnel, and radiological workers.

Line managers are responsible for ensuring that their personnel attend GET within one month of their initial assignment to the WIPP and that they maintain the retraining and refresher requirements associated with GET. Line managers ensure that workers whose job assignments require access to radiological areas have completed Radiological Worker I and/or II training, as appropriate to their job assignments. Line managers responsible for waste handling personnel, engineers, schedulers, dosimetry technicians, medical personnel, radiochemistry personnel, and procedure writers whose job assignments support actual or potential radiological activities and radiological systems ensure that their personnel are trained appropriate to the tasks they perform at the WIPP and in the principles of ALARA.

Radiological ALARA committee members are responsible for obtaining and maintaining a minimum of Radiological Worker I training as required by WP 12-2, WIPP ALARA Program Manual,[10] being trained in the principles of ALARA, basic ALARA techniques, and dose-reduction techniques, and participating in selected portions of job-specific and specialized training, particularly in situations using mock-ups, before performing their work functions.

7.4 ALARA Policy and Program

The WIPP ALARA program is defined in WP 12-2.[10] The ALARA program interfaces with the overall WIPP radiological protection program described in WP 12-5.[7] The WIPP ALARA committee is established by management charter MC 9.4, Radiological ALARA Committee.[11] The WIPP ALARA program minimizes the radiation exposure to workers, the public, and the environment. The program requires pre- and post-job reviews of work that exceeds preset triggers as well as reviews of designs, programs, and procedures that involve control activities where there is a potential for radiation exposures. ALARA issues are reviewed by the WIPP ALARA committee.

WP 12-2[10] requires radiation safety training for personnel who routinely work in the controlled areas of the facility, radiological control procedures, and continued review of operations for enhancements and improved efficiency. RCTs participate in RH waste handling and provide up-to-date information to waste handling operators as to radiation levels and locations where exposures can be minimized. Performance is monitored through audits and periodic review of exposures, procedures, and incident reports, and recommending corrective action when required.

The ALARA principles applied to the WIPP design were based on DOE/EV/1830-T5, *A Guide to Reducing Radiation Exposure to as Low as Reasonably Achievable*,[12] and DOE Order 6430, *General Design Criteria Manual for Department of Energy Facilities*,[13] which was the original design basis. Current design modifications are made in accordance with 10 CFR Part 835[1]; DOE O 420.1A, *Facility Safety*[14]; DOE O 430.1A, *Life-Cycle Asset Management*[15]; DOE G441.1-2[3]; and other codes, standards, and orders applicable at the time of modification. Changes to the WIPP structures, systems, and components are made in accordance with the engineering change order process described in WP 09-CN3007, Engineering and Design Document Preparation and Change Control,[16] which includes ALARA reviews.

ALARA practices include the use of RWPs, radiological postings, use of shielding, monitoring and postings. Design features that keep exposures ALARA are discussed below:

<u>Facility Arrangement</u> - The WIPP areas to which access is managed to protect individuals from exposure to radiation and/or radioactive materials are identified as controlled areas, and are administrated in accordance with the WP 12-5.[7] The Controlled Areas are normally segregated from other operating areas by physical barriers (e.g., tape, rope, fences, walls, bulkheads) and signs that are conspicuously posted with at least one sign visible at each accessible point on the posted area boundary. The surface Controlled Areas include the parking area on the south side of the waste handling building (WHB) and the WHB itself as shown in Figure 2.4-1.

<u>WHB Arrangement</u> - A Controlled Area is established in the WHB to support waste handling operations. All entrances to Controlled Areas are posted and personnel must either have current training or be escorted by an individual who has current GET.

Airlocks are located between areas with different levels of contamination potential. The ventilation system and airlocks act to prevent and mitigate the spread of contamination by maintaining pressure differentials between radiological areas. Ventilation is directed from areas with low potential for contamination to areas with higher potential for contamination.

RH Waste Handling Area Arrangement - The RH waste handling area of the WHB is arranged so that waste handling flow patterns are as direct as possible from shipping package unloading to hoist loading and that adequate space is provided for waste transfer activities. RH waste is only removed from a shipping cask inside the hot cell complex. A shielded facility cask is used to transport RH waste canisters from the surface to the underground.

Underground Disposal Area Arrangement - The underground disposal area is segregated from other areas of the WIPP underground by bulkheads to separate ventilation flow paths. Access control and personnel traffic patterns are considered in the plant layout to minimize the potential for spreading contamination, and to minimize personnel radiation exposure. RH waste containers are disposed in horizontal boreholes that are in the walls of the waste disposal rooms. No RH waste is disposed of in Panels 1 and 2 in the underground.

Waste Handling Equipment - Cranes, lifting fixtures, etc. used to move waste containers are designed to minimize the potential for drops or punctures that could result in a radiological release. Waste handling equipment has smooth cleanable surfaces, and crevices and corners are minimized or eliminated, where practical. Mechanical handling equipment is designed for easy replacement for decontamination and/or repair.

Instruments - Radiation monitoring equipment or other equipment that is located near areas with potentially higher radiation levels are designed for easy removal such that the item can be moved to an area with a lower radiation background for calibration or repair. Other than radiation monitoring equipment, instrumentation and control devices for other WIPP systems and components are located in areas away from potential radiological materials.

Lighting and cameras - Multiple electric lights and cameras are provided in the hot cell complex to monitor RH waste handling. The loss of a single light or camera lamp will not impact the waste handling process and does not require immediate replacement of the defective lamp or camera.

Heating, Ventilation, and Air Conditioning (HEPA) Equipment - HEPA filter housings are located in rooms that are smooth coated. Filter housings are located such that access and filter changes can be accomplished with minimal potential for contamination.

Shielding - Unlike contact handled (CH) waste handling, RH waste handling is performed in areas or with equipment that provides shielding such that the dose rate due to uncollided and scattered radiation through the shield are less than the maximum levels specified for each design radiation zone. Shield wall thicknesses are shown in plant arrangement drawings. Shielding materials at the WIPP include concrete/rebar, lead, steel, or salt. The viewing windows in the walls of the upper hot cell include leaded glass and oil. Openings such as doors, hatches, windows, ventilation ducting, and piping are designed to prevent radiation streaming. Penetrations through primary shielding are typically placed so that they do not provide a direct line through the shield wall to the radiation source. Designs include offset piping connections, stepped doors or hatches, shadow shields, and labyrinths. Large diameter penetrations include additional concrete or steel around the penetration, shield collars or leaded grout around pipes and penetrations. Temporary shielding, such as lead blankets, bricks, or other materials may also be employed, as required, during maintenance or recovery in the event of a container breach. Access to potentially high radiation areas involves passage through shield doors or labyrinth walls which prevents direct radiation streaming into adjacent areas. Labyrinth shielding is designed so that the exposure due to uncollided and scattered radiation is less than the maximum levels specified for the adjacent area.

The direct radiation sources that are the basis for shielding design are categorized from RH waste.

RH waste composition is discussed in Appendix DATA of the Title 40 CFR Part 191 Subparts Band C Compliance Recertification Application, 2004. For RH TRU waste, the most abundant isotopes are Cs-137, Sr-90, Pu-239, Ba-137m, Pu-241, and Y-90. Current design requirements specify that routinely occupied areas have radiation levels less than 1,000 mrem/year. The hot cell complex, the facility cask, and the shield collar and transfer mechanism associated with the HERE will meet this requirement for RH waste handling operations as those structures and components were designed to handle levels up to 400,000 R/hour. These levels will be verified during initial RH waste operations.

For surface RH waste handling activities, several components provide shielding as discussed in Chapter 2. The road cask provides shielding until the waste is inside the hot cell complex within the RH side of the WHB. As discussed in Chapter 2, waste canister remains in the 72-B shipping cask until it is transferred to the facility cask, and waste drums remain in the 10-160B shipping cask until inside the hot cell complex. The facility cask provides shielding for transport of the RH waste canisters from the surface to the underground disposal locations. The facility cask provides a cylindrical steel and lead shield enclosure around one RH canister, and has shield valves at either end. The facility cask includes sufficient shielding to reduce gamma radiation levels to less than 200 mrem/h (2 mSv/hr) at the surface of the cask from a RH canister with 7,000 rem/hr dose rate. The control console for operating equipment in the upper hot cell is located outside the hot cell complex with CRT screens for viewing the waste handling activities. The upper hot cell includes oil filled shield windows that allow viewing of waste handling operation, especially during operation of the wall mounted master-slave manipulators. In the facility cask loading room, the control console for equipment in the transfer cell is located behind a shadow shield.

In the underground, when transferring a RH canister from the facility cask to the borehole in the disposal room, the HERE shielding overlaps with the facility cask to minimize radiation streaming paths. The controls for the HERE include several interlocks to ensure that shielding is maintained throughout the emplacement process. Following emplacement of the waste canister the HERE and facility cask maintain shielding and a shield plug is also inserted into the waste borehole to reduce radiation levels in occupied areas of the panel to maintain radiation exposures ALARA while additional waste handling operations are conducted The operating console for the HERE is designed such that it can be located nominally 20 ft. away from the emplacement equipment.

The shielding requirements for RH waste handling emplacement equipment is to limit radiation levels in all areas accessible to whole body exposure to less than 100 mrem/hr during emplacement operations and to less than 5 mrem/hr for the final disposal configuration. The facility cask is designed such that the radiation dose rate on the outer surface of the cask is less than 200 mrem/hr using a canister with a surface dose rate of 7,000 rem/hr. The hot cell complex was designed for radiation up to 400,000 R/hr RH waste drums or canisters do not exceed 1000 rem/hr.

7.5 Radiological Protection Training

WP 12-5[7] outlines the radiological protection training required for personnel working at or visiting the WIPP. Radiation safety training is conducted at the WIPP to ensure that each worker understands: (1) the general and specific radiological aspects of their assignment, (2) their responsibility to their co-workers and the public for safe handling of radioactive materials, and (3) their responsibility for minimizing their own radiation exposure. The level of training is commensurate with the requirements of an individual's job. Training includes GET and may include Radiological Worker I and II training. RCTs receive training consistent with the guidance provided in DOE Handbook 1122-99, *Radiological Control Technician Training*.[17] GET and Radiological Worker refresher training is required annually. RCT continuing training is performed annually, and requalification is done every two years. Site-specific training and refresher training includes changes in requirements and updates of lessons learned from operations and maintenance experience and occurrence reporting, for the site and across the DOE complex.

GET is required for all the WIPP employees and is required for entry into the Controlled Area. Visitors who enter Controlled Areas receive a radiological safety orientation that includes basic radiation protection concepts, risk of low-level occupational radiation exposure, radiological protection policies and procedures, visitor and management responsibilities for radiation safety, adherence to radiological posting and labeling, applicable emergency procedures, and training for issuance of dosimeters, where applicable. Radiological Worker I and II training is required for unescorted entry into areas as stated in the Table 7.5-1. WP 12-9, WIPP Emergency Management Program,[18] establishes the emergency preparedness program for the protection of personnel and property for which the WIPP is responsible.

Table 7.5-1, Radiological Worker Entry Training Requirements

Areas	GET or Visitor Orientation	Radiological Worker I	Radiological Worker II
Allows entry into Controlled Areas	YES	YES	YES
Allows entry into Radioactive Material Areas or Radiological Buffer Areas	NO	YES	YES
Allows entry into Radiation Areas	NO	YES	YES
Allows entry into High- or Very-High-Radiation Areas	NO	NO	YES
Allows entry into Contamination Areas and High-Contamination Areas	NO	NO	YES
Allows entry into Airborne Radioactivity Areas	NO	NO	YES

7.6 Radiation Exposure Control

Radiation exposure control is addressed in the WP-12 series programs and implementing procedures. External radiation exposure control is accomplished at the WIPP by establishing administrative dose control levels well below DOE regulatory dose limits and by institutionalizing processes such as access control and postings into areas with the potential for radiological exposure, radiological surveys, contamination control, radiation work permits, work planning and control, personnel protective equipment, dosimetry, radiological monitoring and sampling, source control, and emergency radiological event response, and training of the WIPP personnel and visitors.

Because waste containers are not opened at the WIPP and they must meet 10 CFR Part 835 external contamination limits prior to shipment, significant contamination is not expected at the WIPP. ALARA practices, use of RWPs, and ventilation design are the main methods for controlling contamination, should it occur. Inhalation and ingestion of radiological materials is prevented through postings and prohibiting eating and drinking in posted area.

7.6.1 Administrative Limits

This section provides a summary of the occupational dose limits for the WIPP workers. Waste containers accepted for disposal at the WIPP are expected to meet the 10 CFR Part 835 external contamination limits. WIPP normal operations do not involve any expected releases of airborne radioactive materials. As such, the projected occupational worker dose from normal operations is expected to result from direct radiation from waste containers only, with no contribution from internal dose (CEDE) due to airborne radiological materials.

The dose to personnel from RH waste handling varies with the number of shipments and the radiation dose rates of the waste in those shipments. Each year the ALARA committee estimates the doses to personnel based on the expected numbers and dose rates of the shipments. The actual doses received by workers are then reviewed by the committee to determine if work was performed to limit personnel exposures to radiation and radioactive materials to ALARA levels.

Occupational dose limits from 10 CFR Part 835[1] are provided in Table 7.6-1. The occupational dose limits provided in Table 7.6-1 apply to all general employees and is expressed as roentgen equivalent man (rem). A site-specific administrative control has been established at less than 1 rem per year, per person, in accordance with WP 12-5.[7] Other administrative control levels are defined in Table 7.6-1. General employees who have not completed at least Radiological Worker I training are not permitted unescorted access to any radiological area, Radioactive Material Area, or Radiological Buffer Area. No individual is allowed to exceed the WIPP administrative control levels without prior written approval of the RS&EM Safety Manager and the WTS General Manager.

Efforts are made to control each individual's lifetime occupational dose below a lifetime control level of N rem where N is the age of the individual in years. In rare cases, emergency exposure to radiation may be necessary to rescue personnel or to protect major property. Emergency exposures are authorized in accordance with the provisions contained in 10 CFR Part 835. These doses are in addition to, and accounted for separately from, the doses received under the limits in Table 7.6-1.

Table 7.6-1, WIPP Occupational Dose Limits, DOE, and WIPP Administrative Control Levels

Type of Exposure	Occupational Dose Limit	DOE Admin Control Level	WIPP Admin Control Level
General Employee: Whole Body (internal + external) (TEDE) Whole body dose total effective dose equivalent (TEDE) = effective dose equivalent from external exposures + committed effective dose equivalent from internal exposures	5 rem/year	2 rem/year	1 rem/year
General Employee: Lens of the Eye (external)	15 rem/year	N/A	3 rem/year
General Employee: Skin and extremities (external shallow dose)	50 rem/year	N/A	10 rem/year
General Employee: Any organ or tissue (other than lens of eye) (internal + external)	50 rem/year	N/A	10 rem/year
Declared Pregnant Worker: Embryo/Fetus (internal + external)	0.5 rem/gestation period	N/A	0.5 rem/gestation period
Minors: Whole body (internal + external) (TEDE)	0.1 rem/year	N/A	0.1 rem/year
Minors: Lens of the eye, skin, and extremities	10% of General Employee limits	N/A	10% of General Employee limits

7.6.2 Radiological Practices

Radiological practices at the WIPP includes proceduralizing those processes with the potential to result in a radiological exposure and preplanning work such that the radiological hazards are evaluated at the earliest stage in a job. Preplanning work is directed to controlling contamination at the source, eliminating airborne radioactivity, maintaining personnel exposure below regulatory limits and performing work that assures ALARA exposures. The RWP specifies the controls necessary for entry into an area with the potential for a radiological exposure. The RWP may require additional dosimetry and monitoring devices, protective clothing, and respiratory equipment. The necessity for these items is based on radiation level, a combination of surface contamination and radiation level, the presence of airborne radioactivity, or the potential for occurrence of any of these conditions. When required, these additional control items are prescribed on an RWP that personnel must follow.

Waste containers are not opened at the WIPP and are also not removed from the RH shipping container until it is moved into the WHB hot cell complex, where access is controlled. The RH shipping containers are vented in the RH bay where equipment is available to direct airflow through HEPA filtration and a sample filter. General radiological control practices include:

Access Control - Access to radiological areas of the facility is controlled in accordance with 10 CFR Part 835.[1] Only personnel who have successfully completed the requirements specified in WP 12-5[7] are allowed unescorted entry to the radiological areas of the site. All other personnel will require an escort. Personnel performing radiological work in a radiological area are required to sign in on an RWP. Access into the hot cell complex is restricted when RH waste containers are outside of a shielded shipping container. Access to areas adjacent to the hot cell complex are restricted until radiation doses are determined by routine surveys in addition to shielding verification surveys.

Personnel Access Control Points - Access to the areas at the WIPP where radioactive materials are handled is controlled and limited to personnel who have successfully completed the appropriate level of radiological training. Personnel leaving contamination, high contamination, and airborne radioactivity areas are required to perform a personnel survey prior to exit.

Radiological Monitoring - Personnel monitoring is performed in accordance with WP 12-3, Dosimetry Program,[19] and WP12-5.[7] This is discussed in Section 7.7.

Radiological Posting - Areas within the WIPP including the underground disposal area are posted in accordance with 10 CFR Part 835[1] and WP 12-5[7] to specify the actual or potential radiological hazard. Posting provides necessary information and access control for minimizing personnel radiation exposures and the potential spread of contamination. Exposure control is accomplished by identifying areas containing sources of radiation and/or contamination, and controlling personnel access into these areas. Radiological areas are designated and defined in 10 CFR Part 835[1] and in the WP 12-5[7] as follows:

- Radiological Area - Any area within a controlled area defined as a radiation area, high radiation area, very high radiation area, contamination area, high contamination area, or airborne radioactivity area.

- Controlled Area - Any area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials.

- Radiological Buffer Area - An intermediate area established to prevent the spread of potential radioactive contamination. The area may surround contamination areas, radiation areas, high contamination areas, and airborne radioactivity areas.

- Radioactive Material Area - Any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values in Appendix E of 10 CFR Part 835.[1]

1 • Radiation Area - An area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in one hour at 30 centimeters from the source, or from any surface that the radiation penetrates.

2 • High Radiation Area - An area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (1 sievert) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

3 • Very High Radiation Area - An area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 gray) in one hour at one meter from a radiation source or from any surface that the radiation penetrates.

4 • Contamination Area - Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Appendix D of 10 CFR Part 835,[1] but do not exceed 100 times those values.

5 • High Contamination Area - Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Appendix D of 10 CFR Part 835.[1]

6 • Airborne Radioactivity Area - Any area, accessible to individuals, where: (1) the airborne radioactivity, above natural background, exceeds or is likely to exceed the Derived Air Concentration (DAC) values listed in Appendix A or Appendix C of 10 CFR Part 835,[1] or (2) an individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.

7 Shielding Integrity and Verification - The integrity of the shielding and its design features is ensured by
8 the adherence to the requirements and recommended practices described in American National Standards
9 Institute (ANSI) ANSI/ANS 6.4-1997, "Nuclear Analysis and Design of Concrete Radiation Shielding
10 for Nuclear Power Plants,"[27] with the following additional design criteria:

11 • In addition to the applied loads requirements listed in Section 4.3.3 of ANSI N101.6-1972, "Concrete Radiation Shields,"[28] the concrete radiation shield structural analysis also considers steady-state and transient thermal loads.

12 • Detailed thermal stress analysis in the design of reinforcement for controlling thermal cracking (temperature reinforcement) in specific concrete radiation shields is included in determining variables used in equations for bending moment and tensile stress, as described in Section 6.4 of ANSI N101.6-1972.[28]

13 • Reinforcing steel or other means are provided for transferring shear and other forces through a construction joint, as described in Section 8.8.7 of ANSI N101.6-1972.[28]

14 Radiation Monte Carlo N-Particle (MCNP) and Standardized Computer Analyses for Licensing
15 Evaluation (SCALE) computer codes were used to more precisely estimate shielding worth of RH facility
16 structures. In July of 2002, the report "Final Results of the WIPP RH TRU Facility Penetration and
17 Shielding Analysis"[29] was completed. The report complies with ANSI/ANS 6.4-1997,[27] which allows for
18 computer modeling in leu of radiation sources in performing shielding analysis. The report identifies
19 those areas that could be posted as a radiation area based on the radiation level of the waste being
20 processed, including the cask unloading room, the crane maintenance room, the hot cell, the facility cask
21 loading room, the facility cask itself, and the HERE.

During initial RH waste handling, general area surveys will be conducted. Locations where general area radiation levels could cause individuals to exceed 5 mrem (.05 mSv) in any one hour or 100 mrem (1 mSv) in a year will be posted, barricaded, and shielding added, if necessary.

Radiation and Contamination Surveys - In addition to the shielding verification surveys described above, RCTs perform routine radiation and contamination surveys of the facility and surveys of the waste packages upon receipt of waste shipments. Additional surveys are preformed using robots or manipulators when waste containers are removed from the shipping cask. Survey areas and frequencies are established in accordance with health physics procedures and are based upon the likelihood of contamination and changes in radiation level. Surveys consist of measurements for dose rate and contamination, as appropriate, for the specific area. RCTs perform surveys on normally inaccessible areas when they are opened for maintenance and/or inspections. These areas include portions of the hot cell complex, ventilation, piping, drains, and overhead structural surfaces in the waste handling areas.

Radioactive Material Control - This includes control of radioactive sources and control of radioactive material produced through work processes performed on-site. Use of sources on-site is controlled in accordance with WP 12-HP3200, Radioactive Material Control,[20] to ensure proper control, leak testing, inventory, transfer, and disposal of sources are maintained at all times to prevent loss/theft, spread of contamination, and other abnormal occurrences involving radioactive sources. Any item used in a process that involves known or suspected presence of radioactive contamination or radioactive materials is surveyed prior to release from a radiological area. Items which could contain internal or masked (e.g., painted) contamination are evaluated prior to release. If the survey indicates the presence of radioactive material on the item, the item is either decontaminated or disposed of as radioactive waste.

Airborne Radioactivity Monitoring Program - The airborne radioactivity monitoring program complies with 10 CFR Part 835,[1] and verifies that the survey program described above is detecting contamination control problem areas, and those problem areas are corrected before loose surface contamination becomes airborne. The equipment used for air sampling and monitoring is described in Section 7.8. The airborne monitoring program is described in WP 12-5.[7]

7.6.3 Dosimetry

The basis of the WIPP dosimetry program, contained in WP 12-3,[19] is to measure and report occupational radiation exposures to individuals at the WIPP site in compliance with 10 CFR Part 835. WIPP personnel are classified as radiation workers or non-radiation workers. Non-radiation workers are typically not monitored for occupational exposure. For radiation workers, the external occupational radiation exposures of concern are of ionizing radiation (x-ray, gamma, beta, and neutron).

The external radiation dosimetry program uses thermoluminescent dosimeters (TLDs) to measure occupational radiation exposures to external radiation exposure for radiation workers. Radiation workers are assigned a TLD and are instructed in its use by dosimetry personnel. TLDs remain at the site when workers leave for the day and pick up their assigned TLD when returning to the site. Electronic personnel dosimeters are also issued to personnel when required by the radiological work permit and are read and recorded upon leaving the area. TLDs are exchanged quarterly for most individuals and monthly for individuals with projected exposures approaching 1 roentgen equivalent man (rem) annually.

The internal dosimetry program at the WIPP to determine internal exposure measurement may include in-vitro bioassay examination (e.g., urinalysis, and/or fecal analysis) and in-vivo bioassay examination (whole-body counting and chest counting). There are no planned or expected releases of airborne radioactive materials that may present an internal occupation radiological hazard. To verify the absence of airborne radioactivity, work place monitoring is performed using portable air samplers, fixed air samplers (FASs) and continuous air monitors (CAMs). The WIPP waste handling operations do not involve opening waste containers. Routine bioassay is not required at the WIPP. Bioassay is performed periodically for workers who handle radioactive materials as a normal function of their job, to confirm that there is no internal exposure. Confirmatory bioassay is performed annually. Any waste handling event resulting in loss of radioactive material containment at the WIPP triggers an internal dose assessment to limit further occupational exposures and to facilitate any decision for medical therapy to remove internal contamination. This could be triggered by high airborne activity in work areas and/or unexpected contamination incidents.

Radiation exposure data for monitored individuals is reported in compliance with 10 CFR Part 835[1] and DOE O 231.1A, *Environment, Safety and Health Reporting*.[21] Radiation exposure data is confidential and controlled. An annual radiation dose report is provided to each individual monitored at the WIPP site during the year, and is provided upon request for individuals terminating employment, or from individuals requesting more detailed information.

Personnel dosimetry records are maintained at the WIPP site by dosimetry personnel. Occupational exposure records are maintained in a readily retrievable database, to permit ready accounting of employees' accumulated radiation exposure. The WIPP dosimetry program and implementing procedures are included in the WIPP WP-12 series procedures.

7.6.4 Respiratory Protection

Respiratory protection is addressed in Chapter 5 of WP 12-5,[7] and WP 12-IH.02, WIPP Industrial Hygiene Program.[22] The respiratory protection program meets the requirements of American National Standards Institute (ANSI) Z88.2-1992.[23] Only respiratory protection equipment approved for use by the National Institute of Occupational Safety and Health is used at the WIPP. Workers who may be required to wear respiratory protection equipment must attend a training program on the equipment use during normal, abnormal and emergency conditions. They are fitted for the devices they are required to wear, and are given a special medical examination to ensure that there is compatibility with wearing the devices.

Respiratory protection is required when specified on the RWP and when levels exceed the removable and total contamination levels specified in WP 12-5. Respiratory protection equipment available at the WIPP includes self-contained breathing apparatus, airline supplied-air suits and hoods, and respirators with particulate or gas-filtering cartridges. Only self-contained breathing apparatus may be used in toxic or oxygen-deficient atmospheres.

Use and maintenance of respiratory protection equipment is proceduralized in the WIPP WP-12 series procedures.

7.7 Radiological Monitoring

Radiological monitoring is performed in accordance with WP 12-3[19] and WP12-5,[7] and includes the following activities:

<u>Radiation and Contamination Surveys</u> - RCTs perform routine radiation and contamination surveys of the facility and surveys of the waste packages upon receipt. In addition, RCTs will perform surveys on normally inaccessible areas when they are opened for maintenance and/or inspections. These areas include ventilation ductwork and filter housings, piping, drains, and overhead structural surfaces in the waste handling areas. Routine survey areas and frequencies are established in accordance with 10 CFR 835 and implemented in health physics procedures and manuals, and are based upon the probability of

contamination, changes in radiation level, and upon personnel occupancy. These surveys consist of measurements for dose rate and contamination, as appropriate, for the specific area.

Radioactive Material Control - There are two facets to the control of radioactive material. The first is radioactive source control. Radioactive sources, including Plutonium, Strontium/Yttrium, and Cesium, are used to test, calibrate, and check the operation of radiation detection instrumentation. Radioactive sources are also brought on-site by external organizations for testing, radiography, and soil density operations. Use of sources on-site by external organizations is controlled in accordance with WP 12-HP3200.[20] The Radiological Control Manager ensures the external organization meets training and source documentation requirements prior to authorizing the source on-site. The radioactive source control program ensures that proper control, leak testing, inventory, transfer, and disposal of these sources are maintained at all times to prevent loss/theft, spread of contamination, and other abnormal occurrences involving radioactive sources.

The second facet of the radioactive material control program is the control of radioactive material produced from radiological work processes performed on-site. Any item used in a process that involves known or suspected presence of radioactive contamination or radioactive materials is surveyed prior to release from a radiological area. Items which could contain internal or masked (e.g., painted) contamination will be evaluated prior to release. If the survey indicates the presence of radioactive material on the item, then the item is either decontaminated or disposed of as radioactive waste.

Various types of protective clothing and equipment protect personnel from contamination. Protective clothing is provided for body, head, hand, and foot.

Contamination control equipment is used to prevent or limit the spread of radioactive contamination, and to assist in its removal. The equipment is stored and routinely inventoried in cabinets in or near areas where it is normally used.

Work place radiation monitoring is performed in waste handling areas, in the exhaust of the active disposal room, and at the effluent of the WHB and underground ventilation exhaust with instrumentation as discussed in Section 7.8.

Environmental monitoring is also performed and requires monitoring of air, groundwater, surface water, soils, sediments, and biota to characterize the radiological environment around the WIPP facility. Environmental monitoring is performed in accordance with DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan*.[24] The purpose of radiological environmental monitoring is to measure the radionuclides in the ambient environment media. This allows for a comparison of sample data to results from previous years and to baseline data to determining the impact of the WIPP operations on the surrounding environment. For each sample a chain of custody form is initiated to track and maintain an accurate written record of sample handling and treatment from the time of sample collection through delivery to the laboratory. The results from environmental monitoring are compiled periodically in a site environmental report, the most recent being DOE/WIPP 05-2225, *Waste Isolation Pilot Plant 2004 Site Environmental Report*.[25] Meteorology data from the WIPP meteorological station is also summarized in the site environmental report. The data is used for atmospheric dispersion modeling and used as necessary in the review of environmental radiological data.

7.8 Radiological Protection Instrumentation

The radiological protection instrumentation used by the health physics personnel include:

- Fixed radiation counting instruments (laboratory type)
- Portable radiation/contamination survey instruments
- Airborne radioactivity sampling and monitoring instruments
- Personnel monitoring instruments

Instruments are repaired and calibrated on-site or at off-site calibration facilities. In some cases, specialized instruments may be returned to the manufacturers for repair and calibration. If the instruments have been used in areas where they have the potential to be contaminated, radioactive contamination surveys will be conducted before any maintenance/calibration can start. The use, maintenance, and calibration of radiological protection instrumentation is procedurally controlled.

The radiation instrumentation used at the WIPP is further discussed as follows:

Fixed Radiation Counting Instruments - Fixed radiation counting instruments are located in the counting laboratories and at specific task monitoring stations. These monitoring locations include the RH bay, the hot cell operating gallery, and the transfer cell service room. The instruments in the counting laboratories include gross radioactivity counters and spectrographic systems. These instruments are used to verify radiological conditions are within limits during job coverage and receipt surveys. The instruments possess the sensitivities required for monitoring airborne contamination. Instruments are periodically calibrated using approved procedures and with standard sources, traceable to the National Institute of Standards and Technology (NIST). Instrument response and operation is verified each operating day to verify that the instrument background and calibration have not changed.

When required, samples are prepared for counting in the sample preparation facility. Sample preparation for counting may include evaporation, ashing, partitioning, grinding, chemical separation, or placing samples in containers that conform the sample to a defined geometry.

Portable Radiation Survey Instruments - The portable radiation detection instruments are used to perform radiation and contamination surveys in the field. Portable instruments include alpha contamination detectors, beta contamination detectors, gamma survey meters, and neutron survey meters. Portable gamma dose rate instruments are calibrated in the calibration room using a shielded calibrator and approved procedures. Portable neutron dose rate instruments are sent to a qualified vendor for calibration. Portable contamination instruments are calibrated in the area of the instrument calibration room with NIST traceable sources and approved procedures. Prior to use, these instruments are checked for response with a check source containing a nominal amount of radioactivity. Those instruments that cannot be calibrated at the WIPP are sent to a calibration facility that has been approved by Quality Assurance.

Personnel Monitoring Instruments and Service - The WIPP has a personnel dosimetry program that conforms to the requirements of 10 CFR Part 835.[1] The program is certified by the DOE Laboratory Accreditation Program for Personnel Dosimetry, and is conducted in accordance with WP 12-3.[19] Direct reading dosimeters are used when required by an RWP. These dosimeters are used to keep track of exposure in between TLD readouts. The TLD reading is the record of exposure. Employees who handle waste perform contamination surveys on their clothing and body. In addition, when special operations are conducted, contamination surveys of personnel are performed by or under the direction of a qualified RCT. Portal monitors are placed at the WIPP site security gate to monitor personnel for radiation sources. Bioassay programs are conducted in accordance with WP 12-3.[19]

Calibration of Radiation Survey Instruments - All calibrations of radiological instruments are traceable to NIST or other equivalent recognized standards. The portable dose rate instruments are calibrated with a shielded calibrator that minimizes radiation exposure to the calibration technician. Portable sources are used to calibrate fixed instruments such as CAMs. Accountable sources are checked out and under the direct control of RCTs or qualified individuals during calibration activities in accordance with WP 12-HP3200.[20] Instruments receive periodic electronic calibration using NIST traceable, calibrated electronic sources. Radiation survey instrument calibration records are maintained for the life of the facility.

Airborne Radioactivity Monitoring - Two alpha CAMs and a beta CAM are installed in the underground disposal area at the exit of the active waste emplacement room. The CAMs are in operation in the RH bay at the cask preparation station, in the transfer cell service room, in the cask unloading room, and the facility cask loading room. The CAMs are typically in operation in the underground except when removed from service for maintenance or outage activities. The CAMs continually collect and measure airborne particulates by pulling air through a filter in proximity to an integral beta-gamma and/or alpha spectrometer. The CAMs provide a local and remote readout and alarm in the central monitoring room. Each CAM is set to alarm within the limits in 10 CFR Part 835.[1] Alpha CAMs are sensitive to an energy range of 1 MeV to 10 MeV. The Beta CAM has an energy range rom 80 KeV to 2.5 Mev. The CAMs located in the exhaust of the active disposal room have the capability to divert the underground ventilation exhaust through HEPA filters prior to release to the environment.

FASs are located in the WHB, the exhaust filter building, the support building and the TMF and provide an indication of activities that could be causing releases of airborne radioactivity before they are detected by job coverage air sampling. The FASs are connected to the plant vacuum system and are regulated to approximately 1.0 scfm.

Effluent samplers are installed on the exhaust of the underground at Station A and Station B, in the underground in E-300 before the disposal exhaust joins the exhaust from other areas of the underground, and on the exhaust of the WHB at Station C for determining the presence or absence of airborne particulate radioactivity releases. The effluent samplers flow rate is nominally 1 scfm. The effluent samplers at Station A, B, and C are designed to withstand the effects of the design basis earthquake, and are installed with backup power to allow monitoring in the event of a power failure. The effluent samplers collect periodic confirmatory particulate samples from the total volume of air being discharged. The samplers consist of a sampling probe, a filter holder, and a vacuum supply. Sample locations may have multiple filters to allow parallel sampling for outside agencies. The analysis data from effluent samplers is used for quantifying total airborne particulate radioactivity discharged. This is done to demonstrate compliance with the mandated regulatory requirements contained in 40 CFR Part 191, Subpart A;[4] and 40 CFR Part 61, Subpart H.[5] The counting equipment used to analyze FAS filters provide indication of releases at much lower levels than general area samples or CAMs.

The underground room exit CAMs and effluent samplers are supplied with an uninterruptible power supply in the event of a power outage.

In addition to the permanently installed equipment, portable CAMs and portable air samplers are provided. The portable air samplers and portable CAMs are similar to those installed in waste handling areas. Portable samplers normally are used for sampling routine/nonroutine operations, for emergency air sampling, or to temporarily replace inoperable equipment. The CAMs are calibrated periodically and after repairs, using standards that are traceable to the NIST. The source and detector geometry during calibration are the same as the sample and detector geometry in actual use.

Area Radiation Monitoring Instruments - ARMs are utilized to provide indication of RH waste gamma radiation levels and to verify shielding is operating as expected. An ARM is located in the RH bay at the cask preparation station. The ARM provides a remote indication of dose rates where workers are unbolting the lid in addition to the local dose rate surveys conducted by RCTs prior to the work starting. ARMs are also located in the cask unloading room, transfer cell service room, and the hot cell to provide indication of the radiation levels of the waste being moved through the areas. An ARM is located in the facility cask loading room to verify that the telescoping port shield properly engages on the facility cask as canisters are being pulled up from the transfer cell.

Radiological analysis and sample preparation facilities are located at the Carlsbad Environmental Monitoring and Research Center and in the safety and emergency services building, and in the support building. The dose rate instrument calibration facility is located in the analytical laboratory in the support building. Contamination survey instruments are calibrated in the analytical lab in the support building. The dosimetry laboratory is located in the safety and emergency services building. No other radioactive materials, other than those used for calibration purposes, are permitted in the dosimetry laboratory.

7.9 Radiological Protection Record Keeping

Management of radiological records are maintained in accordance of WP 12-5[7] and WP 15-PR, WIPP Records Management Program.[26] Dosimetry records are maintained as described in WP 12-3.[19]

Individual monitoring records are maintained to demonstrate compliance with the regulatory limits. Radiation dose records contain information sufficient to identify each person. Procedures, data, and supporting information needed to reconfirm a person's dose at a later date are maintained. External dose records includes applicable extremity, skin, lens of the eye, and whole body dose monitoring results. These doses are usually measured with personnel dosimeters, but records may include evaluations resulting from anomalous dose results such as unexpected high or low doses, dose reconstructions from lost or damaged dosimeters, or for unbadged workers, evaluations of nonuniform radiation doses. Internal dose records include committed effective dose equivalent, committed doses to the affected organs and tissues, and identity of radionuclides. The supporting information typically includes applicable whole body and lung counting results (including chest wall thickness measurements where applicable), applicable urine, fecal, and specimen analysis results, including estimated intake. Emergency doses and planned special exposures are accounted for separately, but are maintained with the individual's occupational exposure records.

Records of doses, including zero dose, received by all visitors for whom monitoring was performed is maintained.

Records of the formal written declaration of pregnancy, including the estimated conception date, pregnancy conclusion date, and revocations of declarations of pregnancy are maintained. The dose equivalent to the embryo/fetus of a declared pregnant radiological worker is maintained with the occupational dose records for that worker.

Records include results of monitoring and surveys for radiation and radioactive materials, results of monitoring and calculations used to determine individual occupational doses, results of surveys for release of materials from radiological areas, results of sealed radioactive source leak tests and inventories, results of surveys of radioactive material packages received from transportation.

Personnel records that name an individual are private information and are available only to the employee and to personnel needing them for the performance of their duties. The release of this information to other persons is permitted only upon specific, written approval of the individual or when required by law.

The complete records of radiological incidents and occurrences involving personnel dose is retained in, or cross-referenced to, the individual's dose records. Records related to doses exceeding the Table 2-1 limits including authorized emergency doses and planned special exposures is maintained. Records of authorization to exceed administrative control levels shall be retained.

Medical records are maintained in accordance with industrial safety records requirements. These include the preemployment examinations, physical examinations, fit test results and medical evaluations and treatment performed in support of the radiological control program.

Formal records or summary reports of training and qualification shall be readily available to first-line supervision and management of involved personnel to aid in making work assignments.

The personnel training records are maintained by technical training. Retained records include GET, radiological worker training and refresher or retraining, radiological safety training including instructor training, training of radiological control personnel, respiratory protection training, and training of emergency response personnel. Documentation of completion of radiological orientation is maintained for visitors entering an area where radiation monitoring is required.

Records of the radiological control program, policy statements, procedures, work authorizations, and supporting data are maintained in such a way as to allow correlation with the corresponding support information. Completed RWPs are maintained. Records generated by radiological control procedures are maintained so that the resulting document can be tied back to the governing procedure.

ALARA records are maintained in accordance with WP 12-2.[18]

7.10 Occupational Radiation Exposures

Occupational radiation doses at the WIPP are expected to average about 1.5 person-rem per year. This is based on site radiation exposures for the years 2001 through 2004 which ranged from 1.103 to 2.298 person-rem. Actual collective doses for waste handling operations will vary based on shipments received and dose rates on the waste containers.

Collective occupational doses from waste handling activities at WIPP are estimated at the beginning of each year. These estimates are based on the expected shipping rates from each waste generator, the average container dose rates from those waste generators from the previous years and a collective dose conversion factor. The collective dose conversion factor is based on the previous years' ratio of worker collective dose divided by the sum of waste container dose rates. Management then reviews the projected doses and determines if any intervention is necessary to reduce doses.

References for Chapter 7

1. 10 CFR Part 835, *Occupational Radiation Protection*, January, 1993.

2. DOE-STD-1098-99, *DOE Radiological Control Standard*, July, 1999.

3. DOE G441.1-2, *DOE Occupational ALARA Program Guide*.

4. 40 CFR Part 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes"; Subpart A, "Environmental Standards for Management and Storage."

5. 40 CFR Part 61, "Environmental Protection Agency Regulations on National Emission Standards for Hazardous Air Pollutants"; Subpart H, "National Emission Standard for Radionuclide Emissions from Department of Energy (DOE) Facilities."

6. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, June, 1990.

7. WP 12-5, WIPP Radiation Safety Manual.

8. 10 CFR Part 835, Subpart K, "Design and Control."

9. DOE/WIPP-02-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, 2005.

10. WP 12-2, WIPP ALARA Program Manual.

11. MC 9.4, Radiological ALARA Committee.

12. DOE publication DOE/EV/1830-T5, *A Guide to Reducing Radiation Exposure to as Low as Reasonably Achievable*.

13. DOE Order 6430, *General Design Criteria Manual for Department of Energy Facilities*, June 1981. (Has been superceded)

14. DOE Order O 420.1A, *Facility Safety*, October 1995. (Has been replaced by 420.1B October 2005)

15. DOE Order O 430.1B, *Real Property Asset Management*, September 2003.

16. WP 09-CN3007, Engineering and Design Document Preparation and Change Control.

17. DOE Handbook 1122-99, *Radiological Control Technician Training*.

18. WP 12-9, WIPP Emergency Management Program

19. WP 12-3, Dosimetry Program.

20. WP 12-HP3200, Radioactive Material Control.

21. DOE O 231.1A, *Environment, Safety and Health Reporting*

22. WP 12-IH.02, WIPP Industrial Hygiene Program.

23. ANSI Z88.2-1992, *American National Standard for Respiratory Protection*.

24. DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan*, 2004.

25. DOE/WIPP 05-2225, *Waste Isolation Pilot Plant 2004 Site Environmental Report.*

26. WP 15-PR, WIPP Records Management Program.

27. ANSI/ANS 6.4-1997, *Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants*.

28. ANSI N101.6-1972, *Concrete Radiation Shields*.

29. "Final Results of the WIPP RH TRU Facility Penetration and Shielding Analysis," Radiological Control Position Paper 2002-03.

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8.1 Introduction

The purpose of this chapter is to describe the key elements of the WIPP hazardous material protection program most important to the safety basis. It summarizes provisions for hazardous material protection other than radiological hazards and summarizes the hazardous materials concerns. The elements of this chapter include:

- An overall description of the hazardous material protection policy and program
- A summary of the hazardous material exposure control program
- Information on the hazardous material communication program

8.2 Requirements

The standards, regulations, and DOE Orders required for establishing the safety basis of the facility, specific to the hazardous materials program include the following:

- 29 CFR Parts 1900-1999, Occupational Safety and Health Act[1]
- 29 CFR Parts 1926.1, "Safety and Health Regulations for Construction"[2]
- 10 CFR Part 850, "Chronic Beryllium Disease Prevention Program"[3]
- DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*[4]
- DOE Order 450.1A, *Environmental Protection Program*[5]
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*[6]

8.3 Hazardous Material Protection and Organization

Hazardous material protection is an integral part of the WIPP industrial safety program (WP 12-IS.01-1, Industrial Safety Program - Structure and Management),[7] and WP 12-IH.02, WIPP Industrial Hygiene Program Manual - Overview.[9] The organization responsible for implementation is the WIPP Industrial Safety and Hygiene (IS&H) section. Implementation of the defined program elements controls occupational health hazards originating from chemical, biological, and physical (excluding ionizing radiation) agents. WP 12-IH.02-4, Hazard Communication & Hazardous Material Management Plan[10] is used to control the acquisition (requisition and procurement), use, handling, and storage of non-radiological waste hazardous materials and chemicals. Protection of personnel from radiological material falls under the radiation protection program discussed in Chapter 7 of this documented safety analysis (DSA).

The hazardous material program is established to protect human health and the environment by controlling chemical hazards. This program defines the scope of chemical covered and provides direction and references to analyze the hazards that are inherent in their storage and use. It describes the processes and systems used for self-performed work and by subcontractors for their activities to control chemical hazards to protect personnel, the public, and the environment.

The organizational structure and responsibilities delegated by the WTS General Manager for IS&H is discussed in Chapter 17 of this DSA. In addition, the following functions are assigned to IS&H:

- Chemical safety
- Industrial hygiene
- Fire prevention, protection, and control
- Medical examinations, diagnosis, treatment, and preventive medicine
- Safety training

WP 12-IH.02[9] identifies the qualifications and positions of authority and responsibilities of the IS&H organization. IS&H liaisons with other safety organizations, and facility operations is discussed in WP 12-IH.02.[9]

8.4 ALARA Policy and Program

The hazardous materials exposure control program at the WIPP seeks to ensure that employee exposures to hazardous materials are minimized and maintained beneath levels of regulatory toxicological concern. The as low as reasonably achievable (ALARA) program (WIPP ALARA Program Manual, WP 12-2)[11] ensures that employee exposure to radioactive material is ALARA. The programs evaluate potential hazards for radioactive, chemical, physical, and biological agents and ergonomic stressors using DOE requirements, and Occupational Safety and Health Act (OSHA),[1] National Institute for Safety and Health, and U.S. Environmental Protection Agency (EPA) exposure assessment methodologies. The following controls are used to keep the hazardous materials exposures ALARA:

- Using approved and controlled procedures that provide administrative or engineering controls that minimize or eliminate exposure to hazardous materials
- Furnishing employees the necessary personal protective equipment (PPE) and training on the proper use of PPE
- Training employees to recognize potential hazards, take safety precautions, understand consequences of an accident, and know the actions to take in case of an accident
- Monitoring the work environment to obtain personnel and area exposure data
- Reviewing and approving all chemical use and storage at the WIPP
- Maintaining Material Safety Data Sheets (MSDSs)

8.5 Hazardous Material Training

WP 12-IH.02-4[10] requires hazards communication training be provided to the WIPP personnel through the General Employee Training (GET) and GET refresher instructions. This training covers the topics required by 29 CFR §1910.1200, "Hazard Communication,"[12] as well as site-specific policies and procedures, including access to on-line MSDS databases. Information about new site hazards and changes in applicable policies or procedures is provided to employees in the annual GET refresher training.

Personnel who sample for hazardous constituents or who are responsible for management of hazardous waste receive training as a hazardous waste worker. Sampling personnel also must complete a qualification card.

Job-specific hazard communication training for chemical hazards is provided through pre-job briefings and on-the-job instruction involving management and employees.

8.6 Hazardous Material Exposure Control

WP 12-IH.02[9] encompasses the comprehensive aspects of industrial hygiene defined by DOE Order 440.1A,[4] excluding ionizing radiation, physical safety, fire prevention, medical examinations, and formal training, which are addressed by other industrial hygiene programs. Hazardous materials and chemicals are controlled through a combination of engineered controls, administrative controls, and PPE.

WP 12-IH.02[9] protects the WIPP workers by anticipating, recognizing, evaluating, and controlling chemical, physical, biological, and ergonomic factors and/or stressors in the workplace. The permissible exposure limits used in hazard evaluation and hazard communication shall not exceed those in the mandatory standards of DOE Order 440.1A.[4]

Industrial Safety and Health personnel conduct surveys to ensure the adequacy of controls to ensure adequacy of controls. Procedures provide guidance for on-site handling and disposal of waste materials, including chemically contaminated waste, personnel monitoring when necessary or requested, establish PPE requirements, and job site sampling and monitoring when required.

WP 12-IH.02-9, WIPP Industrial Hygiene Program - Beryllium Exposure Prevention Program,[8] has been developed as some of the TRU waste forms being disposed of at the WIPP include beryllium. No activities at WIPP involve direct handling of beryllium as part of normal operations. The program identifies the controls necessary for worker protection from beryllium in the event that a waste container is breached. In general, since beryllium may be in the waste, the controls that provide radiological protection also provide protection from beryllium.

8.6.1 Hazardous Material Identification Program

WP 12-IH.02,[9] and implementing procedures, ensure the proper management of material hazards by establishing procedural and programmatic controls for hazardous materials procurement. Restricted materials are identified that require written IS&H/Site Environmental Compliance management approval prior to purchase. Receipt inspection is conducted as appropriate to ensure control of hazardous materials throughout the site. Chemicals purchased for use are reviewed for their associated hazards. Where feasible, less hazardous materials are selected. Once received, hazardous materials are inventoried and traced until they are used or disposed. A Hazardous Materials Area Representative (HMAR) maintains inventory lists of the hazardous materials used in areas of their responsibility. An MSDS is maintained for each chemical. The MSDS provides chemical-specific information including chemical name, manufacturer, physical properties, chemical properties, reactivity, and fire suppression information.

Workers are trained annually through GET in the ways to obtain MSDS information, including paper or electronic copies, and how to interpret them. Employees receive annual Hazardous Waste Worker if handling hazardous chemicals is specific to their work assignment. Workers also receive information specific to the hazards and conditions of their specific work area.

When work is to be performed by a subcontractor, the subcontractor's safety and health program is required by WP 12-IH.02-4[10] to address hazardous and toxic materials brought on-site by the contractor. The subcontractor must provide MSDSs for these chemicals, and the chemicals are entered into a centralized list.

8.6.2 Administrative Limits

The industrial hygiene monitoring program for evaluating employee exposures to potential chemical, physical, biological, and ergonomic health hazards ensures that the personnel exposure to hazardous material does not exceed those in the mandatory standards in DOE Order 440.1A.[4]

8.6.3 Occupational Medical Programs

The occupational medical site personnel, as defined in WP 15-HS.02, Occupational Health Program Plan,[13] work in cooperation with other WIPP site organizations to optimize the maintenance of a healthful work environment. Preemployment, periodic, return-to-work, and termination health examinations are coordinated through the WIPP Human Resources Department. Diagnosis and treatment of occupational injuries and illnesses are coordinated with the WIPP organizations where these incidents may occur. Health maintenance and preventive medical activities are coordinated with IS&H.

As part of the program, the WIPP employs a part time occupational medical physician. The physician is assisted by an on-site occupational health nurse and emergency service technicians. The emergency service technicians provide 24-hour emergency medical coverage on the site.

The occupational medical program is designed to accomplish the following:

- Ensure the health and safety of employees in their work environments, through the application of occupational health principles.
- Determine the physical fitness of employees to perform job assignments without undue hazard to themselves, fellow employees, or the public at large.
- Ensure the early detection and treatment of employee occupational illness, or injuries, by means of scheduled periodic health evaluations and a wellness awareness program.
- Provide employees, as appropriate, with medical evaluations, guidance, counseling, and referrals to specialists in support of physical and mental health. This includes assisting the Occupational Medical Director as defined in WP 15-HS.02[13] with the planning, implementation, and administration of the Employee Assistance Program and the Alcohol/Substance Abuse Rehabilitation Program.
- Maintain confidentiality of employee medical records.
- Maintain employee exposure and medical records in accordance with 29 CFR §1910.1020, "Access to Employee Exposure Medical Records,"[14] and document exposures to hazardous chemicals

8.6.4 Respiratory Protection

WP 12-IH.02[9] defines the WIPP respiratory protection program as part of the WIPP's Integrated Safety Management Program (MP 1.28, Integrated Safety Management).[15] WP-IH.02-6, Respiratory Protection,[16] specifies the program responsibilities, training and qualification requirements for respirator wearers and managers, and the requirements for selection and issuance of respirators. The program provides compliance with OSHA and MSHA respiratory protection regulations. Training is provided before initial use and every subsequent year for general respiratory use. Elements of the respiratory protection program required for radiological protection include the following:

- Explanation of why respiratory protection is required
- Nature, extent, and effects of respiratory hazards in the workplace
- Explanation of available engineering and administrative controls
- Explanation of why a particular type of respirator has been selected for a specific respiratory hazard
- Description of hazards typically encountered and the respiratory equipment provided for the individual's job category
- Explanation of the operations, capabilities, and limitations of the respirator selected
- Instruction and individual participation in inspecting, donning, performing a user seal check, wearing, and doffing a respirator
- Instruction in proper issuance of respirators
- Maintenance and storage of respirators
- Instruction for verifying that the labeling and color-coding of filtering media are correct
- Instruction in proper disposal of the facepiece and cartridges
- Instruction in how to recognize and cope with emergencies
- As applicable, instruction for special respirator use (e.g., in emergency procedures, and the use of emergency escape devices, special respirators and air suits)
- Regulations concerning respirator use
- Importance of respirator wearers informing supervisors of any problems experiened by them or their coworkers while wearing respirators
- The need for a successful completion of a fit-test

8.7 Hazardous Material Monitoring

DOE Order 450.1[5] requires each DOE site to conduct environmental sampling and monitoring to prevent the spread of hazardous materials both internal and external to the facility. DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan,*[17] implements this Order at the WIPP site. The internal monitoring program, includes controls for hazardous chemicals/materials. Hazardous materials and chemicals are controlled through procedures addressing inventory control, material screening, material accountability, and labeling. Environmental monitoring is conducted throughout the year and the analytical data is reported in the annual site environmental reports (current report is DOE/WIPP 05-2225, *Waste Isolation Pilot Plant 2004 Annual Site Environmental Report*).[18]

8.7.1 Volatile Organic Compound Monitoring

The airborne emission of volatile organic compounds (VOCs) is the only credible release pathway from the WIPP during disposal operations, and the final closure design basis requires this pathway to be eliminated upon final closure.

A baseline VOC monitoring program was conducted at the WIPP and the results of the baseline program were used, in part, to define the confirmatory monitoring program for the disposal phase. VOC monitoring will be conducted throughout the disposal phase of operations to determine VOC concentrations attributed to open and closed panels. WP 12–VC. 02, Quality Assurance Project Plan for Confirmatory Volatile Organic Compound Monitoring,[19] describes a sampling and analysis program to confirm the theoretical calculations. The VOC monitoring program quantifies VOC concentrations in the ambient mine air at the WIPP and addresses the following elements:

1. Rationale for the design of the monitoring program, based on:
   - Possible airborne pathways from the WIPP during the active life of the facility.
   - VOC sampling operations at the WIPP.
   - Optimum location of the ambient mine air monitoring stations to confirm theoretical calculations.
2. Descriptions of the specific elements of the monitoring program including:
   - The type of monitoring conducted.
   - The location of the monitoring stations
   - The monitoring frequency
   - The specific hazardous constituents monitored
   - The implementation schedule for the monitoring program
   - The equipment used at the monitoring stations
   - The sampling and analytical techniques used
   - Data recording and reporting procedures

Sampling in the underground for target VOC compounds, as listed in Table 8.1, takes place at two locations designated as air monitoring stations VOC-A and VOC-B. VOC-B samples for VOCs in the upstream sources (inlet ventilation air to TRU waste disposal panels) and VOC-A samples the underground exhaust air which is the total of VOCs from upstream sources plus any VOC releases from emplaced TRU waste. Confirmatory VOC sampling began with initial RH waste emplacement in future Panels. Some sampling, however, was conducted prior to waste disposal to evaluate the monitoring system. For each quantified target VOC, the concentrations measured at Station VOC-B are subtracted from the concentrations measured at Station VOC-A to assess the magnitude of VOC releases, if any, from the emplaced waste.

Table 8-1 lists the maximum public exposure concentration at the site boundary from VOC air emissions from both the WHB and the underground. As shown in the table, the total risk from contributions from all nine VOC emissions is considerably less than the acceptable risk level.

Monitoring is performed using pressurized sample collection in stainless steel canisters described in the EPA Compendium Method TO-14A, *Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas*.[20] The TO-14A[20] sampling concept uses six-liter passivated stainless-steel canisters to collect integrated air samples at each sample location. This conceptual method is used as a reference for collecting the samples at the WIPP.

The VOC monitoring program is run under WP 12–VC. 02,[19] that has been prepared in accordance with *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, EPA QA/R-5.[21] Quality criteria for the target analytes are presented in Attachment N of Hazardous Waste Facility Permit.[22] Definitions of the criteria are given in Attachment N, along with a discussion of other aspects of the quality assurance program, including sample handling, calibration, analytical procedures, data reduction, validation and reporting, performance and system audits, preventive maintenance, and corrective actions.

8.7.2 Meteorological Monitoring

The meteorological monitoring program at the WIPP is performed in accordance with WP 02-EM.01, WIPP Meteorological Quality Assurance Plan,[23] which was written using guidance contained in EPA-454/R-99-005, *Meteorological Monitoring Guidance for Regulatory Modeling Applications*.[24] Meteorological data is monitored and recorded to supplement characterization of the local environment and facilitate the interpretation of data from other environmental monitoring activities at the WIPP.

8.7.3 Nonradioactive Air Contaminants Monitoring

WP 12-IH.02-1, WIPP IH Program - Hazard Assessment,[25] implements the WIPP air quality monitoring program. To ensure compliance with American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLV), administrative or engineering controls are determined and implemented whenever possible. When such conditions are not feasible to achieve full compliance, protective equipment and/or protective measures are used to keep employee exposures to air contaminants within prescribed limits. Any equipment and/or technical measures used must be approved by IS&H personnel.

8.7.4 Diesel Emissions Monitoring

Vehicle emissions of underground equipment are periodically monitored in accordance with WP 12-IH.02[9] to assure the health and safety of personnel. Incomplete combustion of diesel fuels causes contaminants of carbon monoxide, carbon dioxide, and nitrogen dioxide. The air in the underground is periodically monitored for these contaminants, to ensure compliance within TLV limits. Vehicles are checked for carbon monoxide and nitrogen dioxide emissions after preventive maintenance checks and during scheduled overview inspections.

8.7.5 Workplace Monitoring

Periodic and unscheduled surveys and inspections are performed by IS&H in accordance with WP 12-IH.02[9] to identify any actual or potential hazards, problems, or undesirable conditions that could adversely impact facility workers in the workplace. Examples of items surveyed are drinking water potability; local exhaust ventilation systems; and chemical, physical, and biological hazards. Sampling of the environment involves calibration of equipment, actual sampling, and recording the results in terms of the actual impact to the worker.

8.8 Hazardous Material Protection Instrumentation

WP 12-IH1006, Airborne Contaminant Sampling,[26] details methods used for collection of airborne contaminant samples to determine employee exposure. Industrial Hygiene has the responsibility to sample airborne contaminants. When necessary, IS&H monitors or tests the air in areas where hazardous chemicals are stored, and in areas where workers may be exposed to concentrations of airborne fumes, mists, or vapors. Surveys are recorded; records contain the location, time, job description, or occurrences that may be associated with the contaminants and instruments used. Chemical inventories, reports and monitoring data are available to Health Services personnel for use in the medical monitoring program.

In the underground, airborne concentrations of mists, fumes, or vapors are monitored and sampled as needed, or upon request, by suitable devices such as Draeger pumps or other portable direct reading instruments. If relevant air concentrations are found in excess of the TLVs, immediate corrective actions will be taken as determined by IS&H, and the air will be periodically tested until in compliance.

Air quality monitoring equipment is calibrated in accordance with manufacturers' recommendations, with an accurate record kept of pre-calibration conditions of the instrument. Functional tests are performed daily. Competency of individuals required to use air monitoring equipment is verified. Functional testing competency requires a formal training program. The selection and placement criteria for technical equipment, types of detectors, and monitors are determined by Industrial Hygiene as defined in WP 12-IH1006.[26] Chapter 10 of this DSA discusses the procedure for the control and calibration of test equipment, the functional testing programs and the maintenance programs for technical equipment.

8.9 Hazardous Material Protection Record Keeping

WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description,[27] defines record keeping requirements at the WIPP. Records are specified, prepared, reviewed, approved, controlled, and maintained to accurately reflect completed work and facility conditions and to comply with statutory or contractual requirements. WP 15-PR3002, Records, Filing, Inventorying, Scheduling, and Dispositioning,[28] and associated procedures ensure that records are reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the locations where required.

Hazardous materials inventories will be initiated by IS&H and conducted by the HMAR designated by the responsible manager for the area in which the hazardous materials are to be stored and used. A quarterly inventory report will be prepared by IS&H based on input from HMARs from each affected area. The information is then used by Site Environmental Compliance to develop an annual inventory report to satisfy federal environmental reporting requirements.

8.10 Hazard Communication Program

The requirements for hazard communication are set forth in 29 CFR §1910.1200.[12] The WIPP hazard communication program is defined in detail in WP 12-IH.02.[9] Section 8.6.1 of this chapter and discusses hazard communication training for all employees and subcontractors.

The *OSHA Hazard Communication Standard* applies to hazardous chemicals procured and generated in the workplace and/or laboratories; consumer products used in janitorial activities; and pure chemicals associated with the treatment, storage, and disposal at RCRA facilities.[12]

Training on the *OSHA Hazard Communication Standard* is a requirement of all personnel who work with or enter areas where hazardous materials are used. Training of employees is discussed further in Chapter 10 of this DSA.

8.11 Occupational Chemical Exposures

The primary occupational, nonradiological hazard to both the worker and the public during normal operations is from the airborne release of diesel fuel exhaust. Occupational exposures to VOCs and other hazardous materials at the WIPP site do not constitute a concern. Monitoring results for VOCs are discussed in Section 8.7.1 of this chapter.

References for Chapter 8

1. 29 CFR Parts 1900-1999, Occupational Safety and Health Act, July 2004.
2. 29 CFR Part 1926.1, "Safety and Health Regulations for Construction," July 2004.
3. 10 CFR Part 850, "Chronic Beryllium Disease Prevention Program"
4. DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, March 1998.
5. DOE Order 450.1, Change 1, *Environmental Protection Program*, January 2005.
6. DOE Order 5480.4, Change 4, *Environmental Protection, Safety, and Health Protection Standards*, January 1993.
7. WP 12-IS.01-1, Industrial Safety Program - Structure and Management.
8. WP 12-IH.02-9, WIPP Industrial Hygiene Program - Beryllium Exposure Prevention Program
9. WP 12-IH.02, WIPP Industrial Industrial Hygiene Program Manual - Overview.
10. WP 12-IH.02-4, Hazard Communication & Hazardous Material Management Plan.
11. WP 12-2, WIPP ALARA Program Manual.
12. 29 CFR §1910.1200, "Hazard Communications," July 2004.
13. WP 15-HS.02, Occupational Health Program Plan.
14. 29 CFR §1910.1020, "Access to Employee Exposure Medical Records," July 2004.
15. MP 1.28, Integrated Safety Management.
16. WP 12-IH.02-6, Respiratory Protection.
17. DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan*.
18. DOE/WIPP 05-2225, *Waste Isolation Pilot Plant 2004 Annual Site Environmental Report*.
19. WP 12-VC.02, Quality Assurance Project Plan for Confirmatory Volatile Organic Compound Monitoring.
20. TO-14A, *Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas*.
21. EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans*, Washington, DC, 1994.
22. Hazardous Waste Facility Permit No. NM4890139088-TSDF, issued by the New Mexico Environment Department.

23. WP 02-EM.01, WIPP Meteorological Quality Assurance Plan.

24. EPA-454/R-99-005, *Meteorological Monitoring Guidance for Regulatory Modeling Applications*, U.S. Environmental Protection Agency, Washington, DC, 2000.

25. WP 12-IH.02-1, WIPP IH Program - Hazard Assessment.

26. WP 12-IH1006, Airborne Contaminant Sampling.

27. WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.

28. WP 15-PR3002, Records, Filing, Inventorying, Scheduling, and Dispositioning.

Table 8-1, Maximum Occupational and Public Exposure From Underground Waste VOC Emissions

Indicator Volatile Organic Compounds	Worker Receptor Concentration (ppmv)		Applicable Exposure Standard ACGIH TLV[c] (ppmv)	Estimated Risk for Carcinogens and Hazard Quotients for Non-Carcinogens for Public Exposure to Waste Emissions	Acceptable Level of Risk [e]
	Surface	Underground			
Carbon Tetrachloride	3.0E-04	1.2E-02	10	3E-08	1E-06
Chlorobenezene [a]	6.9E-04	2.9E-02	75	4E-06[d]	1
Chloroform	2.7E-04	1.0E-02	50[b]	2E-09	1E-06
1,1-Dichloroethylene	1.2E-03	4.7E-02	5	2E-09	1E-05
1,2-Dichloroethane	3.8E-04	1.5E-01	50	8E-10	1E-06
Methylene Chloride	4.5E-03	1.6E-02	25	6E-10	1E-06
1,1,2,2-Tetrachloroethane	3.2E-04	1.3E-02	5	3E-09	1E-05
Toluene [a]	1.6E-03	6.7E-02	200	3E-07[d]	1
1,1,1-Trichloroethane	4.0E-03	1.6E-01	350	2E-08	1E-05

a. Non-carcinogen (all others are class B2 or C carcinogens)
b. Ceiling value limit not to be exceeded
c. Equivalent to or less than applicable OSHA PEL
d. Non-carcinogen hazard quotient
e. Acceptable level of risk for carcinogens is the probability of developing cancer, and for non-carcinogens is a hazard quotient less than or equal to 1

RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

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RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 Introduction

This chapter provides information on the site-derived radioactive waste and site-generated nonradioactive hazardous waste. Included is information on (1) identification and sources of the site waste streams, (2) waste management process, and (3) waste sources and characteristics.

The Waste Isolation Pilot Plant (WIPP) was designed and built to dispose of transuranic (TRU) waste generated by the defense-related activities of the U.S. Government. Maintenance and operations of the facilities and equipment used in the waste handling processes generate waste. Chapter 2 provides the RH waste handling facility and process description, while Chapter 3 provides the hazard identification of the RH waste shipped to the WIPP.

9.2 Requirements

The following regulations form the basis of the WIPP site-derived radioactive waste and site-generated hazardous waste management program:

- WIPP Hazardous Waste Facility Permit (HWFP) No. NM4890139088-TSDF.[1]
- 10 CFR Part 835, "Occupational Radiation Protection."[2]
- 29 CFR §1910.120, "Hazardous Materials Operations and Emergency Response," Subpart H, "Hazardous Materials."[3]
- 40 CFR Parts 260-268 and 273, U.S. Environmental Protection Agency regulations implementing the Resource Conservation and Recovery Act (RCRA).[4]
- 40 CFR Part 273, "Universal Waste."[5]
- 20.4.1 NMAC (New Mexico Administrative Codes), "Hazardous Waste Management.[6]
- DOE Order 435.1, *Radioactive Waste Management*.[7]
- DOE Order 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*.[8]
- DOE Order 450.1, *Environmental Protection Program*.[9]
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.[10]

9.3 Radioactive and Hazardous Waste Management Program and Organization

The Waste Handling Operations organization is responsible for the management and disposal of waste derived from the waste handling process; maintenance/operations of the waste handling facilities, as described in Chapter 2; and from decontamination performed in the RH waste handling facilities or equipment. Any waste derived from the described activities is managed using WP 05-WH1036, Site-Derived Mixed Waste Handling,[11] which implements the waste management and disposal requirements of the HWFP.[1]

The WIPP hazardous waste management program (HWMP) is used for site-generated hazardous waste. The HWMP is delineated in WP 02-RC.01, Hazardous and Universal Waste Management Plan.[12] Site Environmental Compliance (SEC) administers the HWMP at the WIPP. The managers of the departments generating the hazardous waste are responsible for controlling and managing the hazardous waste generated by their organization. Quality Assurance is responsible for the evaluation of disposal facilities for inclusion into the Quality Supplier's List and oversight of site waste management activities. Operations is responsible for transferring hazardous waste to designated storage or disposal areas, marking the waste containers as directed by HWMP, and assisting in the packaging of waste for transport. Industrial Safety is responsible for providing employees involved in the management of hazardous waste with information on hazardous properties, safe handling of the waste, and identifying the appropriate personal protective equipment for handling hazardous waste. Shipping Coordination is responsible for providing appropriate waste containers, packaging waste in preparation for shipment to a permitted Treatment Storage Disposal Facility (TSDF), and coordinating hazardous waste shipments to a TSDF as specified in 40 CFR Part 262.[4]

9.4 Radioactive and Hazardous Waste Streams and Sources

The primary waste streams at the WIPP site are:

- Waste shipped to the WIPP for disposal.
- Site-derived radioactive waste generated from radiological activities (swiping and decontaminating) involving the waste containers and waste handling equipment and facilities.
- Site-generated nonradioactive hazardous waste.

The principal operations at the WIPP site involve the receipt of waste from generator sites, and disposal of that waste. The RH waste received for disposal at the WIPP must meet the requirements of DOE/WIPP-22-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant[13], referred to in this documented safety analysis (DSA) as the RH WAC, before shipment. The RH WAC identifies the waste acceptance criteria applicable to the transportation, storage, and disposal of RH waste at the WIPP site. Any RH waste shipped from a generator site to the WIPP must comply with the RH WAC.[13] Chapter 2 of this DSA provides the description of the RH waste handling facility and equipment, and Chapter 3 identifies the hazards of RH waste.

Site-generated nonradioactive hazardous waste typically includes absorbed liquids from spills, and waste generated from the maintenance and operations of the non-waste handling WIPP facilities, which typically includes oils, coolants, solvents, batteries, and other solid wastes.

There are no gaseous waste streams at the WIPP.

9.4.1 Waste Management Process

The Waste Isolation Pilot Plant Pollution Prevention Program Plan (WP 02-EC.11)[15] implements the requirements of DOE Order 450.1.[9] The plan allows some of the site-generated hazardous waste such as batteries, and used oils and solvents to be recycled, which removes those items from the waste stream. The site-generated hazardous waste not recycled is accumulated in a satellite accumulation area where it is managed in accordance with WP 02-RC3109, Satellite Accumulation Area, Hazardous Waste Storage Area, and Universal Waste Storage Area Inspections,[16] which implements requirements of 40 CFR Part 273,[5] 20.4.1 NMAC,[6] and 40 CFR §262.34, "Accumulation Time."[17] The waste disposal process is initiated by using WP 02-RC3108, Request for Disposal,[18] to start the disposal process for all waste except those managed by WP 02-EC.11.[15] Completion of the disposal process is accomplished by the SEC using WP 08-NT3103, Shipment of Waste.[19]

9.4.2 Waste Sources and Characteristics

The WIPP is a permitted[1] hazardous waste disposal facility of RH waste generated by the defense related activities of the U.S. Government. RH waste handling is accomplished in the RH bay and hot cell complex in the RH portion of the WHB. Any waste derived from waste handling is managed and disposed of in accordance with WP 05-WH1036.[11] RH waste disposed of at the WIPP contains solids and very little liquids in compliance with the RH WAC.[13] Gaseous wastes are not allowed in the RH waste shipped to the WIPP.

The site-generated hazardous waste does not come from a particular process, it is generated during the performance of maintenance and operations of non-waste handling facilities and equipment. Safe storage of site-generated hazardous waste and associated hazards are administered by the performance of WP 02-RC.01,[12] WP 02-RC3109,[16] and WP 12-IH.02-4, WIPP Industrial Hygiene Program - Hazard Communication & Hazardous Materials Management Plan.[20]

9.4.3 Waste Handling or Treatment Systems

The WIPP is not a permitted treatment facility and does not treat site-generated hazardous waste. Site-derived waste may include, but is not limited to materials contaminated with TRU mixed-waste that has been characterized for disposal at the WIPP. Site-derived waste is characterized by process knowledge, and/or spill response activities and disposed of in accordance with the requirements of the CH WAC[21] and the HWFP.[1]

References for Chapter 9

1 Hazardous Waste Facility Permit No. NM4890139088-TSDF, as amended, issued by the New Mexico Environment Department, October 27, 1999.

2 10 CFR Part 835, "Occupational Radiation Protection," February 2002.

3 29 CFR §1910.120, "Hazardous Materials Operations and Emergency Response, Subpart H, Hazardous Materials," March 2005.

4 40 CFR Part 260-268 and 273, U.S. Environmental Protection Agency regulations implementing the Resource Conservation and Recovery Act.

5 40 CFR Part 273, "Universal Waste."

6 20.4.1 NMAC, "Hazardous Waste Management."

7 DOE Order 435.1, Change 1, *Radioactive Waste Management.*

8 DOE Order 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*.

9 DOE Order 450.1, Change 1, *Environmental Protection Program*.

10 DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, January 7, 1993.

11 WP 05-WH1036, Site-Derived Mixed Waste Handling.

12 WP 02-RC.01, Hazardous and Universal Waste Management Plan.

13 DOE/WIPP-*22-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, 2005.

14 63 *Federal Register* 35384, *Disposal of Polychlorinated Biphenyls [PCBs]: Final Rule*, U.S. Environmental Protection Agency.

15 WP 02-EC.11, Waste Isolation Pilot Plant Pollution Prevention Program Plan.

16 WP 02-RC3109, Satellite Accumulation Area, Hazardous Waste Storage and Universal Waste Storage Area Inspections.

17 40 CFR 262.34, Standards Applicable to Generators of Hazardous Waste, Accumulation Time, July 2004.

18 WP 02-RC3108, Request for Disposal, Rev. 5, October 2004.

19 WP 08-NT3103, Shipment of Waste, Rev. 4, September 2004.

20 WP 12-IH.02-4, WIPP Industrial Hygiene Program - Hazard Communication & Hazardous Materials Management Plan, Rev. 2, August 2004.

21 DOE/WIPP-02-3122, *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant.*

INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

10.1 Introduction

The purpose of this chapter is to describe the key elements of the program under which initial testing, in-service surveillance and maintenance activities at the Waste Isolation Pilot Plant (WIPP) facility are conducted. This chapter presents information demonstrating that testing is performed to ensure that the tested structures, systems, and components (SSCs) meet their functional and performance requirements such that the SSC has reasonable assurance of fulfilling its normal and safety functions described in this Documented Safety Analysis (DSA).

The key attributes of the WIPP initial testing, in-service surveillance and maintenance activities are:

- The initial testing of specified items, services and processes is controlled through procedures that address the implementation requirements for the initial testing program
- The in-service surveillance program assures testing, calibration, or inspection requirements are applied to operational equipment, safety class and safety significant SSCs, and design features to maintain operation of the facility as specified in this DSA.
- The maintenance program ensures that maintenance activities are conducted to preserve and restore the availability, operability, and reliability of plant SSCs and design features important to operation of the facility

10.2 Requirements

The standards, regulations, and U.S. Department of Energy (DOE) Orders required for establishing the initial testing, in-service surveillance and maintenance at the WIPP are provided in:

- DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*[1]
- DOE Order 430.1B, *Real Property Asset Management*[2]
- DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*[3]
- DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*[4]
- DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*[5]
- DOE Order 420.1A, *Facility Safety*[6]

10.3 Initial Testing Program

Testing of the WIPP SSCs is required by the WIPP's System Design Description General Plant Design Description [7] and WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.[8] The WIPP initial testing program is a process that verifies and document the operation of permanent plant installed SSCs according to specifications and/or other site approved design basis documents. Initial testing overlaps with other areas of safety management. The procurement, receipt, and testing of equipment for a new or modified facility prior to service is controlled. Procedures address the requirements for the initial testing program including; identification of item functional requirements and characteristics, item acceptance, and satisfactory performance testing. A review process ensures that organizational, functional, and administrative controls are in place for initial startup of systems and/or operations.

10.3.1 Start-Up Testing

The WIPP Start-Up Test Program, WP 09-SU.01,[9] establishes administrative controls to verify and document that SSCs required for safe operation of the WIPP facility meet established design criteria and functional requirements of approved test procedures. A start-up test may be a formal start-up test, an acceptance test, or a postmodification retest. Start-up tests/retests will be reviewed and approved by a qualified start-up test engineer (STE). WP 09-SU.01[9] specifies the qualifications and responsibilities of STEs.

When a formal start-up test is required, it will be written in accordance with WP 15-PS.2, Technical Procedure Writer's Guide,[10] and processed in accordance with WP 15-PS3002, WID Controlled Document Processing.[11]

Start-up tests document SSC performance and operability as installed at the WIPP; and ensure that any deviations from design requirements are reviewed for acceptability prior to relying on the SSC. Start-up tests may include testing documentation from the manufacturer or elsewhere, that demonstrates the SSC meets system design requirements.

Start-up/postmodification tests/retests are specifically written to test the subject SSC to the engineering and design specifications, which will be documented by the cognizant system engineer in the test/retest section of the modification work order per the requirements of WP 09-SU.01,[9] and WP 10-2, Maintenance Operations Instruction Manual.[12] The following criteria is used to determine the requirement for start-up/postmodification testing at the WIPP:

- Functional Classification of SSCs (Safety Class, Safety Significant, or Defense in Depth)
- SSCs described in the RH DSA
- SSCs that confine or measure the release of radioactive material
- SSCs used for the handling and/or storage of transuranic waste
- SSCs designed to ensure personnel or environmental safety
- SSCs designed to ensure the physical security of the WIPP facility

10.3.2 Modification Testing

STEs review and approve the test/retest section of modification work orders in accordance with WP 10-WC3011, Maintenance Process.[13] Test results are documented and conformance with acceptance criteria evaluated/approved by a STE to ensure that test requirements have been satisfied. STEs determine wether adequate start-up testing for new or modified designs is accomplished by the test/retest section of a modification work order. SSCs that have undergone prior start-up testing may be retested with the test/retest section of the implementing modification work order. SSC modifications are tested in the same manner as the original design. Implementation of modifications/changes, including retesting, are accomplished by approved and current procedures.

10.3.3 Preoperational Testing

Prior to initiating waste handling activities on each shift, waste handling equipment is operationally tested. Preoperational testing determines if equipment needs maintenance or if it is operationally ready to perform its waste handling task.

Another type of preoperational testing is that which demonstrates the waste handling process from receipt through final emplacement is conducted to demonstrate that operating personnel can safely handle waste packages, demonstrate the satisfactory operation of the WIPP waste handling equipment, and demonstrate that the operating procedures are sufficiently detailed to perform normal waste handling operations, and to recover from off-normal occurrences encountered during waste handling operations. This type of preoperational testing is typically conducted prior to and during readiness reviews.

10.4 In-Service Surveillance Program

In-service surveillance testing and calibration is performed in accordance with approved procedures and is conducted in accordance with established schedules. In-service testing and calibration is applied to operational equipment, safety class and safety significant SSCs, and to design features as credited in this DSA. In-service testing and calibration ensures safe and reliable operation of the equipment important to safety.

In-service surveillance is also performed by implementation of WP 04-CO, Conduct of Operations[14] which describes the development and use of Round Inspection Sheets that identify equipment to be monitored. Operators use the round sheets to record key equipment parameters including when equipment parameters exceed maximum/minimum values. Supervisory personnel review the round sheet data including a review for adverse trends. Identified trends are evaluated to determine if immediate corrective action is required and appropriate cognizant personnel are informed of the trend to identify if other actions are required.

10.4.1 Surveillance Test Equipment and Results Trending

The WIPP procedure WP 10-AD3028, Calibration and Control of Measurement and Test Equipment,[15] is used for the control and calibration of measuring and test equipment (M&TE) used in performing in-service surveillance testing and calibration. Procedure WP 10-WC3011[13] provides instructions for trending of historical data obtained from surveillance tests and other maintenance activities.

10.4.2 Programmatic Review

If deficiencies are identified during an in-service surveillance, inspection, or test, an Action Request form (maintenance work order) is prepared in accordance with WP 10-2.[12]

10.4.3 Training of Personnel Who Perform Surveillance Testing or Maintenance

The managers of personnel performing surveillance testing have the overall responsibility and authority for the content and effective conduct of the training and qualification program(s) within their organization. Managers training responsibilities are:

- Define training and qualification requirements for personnel in each functional level.
- Review and approve training program content.
- Review and update qualification and training programs biennially to reflect changes to the facility, procedures, regulations, and applicable industry operating experience, and document the review in writing to Technical Training.

- Define specific job positions that have a direct impact on employee, facility, or public safety and require a systematic approach to training application in accordance with DOE Order 5480.20A.[5]

- Verify that all employees under their cognizance complete required training and qualification requirements.

Training and qualification programs are developed, based on input from managers, and administered by the WIPP Technical Training Department.

10.5 Maintenance Program

The maintenance program, described in WP 10-2,[12] is implemented to ensure that maintenance activities are conducted to preserve and restore the availability, operability, and reliability of the WIPP SSCs important to operation of the facility. The maintenance organization, responsibilities, work scope, management and control, and interfaces are prescribed in WP 10-2[12] and WP 10-WC3011.[13]

Maintenance work control and work activities, performed by the WIPP maintenance personnel or subcontractors, are performed in accordance with WP 10-WC3011.[13] Subcontracted maintenance activities are also specified in a Statement of Work. The maintenance work control program includes the following elements:

- A configuration management process established to ensure the integrity of the SSCs

- A prioritization process used to properly emphasize safety requirements, the maintenance backlog, system availability, and requirements for those infrastructure elements identified as part of the nuclear facility safety basis

- A process for feedback and improvement established to provide relevant information regarding operations, maintenance, and assessment efforts

- Maintenance procedures and other work-related documents (e.g., drawings and instructions) to provide appropriate work direction and to ensure that maintenance is performed safely and efficiently

- An interface with the cognizant system engineer to support maintenance activities associated with assigned systems. The system engineer's activities include providing technical support to maintenance activities, evaluating modification impacts, coordinating and reviewing maintenance activities, and supporting readiness reviews

- An accurate maintenance history in a system that is retrievable by component

The maintenance program is tailored to the WIPP operation through a graded approach. A graded approach considers the element's relative importance to safety of workers, the public, and the environment, safeguards and security, fulfillment of the programmatic mission, and other site/facility specific requirements. A graded approach is used in determining the level of formality, detail, and resources required.

10.5.1 Maintenance Organization and Administration

WP 10-2[12] identifies the groups that constitute the maintenance organization and the positions within each group and their responsibilities. Maintenance work activities are performed in accordance with WP 10-WC3011.[13] Surface maintenance facilities include a mechanical shop, and electrical shop, and an area for instrumentation and control calibration. Measurement and test equipment and tools for specific jobs are checked out from a “tool crib”. There is also a maintenance shop in the north end of the underground for making equipment repairs.

10.5.2 Training and Qualification of Maintenance Personnel

WP 10-2[12] delineates the training requirements for maintenance personnel. Training and qualification of maintenance personnel is discussed in Section 10.4.3.

10.5.3 Post-Maintenance Testing

Post maintenance testing is performed to verify that SSCs will fulfill their design function when returned to service after maintenance. Post maintenance testing is performed by the department responsible for the SSC on which maintenance was performed. WP 10-WC3011[13] implementing procedures identifies the post maintenance testing requirements for completed corrective maintenance. Post maintenance testing of SSCs operated by Facility Operations is governed by the requirements of WP 04-CO[14] and the operations procedures specific to the equipment.

10.5.4 Control and Calibration of Measuring Equipment

Calibration of monitoring and data collection (measuring) equipment used at the WIPP is in accordance with WP 10-AD.01, Metrology Program.[16] Control and calibration of M&TE is addressed in Section 10.4.1.

10.5.5 Maintenance History and Trending

WP 10-2[12] provides instruction used for trending the maintenance history of plant equipment and implements the requirements of DOE-STD-1073-93, *Materials Condition and Aging Management Program*.[17] Trending is used to identify improvements in the maintenance program, as well as needed equipment modifications.

The process of trending equipment and analyzing operational data satisfies the need for periodic assessment of design life, design operating conditions, and performance characteristics. It applies to the Mode Compliance Equipment only (as designated by the Master Equipment List), which has been determined to be those components whose failure would have a major cost, safety, or programmatic impact on waste handling operations. The organizational interfaces for the Materials Condition and Aging Management are defined in the instructions for the WIPP trending program.

References for Chapter 10

1. DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, June 2001.
2. DOE Order 430.1B, *Real Property Asset Management*, September 2003.
3. DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1-1*, September 2001.
4. DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 2, October, 2001.
5. DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, Change 1, July 2001.
6. DOE Order 420.1A, *Facility Safety*, May 2002.
7. SDD GPDD, General Plant Design Description System Design Description.
8. WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.
9. WP 09-SU.01, WIPP Start-Up Test Program.
10. WP 15-PS.2, Technical Procedure Writer's Guide.
11. WP 15-PS3002, WID Controlled Document Processing.
12. WP 10-2, Maintenance Operations Instruction Manual.
13. WP 10-WC3011, Maintenance Process.
14. WP 04-CO, Conduct of Operations.
15. WP 10-AD3028, Calibration and Control of Measurement and Test Equipment.
16. WP 10-WC.01. Metrology Program.
17. DOE-STD-1073-93, *Materials Condition and Aging Management Program*.

OPERATIONAL SAFETY

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OPERATIONAL SAFETY

11.1 Introduction

This chapter identifies the key elements of the Waste Isolation Pilot Plant (WIPP) programs that provide for operational safety, conduct of operations and the fire protection program. Conduct of operations specifically focuses on the bases of operations programs specified by U.S. Department of Energy (DOE) Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*.[1] DOE Order 5480.19[1] addresses many of the other topics covered in Title 10 *Code of Federal Regulations* (CFR) Part 830, Subpart B, "Nuclear Safety Management"[2] (e.g., management, organization, the institutional safety provisions, procedures, training, and human factors) and is applicable to all facilities including industrial facilities. Elements of conduct of operations are also covered in other chapters of this documented safety analysis (DSA).

The scope of this chapter includes:

- Identification of operation safety aspects of the conduct of operations program
- Integrated summary of the main features of the conduct of operations program
- Description of the WIPP fire protection program

Application of the graded approach for conduct of operations and the fire protection program is based on the hazards associated with facility operations and the complexity of those operations. Use of the graded approach does not compromise the safety of the public, employees, or facilities; adversely impact the environment; or result in noncompliance with contractual requirements. Safety is given priority over other programmatic considerations.

11.2 Requirements

The standards, regulations, and DOE Orders required for establishing the safety basis for the WIPP, a Hazard Category 2 nuclear facility, specific to operational safety programs include the following:

- 29 CFR Part 1910, "Occupational Safety and Health Standards"[3]
- 29 CFR Part 1926, "Safety and Health Regulations for Construction"[4]
- DOE Order 210.1A, *Facility Safety*, Section 4.2, "Fire Protection"[5]
- DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*[6]
- DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*[1]

11.3 Conduct of Operations

The section summarizes the applicability of conduct of operations to the WIPP facility and identifies the salient features of the conduct of operations program as required by DOE Order 5480.19.[1] Operation of WIPP is conducted in accordance with approved procedures and DOE/WIPP-03-3178, *WIPP Remote-Handled (RH) Technical Safety Requirements* (TSRs).[7] This RH DSA considers the term "operations" as reflecting those daily activities, resources, management, and communication required to support the

WIPP in meeting goals and objectives for the intended facility purpose of disposing of defense generated transuranic waste.

Supervisors are responsible for reporting to the Facility Shift Manager (FSM) any conditions that may affect the operation or operability of the facility. The FSM approves the operation of plant equipment and releases work as part of the work control process. All maintenance, inspection, and testing work is scheduled through the plan of the day and plan of the week meetings.

Pre-job briefings are conducted regularly by supervisors to ensure that the operational activities are completed safely, correctly, and efficiently.

11.3.1 Shift Routines and Operating Practices

WP 04-CO, Conduct of Operations,[8] specifies the shift routines and operating practices that apply to the WIPP facility operating and support personnel. Operation of the WIPP facility is performed in accordance with approved operating procedures by qualified personnel. WP 04-CO[8] specifies the organizational interfaces for making changes to the plant configuration. The responsibility for maintaining proper configuration of the facility and authorizing changes of general surface and underground equipment rests with the FSM. Changes in equipment status are communicated to the Central Monitoring Room Operator (CMRO). Changes in equipment or system status that affects the waste handling process are required to be reported to the CMRO.

Waste handling operations incorporate the shift routines and operating practices aspect of conduct of operations by the following activities:

- Performing preoperational checks of waste handling equipment prior to use for waste handling
- Wearing the proper personal protective equipment and adhering to the safe working and operating requirements of the facility industrial safety program
- Operating equipment on which they are qualified
- Utilizing ALARA techniques when performing work
- Observing process indicators (e.g. warning lights, equipment back up alarms, etc) and responding to abnormal or unexpected indications
- Not having potentially distractive written material and devices at their work stations

Only facility operations personnel reset protective devices.

11.3.2 Control Area Activities

The control areas at the WIPP consists of the CMR and the hoist control room at each of the three hoists (salt handling, air intake, and waste). Portions of the CH bay and RH part of the WHB are controlled areas when waste is present. Access to and activities performed in the WIPP control areas are controlled by WP 04-CO.[8]

11.3.3 Communications

Communications within the WIPP are accomplished through the use of the public address (PA) system, the Site Notification System (SNS) via plectrons, radios, beepers, mine phones, and touch-tone telephones. The CMR is the focal point for communications between surface and underground operations. Communications to site personnel of an abnormal or emergency situation is performed by the CMRO as follows:

- Use the PA system, the SNS and the mine phone when making site wide announcements.
- Use the surface zone of the PA system and the SNS to make an announcement applicable to only surface personnel.
- Use the Zone 4 of the PA system and the mine phone to make an announcement applicable to only underground personnel.
- If an emergency or response announcement is made, an introduction tone will precede the announcement.
- If the response action is ongoing, the announcement will be repeated every 15 to 30 minutes.
- When the emergency or response is terminated, an announcement stating such will be made.

The CMRO uses the PA system and the mine phone to announce the status of waste handling operations (waste handling or waste disposal). Personnel working in areas where the PA system cannot be heard are notified by flashing lights, vibrating pagers, or by other personnel. The most reliable form of communication in the underground is the mine pager phones. PA emergency communications are periodically tested to ensure functionally.

Facility operations and waste handling operations use portable radios and verbatim repeat back communications.

11.3.4 Control of On-Shift Training

Equipment/systems qualification training will occur in the form of instructed on-the-job training (OJT), following established training programs, as addressed by training documentation, to maintain instructional uniformity. The responsibilities of the manager, instructor, and trainee are identified in WP 14-TR3308, On-the-Job Training.[9]

On-shift training is conducted by subject matter experts (SMEs) and OJT evaluators, who are also trained in accordance with site training procedures. A SME or OJT evaluator observes trainee performance skills to ensure that no adverse actions occur. Procedure steps, cautions, and notes must be discussed with the SME before operating any equipment. Trainees are monitored until the trainee has demonstrated proficiency in performing a skill. Training procedures provide documentation guidance for operator qualification and certification programs. Qualification cards are signed by the SME, documenting that the trainee has successfully and adequately demonstrated proficiency of that skill.

11.3.5 Control of Equipment and System Status

The FSM, as the senior operating person on shift, is tasked with maintaining a broad overview of operations. The FSM's perspective of the status of the WIPP must be the focal point for shift operations. The FSM has the responsibility for maintaining proper configuration and authorizing changes of general surface and underground equipment and systems. The hoisting manager has the responsibility for maintaining proper configuration and authorizing changes of hoisting equipment and systems. The waste handling manager has the responsibility for maintaining proper configuration and authorizing changes of waste handling equipment and systems.

The FSM, hoisting manager, or waste handling organization, as appropriate, will be advised of the status of equipment and systems delegated by the FSM, hoisting manager, or waste handling manager to other shift positions. The cognizant manager will ensure that equipment status changes are effectively communicated to the CMR and other shift positions and operators as appropriate. Operations managers must report status changes of plant equipment.

The FSM, hoisting manager, or waste handling manager, as appropriate, will authorize, in writing, all shift actions (including maintenance) for equipment that is important to plant safety, affects operations, or changes control indications or alarms. For emergent work, when FSM approval through the Plan of the Day is not feasible, the hoisting manager or waste handling manager, as appropriate, will ensure FSM approval is obtained before authorizing work.

Equipment and systems are checked for proper alignment before being placed into operation. Approved operating procedures are used to ensure that equipment is controlled, checked, and monitored. Equipment is functionally tested following maintenance to verify that the maintenance performed corrected the original problem and that no new problems were introduced. The functional test also demonstrates the equipment's capability of performing its intended function. The cognizant operations manager ensures that testing proves equipment operability.

The Central Monitoring System (CMS), with display in the CMR, monitors the status of plant systems and equipment including; the waste handling building (WHB) ventilation, continuous air monitors, plant air, and the WHB and support building chilled water systems. The CMRO monitors the CMS display and notifies the appropriate operations department of any alarm conditions. Response to the alarms are in accordance with approved procedures.

The distribution and control of equipment and system engineering drawings and specifications is satisfied by the performance of procedure WP 09-CN3007, Engineering and Design Preparation and Change Control.[10]

11.3.6 Lockouts and Tagouts

WP 12-IS.01-2, Industrial Safety Program - Lockout/Tagout and Nonelectrical Energy Hazards [11] establishes the WIPP Lockout/Tagout program required by DOE Order 5480.19[1] and 29 CFR §1910.147, "The Control of Hazardous Energy (Lockout/Tagout)."[12] The WIPP procedure, WP 04-AD3011, Equipment Lockout/Tagout,[13] used in conjunction with procedure WP 10-AD3005, Control and Use of Maintenance Locks,[14] implements the lockout/tagout activities used for isolating, blocking, and securing facility systems and components; the placement and removal and transfer of the lockout/tagout devices (tags and locks); and the testing of the systems and components to determine and verify the effectiveness of lockout/tagout.

11.3.7 Independent Verification

Procedure WP 04-AD3005, Administrative Control of System Lineups,[15] provides independent verification information and instructions for the following

- Methodology for determining which systems require lineups and which systems require independent verification
- Instructions for developing system lineups
- Requirements for performing complete or partial system lineups
- Instructions for the performance and review of system lineups
- Documentation requirements for system lineups

11.3.8 Log Keeping

Logbooks are kept at each of the control locations identified in Section 11.3.2 and at four waste handling operations locations, CH and RH areas of the WHB and underground. A logbook is also located in the Emergency Operations Center (EOC) and is maintained when the EOC is activated. The logbooks are maintained by designated personnel working in that area. The CMR logbook is maintained by the CMRO; the three hoisting logbooks are maintained by the hoist man at each of the three shafts; and the waste handling logbooks are maintained by waste handling personnel in the WHB and underground. Procedures WP 04-CO,[8] and WP 04-AD3008, Shift Operating Logs[16] provide guidance on the use of logbooks and recording information in them.

The FSM and the cognizant operations manager (hoisting shift manager and waste handling shift manager) are responsible for reviewing logbooks for completeness and for their approval.

11.3.9 Operations Turnover

The operations turnover process, as defined in WP 04-CO,[8] ensures that conditions related to abnormal lineups, status of major components, and planned or in-progress surveillances or activities, and other special instructions are reported to the oncoming supervisor.

Oncoming personnel and supervisors conduct a review of plant status and turnover information before responsibility is transferred for the shift. The off-going supervisor performs the turnover at a time when facility conditions are stable for the oncoming personnel.

11.3.10 Operations Aspects of Facility Chemistry and Unique Processes

The WIPP is a unique transuranic waste handling and disposal facility and has no facility chemistry processes as described in DOE Order 5480.19,[1] Waste handling personnel are trained and qualified to perform the waste handling and disposal operations.

11.3.11 Required Reading

The WIPP required reading program is discussed in Management Policy (MP) 1.30, Required Reading.[17] Required reading material includes, but is not limited to procedures, equipment changes, operating experience information, and other information needed to keep operating personnel aware of facility activities and conditions, including safety information. The required reading program ensures that designated individuals read, understand, and remain informed of important information. Completion of required reading is documented.

11.3.12 Timely Orders to Operators

Orders to operators are essential tools to communicated special conditions and instructions to shift personnel. Operator orders will be segregated into long-term orders (Standing Instructions) and daily orders (Shift Instructions) to facilitate a review by shift personnel. Standing order information intended to supplement a procedure is incorporated into the appropriate procedure by a revision or change being generated and issued. Items specific to waste handling operations that may change the waste handling process as described in this DSA must be processed as a procedure change to ensure changes are reviewed for unreviewed safety question.

11.3.13 Operator Aid Postings

The WIPP procedure, WP 04-MD3003, Control of Operator Aids[18] controls the use of operator aids and ensures that only up to date information and controlled drawings are contained in the operator aids. Operator aids are copies of procedures, system drawings, information tags, and graphs that help operator perform their duties.

11.3.14 Equipment and Piping Labeling

The WIPP procedure, WP 09-CN3021, Component Indices,[19] establishes the requirements for controlling and method for assignment of equipment numbering and labeling, including numbering instrument loops, valves, pipes, dampers, cables, conduit runs and structures. WP 09-CN3021[19] also addresses the specific responsibilities for maintaining the WIPP SSC Component Indices (CIs). Information regarding the CIs are maintained in the computerized History and Maintenance Planning System Equipment Module.

11.4 Fire Protection

The WIPP fire protection program is designed to ensure personnel safety, the mission, and property conservation. These objectives are met by incorporating automatic fire suppression systems, using fire resistant materials in building construction, providing fire barriers and fire doors, and enclosing vertical openings in buildings, thereby preventing the spread of fires. Building designs incorporate features for fire prevention. Also, fire hazards are controlled throughout the WIPP. The plant design meets the improved risk level of protection defined in DOE O 420.1A, *Facility Safety*, Section 4.2, "Fire Protection,"[20] and satisfies the applicable sections of the National Fire Protection Association (NFPA) Codes, DOE Orders, and federal codes to the extent described in DOE-WIPP-3217, *Waste Isolation Pilot Plant Fire Hazard Analysis (FHA) Report*.[21] The WIPP design incorporates the following features:

- Most buildings and their support structures are protected by fixed, automatic fire suppression systems designed to the individual hazards of each area. The WHB including the waste hoist tower, support building, and TMF have wet pipe sprinkler systems. The TMF sprinklers are supplied by the WHB sprinkler system. In the RH portion of the WHB, some areas of the hot cell complex do not include sprinklers including the cask unloading room, upper and lower hot cell, transfer cell, and below grade rooms on the south side of the transfer cell.

- Noncombustible construction, fireproof masonry construction, and fire resistant materials are used whenever possible. The bulkheads, airlocks, and overcasts in the underground are also of non-combustible construction.

- Fire separations are installed where required because of different occupancies per the Uniform Building Code.

- In multistory buildings, vertical openings are protected by enclosing stairways, elevators, pipeways, electrical penetrations, etc., to prevent fire from spreading to upper floors. The waste hoist tower is an exception and has an open path from the hoist tower to the bottom of the waste shaft to accommodate the hoist ropes.

- A combustible loading control program is in place to minimize the accumulation of combustibles within the WHB, the TMF, and area between the support building and WHB.

- The area within the Property Protection Area (PPA) security fence is either paved or graveled with minimal vegetation. A gravel road parallels the PPA perimeter security fence, which acts as a fire break in the event of a wild land fire. Several features outside the perimeter security fence also serve as fire breaks and include the salt pile to the north, pond areas to collect rain runoff to the north, east and south, a paved parking area and access road to the west, and berms and the electrical switch yard to the east.

To ensure reliability of the active fire protection systems, inspection, testing, and maintenance programs are provided. There are also administrative controls for the fire system impairments, hot work and internal audits of the inspection, testing and maintenance, and other program elements essential to the maintenance of a fire protection program, as required by DOE Orders.

11.4.1 Fire Hazards

The main fire hazards to the WIPP waste handling facilities as presented in Chapter 3 of this DSA are combustibles such as wood pallets, crates, plywood, paper associated with work activities, plastic signs, plastic containers, plastic slipsheets, shrink wrap, personal protective equipment, petroleum based combustibles (e.g., grease, hydraulic fluid). Other identified fire hazards include hydrogen gas generated from lead-acid batteries on facility equipment and from battery charging stations; the diesel fuel used by facility equipment; flammable gas and flammable compressed gas; and the flammable material in the waste containers (cellulose, plastics, and rubber, etc.).

Pyrophoric materials are prohibited in both CH and RH waste contents through the DOE/WIPP-22-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant[22], referred to in this DSA as the RH WAC. Generator site adherence to the RH WAC controls the fire hazards contained the RH waste shipped to the WIPP. The CH and RH underground waste handling vehicles each have an automatic/manual fire suppression system to ensure that any fire resulting from fuel or hydraulic leaks, or the engine are extinguished before they become larger fires with the potential to breach waste containers. Non-waste handling vehicles are prohibited in the active disposal room during waste handling to prevent collisions that could result in fire. When non-waste handling vehicles are needed in an active disposal room, a spotter and a fire watch are required when they are operated within 75 ft. of the CH disposal array waste face. The lube truck is prohibited from the active disposal room. The concentration of any generated hydrogen gas is kept below the lower explosion limit by the air flow caused by the ventilation systems.

The WIPP Fire Hazard Analysis (FHA)[21] concluded that the WIPP has adequate suppression systems in place to mitigate a fire. To prevent fires from starting or propagating, combustible loading in the WHB and underground disposal area is procedurally controlled through WP 12-FP3003, Combustible Loading Controls for the Waste Handling Building and Underground,[23] and protected with controls as discussed in Chapter 3 and 5 of this DSA.

11.4.2 Fire Protection Program and Organization

WP 12-FP.01, WIPP Fire Protection Program,[24] establishes the requirements for a comprehensive fire and related hazards protection program for the WIPP based on DOE O 420.1A.[20] The WIPP is designed with active and passive fire protection features. To meet the program goals and objectives, fire safety practices are required of each employee and subcontractor during their daily work and are an integral part of all activities at the WIPP. WP 12-FP.01,[24] has incorporated DOE orders, NFPA requirements, and other applicable federal, state, and local fire safety requirements.

The Fire Protection Self-Survey Facility Appraisal is performed annually in accordance with DOE guidelines and addresses the following, at a minimum:

- Life safety
- Inspection, testing, and maintenance reports
- Fire suppression equipment
- Water runoff
- Fire apparatus accessibility
- Administrative controls
- Temporary protection and compensatory measures
- Fire barrier integrity
- Fire suppression system tests and adequacy of water supplies
- Maintenance procedures for maintaining fire suppression systems
- Status of findings from previous survey

Procedure WP 12-FP3003[23] contains the requirements for controlling the introduction, storage, and handling of ordinary combustibles, combustible/flammable liquids, and flammable gases in the WHB, the underground disposal transport path, and the active disposal room at the WIPP. The required fire control measures are for the purpose of preventing fires and the associated consequences to ensure protection of workers and the public.

The Safety and Health Manager has the responsibility to provide principal overview for the WIPP Fire Protection Program. The Industrial Safety and Hygiene Manager is responsible for the implementation of the WIPP Fire Protection Program and for providing staffing and resources for maintaining and revising, as necessary, the fire protection program. Fire Protection Engineering is responsible for administering the WIPP Fire Protection Program and ensuring its integration with this DSA, the WIPP FHA Report, and the Hazardous Waste Facility Permit issued by the New Mexico Environment Department to the WIPP. The WIPP Emergency Services is responsible for implementing inspection, maintenance, and testing of fire protection systems and equipment.

11.4.3 Combustible Loading Control

Combustible loading control is the most significant part of the WIPP fire protection program. Combustible loading is procedurally controlled and is required by specific administrative controls in the RH TSRs.[7] Combustible loading control includes facility inspections, assessments, and fire protection engineering reviews. Periodic inspections are performed to identify and correct potential fire hazards and/or conditions of noncompliance with WP 12-FP3003.[23]

Combustible loading controls for the WHB and underground include vehicle restrictions including vehicle types allowed and standoff distances in the WHB, active disposal room, near the CH disposal array, and near waste in transit in the underground. Combustible loading controls also place restrictions on transient combustibles including use and storage of flammable gas and flammable compressed gas. Periodic combustible loading inspections are performed and documented.

11.4.4 Firefighting Capabilities

The WIPP Emergency Management organization develops and maintains emergency response plans and procedures that govern and facilitate all aspects of emergency response at the WIPP, including fire protection and mutual aid agreements for firefighting.

Fire protection engineers prepare and maintain the WIPP site prefire plans. The prefire plans are used to provide important firefighting information to responders. Prefire plans are reviewed and updated as necessary to accommodate any changes at the site. Copies of the prefire plans are maintained in the EOC and in emergency response vehicles.

Firefighting equipment at the WIPP includes a fully-equipped pumper engine, a brush fire truck, associated firefighting equipment, and trained firefighters. The fire brigade and the Emergency Response Team are the WIPP site trained firefighters. Personnel belonging to the two groups receive extensive on site training including CPR, hazardous waste worker, radiation worker, and firefighting. They are required to annually attend a one week live fire fighting training that is compliant with NFPA- 600 and offered by the State of New Mexico. One member of the fire brigade is an Emergency Services Technician (EST). The ESTs, who are state-licensed as described in DOE Order 5480.19,[1] emergency medical technicians, provide 24-hour emergency medical response capability at the WIPP facility. Site firefighting activities are led by the FSM.

Memoranda of Understandings between the WIPP and several key community organizations are important aspects of the available protective actions governed by legal cooperation agreements. The mutual aid agreement between the DOE and the Eddy County Commission provides for the actual assistance of the parties in the furnishing of fire protection for the Eddy County Fire District and the WIPP site.

11.4.5 Fire Fighting Readiness Assurance

To ensure fire fighting readiness, the fire water supply and fire suppression system for the Support Building and WHB are required to be operable to support waste handling operations and storage in the WHB and in the underground during transport of waste using the waste hoist. The fire water supply and suppression system require periodic inspections and surveillance to ensure system operability. Fire protection systems inspection, maintenance, and testing program requires WTS organizations, with fire protection engineering oversight, to perform inspection, maintenance, and testing of fire protection equipment and systems at regular intervals. The inspections, maintenance, and testing are accomplished in accordance with applicable DOE directives and implementation guidance.

ESTs conduct inspections of facility fire suppression systems and emergency equipment and are responsible for keeping the assigned emergency apparatus in good operating condition.

All fire protection inspection, maintenance, and testing documentation is maintained as records. Fire protection engineers verify accomplishment of fire protection program record keeping and may initiate corrective action(s) required to resolve any deficiencies identified during inspections, maintenance, or testing activities.

References for Chapter 11

1. DOE Order 5480.19, Change 2, *Conduct of Operations Requirements for DOE Facilities,* October 2001.

2. 10 CFR Part 830, Subpart B, "Nuclear Safety Management."

3. 29 CFR Part 1910, "Occupational Safety and Health Standards."

4. 29 CFR Part 1926, "Safety and Health Regulations for Construction."

5. DOE Order 210.1A, *Facility Safety*, Section 4.2, "Fire Protection."

6. DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*.

7. DOE/WIPP-03-3178, WIPP Remote-Handled (RH) Technical Safety Requirements.

8. WP 04-CO, Conduct of Operations.

9. WP 14-TR3308, On-the-Job Training.

10. WP 09-CN3007, Engineering and Design.

11. WP 12-IS.01-2, Industrial Safety Program - Lockout/Tagout and Nonelectrical Energy Hazards.

12. 29 CFR §1910.147, "The Control of Hazardous Energy (Lockout/Tagout)."

13. WP 04-AD3011, Equipment Lockout/Tagout.

14. WP 10-AD3005, Control and Use of Maintenance Locks.

15. WP 04-AD3005, Administrative Control of System Lineups Independent.

16. WP 10-AD3008, Shift Operating Logs.

17. MP 1.30, Management Policy, Required Reading.

18. WP 04-MD3003, Control of Operator Aids.

19. WP 09-CN3021, Component Indices.

20. DOE O 420.1A, Facility Safety, Section 4.2; Fire Protection, May 2002.

21. DOE-WIPP-3217, Waste Isolation Pilot Plant Fire Hazard Analysis Report.

22. DOE/WIPP-22-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, 2005*.

23. WP 12-FP3003, Combustible Loading Controls for the Waste Handling Building and Underground.

24. WP 12-FP.01, WIPP Fire Protection Program.

PROCEDURES and TRAINING

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PROCEDURES and TRAINING

12.1 Introduction

The objective of this chapter is to describe the key elements of the Waste Isolation Pilot Plant (WIPP) procedures and training programs.

The scope includes the processes by which the technical content of the procedures and training programs are developed, verified, and validated. The goal is to ensure that the facility is operated and maintained by personnel who are qualified and competent to carry out their job responsibilities using procedures and training elements that have been developed and kept current by the use of feedback and continuous improvement. It is important that operators are trained and qualified and have well developed, current procedures to perform their duties. This assures assumptions made in the safety basis regarding both procedural compliance and response are maintained. A programmatic commitment to ongoing procedures and training programs is considered to be a necessary part of safety assurance. The WIPP training program is organized and managed to facilitate planning, directing, evaluating, and controlling a systematic training process that fulfills job-related needs and regulatory requirements. Washington TRU Solutions LLC (WTS), the management and operating contractor for the WIPP, is responsible for establishing and administering the overall training program for the WIPP personnel. Operations procedures are provided to ensure the facility is operated within its safety basis.

In summary, the key attributes of the WIPP Procedures and Training Programs for procedures and training for safety analysis purposes are:

- Work processes are controlled by approved procedures, and management controls appropriate to the specific tasks to be performed.
- Procedures are maintained under change control.
- Procedures are periodically reviewed for accuracy and applicability.
- Procedure development includes validation to assure technical accuracy and proper consideration of human factors issues.
- The training program ensures the work force is trained and qualified, with the knowledge, skills, and abilities to effectively perform their work while protecting themselves, coworkers, the public, and the environment.
- Training includes incorporation of results from a formal lessons learned process.

12.2 Requirements

Minimum requirements for the selection, qualification, and training of personnel at the WIPP are specified in DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*.[1] The minimum requirements for procedures are specified in DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*.[2] DOE Order 420.1A, *Facility Safety*,[3] defines the procedure and training requirements for system engineers.

12.3 Procedure Program

WP 04-CO, Conduct of Operations[4] and WP 15-PS3002, WTS Controlled Document Processing,[5] provide specific guidance for the development of procedures and training that ensure personnel are qualified and competent in fulfilling their job-related responsibilities. WP 13-1, WTS Quality Assurance Program Description,[6] requires that technical documents and procedures be reviewed for adequacy, correctness, and completeness prior to approval and issuance as controlled documents. Training requirements are implemented by the WIPP Training Implementation Matrix (TIM)[7] and the WP 14-TR.01, WIPP Training Program.[8]

WP 04-CO[4] states that operation of the facility will be in accordance with approved operating procedures and will be performed by qualified personnel. Formal written operating procedures are prepared for modifications that would affect the safety and/or the design of the facility as defined in this Documented Safety Analysis (DSA). Procedures govern configuration control, maintenance, and calibration of the WIPP structures, systems, and components (SSCs), particularly those that are functionally classified in Chapter 3 of this DSA.

Management policy MP 1.28, Integrated Safety Management,[9] provides guidance for the development of safety management functions. These activities define scope of work, identify and analyze hazards, develop and implement hazard controls, perform work within controls, and provide feedback on adequacy of controls and continuous improvement in defining and planning work. These policies and procedures are developed and managed in accordance with WP 15-PS3002.[5] Inspection and surveillance/test requirements are delineated in WP 13-1[6] and Chapter 5 of this DSA and accomplished through procedures or work instructions in accordance with WP 10-2, Maintenance Operations Instruction Manual.[10] Chapter 14 of this DSA further discusses quality requirements for inspection and testing which are performed in accordance with approved implementing procedures.

12.3.1 Development of Procedures

Procedures prescribe the actions and steps that are essential to safe and consistent performance of administrative, operations, and maintenance activities. Instructions and guidance documents are used to supplement procedures and ensure specific information is conveyed to the user in the best manner possible. Identification of the need for a new procedure is based on the following criteria:

- Failure to correctly perform an operation or activity will have a negative impact on the work process.
- The complexity of the operation or activity exceeds the knowledge of assigned personnel.
- Requirements need to be documented and interpreted to assure compliance and communicate management direction.
- Users require the current version of a procedure to assure proper implementation.
- Upper tier policies or directives require that a procedure be written.

WP 15-PS3002[5] controls the process for procedure development. The cognizant organization manager assigns a technically competent person as defined in WP 13-1,[6] to develop the technical content of the document. Procedures are required when a defined task or activity is to be performed, which meets one of the following criteria: (1) accomplishes work or activities defined in WP 13-1,[6] or creates quality records, (2) provides specific direction for the operating equipment and/or systems included in the configuration management process, (3) provides specific direction for physical activities that require repeatability and documented results, as described in WP 15-PS.2, Technical Procedure Writer's Guide.[11] An unreviewed safety question (USQ) screening is performed on all new procedures and changes to existing procedures by a qualified individual in accordance with WP 02-AR3001, Unreviewed Safety Question Determination.[12]

Procedures are verified and validated for normal, abnormal, and emergency operations and for surveillance testing and maintenance as defined in WP 13-1.[6] Following completion of the technical review and validation process, document packages are sent to the Document Review Committee for final review, then the procedure is approved for use by the cognizant organization manager. The following are examples of procedures developed and approved by this process:

- WP 02-1, Waste Isolation Pilot Plant Groundwater Monitoring Program Plan[13]
- WP 04-CO, Conduct of Operations[4]
- WP 09-CN, Engineering Conduct of Operations documents[14]
- WP 09-CN3007, Engineering Design Document Preparation and Change Control[15]
- WP 07-1, Waste Isolation Pilot Plant Geotechnical Engineering Program Plan[16]
- WP 05-WH1011, CH Waste Processing[17]
- WP 05-WH1710, 72-B RH Processing[18]
- WP 05-WH1722, 10-160B RH Processing[19]
- WP 08-NT.01, Waste Isolation Pilot Plant Waste Information System Program Plan[20]
- WP 15-2, Management Control System Program Plan[21]

12.3.2 Maintenance of Procedures

WP 15-PS3002[5] requires a periodic review of each procedure during which a technically competent person reviews the procedure to ensure the incorporation of any new requirements, changes in facility configuration, changes in the documented safety analysis or technical safety requirements, changes due to unreviewed safety question determinations, or changes in training. These reviews maintain congruence between the facility’s actual condition, the procedures, and the training for the procedures. Changes to the procedures mandate a technical review that must be signed off by the cognizant organization manager and a technically competent person before issuance as an approved change. USQ screening is required for all changes to procedures.

12.4 Training Program

DOE Order 5480.20A[1] provides the requirements for establishing performance-based training programs and the personnel qualification requirements for DOE nonreactor nuclear facilities. This Order is implemented at the site level by WP 14-TR.01[8] and the TIM[7] which address the development of a formal training program for personnel and site subcontractors in job-related subjects from fundamental technical skills and specialty training to supervisory and management skills. Training program policies and procedures define job function, responsibility, authority, and accountability of WTS personnel involved in managing, implementing, and conducting training.

The primary objective of the WIPP training program is to prepare personnel to operate the WIPP in a safe and environmentally sound manner. To achieve this objective, the training program provides employees with training relevant to their positions. Full-time employees at the WIPP, regardless of employer, receive General Employee Training which includes an introduction to the Public Law 94-580, Resource Conservation and Recovery Act[22] and emergency preparedness processes within thirty days of employment. In this way, everyone at the WIPP is provided basic training of regulatory requirements and emergency procedures. Employees who operate plant equipment, work in areas involving radiological materials, or deal with hazardous or mixed waste management receive additional classroom and on-the-job training designed specifically to teach them how to perform their duties safely, and to ensure the facility's compliance with the regulations.

12.4.1 Development of Training

Formal training programs for personnel who support nuclear facilities are listed in the WIPP TIM[7] and include the following elements:

- Needs/job analysis and identification of tasks for training
- Development of learning objectives
- Development of lesson plans and training guides
- Evaluation of trainee mastery of learning objectives
- Evaluation of the effectiveness of training

The TIM[7] describes the operating organization and the training/qualification programs for positions in the operating organization. It lists each position that is subject to DOE 5480.20A[1] and includes a matrix that shows the status of programs relative to the requirements of DOE 5480.20A.[1] The following are examples of the positions:

- Management Positions
  - General Manager
  - Facility Shift Manager
  - Quality Assurance Manager
  - Mine Operations Manger
  - Radiation Safety Manager
- Technical Staff Management
  - Mechanical Maintenance Manager
  - RH Projects Manager
  - Electrical Maintenance Manager
- Operator
  - Facility Operations Shift Engineer (Operator Supervisor)
  - Underground Operations Engineer (Operator Supervisor)
  - CH Waste Handling Engineer (Operator Supervisor)
  - Waste Hoist Operator

- Maintenance
  - Mechanical Maintenance Technician
  - Instrumentation and Control Technician
- Technician
  - Radiological Control Technician
  - Radiochemistry Technician
- Technical Staff
  - Cognizant Engineer
- Training Coordinator
  - Team Leader - Technical Training
- Training Instructor
  - Technical Training

WP 14-TR.01[10] defines the systematic process used in the design and development of the WIPP training programs. The degree of analysis (needs analysis, job analysis, and task analysis) will vary based on complexity and job function. Using a graded approach, several options exist for analysis:

- A table top method where a team of trainers, supervisors, and subject matter experts meet to identify duty areas, tasks within the duty area, and the tasks to be included in the training program
- Verification and validation of task list from similar facilities and job duty areas
- Use of consensus-based content guides to determine training program content

Job analyses are conducted for qualified positions to determine tasks for training for both normal and emergency duties, establish program goals, and define the scope of training program content. A detailed task analysis may be developed or expected based on a graded approach. The graded approach should take into consideration the existing procedures controlling the activity and if the consequence of performing the task improperly is of low consequence. Group brainstorming or a joint review of the procedure by trainers and subject matter experts are acceptable to determine skills and knowledge.

As part of the development of training, a task list of duties to be included in the training program is developed. Task analyses are performed and task-to-train matrices are developed that include a list of tasks, training determination, and training setting, for qualified positions. Based on the training analysis conducted, training is developed and implemented. Materials to conduct training (e.g., lesson plans, on-the-job training guides, training aids, and student materials) are then developed. During the actual training, trainee mastery of the learning objectives in periodically evaluated. Initial and continuing training programs are established to ensure personnel are qualified to perform job requirements.

12.4.1.1 Initial Training

Initial training may include classroom training and on-the-job training (OJT) necessary to provide an understanding of the fundamentals, basic principles, systems, procedures, and emergency response involved in an employee's work assignments. Initial task or duty area qualification is granted by the line management based on the evaluation of the employee's mastery of the learning objectives presented during the training.

12.4.1.2 General Employee Training

Annual general employee training (GET) is required for all employees, subcontractors, and visitors who have unescorted facility access. Any changes made to GET are included in continuing training programs for all facility personnel. The following areas are included in GET training:

- General description of facilities
- Policies and procedures
- Radiological health and safety programs
- Hazard communication
- Industrial Safety/Hygiene Program
- Fire Protection Program
- Security Program
- Conduct of Operations

12.4.1.3 Criticality Safety Training

Personnel with responsibilities that may affect nuclear criticality safety, including waste handling personnel and their supervisors or those individuals who generate and review nuclear criticality safety evaluations, are trained appropriate to their assigned functions. Chapter 6 of this DSA discusses the criticality program and associated training in further detail.

12.4.1.4 Radiological Protection Training

Radiological protection training is included in GET and addresses the employee's responsibilities for keeping exposures to radiation and radioactive materials as low as reasonably achievable (ALARA). If a person requires unescorted access to a radiological area, additional radiological safety training is required. Radiation Worker Training I and II is required for personnel whose jobs require unescorted access to radiological posted areas. Chapter 7 of this DSA discusses the radiation protection program in further detail.

12.4.1.5 Radiological Control Technician Training

Training program content for radiological control technicians is in accordance with the requirements of 10 CFR Part 835, "Occupational Radiation Protection."[23] Training program elements are in accordance with the requirements of DOE Order 5480.20A[1] and implemented in WP 14-TR.01[8] and the TIM.[7] Training is provided for personnel who are assigned to work in waste handling areas. Training is commensurate with the hazard level and complexity of job duties performed in a waste handling area. Chapter 7 of this DSA discusses radiological worker training in further detail.

GET is required for all the WIPP employees and is required for entry into a waste handling area. Visitors who enter waste handling areas receive a radiological safety orientation that includes basic radiation protection concepts, risk of low-level occupational radiation exposure, radiological protection policies and procedures, visitor and management responsibilities for radiation safety, adherence to radiological posting and labeling, applicable emergency procedures, and training for issuance of dosimeters, where applicable. WP 12-9, WIPP Emergency Management Program,[24] establishes the emergency preparedness program for the protection of personnel and property for which the WIPP is responsible.

12.4.1.6 Hazardous Material Training

Training is provided for workers, supervisors, and managers who are assigned to work with hazardous materials. Training includes the environmental, worker safety, and health subject areas, commensurate with their job assignments as identified in work control documents. Work control documents specify programmatic requirements (including training) such as Hazardous Waste Worker. Chapter 8 of this DSA discusses the program for hazardous materials protection in further detail.

12.4.1.7 Surveillance Testing and Maintenance Training

Training is provided for operations and maintenance personnel involved in surveillance testing. The WIPP procedures address maintenance activities such as training of maintenance personnel, maintenance of SSCs, post maintenance testing, control and calibration of measuring equipment. Chapter 10 of this DSA discusses surveillance testing and maintenance training program in further detail.

12.4.1.8 Fire Protection Program

Fire protection training is governed by the WIPP fire protection program and is included in initial GET. Employees who perform fire watches receive additional training. Chapter 11 of this DSA discusses the fire protection program in further detail.

12.4.1.9 Quality Assurance Training

Quality assurance training is included in initial GET. Chapter 14 of this DSA discusses the quality assurance program in further detail.

12.4.1.10 Emergency Preparedness Training

Basic training is provided to all permanently assigned personnel, including other DOE contractors and subcontractors, through GET and periodic refresher training with respect to the actions they should take during an emergency event. Chapter 15 of this DSA discusses emergency preparedness in further detail.

12.4.1.11 Engineering Training

Training for engineers follows the same systematic approach to training in job-specific duties and qualification programs as for operations personnel. Training requirements including on-the-job-training are developed to ensure that engineers are sufficiently trained to perform the job duties. WP 14-TR3307, Qualification Programs;[25] and WP 14-TR3308, On-the-Job Training,[26] implement associated requirements defined in WP 14-TR.01.[8] All OJT is conducted and evaluated by designated personnel who have been instructed in program standards and methods in accordance with site controlled procedures.

12.4.1.12 Facility Operations Shift Engineer Training

Training programs for facility operations shift engineers are sufficiently comprehensive to cover the areas which are fundamental to the job duties. A core of subjects such as industrial safety, instrumentation and control, basic physics, chemistry industry operating experience, and major facility systems as applicable to the position and the facility is established. Training programs include on-the-job and classroom training on the topics identified for the specific job duties. Continuing training programs are established for operating organization personnel who perform functions associated with engineered safety features as identified in this DSA. Training programs for the requirements of DOE Order 5480.20A[1] and are defined by the TIM[7] and implemented in the WIPP procedures.

12.4.1.13 Waste Handling Engineer Training

Training for waste handling engineers is sufficiently comprehensive to cover the job duties in waste handling areas. Training programs include on-the-job and classroom training[8] on the topics identified for the specific job duties. Continuing training programs are established for operating organization personnel who perform functions associated with the safety basis as identified in this DSA and in DOE/WIPP 03-3178,*Waste Isolation Pilot Plant Remote-Handled (RH) Technical Safety Requirements [TSRs]*.[27]

12.4.1.14 Underground Operations Engineer Training

Training programs for underground operations engineer follow the same systematic approach and training requirements as the facility operations shift engineer. Job-specific training and qualification programs are developed as applicable to work in the underground facility and waste handling areas. Qualification programs are reviewed by management and kept up to date to reflect changes in the underground facility, DSA, and the RH TSRs.[27] The development of qualification programs is defined in WP TR.01[8] and implemented in WP 14-TR3307.[25]

12.4.1.15 Instrumentation and Control Technician Training

Training programs for instrumentation and control technicians follow the requirements of DOE Order 5480.20A[1]. Instrumentation and control technician training consists of a series of qualification cards that are developed for the process controlled calibration and repair of onsite instrumentation used for plant operations. WP 10-AD3028, Calibration and Control of Measurement and Test Equipment,[28] establishes the requirements and responsibilities to identify and recall equipment and obtain calibration services for measurement and test equipment.

12.4.2 Maintenance of Training

WP 14-TR.01[8] implements the requirement for the periodic review of training programs. Program reviews are a shared effort between Technical Training and the functional groups. These reviews ensure that training programs are updated to reflect any changes to the facility, procedures, regulations, documented safety analysis and technical safety requirements, and applicable industry operating experience in accordance with site controlled procedures. Record maintenance follows an approved Records Inventory and Disposition Schedule, reviewed and updated at least annually, to comply with federal codes, policies, or directives concerning training records administration. WP 14-TR.01[8] provides instruction for maintaining training records.

Employees receive refresher training for GET and other job specific training. Employees who are qualified to qualification cards, are required to requalify at a periodicity specific to their qualification.

abnormal tasks. This requalification focuses on continuing training in tasks that are critical to safety, or are difficult, or infrequently performed. Refresher training ensures a proficient and safe workforce.

12.4.3 Modification of Training Materials

DOE-STD-1070-94, *Guidelines For Evaluation of Nuclear Facility Training Programs*,[29] requires a periodic comprehensive evaluation of individual training programs and materials by qualified individuals. Using the combined efforts of the WIPP training instructors and cognizant personnel, programs and materials are evaluated, revised and updated in accordance with WP 1-TR.01.[8] Any improvements or deficiencies are identified and tracked systematically until incorporated into the training programs. Updates may be due to changes in regulations, task performance, modifications to equipment or noted human factors deficiencies. At the completion of program modification, cognizant line management and the WIPP training must approve any revision before implementation.

References for Chapter 12

1. DOE Order 5480.20A, Change 1, *Personnel Selection, Qualification, Training Requirements for DOE Nuclear Facilities*, July 2001.

2. DOE Order 5480.19, Change 2, *Conduct of Operations Requirements for DOE Facilities*, October 2001.

3. DOE Order 420.1A, *Facility Safety*, May 2002.

4. WP 04-CO, Conduct of Operations.

5. WP 15-PS3002, WTS Controlled Document Processing.

6. WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.

7. Training Implementation Matrix (TIM), Rev. 6. Waste Isolation Pilot Plant, Technical Training Department. Access Date: March 15, 2005.

8. WP 14-TR.01, WIPP Training Program.

9. MP 1.28, Integrated Safety Management.

10. WP 10-2, Maintenance Operations Instructions Manual.

11. WP 15-PS.2, Technical Procedure Writer’s Guide.

12. WP 02-AR3001, Unreviewed Safety Question Determination.

13. WP 02-1, WIPP Groundwater Monitoring Program Plan.

14. WP 09-CN Engineering Conduct of Operations documents.

15. WP 09-CN3007, Engineering Design Document Preparation and Change Control.

16. WP 07-1, Waste Isolation Pilot Plant Geotechnical Engineering Program Plan.

17. WP 05-WH1011, CH Waste Processing.

18. WP 05-WH1710, 72-B RH Processing.

19. WP 05-WH1722, 10-160B RH Processing.

20. WP 08-NT.01, Waste Isolation Pilot Plant Waste Information System Program Plan.

21. WP 15-2, Management Control System Program Plan.

22. Public Law 94-580, Resource Conservation and Recovery Act.

23. 10 CFR Part 835, Rev. 21, Occupational Radiation Protection, January 2004.

24. WP 12-9, WIPP Emergency Management Program.

25. WP 14-TR3307, Qualification Programs.

26. WP 14-TR3308, On-the-Job Training.

27. DOE/WIPP 03-3178, Draft Waste Isolation Pilot Plant Remote Handled Technical Safety Requirements.

28. WP 10-AD3028, Calibration and Control of Measurement and Test Equipment.

29. DOE-STD-1070-94, *Guidelines For Evaluation of Nuclear Facility Training Programs*, June 1994.

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HUMAN FACTORS

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HUMAN FACTORS

13.1 Introduction

This chapter describes the impact of human factors on the Waste Isolation Pilot Plant (WIPP) remote handled (RH) waste handling operations. The WIPP RH waste handling operations consist of removing containerized RH waste from shipping packages in the waste handling building (WHB), placing RH waste containers into facility casks for movement to the underground, transferring the facility casks to the underground on the waste shaft conveyance, removing the facility cask from the waste shaft conveyance and transporting it to the active disposal room where the RH waste containers are emplaced into the active disposal room wall with the horizontal emplacement and retrieval equipment (HERE). The chapter includes a description of the human factors process for systematically inquiring into the importance of human factors in facility safety specific to the RH waste handling process and a description of the human machine interfaces with structures, systems, and components (SSCs) important to safety or that provide defense in depth.

13.2 Requirements

DOE O 420.1A, *Facility Safety*,[1] and associated guidance documents discuss the design requirements for facility safety in nonreactor nuclear facilities. Human factors focuses on facility and equipment design that reflects sensitivity to human capabilities and limitations, and considers human reliability and the contribution of human error to facility risk. This chapter is written using the guidance provided by DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for use with DOE O 420.1A, Facility Safety*.[2]

13.3 Human Factors Process

WP 12-NS.06, Human Factors Evaluation Updates,[3] implements the requirement for a human factor evaluation of the RH waste handling process and human-machine interface at the WIPP. Human factors is addressed in WP 09-CN3018, Design Verification,[4] as part of the overall design considerations applied to new or modified designs to the WIPP SSCs. WP 02-RP.03, WIPP Human Factors Evaluation Report,[5] analyzed the adequacy of human factors with respect to RH waste handling process. The evaluation identified human-machine interactions, including the activities of surveillance, maintenance, and normal, abnormal, and emergency operations, to ensure safety was not comprised.

13.4 Identification of Human-Machine Interfaces

Chapter 4 of this RH documented safety analysis (DSA) identifies the safety class (SC) and safety significant (SS) SSCs based on accident analysis in Chapter 3.

SC SSCs that require human-machine interactions are listed below. The remainder of the SS SSCs summarizaed in Chapter 4 of the RH DSA require no human-machine interface to ensure the safety function is present.

SC SSC	Human-Machine Interface Requirement(s)
Automatic/manual fire suppression system on the underground diesel powered RH waste handling equipment including the 41-ton forklift and the 20-ton forklift	The fire suppression system is automatic in the event of a fire on the underground diesel powered waste handling equipment. The system requires surveillances as described in Chapter 5 of this DSA and maintenance in accordance with National Fire Protection Association (NFPA) 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.[6]

SS SSCs that require human-machine interactions are listed below. The remainder of the SS SSCs summarized in Chapter 4 of the RH DSA provide a passive safety function and require no human-machine interface to ensure the safety function is present.

SS SSC	Human-Machine Interface Requirement(s)
WHB Shielding Interlocks - Cask Unloading Room (CUR) Shield Door, Upper Hot Cell Shield Plugs, and Upper Hot Cell Crane	The CUR shield door, the upper hot cell shield plugs, and upper hot cell crane interlocks must prevent the CUR shield door from opening when waste is being removed from a 10-160B in the CUR or items are being transferred between the CUR and upper hot cell when waste is in the upper hot cell, and prevent the hot cell shield plugs from being removed when a 72-B shipping cask is being processed through the CUR. The interlocks require surveillance as described in Chapter 5 of this DSA and periodic maintenance.
WHB Interlocks - Facility Cask Loading Room (FCLR) Grapple Hoist and Shield Bell, Telescoping Port Shield, Facility Cask, and Transfer Cell Ceiling Shield Valve	The interlocks ensure that the telescoping port shield is mated to the bottom shield valve of the facility cask and the shield bell is mated to the top of the facility cask prior to the FCLR grapple hoist lifting a RH waste canister from the transfer cell into the facility cask to provide shielding for worker protection, and to prevent closure of the facility cask shield valves on the grapple hoist ropes or a waste canister. The interlocks require surveillance as described in Chapter 5 of this DSA and periodic maintenance.
WHB Interlocks - Grapple Hoist, Telescoping Port Shield, Facility Cask, Facility Cask Rotating Device, and Facility Cask Transfer Car	The grapple hoist, telescoping port shield, facility cask, facility cask rotating device (FCRD), and the facility cask transfer car interlocks must ensure that the facility cask transfer car cannot move while the facility cask is in the vertical position, the FCRD cannot rotate the facility cask to the horizontal position while the telescoping port shield is in contact with the facility cask bottom shield valve, the telescoping port shield cannot retract while the grapple hoist is not at its fully retracted position, and the grapple hoist cannot go to its fully retracted position until the RH waste canister is resting on the facility cask bottom shield valve. The interlocks require surveillance as described in Chapter 5 of this DSA and periodic maintenance.
WHB Interlocks - Transfer Cell Shuttle Car, CUR Shield Valve, Upper Hot Cell Shield Valve, and Transfer Cell Ceiling Shield Valve	The transfer cell shuttle car, the CUR shield valve, the upper hot cell shield valve and transfer cell ceiling shield valve interlocks are required to ensure that the transfer cell shuttle car cannot move during transfer of a waste canister between rooms within the hot cell complex where RH waste is processed to prevent breaching a canister either by crushing a waste canister or shearing the grapple/crane ropes that are supporting the canister. The interlocks require surveillance as described in Chapter 5 of this DSA and periodic maintenance.
Underground Interlocks - HERE , Facility Cask, and Shield Collar	Interlocks must ensure the facility cask front or rear shield valve cannot be opened unless the HERE tilt sensors show the transfer mechanism is aligned with the alignment fixture, the alignment fixture proximity switches detect the facility cask, and the transfer mechanism proximity switches detect the facility cask. Further, the shield valves on the facility cask cannot be closed if the HERE transfer mechanism is extended beyond either shield valve. The interlocks require surveillance as described in Chapter 5 of this DSA and periodic maintenance.

Underground Ventilation System	Required to provide sufficient airflow to direct airflow away from workers during waste handling in the event of a waste container breach. Sufficient airflow must also be maintained to facilitate evacuation of underground workers in the event of underground fires. The underground ventilation system is required to provide at least 20,000 scfm at the base of the waste shaft and 42,000 scfm in the active disposal room. The technical safety requirements (TSRs) require daily check of the minimum airflow in active disposal room and in the waste shaft ventilation circuit.
Fire Water Supply and Fire Suppression System for the WHB	The fire water supply and WHB fire suppression system must automatically actuate and provide fire suppression sufficient to keep any fire from developing into a large fire that impacts RH or CH waste. The system requires surveillances as described in Chapter 5 of this DSA and maintenance in accordance with NFPA 25.[6]
Waste Hoist Brakes	The waste hoist brakes are required to stop movement of the waste shaft conveyance upon loss of power or hydraulic pressure under all modes of operation including maximum speed and maximum load at any location along the shaft. The waste hoist brakes can stop the fully loaded waste shaft conveyance under all emergency stop conditions. The redundant brakes are designed so that either set is capable of stopping the waste shaft conveyance when the conveyance carries the maximum payload at the maximum hoisting depth. The TSRs require an administrative control to perform preoperational checks on the waste hoist brakes at the beginning of each shift, prior to placing the waste hoist in service
Fence around the Waste Shaft Collar	Provides a barrier to prevent inadvertent access to the waste shaft and prevents uncontrolled access to the shaft. Requires periodic visual inspection for proper operation and to ensure the configuration and change control process that invokes the unreviewed safety question process for a review of all design changes.

Maintenance on SSCs in waste handling areas is done during periods when no waste is being actively handled. When something unusual happens during waste handling operations, or if support systems become unavailable, waste handling can be stopped until an acceptable operating condition is reestablished.

13.5 Optimization of Human-Machine Interfaces

General considerations in optimization of human-machine includes adequate space, lighting, and arrangement of controls, indications, and alarms to accommodate the operator. Emergency audible and visual alarms are provided throughout the underground and surface structures. Doors used for egress are designed for ease of opening in the direction of emergency egress travel.

As part of the design and design verification process, WP09-CN3018[4] includes a checklist to be used as a guide when performing a formal design review. WP09-CN3018[4] addresses several human factors parameters including, instrumentation and control requirements, equipment redundancy, normal and emergency access requirements, personnel requirements and limitations, interface requirements between installed designs and maintenance, radiation protection considerations, and incorporation into the design considerations important to preventing or reducing undue risk to the health and safety of site personnel and the public. The facility design provides adequate space and a favorable environment in which to accomplish maintenance activities. The layout and design of equipment controls and instrumentation, and associated labeling are considered in the design process and also during procedure verification of operating procedures.

WP04-CO, Conduct of Operations,[7] and implementing procedures address, among other items, communication, operator aids, equipment and instrumentation control, component labeling and procedure validation and verification, staffing levels, training requirements, allocation of control function, and facility status turnover between shifts. Training and procedures are discussed in Chapter 12 of this DSA.

WP 10-2, Maintenance Operations Instruction Manual,[8] ensures that human-machine interfaces for maintenance are deliberate and post maintenance and testing is required before an item is returned to service. Operational checklists are completed on waste handling equipment prior to any waste handling activities.

DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*,[9] specifies requirements for a worker protection program. MP 1.12, Worker Protection Policy,[10] provides guidance for a systematic process that ensures safety is integrated into management and work practices at all levels of the organization so that the mission is accomplished while protecting the workers, the public, and the environment. WP 12-IS.01, Industrial Safety Program,[11] as well as its subdocuments and implementing procedures, addresses safe work environments, including physical access, need for protective clothing or breathing apparatus, noise levels, temperature, humidity, ergonomics, and other factors bearing upon physical comfort, alertness and fitness.

Chapter 5 of this DSA derives the WIPP RH TSRs and addresses the required staffing levels for RH waste handling activities, programs that ensure the facility is operated and maintained to protect the workers, public, and environment, and specific administrative actions to prevent accidents from occurring.

Chapter 3 of this DSA discusses human errors as they apply to accidental releases of radioactive or hazardous materials as an integral part of postulated accidents. The analysis of those accidents shows that the SC and SS SSCs, DOE/WIPP-02-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant[12] (referred to in this DSA as the RH WAC), facility design, safety management programs, and operational controls provide confidence that releases can be contained without sophisticated human-machine interfaces.

References for Chapter 13

1. DOE Order 420.1A, *Facility Safety*, U.S. Department of Energy, May 2002.

2. DOE Guide 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for use with DOE O 420.1, Facility Safety*, U.S. Department of Energy, March 2000.

3. WP 12-NS.06, *Human Factors Evaluation Updates*.

4. WP 09-CN3018, *Design Verification*.

5. WP 02-RP.03, *Waste Isolation Pilot Plant (WIPP) Human Factors Evaluation Report*, May 2002.

6. NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, National Fire Protection Association.

7. WP 04-CO, *Conduct of Operations*.

8. WP 10-2, *Maintenance Operations Instruction Manual*.

9. DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, March 1998.

10. MP 1.12, *Worker Protection Policy*.

11. WP 12-IS.01, *Industrial Safety Program - Structure and Management*.

12. DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, 2005.

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QUALITY ASSURANCE

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QUALITY ASSURANCE

14.1 Introduction

This chapter describes the aspects of the Washington TRU Solutions LLC (WTS) quality assurance (QA) program which are pertinent to safety analysis at the Waste Isolation Pilot Plant (WIPP). The following QA features are described in this chapter:

- QA program and organization
- Personnel training and qualification
- Quality improvement processes
- Documents and records
- Work processes
- Design
- Procurement
- Inspection and acceptance testing
- Management assessments
- Independent assessments

WTS applies a graded approach, in accordance with 10 CFR Part 830, *Quality Assurance Requirements*,[1] DOE Order 414.1B, *Quality Assurance*,[2] and DOE-CBFO-94-1012, DOE Carlsbad Field Office Quality Assurance Program Document (CBFO QAPD),[3] for the application of QA requirements to WIPP items and activities. The graded approach process determines the level of controls appropriate for each item or activity, commensurate with the following criteria:

- Functional Classification
- Importance of an item or activity with respect to safety, waste isolation, and regulatory compliance
- Importance of the data to be generated
- The need to demonstrate compliance with specific regulatory, design, and QA requirements
- Impact on the results of performance assessments and engineering analyses
- Magnitude of any hazard or the consequences of failure
- Life-cycle stage of a facility or item
- Programmatic mission of a facility
- Particular characteristics of a facility, item, or activity
- Relative importance of radiological and nonradiological hazards

The WTS graded approach process is implemented in WP 13-QA3005, Graded Approach to Application of QA Controls.[4]

14.2 Requirements

The following documents form the basis for the WTS QA program:

- 10 CFR Part 830 Subpart A[1] applies to contractor work at nuclear facilities. It requires contractors to have a written QA program based on the ten criteria in 10 §CFR 830.122, applied using a graded approach.
- DOE Order 414.1B[2] applies to all DOE work that is not regulated by other agencies/programs. It applies to non-nuclear work at the WIPP. It requires both the DOE and its contractors to have a written QA program based on the ten criteria in DOE Order 414.1B,[2] applied using a graded approach.
- 40 CFR §194.22, "Quality Assurance,"[5] requires the DOE to have a QA program at the WIPP based on ASME NQA-1-1989 Edition, Quality Assurance Program Requirements for Nuclear Facilities (NQA-1).[6]
- The CBFO QAPD[3] consolidates and incorporates the requirements from 10 CFR Part 830, Subpart A[1], DOE O 414.1B[2], NQA-1-1989[6], and other relevant requirement documents. The CBFO QAPD[3] establishes QA program requirements for all quality affecting programs, projects, and activities sponsored by the CBFO.

14.3 Quality Assurance Program and Organization

14.3.1 Quality Policy

WTS is committed to developing, implementing, and maintaining a formal QA program that ensures the highest standards of performance. Problems are identified, graded by importance, tracked, corrected and evaluated for trends so that recurrence is avoided and performance may be improved. Work processes are fundamental to worker safety with respect to work planning and control. Management assessments, defined in WP 04-IM1000, Issues Management Program,[7] are the tools for continued improvement at the WIPP facility.

14.3.2 Program Description

The WTS QA program is defined in WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description (WTS QAPD),[8] and implemented in WTS procedures. WTS has incorporated each requirement in the CBFO QAPD implementation through QA Department audits, surveillances, and reviews. In addition, WTS reviews requirements documents cited in Section 14.2, and revisions, and maintains the WTS QAPD current with their requirements.

The WTS QAPD requires that work is planned, documented, performed under controlled conditions, and periodically assessed to establish work item quality and process effectiveness, and promote improvement. Effective implementation of the WTS QA program is dependent on the efforts of all levels of the WTS organization. Responsibilities are assigned to management and personnel of all WTS organizations for planning and achieving quality and promoting continuous improvement.

14.3.3 Organization and Responsibilities

The WTS General Manager has overall responsibility and authority for the development and implementation of the QA program. The WTS QA manager reports to the WTS General Manager.

1 The QA manager has the following specific responsibilities and authorities (delineated in the
2 WTS QAPD):[8]

3 • Develop, establish, and interpret the overall WTS QA policy and ensure effective implementation.

4 • Maintain liaison with QA organizations from other WIPP participants and other affected organizations.

5 • Ensure QA Department involvement in decisions or commitments which directly affect nuclear safety or waste isolation at the WIPP.

6 • Prepare, maintain, and improve the WTS QAPD.[8]

7 • Prepare and maintain QA plans and procedures that implement the QA program.

8 • Review WTS procedures that implement the QA program.

9 • Schedule and conduct QA independent oversight, including assessments.

10 • Evaluate the adequacy of and approve supplier QA programs.

11 • Track and perform trend analysis of quality problems, and report quality problem areas.

12 • Provide for the administrative processing of documentation concerning conditions adverse to quality.

13 • Be sufficiently independent from cost and schedule considerations.

14 • Have the organizational freedom to effectively communicate with other senior management positions.

15 • Have no assigned responsibilities unrelated to the QA program that would prevent appropriate attention to QA matters.

16 • Assist other departments and sections with quality planning, documentation, measurement, problem identification, and the development of problem solutions.

17 • Provide guidance to all applicable subordinate organizations concerning identification, control, and protection of QA records.

18 • Have sufficient authority, access to work areas, and organizational freedom to:

  – Identify quality problems
  – Participate in development of solutions
  – Verify implementation of solutions
  – Ensure that unsatisfactory conditions are controlled until proper disposition has occurred.

- Disseminate information pertinent to quality performance, including:
  - Status of development and implementation of the QA program
  - Status and resolution of significant quality problems
  - Lessons learned from significant quality problems and adverse conditions
  - Quality management practices and improvements
  - Trend analysis results

Section managers reporting to the QA manager oversee specific QA functions, including:

- Assessments
- Inspections
- QA engineering
- QA programs
- Continuous improvement programs

The QA Department maintains sufficient staffing to support its responsibilities at the WIPP. QA is the only function of QA personnel (other than miscellaneous administrative duties).

14.3.3.1 WTS Departments

Department managers representing the primary functional organizations report directly to the General Manager. The WTS organizational structure is described in Chapter 17.

Department managers are responsible for implementing the WTS QAPD[8] and have the following specific QA responsibilities (delineated in the WTS QAPD):[8]

- Provide the necessary organization, direction, control, resources, and support to achieve their defined objectives.
- Plan, perform, and improve the work.
- Establish and implement policies and procedures that control the quality of work in accordance with the QA program.
- Provide technical and QA training for personnel performing work.
- Ensure compliance with applicable regulations, DOE Orders, requirements, and laws.
- Ensure that personnel adhere to procedures.
- Stop unsatisfactory activities, if necessary, to ensure that cost and schedule do not override environmental, health, safety, and quality considerations.
- Develop, implement, and maintain plans, policies, and procedures that implement applicable portions of the QA program.

- Identify, investigate, report, and correct quality problems.
- Disseminate information pertinent to quality performance.

Line managers are responsible for defining quality requirements for work. Workers are responsible for achieving and maintaining quality in their work, and for promptly reporting to management any condition adverse to quality.

14.3.3.2 Personnel Qualification

Qualification requirements for personnel performing quality related work, including managers, designers, scientists, independent assessment personnel, operators, maintenance personnel, technicians, and inspectors, are established and documented in the WTS training program.

WP 13-QA.04, Quality Assurance Department Administrative Program,[9] defines training and indoctrination requirements for all WTS QA personnel. Inspection and test, nondestructive examination, and assessment personnel are qualified in accordance with the WTS QAPD,[8] WP 13-QA.04,[9] and WP 14-TR.01, WIPP Training Program,[10] to meet the requirements of NQA-1-1989[6] and supplements.

The WIPP training program is described in Chapter 12.

14.4 Quality Improvement

WTS has established processes to detect and prevent adverse quality conditions and to promote quality improvement. Preventive actions are taken, through design, procurement, and other process controls and assessment activities described in the WTS QAPD,[8] to prevent or reduce the probability of occurrence of quality problems. Items and processes that do not meet established requirements are identified, controlled, and corrected. Correction includes identifying the causes of adverse conditions and working to prevent recurrence. All personnel are responsible for identifying nonconforming items, activities, and processes and are encouraged by management to suggest improvements. Quality improvement requirements are delineated in the WTS QAPD.[8]

Control of nonconforming items (i.e., items and materials that do not conform to specified requirements or whose conformance is indeterminate) is implemented in WP 13-QA3004, Nonconformance Report.[11] Nonconforming items are documented on Nonconformance Reports; controlled to prevent inadvertent use; identified by marking, tagging, or other appropriate means; and segregated or controlled administratively. The nonconforming characteristics are reviewed, and recommended dispositions are proposed and approved. Implementation of the disposition is verified by the QA Department before the Nonconformance Report is closed.

Control of conditions adverse to quality (i.e., programmatic and/or process failures, malfunctions, deficiencies, and nonconformances) is implemented in WP 04-IM1000, Issues Management Program Processing of WIPP Forms.[7] Conditions adverse to quality are documented on WIPP Forms. All WTS personnel are responsible for identifying and reporting conditions adverse to quality. Responsible management investigates conditions adverse to quality, determines the extent and impact of the condition, and determines the corrective action response.

Significant conditions adverse to quality, as defined in the WTS QAPD,[8] are reported to and evaluated by the QA Department, relevant regulatory compliance functions, and the appropriate management responsible for the condition, to determine if a work suspension order is necessary. If necessary, work is suspended until the condition is corrected and verified by the QA Department. Any WIPP employee having a concern for employee safety, the safety of the environment, or the quality or regulatory compliance of an activity has the responsibility and authority to suspend the performance of that activity. The QA Department verifies implementation of corrective actions for significant conditions adverse to quality before the WIPP Form is closed.

The WTS improvement analysis process is implemented in WP 13-QA3006, Data Analysis and Trending.[12] WTS performs a periodic site evaluation and trend analysis of performance indicating data. Performance data is identified, collected, and analyzed to identify adverse quality trends and opportunities to improve items, activities, and processes. Results are reported to responsible management and organizations responsible for corrective action.

14.5 Documents and Records

Document review, approval, issuance, and control requirements are delineated in the WTS QAPD.[8] Documents which prescribe processes, specify requirements, or establish design are prepared, approved, issued, and controlled in accordance with approved procedures. Documents are reviewed for adequacy, correctness, and completeness, by designated technically competent reviewers, prior to approval and issuance as controlled documents. The QA Department reviews documents that translate QA requirements into implementing documents to ensure that QA program requirements are properly implemented.

Document changes are indicated in the changed document and reviewed by the organizations or technical disciplines affected. Editorial or minor changes may be made without the same level of review and approval as the original or otherwise changed document.

The distribution and use of documents and forms is controlled. Documents used to perform work are distributed to affected personnel and used at the work location. Effective dates are established for and placed on approved documents. Controls are established and maintained to identify the current status/revision of documents and forms. Obsolete or superseded documents and forms are controlled to avoid their inadvertent use.

Implementation of the WTS procedure process is described in Chapter 12.

Records management requirements are delineated in the WTS QAPD.[8] The WTS records management program is implemented in WP 15-PR, WIPP Records Management Program.[13]

Records are specified, prepared, reviewed, approved, controlled, and maintained to accurately reflect completed work and facility conditions and to comply with statutory or contractual requirements. QA records are completed documents (regardless of medium) that furnish evidence of the quality of items and/or activities. Implementing procedures identify the records they generate. Such records are designated as QA records when applicable in the Records Inventory and Disposition Schedule (RIDS), defined in WP 15-PR.[13] QA records are classified according to their retention times in the RIDS.

QA records are provided reasonable protection from damage until completed, authenticated, and submitted to the records management system. Requirements and responsibilities for QA record transmittal, distribution, receipt, indexing, retention, maintenance, storage, disposition, and retrievability are established in WP 15-PR.[13] Disposition requirements for individual records are documented in the RIDS. The records storage arrangements provide adequate protection of records to preclude damage from fire, moisture, temperature, rodent infestation, excessive light, electromagnetic fields, or stacking as deemed appropriate for the type of record being stored.

14.6 Quality Assurance Performance

14.6.1 Work Processes

Each person who performs work at the WIPP is responsible for the quality of his or her work. Work is performed to established, approved, and documented technical standards and administrative controls, and under controlled conditions using approved instructions, procedures, drawings, or other appropriate means. Items are identified and controlled to ensure their proper use, and maintained to prevent their damage, loss, or deterioration.

Quality requirements for performance of work are delineated in the WTS QAPD[8] and implemented in WP 10-2, Maintenance Operations Instruction Manual[14] and WP 04-CO, Conduct of Operations.[15] Specific QA requirements which affect the performance of work by all organizations are incorporated into each organization's procedures.

Personnel performing work are responsible for the quality of their work. Because the individual worker is the first line in ensuring quality, personnel are required to be knowledgeable of requirements for work they perform and the capability of the tools and processes they use. Line managers ensure that personnel working under their supervision are qualified and are provided the necessary training, resources, and administrative controls to accomplish assigned tasks. Criteria describing acceptable work performance are defined for the worker. Line managers periodically review work and related information to ensure that the desired quality is being achieved, and to identify areas needing improvement. Work is planned, authorized, and accomplished under controlled conditions using technical, quality, and implementing procedures commensurate with the complexity and risk of the work.

Individuals performing work comply with applicable implementing procedures. When work can not be accomplished as described in the implementing procedure or accomplishment of such work would result in an undesirable situation, condition adverse to quality, or an unacceptable safety risk, the work is suspended and the procedure changed in accordance with the approved procedure change process.

Quality requirements for item identification and control are delineated in the WTS QAPD.[8] Items are identified and controlled to ensure their proper use, and maintained to prevent their damage, loss, or deterioration. Traceability requirements are specified in design documents or supporting implementation procedures. Items are identified by physical marking or by other appropriate means. Records are maintained to ensure that the item can be traced at all times from its source through installation or end use. The status of inspections, tests and special controls is identified either on the item(s) or in documents traceable to the item(s). Items with limited operating or shelf life are identified to prevent the use of items where the shelf life or operating life has expired.

WP 09-CN3021, Component Indices,[16] and WP 15-PM3517, Stores Inventory Control,[17] implement requirements for item identification and control. Suspect/counterfeit items are controlled in accordance with WP 13-QA.05, Suspect/Counterfeit Items Program.[18]

Quality requirements for handling, storage, and shipping are delineated in the WTS QAPD.[8] Handling, storage, cleaning, shipping, and other means of packaging, transporting, or preservation of items is conducted in accordance with established work and inspection implementing procedures, shipping instructions, or other specified documents. Items are marked or labeled as necessary to adequately identify, maintain, and preserve them. Special environments or controls are indicated as necessary.

Handling, storage, and shipping requirements are implemented in WP 15-PM3517,[17] and the WIPP shipping procedures for various organizations.

Quality requirements for control of special processes are delineated in the WTS QAPD.[8] Special process parameters are controlled, and specified environmental conditions are maintained through implementing procedures, which specify requirements for qualification of personnel, process(es), and equipment, and conditions necessary for completing the special process.

Nondestructive examination processes are controlled in accordance with WP 13-QA.06, Quality Assurance Department Qualification and Certification of Nondestructive Examination Personnel,[19] and individual nondestructive examination method procedures. Code welding is controlled through the work instruction process in accordance with WP 10-2.[14]

14.6.2 Design

Quality requirements for design control are delineated in the WTS QAPD[8] and implemented in WP 09, Engineering Conduct of Operations.[20] Cognizant system engineers are responsible for design, design modifications, associated design documentation such as drawings and specifications, procurement, installation instructions, and testing of structures, systems and components at WIPP.

Items and processes are designed using sound engineering/scientific principles and appropriate standards. Design work, including changes, incorporates appropriate requirements such as general design criteria and design bases. Design interfaces are identified and controlled. The adequacy of design products is verified by individuals or groups other than those who performed the work. Verification work is completed before approval and implementation of the design. In establishing design controls, management is responsible to ensure that design inputs are technically correct; that design interfaces are identified; that authorities, responsibilities, and lines of communication are clearly defined; and that the design processes clearly define the acceptance criteria for the product.

Applicable design inputs are controlled by those responsible for the design. The design process is controlled by procedure. The codes and standards applied to the design are based on the functional classification of the item being designed as discussed in Chapter 2 of this documented safety analysis (DSA). Computer software used to perform design analyses is developed and qualified.

New designs or modifications to existing designs undergo design verification. Design verification is performed using one or a combination of the following methods: design review, alternate calculations, or qualification testing. Design verification takes place prior to release for procurement or manufacture, construction, or to another organization for use in other design work, and is completed before relying on the item to perform its function. Design verification is performed by qualified individuals other than those who performed the design. Formal design review processes independently verify compliance of the design with applicable requirements specified in design input documents. Assumptions, design method, and output are compared and considered to disclose any discrepancies. Alternative calculations are made with alternate methods to verify correctness of the original calculations or analyses. Qualification testing demonstrates the adequacy of performance under conditions that simulate the most adverse design conditions on all components of the system or structure. Modifications to existing designs are approved by the same groups or organizations that reviewed and approved the original design documents.

14.6.3 Procurement

Quality requirements for procurement are delineated in the WTS QAPD.[8] Procurement planning, documentation, selection of suppliers, evaluation of supplier performance, and acceptance of purchased items and services are the elements of procurement control implemented at the WIPP. The WTS has established processes that ensure that procured items and services meet established technical and QA requirements and that they perform as specified.

Procurement planning and document requirements are implemented in WP 15-PC3609, Preparation of Purchase Requisitions,[21] and WP 13-QA3012, Supplier Evaluation/Qualification.[22] Procurement of items and services is planned and controlled to ensure that technical and QA requirements are accurate, complete, and clearly understood by suppliers. Procurement documents define the scope of work and requirements applicable to the item or service being procured. Procurement documents are prepared by the WIPP personnel who complete training, as specified in WP 15-PC3609,[21] and are reviewed prior to issuance to verify that the documents include appropriate provisions to ensure that items or services meet the prescribed requirements. Procurement document reviews include representatives from affected technical organizations, and the QA Department for items and services subject to the QA program.

The QA Department is responsible for performing supplier evaluations for quality-related items and services, in accordance with WP 13-QA3012.[22] Supplier selection is based on an evaluation of the supplier's capability to provide items or services in accordance with procurement document requirements. The evaluation is based on the supplier's history, documentation, or an onsite evaluation of the supplier's facilities, personnel, and quality program implementation. Suppliers are evaluated and accepted by the QA Department before starting work. Approved suppliers are evaluated periodically to verify that they continue to provide acceptable items and services.

Quality related items and services are accepted using specified methods such as source verification, receipt inspection, post-installation tests, certificates of conformance, or a combination of these methods. Quality-related items and services are inspected and accepted in accordance with QA procedures.

14.6.4 Inspection and Testing for Acceptance

Quality requirements for inspection and testing are delineated in the WTS QAPD.[8] Inspections and tests are planned and performed in accordance with approved implementing procedures, using established performance and acceptance criteria. Items and processes are inspected to verify quality at all stages, including source, receipt, in-process, final, and in-service inspections. Items and processes to be inspected or tested, parameters or characteristics to be evaluated, techniques to be used, acceptance criteria, hold points, and the organizations responsible for performing the tests and inspections are identified during the work planning process. Inspection and test requirements are incorporated into the work process and documented using work instructions and hold and witness points, in accordance with QA inspection procedures and WP 10-2.[14] Inspection and test results are documented, and conformance to acceptance criteria is evaluated and documented.

Inspection for acceptance of quality-related items and processes is performed by QA personnel. QA personnel perform nondestructive examinations, receipt, source, and plant inspections, and verify tests as required by work instructions. Inspection and nondestructive examination requirements are implemented in QA procedures.

Test procedures include or reference test objectives and provisions for ensuring that prerequisites have been met, that adequate instrumentation is available and used, that necessary monitoring is performed, and that suitable environmental conditions are maintained. Test results are evaluated by a responsible authority to ensure that test requirements have been satisfied. Test requirements are implemented in WP 09-SU.01, WIPP Start-Up Test Program,[23] and accomplished through test procedures or work instructions in accordance with WP 10-2[14]. The cognizant system engineers are responsible for determination, implementation, and verification of start-up, acceptance, and postmodification testing.

The status of inspections and tests is identified either on the items, or in documents traceable to the items, to ensure that required inspections and tests are performed, and that items that have not passed the required inspections and tests are not inadvertently installed, used, or operated. Nonconforming items and conditions adverse to quality found during inspections and tests are controlled in accordance with WTS nonconformance procedures.

Personnel who perform inspections or tests to verify conformance of items to specified acceptance criteria are qualified in accordance with approved procedures to meet qualification requirements established in the WTS QAPD.[8] Qualification requirements are implemented in WP 13-QA.04,[9] and WP 09-SU.01.[23]

WTS ensures that monitoring, measuring, testing, and data collection equipment used for quality-related inspections and tests is controlled, and calibrated at maintain specified accuracy. Equipment used for inspections and tests is verified to have a current calibration label. Damaged equipment or equipment whose calibration has expired or is suspect is removed from service and controlled until recalibrated/repaired. Calibration requirements are implemented in WP 10-AD.01, Metrology Program[24] and WIPP maintenance procedures.

14.6.5 Independent Assessments

Independent assessment requirements are delineated in the WTS QAPD[8] and are implemented in WP 13-QA.03, Quality Assurance Independent Assessment Program.[25] Planned and periodic assessments are conducted to measure management effectiveness, item and service quality and process effectiveness, and to promote improvement. Management assessments are performed or directed by managers to assess the effectiveness of their organizations' processes. Independent assessments are performed by a group or organization having authority and freedom, sufficient to carry out its responsibilities, from the line organization being assessed. Persons conducting assessments are technically qualified and knowledgeable of the items and processes to be assessed.

14.6.5.1 Audits

The QA Department plans and performs audits to determine the effectiveness of the QA program and compliance with implementing procedures. The QA Department develops an annual audit schedule. An audit plan is developed and documented for each audit. The audit plan includes the scope, requirements, purpose, audit personnel, work to be assessed, organizations to be notified, and schedule. Audits include technical evaluations of procedures, instructions, activities, and items. Past audit results are reviewed to determine whether corrective actions were effective.

Audit team members are selected on the basis of technical qualification and knowledge of the item and/or process being audited. A lead auditor is appointed to indoctrinate and supervise the team, organize and direct the audit, and coordinate the preparation and issuance of the audit report. Lead auditors are qualified in accordance with WP 13-QA.04,[9] and WP 14-TR.01,[10] to meet qualification requirements in the WTS QAPD.[8]

Audit results are documented and reported to responsible management. Conditions adverse to quality are controlled in accordance with WTS assessment and nonconformance procedures. Responsible management investigates and corrects audit findings (conditions adverse to quality). The QA Department evaluates and approves the adequacy of proposed corrective actions and verifies their implementation.

14.6.5.2 Surveillances

QA Department personnel perform surveillances of activities to verify conformance with specified requirements and to evaluate their adequacy and effectiveness. Surveillances are used to monitor work in progress, review documentation, document compliance or noncompliance with established requirements and procedures, identify actual and potential deficiencies, and provide notification to responsible managers of the status and performance of work under assessment.

Surveillance results are documented and reported to responsible management. Conditions adverse to quality are controlled in accordance with WTS assessment and nonconformance procedures. Responsible management investigates and corrects surveillance findings (conditions adverse to quality). The QA Department evaluates and approves the adequacy of proposed corrective actions and verifies their implementation.

14.6.6 Management Assessments

WTS uses the management assessment process delineated in the WTS QAPD[8] and implemented in WP 15-GM1000, Management Assessments,[26] to evaluate the adequacy and effectiveness of its management control systems. While retaining overall responsibility for the assessment process, senior management requires managers at all levels to assess the performance of the activities assigned to their organization. This accomplished through a formal management assessment process.

Management assessments include walkdowns, scheduled assessments, reviews, and critiques. Such assessments are planned and performed as an ongoing activity to verify conformance to applicable requirements and identify opportunities to improve performance and cost-effectiveness. Results and conclusions from these assessments are documented and evaluated. Corrective actions are taken to resolve identified problems and to achieve continuous improvement. Provisions are included to track and follow-up on planned corrective actions from the self-assessments.

References for Chapter 14

1. 10 CFR Part 830, Subpart A, "Quality Assurance Requirements."
2. DOE Order 414.1B, *Quality Assurance*, April 2004.
3. DOE-CBFO-94-1012, U.S. Department of Energy Carlsbad Field Office Quality Assurance Program Document, Rev. 6, September 2004.
4. WP 13-QA3005, Graded Approach to Application of QA Controls.
5. 40 CFR §194.22, "Quality Assurance."
6. ASME NQA-1-1989 Edition, *Quality Assurance Program Requirements for Nuclear Facilities*.
7. WP 04-IM1000, Issues Management Program Processing of WIPP Forms.
8. WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.
9. WP 13-QA.04, Quality Assurance Department Administrative Program.
10. WP 14-TR.01, WIPP Training Program.
11. WP 13-QA3004, Nonconformance Report.
12. WP 13-QA3006, Data Analysis and Trending.
13. WP 15-PR, WIPP Records Management Program.
14. WP 10-2, Maintenance Operations Instruction Manual.
15. WP 04-CO, Conduct of Operations.
16. WP 09-CN3021, Component Indices.
17. WP 15-PM 3517, Stores Inventory Control.
18. WP 13-QA.05, Suspect/Counterfeit Items Program.
19. WP 13-QA.06, Quality Assurance Department Qualification and Certification of Nondestructive Examination Personnel.
20. WP 09, Engineering Conduct of Operations.
21. WP 15-PC3609, Preparation of Purchase Requisitions.
22. WP 13-QA3012, Supplier Evaluation/Qualification.
23. WP 09-SU.01, WIPP Start-Up Test Program.
24. WP 10-AD.01, Metrology Program.

25. WP 13-QA.03, Quality Assurance Independent Assessment Program.

26. WP 15-GM1000, Management Assessments.

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EMERGENCY PREPAREDNESS PROGRAM

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EMERGENCY PREPAREDNESS PROGRAM

15.1 Introduction

The WIPP Emergency Management Program, WP 12-9,[1] provides an organized plan of action for dealing with emergencies at the Waste Isolation Pilot Plant (WIPP). This program identifies lines of authority, responsibilities of emergency response personnel and organizations, and the WIPP manpower and equipment resources available to cope with emergencies.

A hazards survey conducted as required by U.S. Department or Energy (DOE) Order 151.1A, *Comprehensive Emergency Management System*,[2] and DOE G151.1-1, *Emergency Management Guide*,[3] is documented in WP 12-RP.01, Emergency Planning Hazards Survey of the Department of Energy Waste Isolation Pilot Plant Report.[4] The report concluded that an emergency planning hazards assessment (EPHA) was required for the WIPP under the same provision.

DOE/WIPP 05-3331, *WIPP Remote-Handled (RH)Waste Handling Emergency Planning Hazards Assessment* (EPHA),[5] analyzes the accident scenarios identified in this documented safety analysis (DSA). In addition, two malevolent acts were analyzed that reflected both moderate and large amounts of material at risk. The spectrum of accidents analyzed in this DSA have been determined to be bounding for the WIPP; hence they are used for emergency planning purposes. The EPHA[5] evaluates the consequences of the DSA accidents and two malevolent acts. The EPHA[5] is reviewed annually and revised as necessary.

The WIPP Emergency Management Program (EMP)[1] is followed to minimize the impact of emergency events upon the health and safety of plant personnel, the general public, and the environment. In events concerning hazardous materials/waste, the WIPP Resource Conservation and Recovery Act (RCRA) Contingency Plan, Attachment F to the WIPP Hazardous Waste Facility Permit (HWFP) (No. NM4890139088-TSDF),[6] is implemented.

Emergency response at the WIPP consists of WP 12-9;[1] the Contingency Plan;[6] and the WP 12-ER Emergency Response Procedures.[7] Emergency events involving DOE operations or property at the WIPP are reported to the DOE Carlsbad Field Office (CBFO).

The EPHA[5] identifies and describes the RH waste handling process and operations, identifies the hazardous materials inside the WIPP Property Protection Area and describes the hazards and hazardous materials that are outside the Property Protection Area. The EPHA[5] also provides accident consequence analysis and identifies the Protective Action Guidelines (*Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*) (PAGs) published by the U.S. Environmental Protection Agency.[8]

The EMP[1] applies to all personnel employed at, or assigned to the WIPP, and defines emergency response roles and responsibilities. The EMP[1] does not include any required DOE radiological response to transportation accidents that occur away from the facility. Such DOE response, if requested by the state, is directed by the cognizant DOE Operations Office. The WIPP personnel are available to support local and state organizations in such cases, as directed by the DOE Albuquerque Operations Office.

15.2 Requirements

The EMP[1] establishes the requirements and procedures in compliance with the following:

- DOE Order 151.1A, *Comprehensive Emergency Management System*[2]
- DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information*[9]
- 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"[10]
- 40 CFR Part 265, Subpart D, "Contingency Plan and Emergency Procedures"[11]
- 40 CFR §265.37, "Arrangements with Local Authorities"[12]
- 40 CFR §265.52(c), "Content of Contingency Plan"[13]
- 29 CFR §1910.120, Paragraph (p), "Certain Operations Conducted Under the Resource Conservation and Recovery Act of 1976"[14]
- HWFP, Attachment F.[6]

Guidelines for radiological exposure related to public and worker health and safety implemented in site emergency procedures are maintained consistent with current PAGs.[8]

Guidelines for hazardous material exposure (other than radiological) related to public and worker health and safety implemented in site emergency procedures are maintained consistent with the *Emergency Response Planning Guidelines* published by the American Industrial Hygiene Association.[15]

15.3 Scope of Emergency Preparedness

The EMP[1] is developed from a spectrum of emergencies identified in this DSA, through the EPHA,[5] and standard workplace hazards. The EPHA[5] identifies, evaluates, establishes emergency action levels (EALs) and selects the range of initiating events, based on this DSA, for emergencies for workers, the public, and the environment.

The EMP[1] applies to safety response actions relative to the following:

- Radiological emergencies
- Waste container breaches in the Waste Handling Building
- Underground emergencies (medical and fire)
- Waste container breaches in the underground
- Severe weather emergencies
- Security (malevolent acts) emergencies
- Earthquakes/seismic events
- Surface emergencies (medical and fire)

15.4 Emergency Preparedness Planning

The EMP[1] identifies necessary actions for dealing with sitewide and area emergencies, and defines the lines of authority. Responsibilities of emergency response personnel and organizations are detailed in the program, including a discussion of the WIPP labor and resources required.

Operational emergencies at the WIPP are classified by EALs that provide specific predetermined criteria allowing the WIPP emergency personnel to categorize operational emergencies. The classification of operational emergencies is detailed in WP 12-ER3904, Categorization and Classification of Operational Emergencies.[16]

15.4.1 Emergency Response Organization

The WIPP Facility Shift Manager (FSM) is the Incident Commander and RCRA Coordinator who is in charge of mitigation activities and ensuring that proper emergency response activities are conducted. The FSM is responsible for activation of the emergency response and/or support teams as needed. The FSM activates the Emergency Operations Center (EOC) for operational emergencies. The Washington TRU Solutions LLC (WTS) General Manager, or designated alternate, functions as the Crisis Manager (CM). Upon activation of the EOC, the CM assists the FSM in ensuring that necessary emergency actions take place or assists with further emergency actions. These actions may involve DOE facilities in Carlsbad. Management of an emergency depends on the time and location of the event as determined by the FSM or CM. Upon activation of the EOC, the WIPP program provides for immediate management response, and for proper notifications to be made during an emergency.

The WIPP has the ability to convene a Crisis Management Team, which is an executive decision-making group tasked specifically to respond to emergencies. The Crisis Management Team consists of several personnel experienced in dealing with emergencies and assembles in the EOC. The Operational Assistance Team may be activated with the Crisis Management Team, to provide technical, logistical, and administrative support. The Operational Assistance Team assembles in the Central Monitoring Room (CMR) area. Individuals on these teams are governed by specific directions found within the WIPP EMP.[1]

Depending upon the location, severity, and type of emergency, the FSM has several Memoranda of Understanding (MOUs) that can be activated. The MOUs between the WIPP and several key community organizations are important aspects of the available protective actions governed by legal cooperation agreements. A tabular summary of these agreements including their purpose is as follows:

- JOINT POWERS AGREEMENT BETWEEN THE UNITED STATES DEPARTMENT OF ENERGY AND THE CITY OF CARLSBAD AND THE COUNTY OF EDDY AND NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT FOR A JOINT-USE ALTERNATE EMERGENCY OPERATIONS CENTER. This MOU directs that the parties involved shall share in establishing and maintaining an alternate EOC.

- MUTUAL AID FIREFIGHTING AGREEMENT BETWEEN THE EDDY COUNTY COMMISSION AND THE U.S. DEPARTMENT OF ENERGY. This Agreement provides for the actual assistance of the parties in the furnishing of fire protection for the Eddy County Fire District and the WIPP site.

- FEDERAL BUREAU OF INVESTIGATION/DEPARTMENT OF ENERGY MEMORANDUM OF UNDERSTANDING. This MOU deals with threats and criminal acts associated with theft, sabotage, or hostage attempts against the DOE-AL sites within the state of New Mexico.

1 • MEMORANDUM OF UNDERSTANDING BETWEEN THE DOE AND THE U.S. DEPARTMENT OF INTERIOR, ROSWELL DISTRICT. This agreement provides for a fire management program that ensures a timely, well coordinated, and cost effective response to suppress wild fire within the land withdrawal area.

2 • MEMORANDUM OF UNDERSTANDING BETWEEN THE UNITED STATES DEPARTMENT OF ENERGY AND THE NEW MEXICO DEPARTMENT OF PUBLIC SAFETY CONCERNING MUTUAL ASSISTANCE AND EMERGENCY MANAGEMENT. The MOU applies to any actual or potential emergency or incident that: involves a significant threat to employees, or the public; involves DOE property; involves threat to environment reportable to an off-site organization; requires combined resources of the DOE and the state; requires DOE resources unavailable from the state or vice versa; involves any other incident for which a joint determination has been made by the DOE and the state that the provisions of this MOU apply.

3 • AGREEMENT BETWEEN CBFO MANAGER, U.S. DEPARTMENT OF ENERGY, INTREPID MINING, LLC., and MOSAIC CORP. This agreement provides for mine operators having two mine rescue teams available whenever miners are underground, and backup rescue capability is deemed desirable.

4 • MEMORANDUM OF UNDERSTANDING: EMERGENCY RADIOLOGICAL TREATMENT CENTER FOR THE WASTE ISOLATION PILOT PLANT PROJECT BETWEEN THE U.S. DEPARTMENT OF ENERGY AND CARLSBAD MEDICAL CENTER. This MOU provides for an Emergency Radiological Treatment Center at the Carlsbad Medical Center.

5 • MUTUAL AID AGREEMENT BETWEEN THE CITY OF CARLSBAD AND THE U.S. DEPARTMENT OF ENERGY. This agreement authorizes assistance in times of declared emergency where the enormity of the emergency exceeds the response capability of the responsible jurisdiction.

6 • MUTUAL AID AGREEMENT BETWEEN THE CITY OF HOBBS AND THE U.S. DEPARTMENT OF ENERGY. This agreement authorizes assistance in times of declared emergency where the magnitude of the emergency exceeds the response capability of the responsible organization.

7 • INTERAGENCY AGREEMENT BETWEEN THE U.S. BUREAU OF LAND MANAGEMENT AND THE U.S. DOE, AND THE U.S. NATIONAL PARK SERVICE (NPS), AND THE U.S. FOREST SERVICE. This agreement provides for assistance in search and rescue missions and training.

8 • MEMORANDUM OF UNDERSTANDING BETWEEN U.S. DOE AND LEA REGIONAL HOSPITAL (L. H.). This MOU provides for an Emergency Radiological Treatment Center.

9 All on-site emergencies shall be reported immediately to the CMR Operator, who gathers specific
10 information relating to the incident and reports that information to the FSM.

11 Other personnel involved with emergency response are:

12 **Emergency Services Technician (EST) -** An EST is a WTS employee whose job is that of full-time
13 emergency responder. The EST responds to emergencies that threaten lives or property at the WIPP

(e.g., medical, fire, hazardous material). The EST reports information pertaining to emergencies to the FSM. ESTs are responsible for keeping the assigned emergency apparatus in good operating condition. ESTs are also responsible for the safe operation of the apparatus and the safety of others involved with the apparatus.

Mine Rescue Teams (MRTs) - The MRTs are responsible for underground reentry and rescue. The MRTs are trained in accordance with 30 CFR Part 49, "Mine Rescue Teams."[17]

15.4.2 Assessment Actions

15.4.2.1 Basis for the Recognition and Declaration of Operational Emergencies

Emergency response actions can be triggered by any of the events listed in Section 15.3. The basis for the recognition and declaration of operational emergencies is the EPHA. The EPHA contains event scenarios ranging from minor to severe, including malevolent acts and events identified in this CH DSA, and the consequences for each event at various receptor locations, including 30 meters, at the Property Protection Area, and the WIPP site boundary. The EPHA identifies the WIPP emergency planning zone and emergency action levels. The EPHA is used by personnel performing WP 12-ER3904[16] to determine the category of an emergency.

15.4.2.2 Recognition and Classification of Operational Emergencies

Operational emergencies are unplanned, significant events or conditions that require time urgent response from outside the immediate/affected facility or area of the incident. Incidents that can be controlled by employees in the affected facility or area are not operational emergencies. Incidents that do not pose a significant hazard to safety, health, and/or the environment and that do not require a time urgent response are not operational emergencies.

Initial activity associated with emergency response includes detection, recognition, categorization, and classification of an emergency event. Events and event symptoms are recognized through direct observation and/or monitoring of indicators. WP 12-ER3904[16] is used by the FSM to determine if an event is to be categorized as an operational emergency and, if required, to be classified as an Alert, Site Area Emergency, or General Emergency. The classification is required when an event has the potential to expose site personnel or the public to hazardous/radioactive materials outside the immediately involved facility.

15.4.2.3 Acquisition of Radiological and Hazardous Material Information

The hazards survey, WP 12-RP.01,[4] determined that the radiological and hazardous material content of the RH transuranic waste received and disposed of at the WIPP, was the source of material at risk (MAR) that could cause an operational event to be classified as an Alert or higher classification.

The WIPP Waste Information System (WWIS) provides an online source of data showing the waste form, type payload, weight, and radionuclide inventory of each waste container shipped to the WIPP. Documents with the WWIS data for each waste container entering the waste disposal process that day are delivered each morning to the EOC. EOC personnel performing dose assessment have access to both the online and printed WWIS radiological data. Additionally, WP 12-ER4916, Consequence Assessment Dose Projection,[18] has an attachment that contains a list of radiological MAR for events described in this RH DSA and the EPHA[5] that can be used for initial dose assessment.

15.4.2.4 Acquisition of Meteorological Information

The WIPP site meteorological monitoring tower is located approximately 1,970 feet northeast of the Waste Handling Building. Instrumentation on the tower measures and records wind speed, wind direction, and temperature at elevations of 2, 10, and 50 meters). The data is displayed in the CMR and in the EOC. WP 12-ER4916[18] is performed in the EOC, and personnel performing the procedure have access to the meteorological information.

15.4.2.5 Estimation of Source Terms and Release Rates

Initial estimates of source terms are determined based on the MAR as identified in the WWIS data or Attachment 4 to WP 12-ER4916.[18] Initial estimates of release rates are determined from the airborne release fractions and respirable fractions listed in Attachment 4 of WP 12-ER4916.[18]

Initial consequence assessment is performed as soon as the EOC is activated and a radiological engineer has reported to the EOC. Consequence assessment is calculated as soon as more definitive information concerning the MAR is received; a greater than 0.5 meter/second wind speed change occurs; or a change in the atmospheric stability class occurs; or thirty minutes elapses since the last calculation.

15.4.2.6 Estimation of Dispersion and Dose Rates

GXQ 4.0,[19] a Gaussian straight line plume model based computer program, is used to calculate atmospheric dispersion and dose. Radiological release dose to the public calculations are performed in accordance with WP 12-ER4916.[18]

15.4.3 Notification

WIPP procedure WP 12-ER3904,[16] provides the instructions for the FSM or designee to determine if an event at the WIPP is to be categorized as an operational emergency and, if required, classified as an Alert, Site Area Emergency (SAE), or General Emergency (GE). The classifications are required when an event has the potential to expose site personnel or the public to hazardous/radioactive materials outside the immediately involved facility. If the event is classified as an Alert, SAE, or GE, procedure WP 12-ER3904,[16] provides instructions for notifying the required external agencies.

If the event is a hazardous/radioactive materials operational emergency, initial consequence assessment is performed to determine the classification of the event. The FSM may direct the EOC or Joint Information Center (JIC) to complete Table 1 of procedure WP 12-ER3904[16] with the most current information, and provide to the EOC Crisis Manager for distribution in accordance with procedure WP 12-ER3002, Emergency Operations Center Activation.[20] WP 12-ER3904,[16] provides instructions for initial notifications, follow-up notifications, and external agencies notification for operational emergencies.

15.4.4 Emergency Facilities and Equipment

15.4.4.1 Emergency Facilities

Central Monitoring Room - The CMR, located in Building 451 (Figure 2.4-1), provides an initial focal point for emergency actions, including communications and response activities. The FSM is located in the CMR where the Central Monitoring System (CMS) is located. The function of the CMS is described in detail in Section 2.8.3.1.

Emergency Operations Center - The EOC is the facility used by the crisis management team and CM to evaluate, perform consequence analysis and assist the FSM as necessary during the emergency. The EOC is located in Building 452 (Figure 2.4-1).

On-Site Alternate EOC - The On-Site Alternate EOC is in the Guard and Security Building, which is a secured area. In the event the primary EOC cannot be activated, the FSM will direct the CMR Operator to activate the On-Site Alternate EOC.

Off-Site Alternate EOC - The Off-Site Alternate EOC is located in the Skeen Whitlock Building in Carlsbad, New Mexico. In addition to its primary purpose of serving the needs of the WIPP, the off-site EOC may provide assistance to the city of Carlsbad, Eddy County, and the state of New Mexico if assistance is requested as part of the MOUs with these entities.

Joint Information Center - The JIC, located at the Skeen-Whitlock Building, provides the Public Affairs Management Team a gathering place for generating information during emergency situations, and is activated as needed. The JIC provides a central location for the coordination and dissemination of emergency pubic information to the media and public.

15.4.4.2 Emergency Equipment

Some of the emergency equipment at the WIPP site include a fully-equipped pumper engine, a brush fire truck, a surface ambulance, with capabilities to respond to off site emergencies and an underground ambulance. The surface emergency equipment is stationed in the Safety building. A detailed list of WIPP emergency equipment appears in Attachment F of the Hazardous Waste Facility Permit No. NM4890139088-TSDF.[6]

Emergency Management conducts regular inspections of emergency facilities using a checklist to document the inspections. The site commitment tracking system is used to tract the completion of inspections of EOC equipment, alternate EOC equipment, DOE equipment provided to Carlsbad Medical Center and Lea Regional Medical Center according to the MOUs. In addition, periodic inspections of the emergency response radio, pager, and plectron systems are conducted.

15.4.5 Protective Actions

Protective actions are measures, such as evacuation or sheltering, taken to prevent or minimize potential health and safety impacts on workers, responders, or the public.

WIPP procedure WP 12-ER3904,[16] provides the instructions for the FSM or designee to determine if an event at the WIPP is to be categorized as an operational emergency and, if required, classified as an Alert, SAE, or GE. If the event is classified as an Alert, SAE, or GE, procedure WP 12-ER3904,[16] is used to identify the EALs and the protective actions required for each type of event classification.

For Hazardous Materials Operational events, additional protective actions such as decontamination, access control, and others may be applicable. Once the level of hazard is identified and the consequences of a release are identified, the consequences are compared to the EALs so that the actions necessary to protect the health and safety of the workers and the public can be determined. The EPHA[5] provides an analysis of those hazards and consequences resulting in the development of preplanned protective actions. Additional protective actions are developed as needs are identified. These are then directly linked to the categorization/classification process so that the issuance of protective actions is automatic upon declaration of an Operational Emergency. The protective actions, including sheltering in place, or site evacuation, are specified for each accident or malevolent act identified in the EPHA[5] and in procedure WP 12-ER3904.[16]

Once continuous consequence assessment is started and additional information is acquired about the event, including the actual release and status of mitigation of the event, reevaluation of protective actions will begin. The re-evaluation of protective actions/recommendations is a product of continuous consequence assessment and is performed throughout the response. The evaluation of habitability for areas being used by responders and sheltered personnel is part of the continuing evaluation for protective actions.

15.4.6 Training and Exercises

Emergency management training consists of formal classroom instruction, self-paced training modules, on-the-job training, drills and exercises. Assigned individuals participating in emergency management must be trained before they are allowed to assist in emergencies.

The Emergency Management Section coordinates and conducts a variety of drills and exercises. A coordinated program of drills and exercises enhances the ability of specialized teams and individual personnel to respond to potentially adverse situations. A full participation exercise is conducted annually to demonstrate an integrated emergency response capability. The integrated exercise includes federal, state, local, regulatory, and/or emergency response organizations which may include DOE/Headquarters, DOE/Albuquerque, and CBFO participants.

15.4.7 Recovery and Reentry

The recovery phase of an emergency is that portion of the response designed to restore order to the affected area. Recovery may involve cleaning up the emergency scene, securing the scene for investigation purposes, or restoring the area to pre-emergency conditions.

Recovery teams must be formed at the completion of the emergency phase of an incident. The FSM appoints a recovery team leader who then identifies the recovery team members. The makeup of the recovery team will be comprised of individuals with the expertise to evaluate and investigate the emergency and to secure the area or return it to pre-emergency conditions.

Reentry is a planned activity to accomplish a specific objective that involves reentering a facility or affected area that has been evacuated or closed to personnel access during the course of the emergency. Reentry planning includes contingency planning to ensure the safety of reentry personnel. All individuals involved in reentry receive a hazards/safety briefing prior to emergency reentry activities, consistent with federal, state, and local laws and regulations. The FSM must approve all reentry plans. All reentry activities must be authorized with written approval of doses/exposures that may exceed occupational or administrative limits.

Guidance for the reentry and recovery following an emergency is based on regard for human life, and conditions existing at the time. The recovery process detailed in WP 12-ER3903, Event Recovery,[21] evaluates the proposed actions by comparing the risks of the hazards to the actual or potential benefits to be gained.

References for Chapter 15

1. WP 12-9, WIPP Emergency Management Program.

2. DOE Order 151.1A, *Comprehensive Emergency Management System*.

3. DOE G151.1-1, *Emergency Management Guide*.

4. WP 12-RP.01, Emergency Planning Hazard Survey for the Department of Energy Waste Isolation Pilot Plant Report.

5. DOE/WIPP-05-3331, *Waste Isolation Pilot Plant Remote-Handled Waste Handling Emergency Planning Hazards Assessment*.

6. Hazardous Waste Facility Permit No. NM4890139088-TSDF Attachment F, issued by the New Mexico Environment Department.

7. WP 12-ER, Emergency Response Procedures.

8. *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, U.S. Environmental Protective Agency, 1992.

9. DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information*.

10. 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," June 1993.

11. 40 CFR Part 265, Subpart D, "Contingency Plan and Emergency Procedures," May 1980.

12. 40 CFR §265.37, "Arrangements with Local Authorities," May 1980.

13. 40 CFR §265.52 (c), "Content of Contingency Plan," May 1980.

14. 29 CFR §1910.120, Paragraph (p), "Certain Operations Conducted Under the Resource Conservation and Recovery Act of 1976 (RCRA)."

15. ERPG, *Emergency Response Planning Guidelines*, American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances, ACGIH.

16. WP 12-ER3904, Categorization and Classification of Operational Emergencies.

17. 30 CFR Part 49, "Mine Rescue Teams."

18. WP 12-ER4916, Consequence Assessment Dose Projection.

19. *GXQ Program Users Guide*, WHC-SD-SWD-3002, Rev.1A, B. E. Hey, December 1994.

20. WP 12-ER3002, Emergency Operations Center Activation.

21. WP 12-ER3903, Event Recovery.

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16.1 Introduction

The WIPP is designed and constructed in a manner that allows ease of decontamination and decommissioning (D&D). During WIPP operations, the facility consists of surface structures, shafts, and subsurface structures. The goal of D&D is to restore the surface area encompassing the WIPP site to preconstruction and preoperational conditions. Surface radiological levels will be returned to levels commensurate with regulatory guidelines. Records of the WIPP will be listed in the public domain and monuments or markers will exist at the site to inform future generations of the presence of the WIPP repository.

16.2 Requirements

The WIPP was designed for a 35-year disposal phase, and will be decommissioned after waste emplacement is completed (see DOE/NTP-96-1204, *National TRU Waste Management Plan*).[1] The Hazardous Waste Facility Permit (HWFP)[2] implements Resource Conservation and Recovery Act (RCRA) (42 *United States Code* §6901)[3] regulations and assumes 25 years for disposal operations and 10 years for closure. Congress and the U.S. Environmental Protection Agency (EPA) have established post-operational requirements for the WIPP within the Land Withdrawal Act (Public Law 102-579)[4]; 40 CFR Part 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Subpart B, "Standards for Disposal"[5]; and 40 CFR Part 194, "Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations."[6] How the DOE satisfies these requirements for the WIPP was described in DOE/WIPP 1996-2184, *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (CCA).[7] The EPA approval of the CCA is documented in *Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the Disposal Regulations: Certification Decision*, (63 *Federal Register* 27354-27406).[8]

Decommissioning requirements applicable to the WIPP are also included in DOE O 430.1B, *Real Property Asset Management*,[9] DOE O 435.1, *Radioactive Waste Management*,[10] and DOE M 435.1-1, *Radioactive Waste Management Manual*.[11] Additional requirements are included in the RCRA as implemented in 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,"[12] and 20.4.1.5 NMAC (New Mexico Administrative Code), Hazardous Waste Management.[13]

16.3 Description of Conceptual Plans

The current design of WIPP incorporates structural and internal features that facilitate the safe and economical D&D of the facility and are consistent with the requirements in DOE M 435.1-1.[11] The following features have been incorporated into the WIPP waste handling surface structures:

- Coatings provide easily cleanable surfaces.
- Cracks, crevices, and joints are sealed to prevent contamination spread to inaccessible areas.
- Exhaust filters at points of potential contamination minimize contamination of long sections of duct work and downstream exhaust equipment.
- Architectural or structural features allow the dismantlement and removal of equipment from areas of contamination or potentially high radiation levels to other areas for decontamination, maintenance, or repair.

Decontamination and decommissioning activities will involve three primary areas: surface structures, subsurface structures, and the shafts. The objective of D&D activities at the WIPP is to return the surface to as close to the preconstruction condition as reasonably possible, while protecting the health and safety of the public and the environment. Decontamination involves the removal or reduction of radioactive or hazardous contamination from facilities, equipment, or soils by washing, chemical or electrochemical action, mechanical cleaning or other techniques to achieve a stated objective or end condition. Decommissioning is part of final facility closure only, and will involve the removal of equipment, buildings, closure of the shafts, and establishing active and passive institutional controls for the facility.

Detailed planning for D&D activities will begin prior to the actual initiation and will incorporate currently available technologies and prescribed decontamination limits consistent with 10 CFR Part 835, "Occupational Radiation Protection"[14] or its equivalent at the time of closure. Surface structures will be decontaminated in accordance with the requirements applicable at the time D&D activities take place and will ensure that personnel and public exposure limits are maintained as low as reasonably achievable and within prescribed limits. Dismantlement of the buildings will be consistent with the revision of the decommissioning plan current at the time of actual D&D activities.

D&D activities are discussed in the *Conceptual Decontamination and Decommissioning Plan for the Waste Isolation Pilot Plant* (DOE/WIPP 95-2072),[15] and in Attachment I of the HWFP.[2] Activities include, but are not limited to:

- Review of operational records for historical information on releases.
- Visual examination of surface structures for evidence of spills or releases.
- Performance of site contamination surveys.
- Decontamination, if necessary, of usable equipment, materials, and structures including surface facilities and areas surrounding the Waste Handling Building.
- Disposal of equipment/materials that cannot be decontaminated but that meet waste acceptance criteria in a Hazardous Waste Management Unit.
- Dismantling of surface facilities.
- Dismantling of underground facilities at the time the panels are closed.
- Emplacement of final panel closure system and emplacement of fill material in the underground, if required.
- Emplacement of shaft seals to minimize the intrusion of fluids into the repository and any migration of hazardous constituents from the underground.
- Regrading the surface to approximately original contours.
- Initiation of active controls which includes monitoring and installation of the Permanent Marker System.

Before final closure activities begin, health physics personnel will conduct a hazards survey of the unit(s) being closed. The presence of radionuclides could also indicate a presence of hazardous constituents. If radionuclides are not detected, sampling for hazardous constituents may still be performed if there is evidence that a spill or release has occurred. The results of the hazards survey will be used to identify any control measures necessary to reduce worker risk from D&D activities. The survey will provide the information necessary to identify the worker qualifications, personal protective equipment, safety awareness, work permits, exposure control programs, and emergency coordination for D&D activities.

A record of the WIPP Project will be listed in the public domain. Active institutional controls are projected to continue for at least the first 100 years after the final facility closure. Postclosure surveillance is projected to consist of periodic drive-by patrolling around the fenced perimeter, and include checks for fence and locked gate integrity and evidence of human activity. Postclosure surveillance activity will be documented. A passive institutional control system consisting of monuments or markers will be erected at the site to inform future generations of the WIPP repository location.

Detailed records will be filed with local, state, and federal government agencies to ensure that the location of the WIPP site is easily determined. This information together with land survey data will be on record with the United States Geological Survey and other agencies as provided by the decommissioning plan. The DOE will maintain permanent administrative authority over those aspects of land management assigned by law (i.e., by the permanent withdrawal legislation).

Further description of the institutional controls to be implemented after closure are found in Attachment I of the HWFP.[2]

Once the permanent markers are installed, the active access control measures and surveillance will be evaluated for continued implementation. The physical surveillance requirements will be provided in the final decommissioning plan. Environmental surveillance after closure will include appropriate radiation monitoring, soil, vegetation, Culebra groundwater monitoring, Delaware Basin surveillance, subsidence monitoring, and wildlife sample analysis. Frequency and duration of the environmental surveillance program will be defined in the final decommissioning plan as prescribed by standards applicable at the time.

References for Chapter 16

1. DOE/NTP-96-1204, *National TRU Waste Management Plan*, Rev. 3, July 2002.
2. Hazardous Waste Facility Permit No. NM4890139088-TSDF.
3. 42 *United States Code* §6901, et seq., Resource Conservation and Recovery Act.
4. Public Law 102-579, as amended Sept. 23, 1996 Public Law 104-201, Subtitle F, Waste Isolation Pilot Plant Land Withdrawal Act.
5. 40 CFR Part 191, Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes, U.S. Environmental Protection Agency, September, 1985.
6. 40 CFR Part 194, Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations, February, 1996.
7. DOE/WIPP 1996-2184, Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant, October, 1996.
8. Federal Register, May 18, 1998, Part III, Environmental Protection Agency, 40 CFR Part 194
9. DOE O 430.1B, *Real Property Asset Management*, October 2005.
10. DOE O 435.1, *Radioactive Waste Management*.
11. DOE M 435.1-1, *Radioactive Waste Management Manual*.
12. 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," U.S. Environmental Protection Agency, May 19, 1980 and subsequent amendments.
13. 20.4.1 NMAC, Hazardous Waste Management
14. 10 CFR Part 835, "Occupational Radiation Protection," December 14, 1993.
15. DOE/WIPP 95-2072, *Conceptual Decontamination and Decommissioning Plan for the Waste Isolation Pilot Plant*, January 1995.

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MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

17.1 Introduction

The objective of this chapter is to describe the Management, Organizations, and Institutional Safety Provisions as they apply to the safe operation of the Waste Isolation Pilot Plant (WIPP). This chapter also outlines the requirements used to develop the safety management programs, includes descriptions of the responsibilities of and relationships between the non-operations organizations having a safety function and their interfaces with the operations organization. This chapter presents the following: (1) the overall structure of the organizations and entities involved in safety-related functions not described earlier in this document, including key responsibilities and interfaces, and (2) the safety programs that promote safety consciousness and morale, including safety review and performance assessment, configuration and document control, occurrence reporting, and safety culture. The overall site management team is described in Washington TRU Solutions LLC (WTS) Management Charter (MC) 1.6, Plant Management Team.[1]

The WIPP is managed and operated by Washington Group International Energy and Environment Business Unit, Washington TRU Solutions LLC.

17.2 Requirements

The standards, regulations, and U.S. Department of Energy (DOE) Orders required for establishing the safety basis for the WIPP specific to Management, Organization, and Institutional Safety Provisions include:

- 10 CFR Part 830, "Nuclear Safety Management."[2]
- 19 CFR Part 1910, "Occupational Safety and Health Standards."[3]
- 29 CFR Part 1926, "Safety and Health Regulations for Construction."[4]
- 30 CFR Part 57, "Safety and Health Standards - Underground Metal and Nonmetal Mines."[5]
- DOE Order 231.1A, *Environment, Safety and Health Reporting*.[6]
- DOE Order 225.1A, *Accident Investigations*.[7]
- DOE Order 420.1A, *Facility Safety*.[8]
- DOE Order 425.1B, *Startup and Restart of Nuclear Facilities*.[9]
- DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*.[10]
- DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*.[11]
- DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Facilities*.[12]
- New Mexico Mine Safety Code for All Mines, 1990.[13]

17.3 Organizational Structure, Responsibilities, and Interfaces

Westinghouse Waste Isolation Division (later Westinghouse TRU Solutions in 2001) managed and operated the WIPP for the DOE from October 1985 to January 2003. In January 2003 the company changed its name to WTS. WTS, as the management and operating contractor, provides the management staff, sets the safety culture, issues policies, and implements programs.

WTS has access to corporate expertise in several disciplines including waste management, risk assessment, safety analysis, environmental services, technical and analytical services, regulatory compliance, transportation, legal, quality assurance (QA), and others, as required.

Several committees have been formed to integrate information regarding environment, safety, health, and radiation protection activities at the various facilities served by Washington Group International (WGI) Energy and Environment Business Unit. The committees facilitate the sharing of solutions to common problems and issues. The WGI management team is supportive of WTS activities by participating in corporate reviews and audits of the WIPP activities, and by providing management attention, as needed.

17.3.1 Organizational Structure

WTS, as the managing and operating contractor (MOC) for the WIPP, is responsible for general management and operating services, including operational safety, engineering management, quality assurance and control, project control, construction management, and environmental services. As part of its responsibility, the MOC ensures that all inputs to facility operations are properly reviewed for health, safety, and environmental implications.

While responsible for all aspects of the WIPP, the DOE has contracted these scopes of work to various organizations. The MOC is responsible for managing the current and future construction contracts, and for operating the WIPP, including day-to-day operations and waste handling operations.

The WTS executive staff defines roles and responsibilities to ensure effectiveness of communication during work planning and execution. The WTS General Manager is responsible for managing the company and guiding the management team toward the safe performance of all work. The General Manager is ultimately responsible for safe accomplishment of work and leads in setting the company standards and expectations for all work under this contract. Other members of the executive staff include: The Assistant General Manager of Site Operations and Disposal; Assistant General Manager of Retrieval, Characterization and Transportation; Chief Financial Officer and Manager of Business Management, Chief Nuclear Engineer and Manager of Engineering; Quality Assurance Manager; Safety and Health Manager; Strategic Planning; Internal Audit Manager; External Programs Manager; Manager of Environmental Permitting, Compliance and Monitoring and General Counsel. The WTS General Manager is responsible for chartering the WTS Plant Management Team to be responsible for implementation of the Integrated Safety Management System (ISMS). The WTS Plant Management Team members are identified in MC 1.6.[1] Management functions are performed according to management policies and requirements defined in the operating contract. Managers are directed to perform field observations and communicate directly with employees and line managers to assess the effectiveness of WTS department managers in applying company safety and environmental standards and requirements.

17.3.2 Organizational Responsibilities

The WTS General Manager has delegated specific responsibilities to executive staff members for the following the WIPP functions:

- Safety and Health - Radiation safety, industrial safety and hygiene, facility emergency management; dosimetry; and environmental protection.

- Regulatory Compliance - Environmental monitoring; regulatory compliance.

- Surface Operations and Maintenance - Operation, control, and maintenance of surface structures, systems, and components, including utilities (electrical, water, sanitary waste) and waste handling equipment; interface with offsite suppliers of electrical and water services.

- Waste Operations - Handling and storing radioactive waste on-site.

- Mine Operations - Transporting salt on the surface and below ground; underground operations including mining and hoisting; operation and control of underground structures, systems, and components.

- Hoisting Operations - Inspections, maintenance and operations of the WIPP site’s shafts and hoists.

- Mine Maintenance - Maintenance of underground structures, systems, and components, including electrical services for waste handling and disposal, and mining operations.

- Regulatory Compliance - Transporting hazardous material off-site.

- Engineering - Design of new or modification to structures, systems, and components; review of designs proposed by other project participants; resolution of technical, maintenance, and operational problems; and configuration control.

- Quality Assurance - Identification, development and definition of quality requirements; interpretation and implementation of QA program elements; performance of assessments and audits; review Federal Registers; and review DOE Orders.

- Project Analysis & Control - Planning and scheduling; integrating technical programs, program development and program reporting, strategic planning and long term budget development; analyzing performance; and recommending work scope priorities.

- Business Management - Financial resources, accounting, material and property control, document and procedure review, and procurement services.

- Nuclear Safety - Criticality safety, Documented Safety Analysis, Unreviewed Safety Question (USQ) process.

- Human Resources (Training) - Coordination of personnel-related functions supporting facility safety, operations, planning and implementing the general employee technical training programs, and certifying/qualifying the operating staff.

- External Communications - Public information programs, governmental affairs, technical outreach and communications; the WIPP web page, visitor's program at the WIPP, identification and resolution of issues between the WIPP Project and outside institutions.

- Transportation - External Emergency Management to prepare emergency response personnel bordering the WIPP transportation routes.

Integrated Safety Management System

The WIPP's mission is to dispose of transuranic waste in an environmentally sound and safe manner. While accomplishing this mission, protection of the environment, the public, and the safety and health of employees is the number one priority for the conduct of operations. WTS conducts nuclear, industrial, occupational health, safety, environmental protection, and emergency management activities in compliance with the requirements and intent of applicable federal, state, and local regulations and procedures. Among the drivers are requirements of the DOE, the Occupational Safety and Health Administration, the Mine Safety and Health Administration, the U.S. Environmental Protection Agency and the New Mexico Environment Department.

ISMS mechanisms are the means by which the safety management functions are implemented and performed. Charters, policies, manuals, plans, procedures, reports, walk around inspections, planning meetings, critiques, and feedback meetings are all mechanisms used at the WIPP for implementing the ISMS. Details regarding the specific mechanisms used by the WIPP to perform work safely are identified in DOE/CBFO 98-2276, *Integrated Safety Management System Description*.[14]

WTS Management Policy (MP) 1.28, Integrated Safety Management,[15] requires WTS to systematically integrate safety into program management and work practices at all levels of the organization to accomplish the WIPP mission while protecting the workers, the public, and the environment. Employees are accountable for identifying and reporting potential hazards and for being involved in implementing solutions, including suspending work, if necessary to prevent serious injury to personnel or damage to equipment. Managers are accountable for preplanning and involving employees in the preplanning process. Managers are responsible for ensuring the safe performance of work and for conducting workplace inspections to ensure a safe work environment. Managers ensure that hazards are identified and mitigated.

WTS uses the following guiding principles as the basis for MP 1.28[15] and its daily operation:

1. Line Management Responsibility for Safety - Line managers (section and group managers) are responsible for the protection of the worker, the public, and the environment. A line manager is an individual who has the responsibility and the authority for getting the job done.

2. Clear Roles and Responsibilities - Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at all organizational levels.

3. Competence Commensurate with Responsibilities - Personnel possess the experience, knowledge, skills, and abilities necessary to discharge their responsibilities in a safe, environmentally sound manner.

4. Balanced Priorities - Resources are allocated effectively to address safety, environmental, programmatic, and operational considerations. Protecting the workers, the public, and the environment is the number one priority and consideration for the conduct of operations.

5. Identification of Safety Standards and Requirements - Before work is performed, the associated hazards are evaluated and an agreed-upon set of safety standards and requirements and mitigating actions is established which, if properly implemented, provide adequate assurance that the worker, the public, and the environment are protected from adverse consequences. Work processes are continually assessed, and assessments are used to improve work practices.

6. Hazard Controls Tailored to Work Being Performed - Administrative and engineering controls to prevent and mitigate hazards are tailored to the work being performed and address associated hazards.

7. Operations Authorization - The safety standards and requirements to be satisfied for operations to be initiated and conducted are clearly established and agreed upon.

17.3.3 Staffing and Qualifications

The WIPP plant management program for personnel selection, qualification, and training is conducted in accordance with DOE Order 5480.20A,[12] resulting in trained and qualified personnel who can conduct operations in the various plant operations in a safe and efficient manner. WTS has established required management training for designated WTS managers. The training requirements include (1) supervisory skills training - leadership, interpersonal communication, responsibility and authority, motivation, problem analysis and decision making, fitness for duty, and administrative policies and procedures; and (2) management training - quality assurance and quality control, facility security and emergency plans, purchasing, material storage, facility modifications, environmental issues, budgeting, and nuclear/industrial/radiation safety. The WIPP management and supervisor training qualifications are described in WTS MP 1.40, Management and Supervisor Training Qualifications.[16]

WP 09, Engineering Conduct of Operations,[17] specifies the training requirements for the WIPP site cognizant system engineers. The Cognizant System Engineer concept is defined by DOE Order 420.1A.[8]

The WIPP technical training department has a Training Implementation Matrix (TIM)[18] as required by DOE Order 5480.20A.[12] The TIM defines the administration of qualification and training programs, and establishes the responsibility, authority, and methods for implementing those programs. The TIM[18] describes the operating organization and lists each position that is subject to DOE 5480.20A[12] and includes a matrix that shows the status of training and qualification programs relative to the requirements of DOE Order 5480.20A.[12]

17.4 Safety Management Policies and Programs

17.4.1 Safety Review and Performance Assessment

The WIPP safety elements are periodically reviewed. The WIPP MOC ensures that applicable environment, safety, and health requirements are met according to 10 CFR §830.204, "Documented Safety Analysis."[19] The review focuses on the functional areas within the safety program including: industrial safety, fire protection, and hazardous material control. Feedback information on the adequacy of controls is gathered; opportunities for improving the definition and planning of work are identified and implemented; line and independent oversight is conducted.

Assessments

An integrated assessment process is used by WTS for conducting overall safety assessment of the WIPP activities. Important components of the assessment program are management assessments and independent assessments. Both types of assessments are delineated in WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description.[20] Management assessments are planned and performed as an ongoing activity where a manager assess the performance of their organization to verify conformance to applicable requirements and to identify opportunities to improve safety and performance. Independent assessments are conducted to evaluate compliance with applicable QA requirements and implementing procedures.

Safety Reviews

WTS annually prepares a comprehensive ISMS report for WTS management review. It determines the effectiveness of the ISMS and includes self-assessments and other evaluations performed by WTS. Areas of improvement are identified, reported and tracked to closure via the WTS Commitment Tracking System. This mechanism helps the team review not only the effectiveness of individual components but also the effectiveness and integration of the entire ISMS.

WTS measures the effectiveness of ISMS through both leading indicators and quantitative safety performance. WTS regularly monitors basic leading indicators, such as management commitment to safety, employee involvement in safety, prevention and control of hazards, work site safety analysis, and safety training. Some additional specific leading indicators include the Lessons Learned Program, results of internal and external inspections and evaluations, and closure of safety-related corrective actions.

Quantitative safety performance monitored at the WIPP include the following:

- Industrial Safety - Recordable case rates; days away, restricted, or transferred.
- Radiation Protection - Worker radiation exposure, contamination events.
- Conduct of Operations - Procedural violations or inadequacy.
- Environmental Protection - Reportable environmental release events, annual trending reports, and environmental assessment results.
- Authorization Bases - Technical safety requirement violations.
- Fire Protection - Impaired or defective fire protection/detection systems.
- Equipment Maintenance - Status of preventive maintenance and corrective maintenance.
- Security - Security incidents, violations, and infractions.
- Transportation Management - Incidents/accidents related to CH waste transportation.

Nuclear Safety Reviews

WP 02-AR3001, Unreviewed Safety Question Determination,[21] implements the requirements of 10 CFR §830.203, "Unreviewed Safety Question Process."[22] The procedure includes screening criteria to determine if a proposed activity requires further evaluation; identification of the training requirements for screeners, evaluators, and independent reviewers; documentation requirements; and identification of the safety basis documents.

Temporary or permanent changes proposed for the WIPP facility as described in the DSA, changes to the waste handling process/equipment, changes to the waste form, changes to the waste configuration, procedure changes, proposed engineering changes, and discovery issues are screened and/or evaluated by qualified personnel using WP 02-AR3001.[21] USQs are reviewed against the DSA and Technical Safety Requirements. A safety evaluation documents any change, as mandated by 10 CFR §830.203.[22] Positive USQ determinations are reviewed by the Nuclear Review Board.

17.4.2 Configuration and Document Control

WP 09[17] implements configuration management requirements through the WP 09 series of procedures. WP 09[17] and implementing WP 09 series procedures includes requirements for design review documentation, system design descriptions, component labeling, as builts, etc.

The WIPP procedures are written to WP 15-PS.2, Procedure Writer's Guide,[23] which references steps for procedure writing found in DOE-STD-1029-92, *DOE Writer's Guide for Technical Procedures*.[24] Modifications to operating procedures resulting from an engineering change order are controlled and implemented through WP 15-PS3002, WTS Controlled Document Processing.[25] The process for review, approval, and cancellation of the WIPP documents is controlled. Changes to procedures identified or referenced in the DSA are evaluated using WP 02-AR3001.[21] New and cancelled procedures are subjected to the USQ process.

17.4.3 Occurrence Reporting and Lesson Learned

The occurrence reporting process at the WIPP is directed by DOE Order 231.1A.[6] The WIPP occurrence reporting implementing procedure is WP 12-ES3918,[26] Reporting Occurrences in Accordance with DOE Order 232.1A. This occurrence reporting procedure provides for reporting events to the Facility Shift Manager (FSM) or his designee for categorization.

An Occurrence Report is initiated by and applies th the activities, projects, and operations of the WIPP and/or subcontract employees. Occurrence reporting directives require that notifications be timely in accordance with the significance of the occurrence and that written reports contain appropriate information describing the occurrence, significance, causal factors, and corrective actions. The DOE is kept fully informed on a timely basis of events that could adversely affect the health and safety of workers, the public, and environment.

Examples of events that should be reported include, but are not limited to the following: events that could endanger or adversely affect personnel safety or operations, or are contrary to DOE requirements. In addition, the procedure requires the event to be investigated to determine the direct cause, root cause and contributing causes, and to develop corrective actions to prevent recurrence. Trending of occurrence report information is performed to determine if there is a common causal factor or a series of causal factors. Identifying the causal factor(s) facilitates corrective actions.

The WIPP Lessons Learned Program was established as required by DOE Order 5480.19,[11] and is implemented by WTS Management Charter MC 9.20, Lessons Learned Working Group.[27] MC 9.20 empowers the Lessons Learned Working Group to administer the Lessons Learned Program, which was implemented to ensure a continuing improvement in plant safety and reliability. Lessons learned bulletins are developed from information obtained from DOE Safety Notices, Nuclear Regulatory Commission Bulletins, external occurrence reports, internal occurrence reports, internal investigative reports, and other pertinent industry documents. Lessons learned bulletins are distributed to the WIPP managers for inclusion into their required reading, as applicable.

17.4.4 Safety Culture

A safe working environment is the priority at the WIPP. Individuals responsible for performing work are continually evaluating their safety, the environment, and the facility. This philosophy is directed from the top down within the organization.

The management approach to occupational health and safety at the WIPP emphasizes the integration of safety into all aspects of the WIPP. The WIPP management has communicated its expectations of site personnel and subcontractors regarding safety through policies, procedures, and programs. Senior management infuses the principles of safety to mid-management, mid-management to line management, and this continues until every employee incorporates safety principles into their job.

Top management is visibly involved in safety and health programs by establishing goals, approving management policies, providing accountability mechanisms, implementing site tracking systems, participating in employee communications, reviewing injury/illness trends, reviewing safety and health summaries, and providing resources to perform jobs safely. Management support is evidenced by the WIPP Voluntary Protection Program (VPP) Star recognition, awarded by the DOE to the WIPP because of the comprehensive health and safety program. "VPP Star" status was first awarded to the WIPP in 1994 based on the VPP application,[28] and has been retained to date. The DOE VPP encourages recognition of successful leading-industry injury and illness prevention programs that result in reducing workplace hazards. The WIPP safety program elements including training, employee involvement, management commitment, and hazard prevention and controls were reviewed during the VPP application and recertification process.

A strong safety culture is a prerequisite and key to the effective integration of safety into all phases of work planning and execution. This core value of safety is fundamental to every work activity at the WIPP and is the basis for the continued growth and strength of this safety culture. WTS commitment to perform work safely is described in MP 1.28, Integrated Safety Management.[15]

References for Chapter 17

1. MC 1.6, Plant Management Team.
2. 10 CFR Part 830, "Nuclear Safety Management."
3. 19 CFR Part 1910, "Occupational Safety and Health Standards."
4. 29 CFR Part 1926, "Safety and Health Regulations for Construction."
5. 30 CFR Part 57, "Safety and Health Standards - Underground Metal and Nonmetal Mines."
6. DOE Order 231.1A, *Environment, Safety and Health Reporting*.
7. DOE Order 225.1A, *Accident Investigations*.
8. DOE Order 420.1A, *Facility Safety*.
9. DOE Order 425.1B, *Startup and Restart of Nuclear Facilities*.
10. DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*.
11. DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 2, October 2001.
12. DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, Change 1, July 2001.
13. New Mexico Mine Safety Code for All Mines, 1990
14. DOE/CBFO 98-2276, *Integrated Safety Management System Description*.
15. MP 1.28, Integrated Safety Management.
16. MP 1.40, Management and Supervisor Training Qualifications.
17. WP 09, Engineering Conduct of Operations.
18. Training Implementation Matrix (TIM), Rev. 6. Waste Isolation Pilot Plant, Technical Training Department. Access Date: March 15, 2005.
19. 10 CFR §830.204, "Documented Safety Analysis."
20. WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description
21. WP 02-AR3001, Unreviewed Safety Questions Determination.
22. 10 CFR §830.203, "Unreviewed Safety Question Process."
23. WP 15-PS.2, Procedure Writer's Guide.

24. DOE-STD-1029-92, *DOE Writer's Guide for Technical Procedures*.

25. WP 15-PS3002, WTS Controlled Document Processing.

26. WP 12-ES3918, Reporting Occurrences in Accordance with DOE Order 231.1A.

27. MC 9.20, Lessons Learned Working Group.

28. Westinghouse Electric Corporation, Waste Isolation Division Voluntary Protection Program Application, 1994.

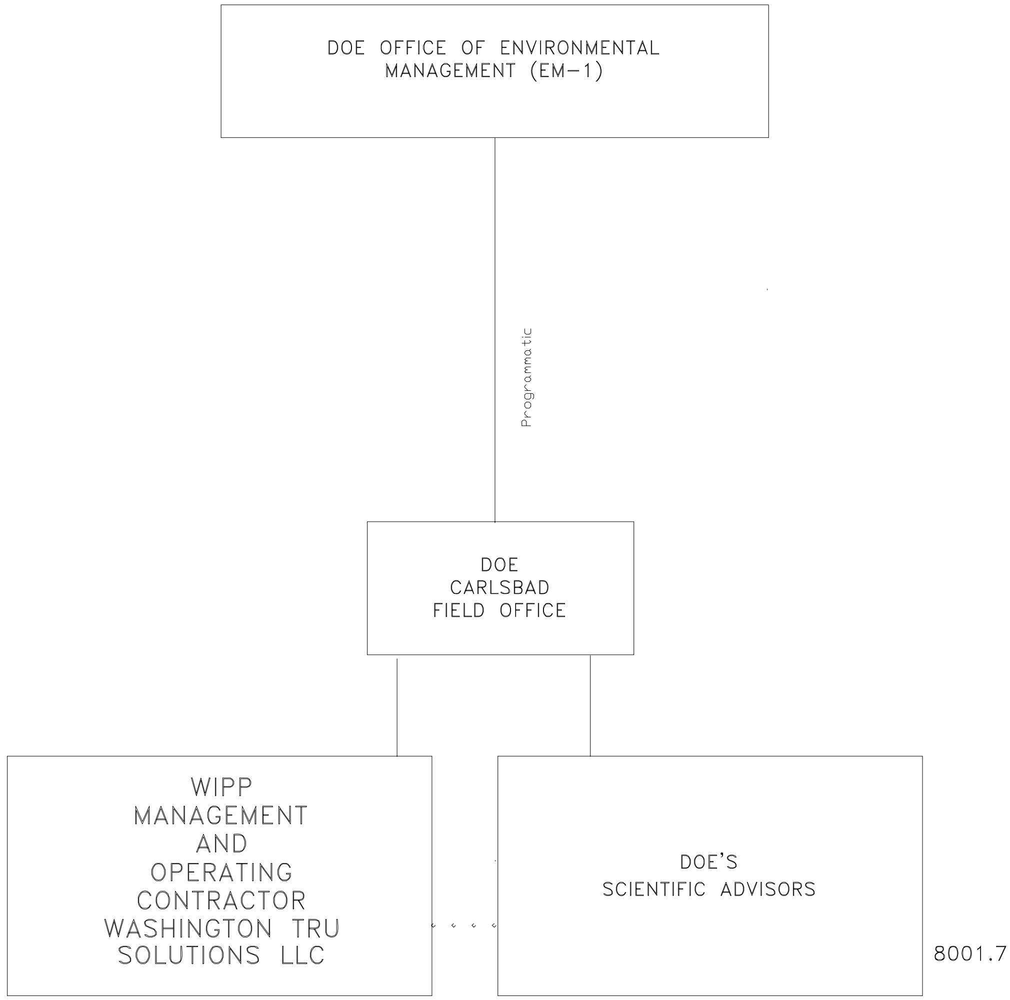

Figure 17.1-1, WIPP Operations Responsibility

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