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DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

This section provides the basis for deriving the WIPP preliminary Technical Safety Requirements (PTSRs) for Remote Handled (RH) waste initially in accordance with the requirements of DOE Order 5480.22, Technical Safety Requirements[1] and is in compliance with 10 CFR 830.205.[2] This section provides the link between the Hazards and Accident Analysis in Chapter 5 of this document and the WIPP PTSRs, DOE/WIPP-03-3178. 10 CFR 830.205[2] and its guide provide detailed criteria for the selection of PTSR Safety Limits (SLs), Limiting Control Settings (LCSs), Limiting Conditions for Operations (LCOs), Surveillance Requirements (SRs), and Administrative Controls (ACs).

The Chapter 5 Hazards and Accident Analyses indicate that SLs, LCSs, LCOs, and SRs are not required for the WIPP facility as derived below. As discussed in Chapter 5, Design Class I Systems, Structures or Components (SSCs) are not required for the WIPP to mitigate any accidental radiological and non-radiological off-site Maximally Exposed Individual (MEI) or noninvolved worker consequences to acceptable levels. WIPP PTSRs in the form of administrative controls (ACs) are derived in this chapter. These ACs provide PTSRs covering the WIPP defense-in-depth approach developed in Chapter 5.

6.1 Requirements

Requirements for the derivation of PTSRs are specified in 10 CFR 830.205[2] and its guide.

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6.2 PTSR Coverage

ACs impose administrative requirements necessary to control operation of the facility such that all PTSR requirements are met. Since no SLs, LCSs, LCOs, or SRs are defined for the WIPP, WIPP specific ACs impose administrative requirements necessary to ensure operation of the facility consistent with the design that was shown to be safe in Chapter 5. These administrative requirements are defined in Section 6.4.5.

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6.3 Derivation of Facility Modes

Operations at the WIPP consist mainly of waste handling, storage, and disposal operations. The following is a definition of the modes of operations. The mode of operation is defined such that the Waste Handling Building (WHB) and the Underground may be in different modes. Prior to receiving waste, the facility is required to be in one of the modes of operation.

6.3.1 Waste Handling Mode

The WHB and/or the Underground is configured for waste handling, and all required defense-in-depth SSCs are operated as required. Maintenance, repair activities, and inspections are allowed as long as they do not prevent the functions of the defense-in depth SSCs required for the Waste Handling Mode. The required SSCs described in Table 6-2 ensure that the defense-in-depth features identified in Chapter 5 as consequence mitigators or additional preventative features are available during those activities (waste handling) that introduce the potential for significant accidents.

6.3.2 Waste Storage/Disposal Mode

Waste handling operations are not being conducted in the WHB and/or in the Underground. WHB and/or the Underground is configured for waste storage or disposal. After receipt of waste, the facility retains its inventory of radioactive and hazardous material. No waste handling operations are allowed during Waste Storage/Disposal Mode except as required to safely complete a waste handling evolution interrupted by SSC malfunction or unavailability, and in accordance with the applicable procedure. Maintenance, repair activities, and inspections are allowed, provided the SSCs required in Table 6-2 for Waste Storage/Disposal Mode are restored to operation in a timely manner, and SSCs are not intentionally removed from service during waste handling completion.

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6.4 Derivation of WIPP TSRs

6.4.1 Safety Limits (SLs)

As defined in DOE Order 5480.22,[1] Technical Safety Requirements, SLs are limits on process variables associated with those physical barriers, generally passive, that are necessary for the intended facility function and that are found to be required to guard against the uncontrolled release of radioactivity and other hazardous material. "Process Variables" refers to observable, measurable parameters such as temperature and pressure. "Passive physical barriers" refers to those barriers that constitute the primary process material boundary.

Based on the analysis presented in Chapter 5, no SLs are identified for the WIPP facility.

6.4.2 Limiting Control Settings (LCSs)

As defined in DOE Order 5480.22,[1] LCSs are settings on safety systems that control process variables to prevent exceeding SLs. More precisely, an LCS is the set point for an instrument or device monitoring a process variable that, if exceeded, initiates actions to prevent exceeding an SL.

The WIPP facility has no SLs identified, therefore, no LCSs are required.

6.4.3 Limiting Conditions for Operations (LCOs)

DOE Order 5480.22,[1] Attachment 1, Section II.2.3.h, provides that "LCOs should be written only for systems and equipment which meet one (or more) of the following descriptions," and prescribes five selection criteria, h.(1) through h.(5). The order also emphasizes that "Maintaining the LCOs at the minimum number necessary will emphasize the importance of the LCOs and better ensure the compliance with them." All five criteria clearly tie the LCOs to the facility accident or transient analyses.

The LCO selection criteria interpretations define TSR content based on key nuclear safety analysis requirements. Specifically, three of the five TSR LCO selection criteria are understood to restrict TSR LCOs to only those requirements that are under the direct control of the facility's operators, and are of primary importance for: **prevention** (Criterion h.(1)), **mitigation** (Criterion h.(2)), and **initial conditions** (Criterion h.(3)) of credible, unmitigated accident scenarios. Additionally, Criterion h.(4) involves the application of criteria h.(1), h.(2), and h.(3) to experiments and experimental facilities, and Criterion h.(5) to systems and equipment that are used for handling fissile material. The specifics of each criterion as applied to the WIPP facility are as follows:

- Criterion h.(1) - Prevention:

  A basic concept in the protection of the public is the prevention of accidents that have the potential for an uncontrolled release of radioactive material. Criterion h.(1) is intended to ensure that TSRs be selected to identify instrumentation that is used to detect, and to indicate in the control room or other control location, a significant degradation of the physical barriers which prevent the uncontrolled release of radioactive or other hazardous materials. For example, instrumentation installed to detect significant degradation of a reactor coolant pressure boundary enables the operator to correct the degraded condition prior to accident initiation or to place the facility in a condition that reduces the likelihood of the accident.

WIPP instrumentation, such as the Continuous Air Monitors (CAMs), Effluent Monitors, Area Radiation Monitors (ARMs), and installed instrumentation to control differential pressure, are not required to prevent accidents as analyzed in the SAR from occurring, or to facilitate the Central Monitoring Room (CMR) operator placing the facility in a condition reducing the likelihood of an accident from occurring. Therefore, Criterion h.(1) has no application to the WIPP.

- Criterion h.(2) - Mitigation:

Criterion h.(2) provides that "Structures, systems, and components that are relied upon in the Safety Analyses to function or actuate to prevent or mitigate accidents, or transients that either involve the assumed failure of, or present a challenge to, the integrity of a physical barrier that prevents the uncontrolled release of radioactive materials ... intended to include only those structures, systems, and components that are part of the primary success path of a safety sequence analysis and those support and actuation systems necessary for them to function successfully."

The "primary success path of a safety sequence analysis" is defined as "the sequence of events assumed by the Safety Analyses, which leads to the conclusion of a transient or accident with consequences that are acceptable. Hence, any SSC in that assumed sequence should be included in the LCO."

Consistent with the primary intent of DOE Order 5480.22[1], establishing requirements for the protection of the public, the existing practice is: 1) to evaluate the unmitigated radiological and non-radiological consequences to the MEI and non-involved worker as the result of an accident; 2) to compare the radiological and non-radiological consequences to established accident risk evaluation guidelines; and 3) if the consequences of the accident exceed the established accident consequence risk evaluation guidelines, to define SSCs and associated TSR LCOs mitigating or reducing those consequences to acceptable levels below the established criteria.

The unmitigated MEI and non-involved worker radiological and non-radiological consequences and risk evaluation guidelines, as documented in Chapter 5, Tables 5.2-3 and 5.2-4, are used as the basis for applying this criterion.

Application of DOE Order 5480.22[1] TSR LCO Selection Criterion h.(2) to the WIPP:

The WIPP SSCs that are assumed to function in the SAR accident analysis mitigating an accident's radiological and non-radiological consequences to within the accident risk evaluation guidelines satisfy Criterion h.(2).

The unmitigated radiological and non-radiological accident consequences were estimated and compared to the risk evaluation guidelines in Chapter 5. The unmitigated radiological and non-radiological accident consequences are below the consequence risk evaluation guidelines; therefore, 1) mitigating SSCs are not required, and 2) TSR LCOs are not required. Tables 5.2-3 and 5.2-4 of Chapter 5 of the SAR list the analyzed accidents, and the mitigated and unmitigated MEI and non-involved worker radiological consequences. All of the radiological and non-radiological accident consequences are well below the applicable risk evaluation guidelines.

- Criterion h.(3) - Initial Condition:

  Process variables as initial conditions of accidents or transients that are monitored and controlled during operations so the parameter remains within the analysis bounds satisfy this selection criterion. The WIPP is not a waste processing facility, therefore process variables are not considered in the PSAR accident analysis as initial conditions for accidents. Thus, Criterion h.(3) is not applicable to the WIPP.

- Criterion h.(4):

  Criterion h.(4) involves applying criteria h.(1), h.(2), and h.(3) to experimental activities involving radioactive or other hazardous materials. There are currently no planned experimental or test activities at the WIPP. Therefore, Criterion h.(4) is not applicable to the WIPP.

- Criterion h.(5):

  Criterion h.(5) applies to fissile material handling facilities and is only related to inadvertent criticality protection. Inadvertent criticality is not a credible hazard at the WIPP. Inadvertent criticality is controlled through the TSR ACs Criticality Program in conjunction with the Waste Characteristics program which conforms to the Remote-Handled Waste Acceptance Criteria (RH WAC).[3] Therefore, Criterion h.(5) is not applicable to the WIPP.

6.4.4 Surveillance Requirements (SRs)

As defined in DOE Order 5480.22,[1] SRs relate to testing, channel calibration, channel operational testing, or inspection to maintain the operability, quality, and safety of SSCs and their support systems. SRs are defined as the requirements necessary to maintain facility operation within the SLs, LCSs, and LCOs. Selection criteria for SRs are defined in DOE Order 5480.22.[1]

Without SLs, LCSs, and LCOs for the WIPP facility, SRs are not required.

6.4.5 Administrative Controls

As discussed in Section 2.4 of Attachment 1 of DOE Order 5480.22,[1] ACs impose necessary requirements controlling operation of the facility to meet all PTSR requirements. Without SLs, LCSs, LCOs, and SRs, WIPP specific ACs impose administrative and operational requirements supporting the WIPP defense-in-depth concept. Basic elements and requirements defined for PTSR AC programs are enforced by the associated implementing WIPP procedures.

Supporting the first layer of defense-in-depth (the prevention of accidents) as defined in Section 5.1.6, WIPP PTSR ACs are established as follows:

- To maintain the design, quality, testability, inspectability, operational capability, maintainability, and accessibility of the facility, PTSR ACs are required relating to: (1) configuration and document control, (2) maintenance, and (3) quality assurance. These ACs are important to ensure the frequency of events and the availability of the operating and design conditions remain as analyzed in Section 5.2.3.

- To ensure that the facility operations are conducted by trained and certified/qualified personnel in a controlled and planned manner, TSR ACs are required relating to: (1) facility operations chain of command and responsibilities, (2) facility staffing requirements, (3) procedures, (4) staff qualifications, (5) conduct of operations, and (6) training. These ACs are important to ensure the low frequency of the accidents analyzed in Section 5.2.3.

- To ensure that hazards are limited within the bounds assumed in Chapter 5.2, or that the occurrence of a deviation from the assumed hazard bounds are at an acceptably low frequency, PTSR ACs are required relating to: (1) waste characteristics (Waste Acceptance Criteria), (2) waste container integrity, (3) criticality safety, (4) fire protection, and (5) waste handling PE-Ci limit. The PTSR AC for waste characteristics limits the radionuclide content of each waste container, restricts the fissile content of the containers, and restricts the presence of waste characteristics unacceptable for management at the WIPP facility. Container integrity ensures the robustness reflected in the waste release analyses, while criticality safety is a designed in-storage and handling configuration that ensures (in conjunction with waste characteristics) that active criticality control is not required.. The fire safety requirement restricts combustible loading in the WHB; and the waste handling PE-Ci limits establish a maximum radionuclide content to ensure the bounds assumed in Section 5.2 are not exceeded.

Supporting the second and third layers of defense-in-depth, WIPP PTSR ACs are identified which establish programs for radiation protection of workers and the environment (including radiation monitoring equipment and airborne radioactivity monitoring), and mitigation of off-normal events through emergency management.

6.4.5.2 SSCs Required to Support Defense-In-Depth

Specific SSCs identified for each accident in Section 5.2.3 that fulfill a defense-in-depth safety function <u>or</u> that are considered essential for waste handling, storage and/or disposal operations are as follows:

1) WHB RH facilities Heating, Ventilation, and Air Conditioning (HVAC);
2) Underground Ventilation and Filtration System (UVFS) (including underground shift to filtration)
3) Waste Hoist Brake System (designated Safety Significant)
4) WASTE HANDLING equipment (including the facility cask loading grapple, grapple hoist system including brakes, RH bay bridge crane, forklifts and attachments, HERE, facility cask rotating device, facility cask transfer car, drum carriage, lifting fixture, etc.) as required during WASTE HANDLING operations only);
5) WHB structure (including Hot Cell with thermal detector) and tornado doors;
6) Central Monitoring System (to support underground shift to filtration only);
7) Radiation Monitoring System (active waste disposal room exit alpha CAM for underground shift to filtration).
8) Devices to restrict operations, including Shield Door and Crane Interlock, Crane and Hot Cell Shield Valve Interlock, Torque limiter on shield valve motor, Force Limiter on Swipe Arm, and Robotic Arm Collision Detector

The applicability of the important defense-in-depth SSCs to each accident analyzed in Section 5.2.3, is listed in Table 6-1. The above SSCs are classified as "defense-in-depth SSCs," and are applicable to each mode as shown in Table 6-2.

As shown in Section 6.4.3, based on the criteria for assigning PTSR LCOs, defense-in-depth SSCs are not assigned PTSR LCOs. The facility has no complex system requirements to maintain an acceptable level of risk. The WIPP WAC for transuranic wastes and the design of the waste handling process and its supporting facilities provide assurance that the immediate consequences of an accident will be limited and allow the WIPP facility to isolate and contain releases while maintaining a high assurance that no additional releases will occur. The facility is designed to minimize the presence and impact of other energy sources that could provide the heat or driving force to disperse hazardous materials. The magnitude of hazardous materials that can be involved in an accident leading to a release is very limited. The radioactive material is delivered to the site in sealed containers, and the waste handling operations are designed to maintain that integrity throughout the entire process required to safely place those containers in the site's underground waste disposal rooms. Inventory limits on individual containers ensure that heat generated by radioactive decay can be easily dissipated by passive mechanisms. Finally, only a limited number of waste containers have the possibility of being breached as a result of any one accident initiating event. As a result, the consequences of unmitigated releases from all accidents hypothesized in Chapter 5, including those initiated by human error, do not produce significant offsite health consequences.

When something unusual happens during normal operations (such as defense-in-depth SSCs becoming unavailable), **waste handling can be simply stopped** until an acceptable operating condition is reestablished. The facility is designed to minimize the presence and impact of other energy sources that could provide the heat or driving force to disperse hazardous materials. Should an accident involving the breach of a container occur, **the plant design permits the immediate cessation of activity and isolation of the area where the breach occurs**. Once isolation is achieved, there is no driving force within the waste or waste handling area that could result in a further release of the waste material. The absence of energy sources that can disperse the radioactive waste allows the immediate termination of all activities, evacuation of personnel, and isolation of the area without the threat of additional consequences. This will enable WIPP personnel to then proceed with detailed planning to meet the unique circumstances of any accidental release prior to initiating decontamination and the execution of recovery actions, while assuring that the health and safety of both workers and the public is protected. The controls necessary to maintain safety during the recovery and cleanup can be documented in the recovery plan, the associated Radiological Work Permit, and the USQ process. In order to ensure protection during recovery from an event that breaches a waste container, the defense-in-depth SSCs for the Waste Handling Mode will be required during the period of time that waste may be exposed.

Based on PSAR Section 5.2.4.1, Evaluation of the Design Basis, specific functional requirements are not assigned here for the defense-in-depth SSCs, rather, the SSCs shall be operated as required in Table 6-2. Detailed design descriptions for the defense-in-depth SSCs may be found in Chapter 4, and the applicable Systems Design Descriptions (SDDs).

6.4.5.2 Defense-In-Depth SSC Operation

Defense-in-depth SSCs are listed in Table 6-1. The applicable SDDs define defense-in-depth SSCs, describe their intended safety functions, and specify the requirements for design, operation, maintenance, testing, and calibration. WIPP procedure WP 04-AD3001, Facility Mode Compliance [4], shall be implemented, and maintained to ensure that defense-in-depth SSCs are operated as required during each facility mode as described in Table 6-2.

If any of the defense-in-depth SSCs fails to operate (when required), or becomes unavailable during Waste Handling operations, or must be taken out of service for maintenance or repair, Waste Handling operations shall be stopped, and the area shall be placed in the Waste Storage/Disposal Mode. Waste Handling operations shall not resume until all defense-in-depth SSCs required for Waste Handling Mode are capable of being operated, as required.

The defense-in-depth SSCs operational requirements ensure that important defense-in-depth SSCs are operated as required during Waste Handling Mode in the surface or underground, to provide protection for the "most likely" waste handling accidents identified in Section 5.2.3:

1. RH2, Fire in the WHB;
2. NC1, Fire in the Hot Cell;
3. RH4-B, LOC in the Underground (waste movement);
4. NC3-A, LOC in the WHB (dropped object on waste material in Hot Cell);
5. NC3-B, LOC in the WHB (dropped object on waste material outside Hot Cell);
6. NC3-C, LOC in the WHB (dropped drum or facility canister in Hot Cell)
7. NC3-D, LOC in the WHB (dropped drum or facility canister outside Hot Cell);
8. NC3-E, LOC in the WHB (puncture of drum in Hot Cell);
9. NC3-F, (hazardous event 12E-3) LOC in the WHB (puncture of drum or facility canister outside Hot Cell); and
10. NC4, LOC in the Underground (waste movement)

For natural phenomenon events:

1. RH6, Design Basis Earthquake;
2. RH7, Design Basis Tornado;
3. NC7, Seismic Event;
4. NC8, Tornado Event;

And for less likely operational accidents evaluated to be beyond extremely unlikely identified in Section 5.2.3:

1. RH1, Fire in the Underground;
2. RH3, LOC in the WHB;
3. RH4-A, LOC in the Underground (waste hoist failure);
4. RH5, Fire Followed by Explosion in the Underground;
5. NC2, Fire in the Underground (same as and bounded by RH1);
6. NC3-C, (hazardous events 10B-1) LOC in the WHB (dropped drum or canister in Hot Cell);
7. NC3-F, LOC in the WHB (puncture of drum or canister outside Hot Cell);

8. NC3-G, LOC in the WHB (puncture of 10-160B cask in RH Bay);
9. NC3-H, LOC in the WHB (dropped 10-160B cask in RH Bay);
10. NC4, LOC in the Transfer Cell or Underground (waste hoist failure and Transfer Cell); and
11. NC6, Fire followed by explosion in the Underground (same as and bounded by RH5)

As discussed, if any of the defense-in-depth SSCs fail to operate (when required), or become unavailable during RH Waste Handling operations, Waste Handling operations shall be stopped, and the facility shall be placed in the Waste Storage/Disposal Mode. Waste Handling operations shall not resume until the required defense-in-depth SSCs are capable of being operated as required.

During Waste Storage/Disposal Mode in the WHB and/or underground, the defense-in-depth SSCs operational requirements ensure that important defense-in-depth SSCs are operated as required to provide protection for less likely operational accidents identified in Section 5.2.3 for natural phenomenon events: (1) RH6 and NC7, seismic and (2) RH7 and NC8, tornado.

It should be noted that the likelihood of RH1, RH3, RH4-A, RH5, NC2, NC3-C, F, G, H and NC6 were evaluated in Section 5.2.3 to be beyond extremely unlikely. As such, for the Waste Storage/Disposal Mode, if any of the required defense-in-depth SSCs fail to operate (when required) or become unavailable, no specific actions are identified other than to perform corrective maintenance on the affected equipment in a timely manner.

A summary of the applicability of defense-in-depth SSCs in relation to the mode definitions is presented in Table 6-2.

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6.5 Design Features

The Design Features of the WIPP Facility are described in Chapter 4 of the PSAR.

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6.6 Interface TSRs

The WIPP Facility does not have interfacing TSRs from other facilities.

References for Chapter 6

1. DOE Order 5480.22, Technical Safety Requirements, September, 1992.

2. 10 CFR 830.205, Technical Safety Requirements, January, 2001.

3. DOE/WIPP-Draft 23-3123, Remote-Handled Waste Acceptance Criteria for the Waste Isolation Pilot Plant.

4. WP 04-AD3001, Facility Mode Compliance

5. DOE/WIPP-DRAFT-3174, Attachment 2, Accident Analysis For RH 10-160B Cask Processing.

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 1 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH1 Fire in the Underground	Primary confinement	Vented DOT Type A, or equivalent, waste canister	5.9.10, 5.9.12	SSC (Passive)
	Secondary confinement	Underground ventilation exhaust system Underground ventilation exhaust HEPA filters	5.9.1 5.9.1	SSC(Active) SSC(Active)
	Hydraulic oil reservoirs on HERE designed with a volume of $\leq$ 20 gallons and to minimize leaks	HERE design	5.9.1	SSC(Passive)
	Fuel tank on forklift designed to minimize leaks	Forklift and forklift fuel tank design	5.9.1	SSC(Passive)
	No other vehicle movement allowed in the waste transport route during RH waste handling in the underground	Waste handling procedures	5.9.5	AC
	There is no other facility cask containing RH waste canisters or CH waste drums in the path of the forklift when facility cask containing RH canisters are processed in the underground	Waste handling procedures	5.9.5	AC
	Forklift operated to prevent failure resulting in an uncontrolled movement of the forklift	Operator training and qualifications	5.9.6	AC
	Operations performed with spotter present	Pre-op checks/inspections	5.9.7	AC
	Throughput of waste canisters is 208/year which translates to 208 forklift operations per year	AOP Review	5.9.15	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management Program	5.9.8	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 2 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH2 Fire in the WHB	Primary confinement	Vented DOT Type A or equivalent RH waste canister	5.9.10 5.9.12	SSC (Passive)
	Secondary confinement	Waste Handling Building (WHB) structure WHB RH HVAC System WHB HEPA filters	5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Active) SSC (Passive)
	The facility cask transfer car located >6 ft from the catch pans for the hydraulic unit of the facility cask rotating device.	Facility cask transfer car location and design	5.9.1	SSC (Passive)
	Facility cask rotating device hydraulic unit has an oil reservoir volume of <40 gal, the hydraulic oil catch pans have a capacity of $\geq$45 gal, and the hydraulic oil reservoir is designed to minimize leaks	Facility cask rotating device design	5.9.1	SSC(Passive)
	Limitations on waste canister radionuclide and fissile inventory and hazardous waste characteristics	WIPP Waste Acceptance Criteria (WAC)	5.9.12	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management program	5.9.8	AC
NC1 Fire in the Hot Cell	The facility shall limit combustibles in the Hot Cell	Fire Protection program	5.9.16	AC
	The facility shall provide regularly scheduled inspections to ensure that the combustibles are maintained at an acceptable level	Fire Protection program	5.9.16	AC
	The facility shall limit the ignition sources in the Hot Cell	Fire Protection program	5.9.16	AC
	The facility shall provide preventative maintenance of the electrical equipment to ensure proper operation	Maintenance program	5.9.3	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 3 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
NC1 Fire in the Hot Cell continued	Primary confinement	Facility canister design (including lid)	5.9.1	SSC (Passive)
	Secondary confinement	Waste Handling Building (WHB) structure (including Hot Cell) WHB Ventilation System	5.9.1 5.9.1	SSC (Passive) SSC (Active)
	The facility shall provide guidance in the event of a fire in the Hot Cell	Procedures and Training	5.9.5, 5.9.6	AC
	RH waste containers accepted into the facility shall be noncombustible, vented, and meet DOT Type A or equivalent certification requirements	WIPP WAC	5.9.12	AC
	No explosive or compressed gasses are permitted in the waste	WIPP WAC	5.9.12	AC
	Warning to personnel of excessive temperatures in the Hot Cell	Thermal detector	5.9.1	SSC (Active)
	Procedures and training to ensure waste drums/ canister integrity	Waste canister/drum integrity	5.9.10	AC
	Operators shall ensure Cask Unloading Room (CUR) shield door is closed	Procedures and Training	5.9.5, 5.9.6	AC
	Operators shall ensure that Hot Cell/ CUR shield plugs are in place	Procedures and Training	5.9.5, 5.9.6	AC
NC5 Explosion Followed by Fire in the Hot Cell	Primary confinement	Facility canister design (including lid) Vented drums	5.9.1 5.9.10	SSC (Passive) SSC (Passive)
	Secondary confinement	WHB and Hot Cell ventilation system	5.9.1	SSC (Passive)

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 4 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
NC5 Fire Followed by Explosion in the Hot Cell continued	Waste drums shall be vented Type A or equivalent certification and be noncombustible and contain no explosive or compressed gasses	WIPP WAC	5.9.12	AC
	Explosives or compressed gasses are not allowed in the waste shipped to WIPP	WIPP WAC	5.9.12	AC
	Operators shall ensure CUR shield door closed	Procedures and Training	5.9.5, 5.8.6	AC
	Operators shall ensure that Hot Cell/ CUR shield plugs are in place	Procedures and Training	5.9.5, 5.9.6	AC
	Procedures and training to ensure waste drum/canister integrity	Waste drum/canister integrity	5.9.10	AC
RH3 Loss of Confinement in the WHB	Primary confinement	Vented DOT Type A or equivalent waste canister	5.9.10, 5.9.12	SSC (Passive)
	Secondary confinement	WHB structure WHB RH HVAC system WHB HEPA filters	5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Active) SSC (Passive)
	Grapple hoist system designed to minimize failures resulting in an uncontrolled movement of the RH waste canister	Grapple hoist system design Configuration control Quality Assurance	5.9.1 5.9.1 5.9.4	AC AC AC
	Grapple hoist system maintained to prevent failure resulting in an uncontrolled movement of the hoist	Preventative maintenance Configuration Control Quality Assurance	5.9.3 5.9.1 5.9.4	AC AC AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 5 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH3 Loss of Confinement in the WHB continued	Grapple hoist system operated to prevent failure resulting in an uncontrolled movement of the hoist	Pre-op checks/inspections (Conduct of Ops) Operator training and qualification Waste handling procedures Hoisting and rigging practices	5.9.7 5.9.6 5.9.5 5.9.5	AC AC AC AC
	Limitations on waste container radionuclide and fissile inventory and waste characteristics	WIPP WAC	5.9.12	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management program	5.9.8	AC
	Shuttle car is designed to support the drop of waste canister from facility cask into the road cask	Shuttle car design	5.9.1	SSC (Passive)
	It is assumed that the facility cask loading grapple is as reliable or better that the TRUPACT crane system	Cask loading grapple system design Configuration control Quality Assurance Preventative maintenance	5.9.1 5.9.1 5.9.4 5.9.3	SSC (Passive) AC AC AC
	Grapple hoist system brakes for RH waste canister during facility cask loading are designed to engage upon loss of power and as such, hold the load, thus minimizing th probability of waste canister breach	Grapple hoist system design Pre-op checks/inspections (Conduct of Ops) Operator training and qualifications Waste handling procedures Hoisting and rigging practices	5.9.1 5.9.7 5.9.6 5.9.5 5.9.5	SSC (Active) AC AC AC AC
	The maximum height from which a waste canister can be dropped is ≤22 ft	Facility cask loading grapple system design	5.9.1	SSC (Passive)

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 6 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH3 Loss of Confinement in the WHB (continued)	Should an accident involving a breach of a waste canister occur, the plant design permits the immediate cessation of activity and isolation of the area where the breach occurs. Once isolation is achieved, there is no driving force within the waste or waste handling area that could result in a further release of the waste material	WIPP Emergency management program	5.9.8	AC
	Distance of the Grapple hoist operator from the dropped waste container is 15 ft	Facility Cask loading grapple system design	5.9.1	AC
	Throughput of waste canisters is 208yr	AOP review	5.9.14	AC
NC3 Loss of Confinement in the RH Bay and Hot Cell	Primary confinement	Vented DOT Type A or equivalent waste drums	5.9.1	SSC (Passive)
	Secondary confinement	WHB structure WHB RH HVAC system WHB HEPA filters	5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Active) SSC (Passive)
	Prevent operator errors when performing the tasks necessary to unload the drums from the 10-160B cask and place them in canisters for permanent storage	Procedures and Training	5.9.5, 5.9.6	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency management program	5.9.8	AC
	Provide radiation and air monitoring to protect facility personnel	Area Radiation Monitors (ARMs) and Continuous Air Monitors (CAMs)	5.9.1	SSC (Active)
	Provide protection to prevent direct radiation exposure and/or the spread of contamination	CUR shield door, Hot Cell shield valve, shield plugs and Hot Cell crane interlock	5.9.1	SSC (Active)

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 7 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
NC3 Loss of Confinement in the RH Bay and Hot Cell (continued)	Provide for inspections and maintenance (including preventative maintenance) to ensure proper operation of equipment	Maintenance program	5.9.3	AC
	All cranes, grapples, and hoists are designed for reliable operation	Crane/grapple design	5.9.1	SSC (Active)
	Shuttle car is designed to support the drop of waste canister from facility cask into the shielded insert	Shuttle car design	5.9.1	SSC (Passive)
	Limitations on waste canister radionuclide and fissile inventory and waste characteristics	WIPP WAC	5.9.12	AC
	Prevent dropping loaded facility canister into the Transfer Cell	Guide tubes Shuttle car design Impact limiter on floor	5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Passive) SSC (Passive)
	Prevent movement of shuttle car/ Hot Cell crane while lowering facility canister into the shuttle car	Shuttle car drive train and motor controller Shuttle car and Hot Cell shield valve interlock Hot Cell crane and shield valve interlock Torque limiter on Hot Cell shield valve	5.9.1 5.9.1 5.9.1 5.9.1	SSC (Active) SSC (Active) SSC (Active) SSC (Active)
	Operators shall ensure the CUR shield door is closed	Procedures and Training	5.9.5, 5.9.6	AC
	Operators shall ensure Hot Cell shield plugs are in place	Procedures and Training	5.9.1	AC
	Prevent the robotic are from causing damage to the canister during the contamination survey	Robotic arm design Force limiter on swipe arm Robotic arm collision detector	5.9.1 5.9.1 5.9.1	SSC (Active) SSC (Active) SSC(Active)

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 8 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH4-A&B Loss of Confinement in the Underground	Primary confinement	Vented DOT Type A or equivalent RH waste canister	5.9.10, 5.9.12	SSC (Passive)
	Secondary confinement	Underground ventilation exhaust system Underground ventilation exhaust HEPA filters Radiation monitoring system (active waste disposal room exit Alpha CAM for underground shift to filtration Central monitoring system (for actuation of underground shift to filtration only)	5.9.1 5.9.1 5.9.1 5.9.1	SSC (Active) SSC (Passive) SSC (Active) SSC (Active)
	RH waste handling equipment designed to prevent failure resulting in a dropped waste canister	Waste handling equipment design Configuration control Quality Assurance	5.9.1 5.9.1 5.9.4	SSC (Passive) AC AC
	RH waste handling equipment maintained to prevent failure resulting in a dropped waste canister	Preventative maintenance Configuration control Quality Assurance	5.9.3 5.9.1 5.9.4	AC AC AC
	Waste handling equipment operated to prevent failure resulting in a dropped waste canister	Pre-op checks/inspections (Conduct of Ops) Operator training and qualification Waste handling procedures Hoisting and rigging practice Operations performed with spotter present	5.9.7 5.9.6 5.9.5 5.9.5 5.9.5	AC AC AC AC AC
	Limitations on waste canister radionuclide and fissile inventory and waste characteristics	WIPP WAC	5.9.12	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency management program	5.9.8	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 9 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH4-A&B Loss of Confinement in the Underground (continued)	Design of the facility cask transfer car, facility cask and waste shaft	Design of the facility cask, facility cask transfer car, and waste shaft	5.9.1	SSC (Passive)
	The facility cask is in a horizontal position and positioned with the greatest moment of inertia. It is held in place by trunnions and supports to keep it from moving	Facility cask and facility cask transfer car design	5.9.1	SSC (Passive)
	Maximum speed of the facility cask transfer car is 30 ft per minute	Facility cask transfer car design	5.9.1	SSC (Passive)
	Maintain configuration control of the waste hoist on which fault tree was based	Configuration control	5.9.1	AC
	Design of motor on the facility cask shield valve will be such that an inadvertent closure of the shield valve will not affect the containment integrity of the waste canister during its emplacement in a borehole	Shield valve and shield valve motor design Configuration control Quality Assurance	5.9.1 5.9.1 5.9.4	SSC (Passive) AC AC
	Design of the HERE hydraulic system will be such that the containment integrity of a misaligned waste canister is not affected during its emplacement in a borehole	Hydraulic system design Configuration control Quality Assurance	5.9.1 5.9.1 5.9.4	SSC (Passive) AC AC
	No other vehicle movement is allowed in the waste transport route during RH waste handling in the underground	Waste handling procedures	5.9.5	AC
	A spotter is present whenever forklift is used to transfer facility cask in the underground	Operator training and qualifications Waste handling procedures Operations performed with spotter present	5.9.6 5.9.5 5.9.5	AC AC AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 10 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH4-A&B Loss of Confinement in the Underground (continued)	The maximum height from which the waste canister can be dropped is ≤22 ft	Facility cask loading hoist design Configuration control Quality Assurance	5.9.1 5.9.1 5.9.4	SSC (Passive)
	Should an accident involving a breach of a waste canister occur, the plant design permits the immediate cessation of activity and isolation of the area where the breach occurs. Once isolation is achieved, there is no driving force within the waste or waste handling area that could result in a further release of waste material	WIPP Emergency Management program	5.9.8	AC
	The door to the waste hoist is not open until the conveyance is locked in position and the pivot rails are in place - prevents the drop of facility cask/waste canister into waste shaft	Waste handling procedures	5.9.5	AC
	Aggressive maintenance program includes post-maintenance functional testing (stroke testing) of all valves following a maintenance operation	Preventative maintenance program Maintenance procedures Post-maintenance testing requirements	5.9.3 5.9.3 5.9.3	AC AC AC
	Maximum test time for standby components is 24 hours	Waste handling procedures Operations checks/inspections	5.9.5 5.9.7	AC AC
	Mission time for the waste hoist is 1000 hrs/yr (7,000 round trips per year) which includes transfers of RH and CH waste to the underground	AOP review	5.9.14	AC
	Floor will be leveled prior to storage operations in a panel room in the underground	Ground control procedures	5.9.7	AC
	Maximum time to transfer one waste canister to the emplacement equipment in the underground is approximately 4 hours	Waste handling procedures	5.9.5	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 11 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH4-A&B Loss of Confinement in the Underground (continued)	Waste hoist system is subjected to a series of thorough "pre-operational check" tests at the start of each eight hour shift. Operation of the waste hoist system does not begin until the tests are successfully completed. In the fault tree analysis the test interval is conservatively assumed to be three times greater or 24 hours. If the hoist system is to be operated more than one shift per day, or there is a change of operator, the hoist system will be removed from service and the same "Pre-operational check" tests will be performed at the start of each shift or for each operator change	Waste handling procedures Pre-op check/inspections Shift turnover procedures	5.9.5 5.9.7 5.9.7	AC AC AC
	Throughput of waste canisters is 208/yr which translates to 208 forklift operations per year	AOP review	5.9.14	AC
RH5 Fire Followed by Explosion in the Underground	Primary confinement	Vented DOT Type A, or equivalent, waste canister	5.9.10, 5.9.12	SSC (Passive)
	Secondary confinement	Underground ventilation exhaust system Underground ventilation exhaust HEPA filters	5.9.1 5.9.1	SSC(Active) SSC(Passive)
	Hydraulic oil reservoirs on HERE designed with a volume of $\leq$ 20 gallons and to minimize leaks	HERE design	5.9.1	SSC(Passive)
	Fuel tank on forklift designed to minimize leaks	Forklift and forklift fuel tank design	5.9.1	SSC(Passive)
	Forklift operated to prevent failure resulting in a damaged/dropped waste canister	Operator training and qualifications Waste handling procedures Forklift operations for RH canisters performed with spotter present	5.9.6 5.9.5 5.9.5	AC AC AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 12 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH5 Fire Followed by Explosion in the Underground (continued)	No other vehicle movement allowed in the waste transport route during RH waste handling in the underground	Waste handling procedures	5.9.5	AC
	There is no other facility cask containing RH waste canisters or CH waste drums in the path of the forklift when facility cask containing RH canisters are processed in the underground	Waste handling procedures	5.9.5	AC
	Throughput of waste canisters is 208/year which translates to 208 forklift operations per year	AOP Review	5.9.15	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management Program	5.9.8	AC
RH6 Seismic Event (DBE)	Primary confinement	Vented DOT Type A, or equivalent, waste canister	5.9.10, 5.9.12	SSC (Passive)
	Secondary confinement	Underground ventilation exhaust system Underground ventilation exhaust HEPA filters Radiation Monitoring system (active waste disposal room exit alpha CAM for underground shift to filtration Central Monitoring System (for actuation of underground shift to filtration only)	5.9.1 5.9.1 5.9.1 5.9.1	SSC(Active) SSC(Passive) SSC (Active) SSC (Active)
	Grapple hoist is designed so that it would not drop or affect the containment integrity of the waste canister when transferring waste canister from the road cask into the facility cask during and after a DBE	Grapple hoist system design	5.9.1	SSC(Active)

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 13 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
RH6 Seismic Event (DBE) (Continued)	Transfer Cell shuttle car is designed such that it would not drop or affect the containment integrity of the waste canister during and after a DBE	Shuttle car design	5.9.1	SSC(Passive)
	Transfer Cell equipment is designed such that it would not affect the containment integrity of the waste canister during and after a DBE	Transfer Cell and Transfer Cell equipment design	5.9.1	SSC (Passive)
	Limitations on waste canister radionuclide and fissile inventory and waste characteristics	WIPP WAC	5.9.12	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management program	5.9.8	AC
NC7 Seismic Event for 10-160B Cask Processing	Secondary confinement	WHB (including Hot Cell) is DBE qualified 140/25 ton crane is DBE qualified Hot Cell crane is DBE qualified PAR®Manipulator is DBE qualified Central Monitoring System (for actuation of underground shift to filtration only).	5.9.1 5.9.1 5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Active) SSC (Active) SSC (Active) SSC (Active)
	The 10-160B cask is designed to withstand the effects of DBE without the release of waste contents	Road cask design	5.9.1	SSC(Passive)
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency Management program	5.9.8	AC
	There shall be documented controls pertaining to returning the facility to normal operation following a seismic event	Recovery plan	5.9.17	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 14 of 15

Accident	**Defense-In-Depth Function**	**Defense-in-Depth Feature**	**TSR Control (AC)**	**Type of Feature (SSC or Administrative Control (AC)**
RH7 Tornado Event (DBT) (continued)	Primary confinement	Vented DOT Type A or equivalent waste canister	5.9.10	SSC (Passive)
	Secondary confinement	Underground ventilation exhaust system Underground ventilation exhaust system HEPA filters Radiation monitoring system (active waste disposal room exit alpha CAM for underground shift to filtration) Central monitoring system (for actuation of underground shift to filtration only)	5.9.12 5.9.1 5.9.1 5.9.1 5.9.1	SSC (Passive) SSC (Active) SSC (Passive) SSC (Active) SSC (Active)
	The road cask is designed to withstand the effects of high wind, tornado, tornado driven missiles, and overturning without the release of waste contents	Road cask design	5.9.1	SSC (Passive)
	The WHB (including the crane and grapple hoist used for RH waste handling) and waste hoist are protected by the WHB structure, and the tornado doors	WHB (including tornado doors) design	5.9.1	SSC(Passive)
	Limitations on waste canister radionuclide and fissile inventory and waste characteristics	WIPP WAC	5.9.12	AC
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency management program	5.9.8	AC

Table 6-1, Summary of Defense-In-Depth Functions and Defense-in-Depth Features Important to Accident Scenarios Page 15 of 15

Accident	Defense-In-Depth Function	Defense-in-Depth Feature	TSR Control (AC)	Type of Feature (SSC or Administrative Control (AC)
NC8 Tornado Event for 10-160B Cask Processing (DBT)	Primary confinement	Vented DOT Type A or equivalent waste canister	5.9.10 & 5.9.12	SSC (Passive)
	Secondary confinement	CMR (for weather monitoring)	5.9.7	AC
	The WHB (including Hot Cell) and waste hoist are protected by the WHB structure, and the tornado doors	WHB (including tornado doors) design	5.9.1	SSC (Passive)
	Provide facility emergency response to the event (notification, evacuation, direct response)	WIPP Emergency management program	5.9.8	AC
	The 10-160B cask meets DOT Type B shipping container certification requirements	Shipping cask design	5.9.1	SSC (Passive)

Table 6-2, Summary of Applicability of Defense-In-Depth SSCs to WIPP Modes

Defense-In-Depth SSCs	Waste Handling Mode		Waste Storage/Disposal Mode	
	WHB	Underground	WHB	Underground
WHB RH facilities HVAC System (excluding Hot Cell ventilation system unless waste is being processed or stored in the Hot Cell)	X		X*	
Waste Hoist (including Brake System - when required to transport waste)	X	X		
WASTE HANDLING equipment (including the facility cask loading grapple, grapple hoist system including brakes, RH bay bridge crane, forklifts, HERE, facility cask rotating device, facility cask transfer car, lifting fixture, etc.) as required during WASTE HANDLING operations only)	X	X		
WHB structure (including Hot Cell with thermal detector) and tornado Doors	X		X*	
Underground Ventilation and Filtration System		X		X
Radiation Monitoring System (active waste disposal room exit alpha Continuous Air Monitor [CAM] for underground shift to filtration)		X		X
Devices to restrict operations including Shield Door and Crane Interlock, Crane and Hot Cell Shield Valve Interlock, Torque limiter on shield valve motor, Force Limiter on Swipe Arm, and Robotic Arm Collision Detector	X			
Central Monitoring System to support underground shift to filtration		X		X

*Note that no defense-in-depth operational requirements apply to the WHB when no WASTE is present

Following failure of a required SSC, the facility will be placed in the WASTE Storage/Disposal Mode. During the time required to effect the required repairs, the facility is not in violation of the TSR.