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Safety Evaluation Report for Approval of

DOE/WIPP 07-3372, Waste Isolation Pilot Plant *Documented Safety Analysis*, Revision 5 and DOE/WIPP 07-3373, Waste Isolation Pilot Plant *Technical Safety Requirements*, Revision 5

Managed and Operated by Nuclear Waste Partnership, LLC
Under U.S. DOE Contract DE-EM0001971

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EXECUTIVE SUMMARY

This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Carlsbad Field Office (CBFO) and Office of Environmental Management (DOE-EM) technical review and approval of Revision 5a to the Waste Isolation Pilot Plant (WIPP) Safety Basis (SB) consisting of DOE/WIPP 07-3372, *Waste Isolation Pilot Plant Documented Safety Analysis* (DSA), and DOE/WIPP 07-3373, *Waste Isolation Pilot Plant Technical Safety Requirements* (TSR). DSA/TSR Revision 5a was formally transmitted to CBFO for approval by transmittal letter AA:16:01045, Subject: Resubmittal of the Waste Isolation Pilot Plant Documented Safety Analysis, Revision 5a for Approval, dated April 18, 2016, from Mr. Philip J. Breidenbach, Project Manager, Nuclear Waste Partnership LLC (NWP), to Mr. Todd Shrader, Manager, Carlsbad Field Office (CBFO). The document revisions were prepared in accordance with 10 CFR 830 Subpart B requirements, applying the safe harbor methodology specified in DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. The SER was prepared in accordance with DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents.*

The revisions were developed following suspension of operations in February 2014, when two major accidents occurred: 1) a significant underground fire involving a salt haul truck and, 2) a radiological release from an emplaced waste drum due to an energetic event within the drum.

This SER applies DOE-STD-1104-2014 to evaluate the Revision 5 documents as a comprehensive upgrade to the safety basis for compliance with DOE-STD-3009-2014, both standards having recently received complete updates.

NOTE: *This SER evaluated the original submittal (Revision 5a) and all directed page changes. Although the body of this SER may reference a specific letter sub-designator, the final version of the DSA/TSR with page changes incorporated has been reviewed and approved by this SER. This final DSA/TSR, as approved for implementation, will be annotated as Revision 5b.*

As part of the comprehensive upgrade to Revision 5 to meet these requirements, the safety basis has, essentially, been re-written from the ground up and includes such improvements as:

- a new hazard analysis supporting selection of a new control suite;
- significant changes to the TSR that include clearer actions, better bases discussion, and new response times appropriate for the required safety functions;
- significant improvements to all Safety Management Programs (SMPs) incorporating newly defined Key Elements (KEs) into the TSR;
- complete reworking of the engineering evaluations associated with safety significant Structures, Systems, and Components (SSCs) to meet applicable requirements;
- incorporation of applicable Accident Investigation Board (AIB) lessons learned, including a recommendation to incorporate Continuous Air Monitors (CAMs) into the control strategy;
- implementation of decisions from the recovery plan developed following the accidents (*Waste Isolation Pilot Plant Recovery Plan*, September 30, 2014, Revision 0), including the decision to utilize filtered ventilation for the underground (UG) waste handling and disposal areas to minimize the risk of future radiological release from the UG;

- the addition of a new, first-in-complex SMP for the WIPP facility to ensure future compliance with the WIPP Waste Acceptance Criteria (WAC) in a manner coordinated with in-process National TRU Program corrective actions.

This SER supersedes the prior SERs for prior DSA and TSR revisions. This SER provides the DOE Approval Authority with the standalone basis for approval of the DSA/TSR, Revision 5 documents, both required to support WIPP operations, including the resumption of contact-handled (CH) waste receipt and subsequent emplacement, and to ensure the WIPP nuclear facility can be operated safely with respect to the workers, the public, and the environment.

To ensure a robust safety basis in support of resumption of operations, DOE directed that WIPP use DOE-STD-3009-2014 as the governing safe harbor methodology, a new revision that imposes specific requirements for mandatory compliance as well as other guidance. The new standard reflects proven best-practices in safety basis development from throughout the DOE Complex. DOE also directed the use of DOE G 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*. Because WIPP handles transuranic (TRU) waste, the Revision 5 safety basis development was also governed by DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities,* developed to guide programs dealing with TRU waste within DOE-EM. This application of DOE-STD-5506-2007 is not its first use at WIPP; it has been applied since Revision 0 of the combined CH and RH DSA and TSR.

To facilitate implementation of DOE-STD-3009-2014 and, more importantly, to help ensure timely preparation of an approvable safety basis in support of WIPP restart, DOE elected to charter their Safety Basis Review Team (SBRT) built on the concept of an Integrated Project Team in DOE-STD-1189-2008, *Integration of Safety into the Design Process.* As referenced in DOE STD-1104-2014, the SBRT provided an in-process review during the contractor's DSA and TSR development in order to more expeditiously address development issues. The SBRT plan is documented in DOE/CBFO-15-3551, *Review Plan for the Documented Safety Analysis and Technical Safety Requirements Waste Isolation Pilot Plant WIPP 07-3372 & WIPP 07-3373 Revision 5*.

Background: WIPP is a Hazard Category 2 non-reactor nuclear facility for waste disposal located near Carlsbad in Eddy County, New Mexico. The WIPP facility mission is to provide safe and permanent disposal for government-owned TRU and TRU mixed wastes in its repository located approximately 2,150 feet underground in bedded salt. WIPP began receipt and disposal of CH waste (waste with <200 millirems per hour (mrem/hr) on contact) in March 1999 and of remote-handled (RH) waste (waste exceeding 200 mrem/hr on contact) in January 2007. WIPP operations to support the mission include the following:

- review of documentation for appropriately characterized and packaged waste;
- authorization of generator sites to ship waste;
- receipt of the waste on site;
- removal of waste from shipping containers inside an above ground facility;
- indoor staging of received waste;
- transfer of waste to the UG for emplacement;
- emplacement of the waste in constructed disposal panels divided into rooms;

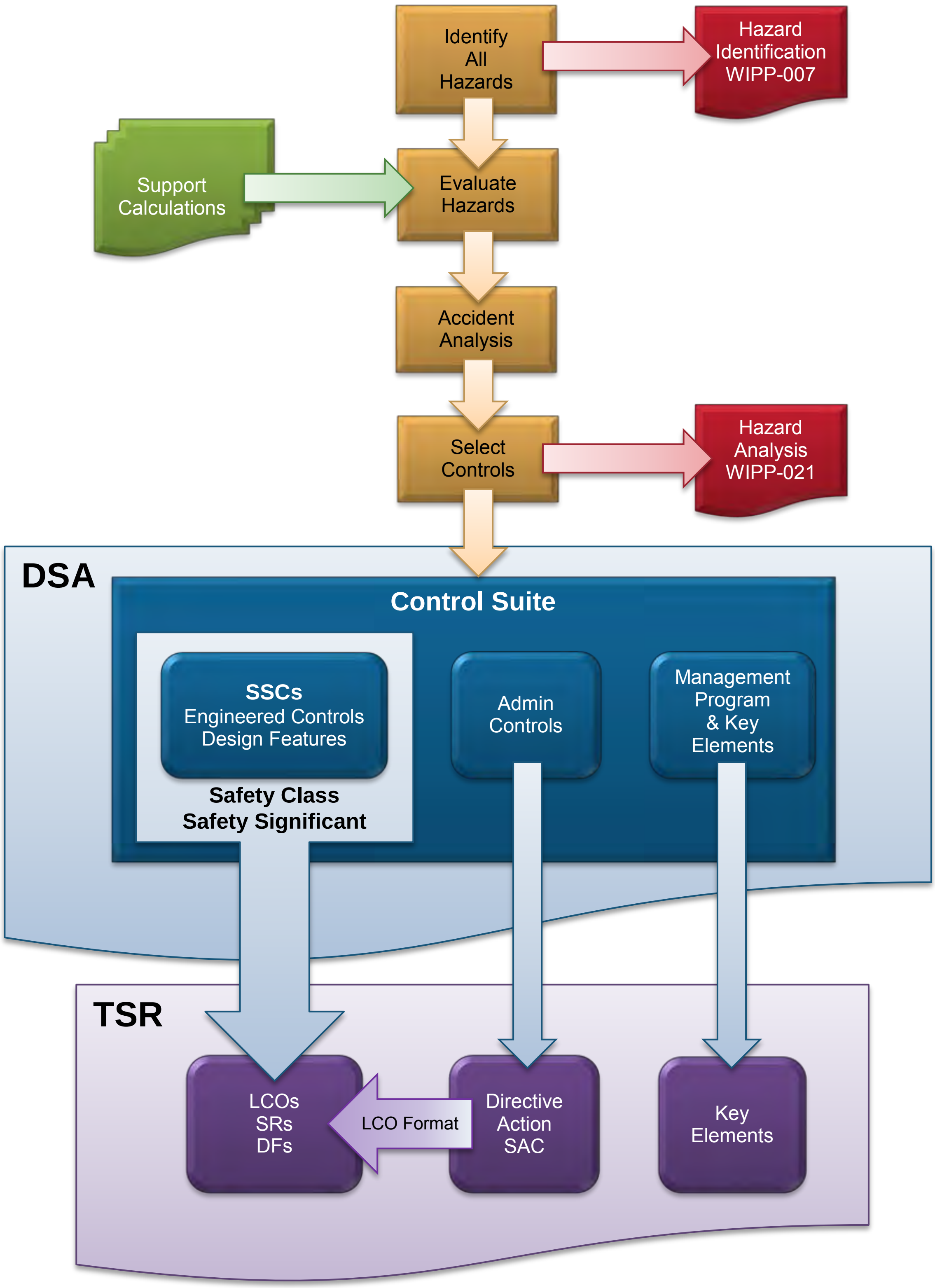
- removing emplaced waste that is subsequently reported as non-compliant and must be returned to the site generator;
- closure of rooms and panels when filled;
- maintenance of both above and below ground facilities.

WIPP is unique among DOE-EM nuclear facilities in that it is not only subject to 10 CFR 830 Subpart B requirements, but is also subject to requirements of 30 CFR 57, “Mineral Resources: Mine Safety and Health Administration – Safety and Health Standards Underground Metal and Nonmetal Mines” through a memorandum of understanding.

WIPP waste is packaged at various generator sites per WAC requirements. The WIPP WAC specify allowable primary waste packaging and content requirements. While primary packaging is not as robust as Type B packaging, these WIPP WAC requirements provide a strong first line defense against the release of any radiological material within WIPP facilities. The waste is received overpacked in robust transport packaging compliant with Type B requirements that suffice to preclude accidental radiological release both in transit and while being handled on site for emplacement in the UG. Upon receipt at the WIPP, the shipping containers are surveyed and all associated shipping manifest documents are reviewed for WIPP WAC compliance. If all requirements are met, the inner packaging is removed from the outer Type B packaging in the Waste Handling Building (WHB), which is designed to confine any release that may occur. The waste is loaded onto the Waste Hoist and down-loaded into the UG for permanent emplacement into rooms of various panels. Once a room is filled, an isolation bulkhead is installed to separate the filled room from the active portions of the disposal area and remove it from the ventilation circuit.

DSA/TSR Development Process: Development of Revision 5 of the DSA/TSR followed the process depicted in Figure ES-1.

Figure ES-1 DSA/TSR Development Process



Hazard Analysis: Hazard analysis includes hazard identification and hazard evaluation. Hazard identification characterized the hazards, both man-made and natural, in terms of type, quantity, and form of radioactive and other hazardous materials, and included screening of standard industrial hazards and chemical hazards. The hazard evaluation considered how those hazards not screened out can lead to hazardous conditions or events that may cause release of radioactive or hazardous materials, and addressed the following seven event types from DOE-STD-5506-2007:

- Fires
- Explosions/energetic events
- Loss of confinement/containment
- Direct exposure to radiation events
- Criticality events
- Externally initiated events
- Natural Phenomenon Hazard (NPH) events

In addition, due to the nature of how WIPP waste is remediated (e.g., use of various chemicals), chemical hazards were also evaluated for a total of eight event types.

As described in WIPP-021, Revision 5, *Hazard Analysis for the Waste Isolation Pilot Plant Transuranic Waste Handling Safety Basis*, a total of 641 hazard events were evaluated for the unmitigated hazard evaluation and grouped into 167 unique and representative radiological events for evaluation from all the major types of accidents, NPH, and external events. Of these, 47 events were identified as having unmitigated Risk Class I or II to one or more of the receptors, requiring further mitigated hazard evaluation or accident analysis. The events carried forward indicate that the principal hazards during WIPP waste handling, temporary storage, and emplacement involve fires or mechanical insults capable of breaching the primary packaging and providing the energy required to disperse the contents.

For the UG, the events that carried forward into the DSA for control selection include:

- Fires
    - pool fires from collisions of vehicles
    - pool fires from leaks of fuel/hydraulics
    - pool fires from dropped fuel or vehicles down shaft
    - ordinary combustible fires adjacent to waste, including fire propagation in waste arrays involving combustible materials (e.g., slip sheets, shrink wrap, magnesium oxide (MgO) sacks)
    - fires initiated within non-compliant waste
- Explosions/energetic events
    - Deflagration within non-compliant waste
    - Over-pressurization within non-compliant waste
    - Exothermic chemical reaction within historically non-compliant waste

- Loss of Confinement/Containment due to mechanical insults capable of breaching the primary packaging and providing the energy required to disperse the contents:
  - puncture of waste container
  - crushing of waste container due to collisions with vehicles or equipment
  - container failure caused by drop down shaft
  - pressurized container impacting waste

For the above ground structures, the following event types carried forward into the DSA for control selection:

- Fires
  - pool fires from collisions of vehicles
  - pool fires from leaks of fuel/hydraulics
  - ordinary combustible fires adjacent to waste, including fire propagation in waste assemblies involving combustible materials (e.g., slip sheets, shrink wrap)
  - fires initiated within non-compliant waste
- Explosions/energetic events
  - Deflagration within non-compliant waste
  - Over-pressurization within non-compliant waste
- External Events
  - Wildland fire penetrates buildings
  - External vehicle accident with fire
- Natural Phenomenon Hazards
  - Lightning strike
  - Seismic event

Other events/event types (e.g., direct exposure to radiation events, criticality events, tornado/high winds, aircraft impact, chemical exposure, etc.) did not carry forward into the DSA for control selection (screened out) because they were:

- Risk Class III/IV
- Low consequence to all receptors
- Not plausible per DOE-STD-3009-2014 (not physically possible)
- External event frequency of occurrence less than 1E-6/yr

Further evaluation and control selection is not required for hazard events that are screened out. Their screening may be based on credited Initial Conditions (ICs), design specific assumptions, calculations, and/or physical characteristics of the WIPP site. The DSA states that these events were reviewed to determine whether any associated controls warranted safety classification even though the event was unmitigated Risk Class III or IV. The SBRT reviewed the specific hazard event decisions in Table ES-1 to ensure that additional controls were not required, and identified one exception for an IC that was incorporated into the TSR as a Specific Administrative Control (SAC):

- a control requiring that TRU Waste outside of the WHB be in a closed Type B Shipping Package. This protects that IC and ensures that any TRU Waste outside of the WHB is protected by the Shipping Package as described above.

Table ES-1 Screened Out Events

Event Type	Location	Event	Justification for Not Screening Forward
Fire	UG WHB Outside	**Fire and internal container deflagration events involving RH Waste in a canister contained within the RH Waste Cask/light-weight facility cask (LWFC)**	• Low consequences to all receptors. • The Facility Cask/LWFC protects the contained TRU Waste Canister from exposure to flame. o Reduces the consequences of this event to Low and Risk Class III for all receptors.

Fire	UG	**Distant fire propagating to an active disposal room or Waste Transport Path**	• Beyond Extremely Unlikely (not physically possible).
			• A pool fire originating a distance of 25 feet from TRU Waste would have negligible effect on the TRU Waste Containers due to the multiplicity of conditions that must exist to result in the containerized waste burning with a resulting release.
			  o Non-combustibility of the salt (initial assumptions)
			  o Distances from TRU Waste.
			• The areas addressed by this event are significantly greater than the 25-foot distance.

Fire	WHB	**Large fires and loss of confinement events involving RH Type B Shipping Packages**	• No release because of the internal deflagration or over-pressurization protection provided by the RH Type B Shipping Packages (**IC**).

Fire Explosions/ energetic	UG	**Fuel storage explosion with fire propagating to an active Waste Disposal Room**	• Anticipated at the source but would not result in a release.
			• Conditions impede a fire/explosion in one portion of the UG propagating over a large distance to another portion of the UG.
			  o Non-combustibility of the salt (initial assumptions).
			  o Distances from TRU Waste (**IC**).
			• Diesel fuel composition/reactivity.
			  o Normally a hydrocarbon mixture of thousands of individual compounds with a carbon number between 9 and 23.
			  o Generally a National Fire Protection Association (NFPA) 30 Class II combustible liquid with a flashpoint between 100°F and 140°F (although some diesel products have a flash point above 140°F).
			  o Boiling temperature of diesel fuel generally ranges between 300°F and 640°F.
			  o Diesel fuel is not stored in the UG under pressure or processed above its flash point.
			  o The ambient temperature in the UG is normally less than 100°F.

Table ES-1 Screened Out Events

Event Type	Location	Event	Justification for Not Screening Forward
Explosions/ energetic	WHB	**Flammable gas explosion in the CH Bay due to hydrogen generation from the charging stations**	• Beyond Extremely Unlikely (not physically possible). • Analysis evaluated the hydrogen generation rate of the fork-truck recharging station in combination with the CH Bay volume and CH Waste Handling Confinement Ventilation System flow rates. o Would require 126.67 hours to reach a hydrogen concentration of 1% by volume with absolutely no ventilation.
Explosions/ energetic	UG	**Flammable gas explosion in a filled panel**	• Beyond Extremely Unlikely based on historical monitoring. • The drums are vented before being sent to WIPP to allow these gases to escape. • The waste in a filled panel creates hydrogen and other flammable gases, such as methane. o RCRA Part B Permit analyses evaluated drum gas generation rates. For methane, it would take five years to reach 1% concentration or 20 percent of the lower flammability limit within a single drum. For hydrogen, the concentration is less than 1% or 25% of the lower flammability limit in a single drum after five years. o The gas exiting the confines of the drums would collect in a filled panel at lower concentration than the source drum. o Not anticipated that a filled panel would reach its lower flammability limit within the operational lifetime of the facility. o Once in the panel, the gases could escape because the rooms are not airtight and do have limited air leakage. • Lack of an evident ignition source for any flammable gas that may accumulate (drum vents are typically made of materials that impede the production of static electricity).
Loss of confinement/ containment	WHB Outside	**Insults to Type B Shipping Packages in the Outside Area or in the WHB**	• No release due to the Type B Shipping Package design (**IC**).
Direct exposure to radiation	WHB	**Direct radiation exposure in the WHB**	• Low consequences. • RH Waste is handled in the Facility Cask Loading Room (FCLR), Transfer Cell, and Cask Unloading Room (CUR), which have thick concrete walls to provide shielding for workers (**IC**).

Table ES-1 Screened Out Events

Event Type	Location	Event	Justification for Not Screening Forward
Direct exposure to radiation	Outside	**Direct radiation exposure from waste in outside areas**	• Low consequences to all receptors. • All TRU Waste shipped to WIPP is required to comply with the WIPP WAC. • TRU Waste is contained in Type B Shipping Packages (**IC**) o Designed to protect the public from radiation exposure during transport of TRU Waste on public roadways. • The Radiation Protection Program (RPP) surveys TRU Waste receipts prior to entry to the site protected area.
Criticality	All	**Criticality events involving the TRU Waste during Waste Handling or disposal.**	• Determined to be incredible events based on Nuclear Criticality Safety Evaluation. o Ensures that the CH and RH processes will remain subcritical under normal and credible abnormal conditions per DOE Order 420.1C and DOE-STD-3007-2007 in accordance with the guidance of DOE-STD-3009-2014.
Externally initiated	WHB	**Range fire propagating to the WHB**	• Beyond Extremely Unlikely. • WIPP Property Protection Area of noncombustible construction (e.g., paved/graveled). • WHB, including the Waste Hoist Tower, constructed of noncombustible materials (**IC**).
Externally initiated	WHB	**Aircraft impacting waste containers in the WHB or the DOT Type B Shipping Package outside area**	• External event that is less than 1E-6 per year based on the methodology outlined in DOE-STD-3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities*.
Externally initiated	WHB	**External offsite vehicles colliding with Waste Containers within the WHB**	• Not plausible due to the distance of public access roads from the WHB and the fenced WIPP Property Protection Area.
Externally initiated	WHB	**Gas pipeline explosion offsite impacting waste**	• Extremely Unlikely with no release. o Large distances separating the WHB and the evaluated hazards. o TRU Waste in Type B Shipping Packages (**IC**).
Externally initiated NPH	WHB	**External or NPH initiated event leading to a catastrophic failure of the Waste Hoist Tower and resulting in a loaded Waste Conveyance dropping down the Waste Shaft**	• Unlikely due to the potential NPH initiators not having impact to loaded Waste Conveyance. o Design and construction of the Waste Hoist Tower (i.e., design basis earthquake (DBE), tornado, high winds, and snow loading) (**IC**). o Waste Hoist Support Structure (**IC**).

Table ES-1 Screened Out Events

Event Type	Location	Event	Justification for Not Screening Forward
NPH	WHB	**High wind or tornado impact of the WHB**	• Tornado or high wind generated missiles were evaluated to be Low consequences which did not warrant further evaluation. • The Design Basis Tornado (DBT) construction of the WHB (**IC**) is adequate to protect the TRU Waste from damage. o Since HEPA filtration is not required for a tornado event, the tornado dampers installed to protect the HEPA filters for the WHB do not require designation as a safety control.
NPH	WHB	**High snow loading of the WHB**	• The roof loading design and construction of the WHB (**IC**) is adequate to protect the TRU Waste from damage.
NPH	UG	**Flooding**	• Low consequences to all receptors.

<u>Initial Conditions:</u> As indicated above, in some cases, events were not carried forward (i.e., did not have an unmitigated Risk Class of I or II) based on identified passive initial conditions which are permitted to be included in unmitigated analyses. Even though these event types were not carried forward, their initial conditions relied upon for their exclusion are required to be specifically protected in the safety basis. Initial conditions relied upon for event exclusion but protected by safety significant (SS) controls are:

- WIPP WAC Compliance (**ADMINISTRATIVE**)
  - Reduces both the likelihood and consequences of adverse events.
  - Provides assurance that waste meets specific criteria for the containers in which it is packaged as well as the contents of each package.
  - Package provides some resistance to adverse events (e.g., drops).
  - Limits radionuclide composition, quantities of liquids, constituencies of contents, combinations of materials.
    - Relied upon when determining consequences from upsets to the containers.
  - Defines boundaries for analysis (including material-at-risk (MAR) limits in various waste containers).
- UG Fuel and Oil Storage Rooms Locations (**DESIGN FEATURE**)
  - Located away from Waste Handling and Storage Areas.
  - Defined in the configuration of the UG.
  - Reduces the likelihood that fires and/or explosions at the UG Fuel or Oil Storage locations could affect the handling and storage of waste.
- RH Waste Cask (Facility Cask/Light Weight Facility Cask) (**DESIGN FEATURE**)
  - Shielding.
    - Lead liner surrounds the enclosed facility canister.
    - Ensures worker exposure is reduced below threshold levels (e.g., direct exposure).
  - Structural Integrity.
    - Robust construction.
    - Ensures that RH Waste is protected from anticipated insults (e.g., fire, deflagration, loss of confinement) by minimizing damage to the Waste Canister that encloses the waste.
    - Reduces the likelihood of the release of radiological material.
- Waste Hoist Support Structure (**DESIGN FEATURE**)
  - Supports the Waste Hoist.
  - Designed to withstand a DBE.
  - Constructed of non-combustible materials.
  - Designed to resist the dynamic forces of the hoisting operations.
    - The dynamic forces are greater than the seismic forces on the UG facilities.

- Waste Handling Building Design (**DESIGN FEATURE**)
  - Serves as a confinement barrier to control the potential for release of hazardous and/or radioactive material.
  - High Wind Protection.
    - Constructed as Type II per the Standard on Types of Building Construction (NFPA 220).
    - Withstands the DBT with 183 mile per hour (mph) winds and a translational velocity of 41 mph, tangential velocity of 124 mph, a maximum rotational velocity radius of 325 feet, a pressure drop of 0.5 force-pounds per square inch (psi) and a pressure drop rate of 0.09 psi per second.
    - Reduces the likelihood for impacts to Waste Containers located in the WHB.
  - Noncombustible Construction and Curbing.
    - Constructed primarily of metal and concrete with exterior surfaces and roofing consisting of noncombustible materials.
    - Curbing extending above the floor of the WHB.
    - Reduces the likelihood for small fires propagating into a large fire.
    - Reduces the likelihood for a fire originating external to the WHB to penetrate the outer wall.
  - Roof Loading.
    - Roof designed to withstand 27 pounds per square foot (lb/ft^2) of snow load.
    - The 100-year recurrence maximum snowpack for the WIPP region is 10 lb/ft^2.
    - Reduces the likelihood for collapse of the WHB roof that could result in the loss of confinement of radiological material.
  - Seismic.
    - Designed and constructed to withstand a DBE with 0.1 g peak ground acceleration (PGA) and a 1,000-year return interval.
  - Waste Shaft Access.
    - The Waste Shaft Collar area prevents direct access to the Waste Shaft.
    - Vehicles/equipment entering the access area must make a 90-degree turn toward the Waste Shaft.
- Facility Cask Loading Room (FCLR), Cask Unloading Room (CUR), and Transfer Cell Shielding (**DESIGN FEATURE**)
  - Constructed of thick concrete for shielding.
    - Reduces the gamma and neutron dose rates below acceptable worker safety thresholds.
    - Reduces the consequences to the facility worker when processing RH Waste Containers or events involving RH Waste outside of a Type B Shipping Package and Facility Cask/LWFC.

- Type B Shipping Package (**DESIGN FEATURE**)
  - o Design is certified by the U.S. Nuclear Regulatory Commission (NRC) for transport of radiological wastes on the public highways.
  - o Extensive testing has been performed.
    - Ensures waste is protected from release in the case of an upset condition.
  - o Prevents radiological releases from its contained loads.
  - o Reduces the likelihood for excessive gamma and/or neutron exposure to workers.
  - o Further protected by the following "TRU Waste Outside the WHB" preventive control.
    - Supports the global assumption that all TRU Waste outside of the WHB is contained in a Type B Shipping Package.
- TRU Waste Outside the WHB (**ADMINISTRATIVE**)
  - o Requires that above-ground TRU Waste Containers outside of the WHB are contained within a closed Type B Shipping Package.
  - o Ensures that Shipping Packages are not opened until located inside the WHB.
    - In the event that unpackaged TRU Waste must be moved back outside of the WHB (e.g., returned to waste generator), it is placed into a closed Type B Shipping Package prior to exiting the WHB.
  - o Reduces the likelihood for TRU Waste Containers to be outside of a Type B Shipping Package and vulnerable when not protected by the WHB.

NOTE: *Although the RH Waste Cask is discussed above as a design feature, the processing of RH Waste is not authorized by this DSA/TSR. The information on RH Waste Casks provided in this SER is for information only. As stated in the DSA Executive Summary, "The remote-handled (RH) TRU process is not being authorized under Revision 5 of the DSA as this activity will not be implemented as part of contact-handled (CH) waste emplacement restart. While the RH process has been included in the hazard analysis (HA) and consequence calculations, together with partial descriptions in various sections of the DSA, the RH process did not drive any of the required safety significant controls. Future authorization of the RH TRU process will require revalidation of the RH analysis and must include a resolution for the vulnerabilities of the RH crane in a seismic event and other comments on the RH hazard evaluations."*

Hazard Evaluation: Tables ES-2 and ES-3 summarize the hazard evaluation events carried forward for control selection into the DSA for both the UG and the WHB, respectively. The events are segregated by event type and grouped for those events with similar risk class. Detail associated with these tables can be found in section 3.3 of the SER. The tables list the event types, the associated unmitigated likelihood/consequences/risk class for the evaluated receptors, the preventive/mitigative controls selected, and the final mitigated likelihood/consequences/risk class for the evaluated receptors (Risk Change). Receptors evaluated include the Public (Maximally-Exposed Offsite Individual (MOI)), the Co-located Worker (CW), and the Facility Worker (FW).

Some consequences were quantitatively evaluated as an aid to assigning the qualitative consequence level. For these, the table includes the total exposure dose (in terms of 50-yr

Total Effective Dose in rem). Consequences with no specific exposure level indicated (in rem) were determined qualitatively per DOE-STD-3009-2014 guidance (e.g., qualitative evaluation is required for FWs). Globally, quantitative evaluations for the MOI or CW are shown as "Low" if less than the applicable thresholds rather than presenting the estimated dose.

Controls were selected to reduce the potential for such hazardous events (prevent) and/or to mitigate their consequences should they occur. Per the hierarchy of controls directed in DOE-STD-3009-2014, preventive controls were selected over mitigative controls. When considering controls, passive controls were selected over active engineered controls which, in turn, were selected over administrative controls. Ultimately, control suites were selected to move each event with a Risk Class of I or II to a Risk Class of III or IV, as indicated in Figure ES-2.

While not shown in Tables ES-2 and ES-3, defense in depth (DID) controls were also identified in the hazards analysis. During the hazard evaluation process, all potential preventive and mitigative features were identified for consideration in a control suite and documented in the hazards analysis. Of the full list of potential candidate controls, selections were made for those to credit and carry forward into the DSA using the above mentioned hierarchy while also considering which ones would provide the greatest protection to the affected receptors. Those candidate controls not specifically credited for receptor protection still remain available as defense-in-depth for their associated event. This provides additional margin to prevent or mitigate events.

Figure ES-2 Preventor/Mitigator Impact to Risk Class

Preventors

Mitigators

Consequence Level	Frequency			
	Beyond Extremely Unlikely	Extremely Unlikely	Unlikely	Anticipated
High	III	II	I	I
Moderate	IV	III	II	II
Low	IV	IV	III	III

To assist the reader in more easily interpreting the change in likelihood and consequences associated with events and their control suites, tables ES-2 and ES-3 are color coded as follows:

- Risk Class I is coded red.
- Risk Class II is coded yellow.
- Risk Class III and IV are coded green.

- For events in which the unmitigated Risk Class I or II was shifted to a mitigated Risk Class of III and IV (red/yellow shifts to green) due to the control suite, the Event title, itself, is coded green.
- For events that COULD NOT be shifted to a Risk Class of III or IV due to the control suite, the Event title itself is coded yellow. Further discussion on these specific events follows in Table ES-3, Risk Outlier Events.
- MOI consequences EXCEEDING 5 rem and requiring consideration of Safety Class controls are coded magenta. Further discussion on these specific events follow.

In addition, the Risk Change column includes arrows to indicate those likelihood and receptor consequences that were reduced due to preventive controls and mitigative controls, respectively.

Table ES-2 Summary of Hazard Evaluation Events for UG Waste Handling and Emplacement

Event	Unmitigated Likelihood Consequences/Risk Class FW	CW	MOI	Credited Preventive Controls	Credited Mitigative Controls	Risk Change FW	CW	MOI
FIRE: **Vehicle collisions** causing pool fire Waste Shaft Station In transport Disposal Room	UNLIKELY			• WIPP WAC (**IC**) • Vehicle automatic fire suppression system (FSS) (**SSC**) • Vehicle preoperational checks (**AC**) • Vehicle attendants-spotter (**AC**) • Vehicle restrictions in vicinity of waste (**AC**) o vehicle exclusion zone during transport o no more than two vehicles within 25 feet of waste face o no lube truck when waste is present		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 280-1130 rem	LOW			HIGH	HIGH	LOW
	I	I	III			III	III	IV
FIRE: **Vehicle leaks** causing pool fire Disposal Room	ANTICIPATED			• WIPP WAC (**IC**) • Vehicle automatic FSS (**SSC**) • Vehicle preoperational checks (**AC**) • Vehicle attendants-spotter (**AC**)	• UVFS/IVS (**SSC**) • Vehicle attendants-notifier (**AC**)	EXTREMELY UNLIKELY		
	HIGH	HIGH 220 rem	LOW			LOW	LOW	LOW
	I	I	III			IV	IV	IV
FIRE: **Lube truck leaks** causing pool fire Disposal Room	ANTICIPATED			• WIPP WAC (**IC**) • Vehicle automatic FSS (**SSC**) • Vehicle preoperational checks (**AC**) • Vehicle attendants-spotter (**AC**) • Vehicle restrictions in vicinity of waste (**AC**) o no lube truck when waste is present		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 1130 rem	LOW			HIGH	HIGH	LOW
	I	I	III			III	III	IV

Table ES-2 Summary of Hazard Evaluation Events for UG Waste Handling and Emplacement

Event	Unmitigated Likelihood Consequences/Risk Class FW	CW	MOI	Credited Preventive Controls	Credited Mitigative Controls	Risk Change FW	CW	MOI

FIRE:
 	
Vehicle or Lube Truck leaks causing pool fire
 	
Waste Shaft Station
In transport
	ANTICIPATED			• WIPP WAC (**IC**)
				• Vehicle automatic FSS (**SSC**)
				• Vehicle preoperational checks (**AC**)
				• Vehicle attendants-spotter (**AC**)
				• Vehicle restrictions in vicinity of waste (**AC**)
				  o vehicle exclusion zone during transport
				  o no lube truck when waste is present
					• Facility pallet (**DF**)
					• Vehicle attendants-notifier (**AC**)
						EXTREMELY UNLIKELY		

	HIGH	HIGH 140 rem	LOW			LOW	MOD	LOW
	I	I	III			IV	III	IV
FIRE: Ordinary **combustible** fires **ADJACENT TO** or **INSIDE** a waste container Waste Shaft Station In transport Disposal Room	ANTICIPATED			• WIPP WAC (**IC**)	• UVFS/IVS (**SSC**) • Vehicle attendants-notifier (**AC**)	ANTICIPATED		
	HIGH	MOD 73 rem	LOW			LOW	LOW	LOW
	I	II	III			III	III	III
FIRE: Forklift carrying **300 gallon diesel fuel container** falls down Waste Shaft onto waste creating pool fire	EXTREMELY UNLIKELY			• WIPP WAC (**IC**) • Waste Shaft access configuration (**IC**) • Waste conveyance control (**AC**) • Vehicle restrictions in vicinity of waste (**AC**)		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 810 rem	MOD 7.3 rem			HIGH	HIGH	MOD
	II	II	III			III	III	IV

Table ES-2 Summary of Hazard Evaluation Events for UG Waste Handling and Emplacement

Event	Unmitigated Likelihood Consequences/Risk Class			Credited Preventive Controls	Credited Mitigative Controls	Risk Change		
	FW	CW	MOI			FW	CW	MOI
FIRE: **Vehicle** carrying waste **falls into sump** creating pool fire Waste Shaft Station	UNLIKELY			• WIPP WAC (**IC**) • Vehicle automatic FSS (for collision only) (**SSC**) • Vehicle preoperational checks (**AC**) • Vehicle attendants-spotter (**AC**) • Waste conveyance control (**AC**)		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH	LOW			HIGH	HIGH	LOW
	I	I	III			III	III	IV
LOSS OF CONFINEMENT: **Vehicle** carrying waste **falls down Waste Shaft** onto a loaded waste hoist conveyance	EXTREMELY UNLIKELY			• WIPP WAC (**IC**) • Waste Shaft access configuration (**IC**) • Waste conveyance control (**AC**)		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 1300 rem	MOD 5.3 rem			HIGH	HIGH	MOD
	II	II	III			III	III	IV
LOSS OF CONFINEMENT: **Waste Hoist Conveyance** loaded with waste **fails** and drops waste. (Seismic or non-seismic)	EXTREMELY UNLIKELY			• WIPP WAC (**IC**) • Waste hoist structure (**IC**) • Waste hoist brakes (**SSC**)		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 550 rem	LOW			HIGH	HIGH	LOW
	II	II	IV			III	III	IV

Table ES-2 Summary of Hazard Evaluation Events for UG Waste Handling and Emplacement

Event	Unmitigated Likelihood Consequences/Risk Class FW	CW	MOI	Credited Preventive Controls	Credited Mitigative Controls	Risk Change FW	CW	MOI
LOSS OF CONFINEMENT: Forklift **puncture** or **pressurized container impact** at waste face	ANTICIPATED			• WIPP WAC (**IC**)	• UVFS/IVS (**SSC**)	ANTICIPATED		
	LOW	MOD 27-29 rem	LOW			LOW	LOW	LOW
	III	II	III			III	III	III
EXPLOSION ENERGETIC EVENT: **Deflagration/over-pressurization** of a non-compliant drum **OUTSIDE** of a closed Disposal Room	ANTICIPATED			• WIPP WAC (**IC**)	• UVFS/IVS (**SSC**) • Suspect container response (**AC**)	ANTICIPATED		
	HIGH	MOD 20-37 rem	LOW			LOW	LOW	LOW
	I	II	III			III	III	III
EXPLOSION ENERGETIC EVENT: **Exothermic chemical reaction** involving non-compliant waste **INSIDE** a closed Disposal Room	ANTICIPATED			• WIPP WAC (**IC**)	• Isolation Bulkheads (**DF**) • UVFS/IVS (**SSC**) • Active Radiation Monitoring (**AC**)	ANTICIPATED		
	HIGH	HIGH 830 rem	LOW			LOW	LOW	LOW
	I	I	III			III	III	III

Table ES-3 Summary of Hazard Evaluation Events for WHB Waste Staging and Handling

Event	Unmitigated Likelihood Consequences/Risk Class			Credited Preventive Controls	Credited Mitigative Controls	Risk Change		
	FW	CW	MOI			FW	CW	MOI
FIRE: **Facility Fire** that results in waste dropping down the shaft Waste Hoist Tower	EXTREMELY UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**) • Waste Hoist structure (**IC**) • Waste Handling Building FSS (**SSC**)		BEYOND EXTREMELY UNLIKELY		
	HIGH	HIGH 340 rem	LOW			HIGH	HIGH	LOW
	II	II	IV			III	III	IV
FIRE: **Vehicle leaks** causing **pool fire** Waste Shaft Collar	ANTICIPATED			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**) • Vehicle/equipment operation prohibition (**AC**)	• Facility Pallet (**DF**)	EXTREMELY UNLIKELY		
	LOW	HIGH <190 rem	LOW			LOW	MOD	LOW
	III	I	III			IV	III	IV
FIRE: **Vehicle leaks** causing **pool fire** CH Bay ***RISK OUTLIER – See Table ES-4***	ANTICIPATED			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**) • Vehicle/equipment operation prohibition (**AC**)	• Facility Pallet (**DF**)	UNLIKELY		
	LOW	HIGH 190 rem	LOW			LOW	MOD	LOW
	III	I	III			III	II	III

Table ES-3 Summary of Hazard Evaluation Events for WHB Waste Staging and Handling

Event	Unmitigated Likelihood Consequences/Risk Class			Credited Preventive Controls	Credited Mitigative Controls	Risk Change		
	FW	CW	MOI			FW	CW	MOI
FIRE: **Pool fire** from within Waste Handling Building **propagates** into CH Bay (higher MAR)	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**)	• Facility Pallet (**DF**)	EXTREMELY UNLIKELY		
	LOW	HIGH 270 rem	LOW			LOW	MOD	LOW
	III	I	III			IV	III	IV
FIRE: **Large combustible** fire CH Bay Room 108	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**) • Waste Handling Building FSS (**SSC**)		EXTREMELY UNLIKELY		
	LOW	MOD 49 rem	LOW			LOW	MOD	LOW
	III	II	III			IV	III	IV
FIRE: Ordinary **combustible** fire **ADJACENT TO** waste containers Waste Handling Building	ANTICIPATED			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**)	• CH confinement ventilation system (**SSC**)	UNLIKELY		
	LOW	MOD 62 rem	LOW			LOW	LOW	LOW
	III	II	III			III	III	III

Table ES-3 Summary of Hazard Evaluation Events for WHB Waste Staging and Handling

Event	Unmitigated Likelihood Consequences/Risk Class FW	CW	MOI	Credited Preventive Controls	Credited Mitigative Controls	Risk Change FW	CW	MOI
FIRE: Ordinary **combustible fire** or **pool fire** Hot Cell Complex ***RISK OUTLIER – See Table ES-4***	ANTICIPATED			• WIPP WAC (**IC**)		ANTICIPATED		
	LOW	MOD 26-79 rem	LOW			LOW	MOD	LOW
	III	II	III			III	II	III
FIRE: Ordinary **combustible** fire after two electric **vehicles collide** CH Bay Waste Collar Area with door 140 open	ANTICIPATED			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**)	• CH confinement ventilation system (**SSC**)	UNLIKELY		
	LOW	HIGH 85-230 rem	LOW			LOW	LOW	LOW
	III	I	III			III	III	III
FIRE: Ordinary **combustible** fire after **vehicle collision** Waste Collar Area with door 140 closed ***RISK OUTLIER – See Table ES-4***	ANTICIPATED			• WIPP WAC (**IC**) • Waste Handling Building FSS (**SSC**)		UNLIKELY		
	LOW	MOD 85 rem	LOW			LOW	MOD	LOW
	III	II	III			III	II	III

Table ES-3 Summary of Hazard Evaluation Events for WHB Waste Staging and Handling

Event	Unmitigated Likelihood Consequences/Risk Class			Credited Preventive Controls	Credited Mitigative Controls	Risk Change		
	FW	CW	MOI			FW	CW	MOI
FIRE: Ordinary **combustible** fires **INSIDE** a waste container Waste Handling Building	ANTICIPATED			• WIPP WAC (**IC**)	CH confinement ventilation system (**SSC**)	ANTICIPATED		
	LOW	MOD 62 rem	LOW			LOW	LOW	LOW
	III	II	III			IV	IV	IV
FIRE/EXTERNALLY INITIATED EVENT: **External fire** breaches Waste Handling Building	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**) • Waste Handling Building FSS (**SSC**)		EXTREMELY UNLIKELY		
	LOW	MOD 84 rem	LOW			LOW	MOD	LOW
	III	II	III			IV	III	IV
FIRE/EXTERNALLY INITIATED EVENT: **Tanker Truck fire** breaches Waste Handling Building	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**) • Vehicle Barriers 25 feet from the WHB (**DF**) • Waste Handling Building FSS (**SSC**) • Fuel tanker prohibition (**AC**)		BEYOND EXTREMELY UNLIKELY		
	LOW	MOD 68 rem	LOW			LOW	MOD	LOW
	III	II	III			IV	IV	IV

Table ES-3 Summary of Hazard Evaluation Events for WHB Waste Staging and Handling

Event	Unmitigated Likelihood Consequences/Risk Class			Credited Preventive Controls	Credited Mitigative Controls	Risk Change		
	FW	CW	MOI			FW	CW	MOI
EXPLOSION ENERGETIC EVENT: **Deflagration/over-pressurization** of a non-compliant drum CH bay	ANTICIPATED			• WIPP WAC (**IC**)	• Suspect container response (**AC**)	ANTICIPATED		
	HIGH	LOW 17 rem	LOW			LOW	LOW	LOW
	I	III	III			III	III	III
NPH: Lightning strike Waste Handling Building	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**)	• CH confinement ventilation system (**SSC**)	UNLIKELY		
	LOW	MOD 62 rem	LOW			LOW	LOW	LOW
	III	II	III			III	III	III
NPH: **Design basis earthquake** (DBE) and fire Waste Handling Building ***RISK OUTLIER – See Table ES-4***	UNLIKELY			• WIPP WAC (**IC**) • Waste Handling Building design (**IC**)		UNLIKELY		
	LOW	MOD 97 rem	LOW			LOW	MOD 97 rem	LOW
	III	II	III			III	II	III

Chemical Hazards: Most non-radiological hazardous materials were screened from further hazard evaluation by applying the guidance in DOE-STD-3009-2014, Appendices A.1 and A.2. Volatile organic compounds (VOCs) that may leak from closed rooms and panels in the UG were not screened, however, consistent with Appendix A.2. VOC hazards were evaluated and concluded not to require safety significant controls. An SMP Key Element was judged to be warranted and was added for this hazard.

Hazard Evaluation Summary: In summary, the SBRT concludes that the hazard analysis:

- Evaluates all activities for which approval is sought.
- Is consistent in approach with safe harbor methodologies from DOE-STD-3009-2014 and supplemental requirements and guidance in DOE-STD-5506-2007.
- Appropriately applies screening of standard industrial hazards and chemical hazards consistent with DOE-STD-3009 requirements.
- Uses methodology to determine the MAR for hazards and accident analysis that is clearly defined, compliant with DOE-STD-5506 requirements, and affords sufficient margin to minimize the risk of Potential Inadequacies in the Safety Analysis (PISAs) when shipments resume, considering the higher MAR that may be expected from the Savannah River Site (SRS) (see SMP Key Element 18-5 to periodically verify MAR assumptions).
- Identifies preventive and mitigative hazard controls for the spectrum of hazards evaluated.
- Evaluates normal, abnormal, and accident conditions, including natural and man-made external events, and identifies the energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials.
- Clearly characterizes hazard analysis results in terms of public safety, defense-in-depth, co-located worker safety, facility worker safety, and environmental protection.

Accident Analysis: With regard to the magenta color coding, two of the evaluated accidents in Table ES-1 entail public consequences that exceed the 5 rem threshold criterion described in DOE-STD-3009-2014 as challenging the Evaluation Guideline. The potential for public consequences that would require consideration of the need for safety class (SC) controls per the requirements of DOE-STD-3009-2014. These events were:

- **FIRE**: Forklift carrying 300-gallon diesel fuel container falls down Waste Shaft onto waste, creating a pool fire (7.3 rem).
- **LOSS OF CONFINEMENT**: Vehicle carrying waste falls down Waste Shaft onto a loaded waste hoist conveyance (5.3 rem).

These events therefore required accident analysis as summarized in SER section 3.3.5. Based on the 7.3 rem and 5.3 rem result being judged as marginally above the low consequence threshold given the calculation conservatisms, it was concluded that no SC controls were required.

Accident Analysis Summary: The SBRT reached the following conclusions regarding the accident analysis of Design/Evaluation Basis Accidents:

- Accident analysis is performed for an adequate set of design/evaluation basis accidents having unmitigated offsite consequences that have the potential to challenge the Evaluation Guideline. Only two accidents slightly exceeded 5 rem to the MOI.
- The accident analysis methodology, as well as the hazard analysis methodology, is clearly identified and appropriate, including identification of initial conditions and assumptions.
- The technical basis for source term values is provided, valid, and appropriate for the physical situation being analyzed, for the Evaluation Basis Accidents (EBA) presented in DSA section 3.4 of the accident analysis, as well as in scoping calculations to estimate the dose to the co-located worker and MOI to assign qualitative consequence levels for the hazard evaluation in WIPP-021 and summarized in DSA section 3.3. The scoping dose calculations provided adequate technical justifications for parameters that were not provided in, or departed from, the default or bounding values described in DOE-STD-3009-2014, DOE-HDBK-3010-94, and DOE-STD-5506-2007. Supporting calculations and technical documents are identified, and were reviewed for critical aspects of safety controls, including ICs, where appropriate.
- Accident analysis clearly substantiates the findings of hazard analysis for the design/evaluation basis events.

Risk Outliers: Control suites suffice to reduce the mitigated event Risk Class to III (minor concern) or below, consistent with DOE-STD-3009-2014 and DOE-STD-5506-2007 guidance, with a few exceptions. A few events remain “risk outliers” in that the credited controls result in a final Risk Class of II (situation of concern). These events, and the proposed justification for DOE concluding that adequate protection is being provided, are summarized in Table ES-4. For these events, the only receptor of concern is the CW. For all risk outlier events, the consequences to the FW and MOI were qualitatively assessed as low for a Risk Class of III for these two receptors. Of these outliers, controls were considered in an attempt to drive the consequences to the CW to Risk Class III, however, as authorized by DOE-STD-3009-2014, controls were not credited for reasons such as:

- Calculations that resulted in consequences placing the event in Risk Class II were very conservative (e.g., assumed maximum PEC in affected containers).
- A considered control would not give enough of a bin reduction to affect the Risk Class.
- The event was occurring in a process area in which operations are not authorized by the DSA (e.g., processing in the Hot Cell complex).

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
FIRE: **Vehicle leaks** causing **pool fire** CH Bay (CH-WHB-01-001a1)	• Likelihood reduced from ANTICIPATED to UNLIKELY • CW MOD • Risk Class II	• ANTICIPATED with CW unmitigated consequences of 190 rem (HIGH). • The identified preventive control is the WHB FSS. • The preventive AC of prohibiting liquid-fueled vehicles in the CH Bay and Room 108 when CH Waste is present outside of closed Shipping Packages provides additional frequency reduction (1/2 frequency bin) • The mitigated frequency of this event reduced to UNLIKELY. • The Facility Pallet is credited as a mitigative control reducing consequences to co-located workers to moderate and Risk Class II. The following factors are judged to reduce consequences as assumed in the analysis and provide a basis for concluding that adequate protection has been provided: 1. Not all containers would be exposed to the flame front (an analysis assumption) as some would be shielded from the heat of the fire by other containers. 2. The WHB confinement ventilation system (CVS) will initially provide effective filtration (although eventual failure due to excessive smoke loading is predicted). 3. Closed facility doors will delay radiological release and increase the potential for settling. 4. The emergency response program addresses protection of the co-located workers (SMP Key Element 15-3).

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
FIRE: **Pool fire** Hot Cell Complex (RH-WHB-01-006a)	• CW MOD • Risk Class II • No reduction in consequences due to no controls	• ANTICIPATED with CW unmitigated consequences of 26 rem (MOD). • No controls are identified for this event so the mitigated consequences are the same as the unmitigated, which is Risk Class II for the CW. • Consequences slightly above the MOD threshold for the CW. The following is a basis for concluding that adequate protection has been provided: 1. The Hot Cell Complex, while not credited, affords a robust barrier to radiological release. 2. The 10-160B mission for which the hot cell was designed is not currently authorized (limiting the potential for material at risk to be present based on the 72B mission). 3. The RH Waste Canister is inside an RH-72B Shipping Package with the inner lid in place. 4. The installed filtered ventilation system, previously credited in DSA Revision 4, minimizes the actual release potential. 5. There are no ignition sources in the Transfer Cell and any that might be introduced will be controlled (SMP Key Element 11-5). 6. Combustibles (liquid or ordinary) are not used to support operations in the cell and any that might be introduced will be controlled (SMP Key Element 11-2). 7. The emergency response program addresses protection of the co-located workers (SMP Key Element 15-3).

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
FIRE: Ordinary **combustible fire** Hot Cell Complex (RH-WHB-03-001a)	• CW MOD • Risk Class II • No reduction in consequences due to no controls	• ANTICIPATED with CW unmitigated consequences of 79 rem (MOD). • No controls are identified for this event so the mitigated consequences are the same as the unmitigated, which is Risk Class II for the CW. • Consequences slightly above the MOD threshold for the CW. The following is a basis for concluding that adequate protection has been provided: 1. The Hot Cell Complex, while not credited, affords a robust barrier to radiological release. 2. The 10-160B mission for which the hot cell was designed is not currently being authorized (limiting the potential for material at risk to be present based on the 72B mission). 3. The installed filtered ventilation system, previously credited in DSA Revision 4, minimizes the actual release potential. 4. There are no ignition sources in the Transfer Cell and any that might be introduced will be controlled (SMP Key Element 11-5). 5. Combustibles (liquid or ordinary) are not used to support operations in the cell and any that might be introduced will be controlled (SMP Key Element 11-2). 6. The emergency response program addresses protection of the co-located workers (SMP Key Element 15-3).

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
FIRE: Ordinary **combustible** fire after **vehicle collision** Waste Collar Area with door 140 closed (CH-WHB-02-001a)	• Likelihood reduced from ANTICIPATED to UNLIKELY • No change in consequences to CW. • CW remains MOD • Risk Class II	• ANTICIPATED with CW unmitigated consequences of 85 rem (MOD). • WHB FSS is credited as a preventive control. • Mitigated event is UNLIKELY with MOD consequences to CW (85 rem) and Risk Class II. • The concern is limited to the case where the fire occurs in the Conveyance Loading Room (CLR) after Door 140 is closed in which the CH WHB CVS would NOT provide filtration and material is released unfiltered, resulting in a dose in the middle of the moderate consequence bin. If the door is open, the consequences are reduced to LOW by the WHB CVS and Risk Class III. The following is a basis for concluding that adequate protection has been provided: 1. Both the nature of the operations being conducted in the small room and the combustible control requirements (SMP Key Element 11-2) limit the presence of ordinary combustibles in the Waste Shaft Access Area. 2. The WHB FSS covers this affected area and risk outlier results are only possible if its failure is assumed. 3. Ignition probability is limited as there are no ignition sources in the CLR and any that might be introduced will be controlled (SMP Key Element 11-2). 4. Outside doors are closed impeding release to the outside prior to settling. 5. The CH Waste Pallet is only in this area for a limited period of time (minutes). In the event that CH Waste could not be immediately downloaded, it would be returned to the CH Bay. 6. The emergency response program addresses protection of the co-located workers (SMP Key Element 15-3).

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
NPH: **Design basis earthquake** (DBE) and fire Waste Handling Building (CH/RH-WHB-25-001a)	• CW MOD • Risk Class II • No reduction in consequences due to no controls	• UNLIKELY with CW unmitigated consequences of 97 rem (MOD). • The WHB structure credited as IC. • TRUDOCK crane seismic designs are IC. • RH Facility Cask design is IC when applicable. • No other controls are identified for this event so the mitigated consequences are the same as the unmitigated, which results in Risk Class II for the CW. • The calculated co-located worker dose is just below the high threshold of 100 rem based on a conservative analysis consistent with accident analysis source term and radiological consequence methods. • Safety Significant controls SHOULD be considered per DOE-STD-5506-2007 for Risk Class II events with moderate consequences. Given minimal margin to the high threshold, the DOE weighed the issue of whether adequate protection was provided and based its final judgment on the following considerations from the DSA and the WIPP-019 supporting calculation: 1) The seismic plus fire event is conservatively analyzed as in the unlikely bin for the unmitigated case. From SAND 78-1596, the most conservative calculated estimate of the 1,000-year acceleration at the WIPP is 0.075 g. For additional conservatism, a peak design acceleration of 0.1 g was selected for the WIPP Design Basis Earthquake to design the SSCs to withstand. The frequency of a 0.1 g earthquake would be lower than 1E-3/yr, approaching the 1E-4/yr upper range for the Extremely Unlikely bin. Considering the normal lack of transient combustibles, a conditional probability on the order of 0.1 for a seismic-induced fire would clearly reduce the frequency of occurrence of a seismic plus fire event to an Extremely Unlikely bin, which would reduce the mitigated risks to Risk Class III. 2) The seismic plus fire event is conservatively analyzed for unmitigated consequences. Although all 80 Waste Assemblies are included in the impact contribution to the unmitigated dose, most of the contribution to the 97 rem estimate is from the seismic-induced fire involving two direct-loaded SWBs. a) The 97 rem to CW is predominantly from the fire involving two SWBs, one at WIPP WAC 560 PE-Ci and the other at 95th percentile 160 PE-Ci. b) Two SWBs bound fires exposing more containers due to an anomaly associated with the DOE-STD-5506-2007 pool fire methodology as demonstrated by the DSA calculation involving 8 SWBs (DOE-STD-5506 allows a use of damage ratio (DR) of 0.5 for > two SWBs in a pool fire.) c) Normal operations do not require a large quantity of ordinary combustibles that could fuel a fire to expose multiple waste containers and SMP Key Element 11-3 requires that they be minimized consistent with operational requirements. However, the unmitigated analysis assumes that some amount of unspecified transient combustibles could be present to cause confined burning within two

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
		SWBs, in addition to the small quantity (1%) assumed displaced from the SWBs that burns unconfined. 3) The DSA and WIPP-019 provides a risk acceptance perspective that a likely source of combustibles that could fuel a fire to expose one or two SWBs being loaded onto a Facility Pallet during unloading a TRUPAC-II, which is a hydraulic fluid leak from the TRUDOC cranes even though they are seismically qualified. The crane has approximately 2.4 gallons of Mobilegear 630 lubricant in three separate reservoirs (hoist gear box, trolley gear box, bridge gear box) that are assumed to leak and accumulate in a pool near two SWBs. a) Direct flame impingement from some unknown source would be required to ignite a gear lubricant pool due to its flashpoint of greater than 392 °F (Mobilegear is a combustible, not flammable liquid). b) In the unlikely event that lubricant is ignited, all of it has to leak and accumulate close enough to an SWB so that 50% of the fuel energy is absorbed by the SWB in order to increase the temperature of the SWB and cause pyrolysis of the assumed combustible contents. c) The radiant energy from this pool fire could increase the temperature in a single SWB from 70 °F to 389 °F. The auto-ignition temperature of paper is 425-475 °F and the auto-ignition temperature of plastic is higher than paper. Thus, even with these conservative assumptions, the energy released during the fire event would not be sufficient to cause a confined burn in one SWB. d) Evaluating a single SWB with confined and unconfined burning assuming the 560 PE-Ci WAC limit would result in 76 rem to the CW, closer to the middle of the moderate consequence bin. 4) The DSA provides another risk perspective if the inventory is less than the WAC loading limit. The dose to CW becomes 23 rem for an SWB at 95th percentile loading of 160 PE-Ci, which is a low consequence and would result in mitigated Risk Class III. In addition, the SBRT considered the following: 5) The 0.01 DR for impact to all waste containers in the WHB is applied to estimate the fraction of unconfined burning, i.e., 1%, consistent with the methodology applied to vehicle impact plus fire scenarios. This methodology is not directly from DOE-STD-5506-2007; however, it is judged to be conservative to account for an impact event that breaches a metal container and expels some fraction of contents that are assumed to be combustible wastes. The 0.01 DR for impact to waste containers from overhead equipment that falls from DOE-STD-5506-2007 code-of-record earthquake represents damage from ventilation ductwork, fire suppression system piping, lighting and electrical conduit, etc., that result in an airborne release from a spill. Although breach of 55-gal drums by falling equipment is possible, such a fall may not breach SWBs due to their more rugged construction, and if it does result in airborne releases from the impact vibration (spill), it is

Table ES-4 Summary of Risk Outlier Events

Event	Risk Issue	Basis for Concluding that Adequate Protection is Provided
		not likely to crush the SWBs, an effect necessary to expel 1% of the contents. In addition, overhead equipment that can fall and impact waste containers in the WHB is limited. 6) Since the WHB withstands the design basis earthquake, even if the filtration system stops working, the release from the facility would be considerably lower due to gravitational settling within the building and air exchange over a prolonged release due to ambient conditions. This alone would be sufficient to reduce the 97 rem to a low consequence due to application of an 8-hr release duration (instead of the DOE-STD-3009-2014 default X/Q) and allowing for deposition within the building. 7) The assumption that the contents of the two direct-loaded SWBs are 100% combustible is also very conservative. Historical averages show that about 20% of direct-loaded SWBs have combustible contents above 50% and less than 10% of direct-loaded SWBs have combustible contents exceeding 90%. Most often, direct-loaded SWBs have a mix of combustible and noncombustible contents. Noncombustible contents lower the ARF/RF for confined burning inside the SWBs and reduce predicted doses. 8) Another perspective is that less than 5% of direct-loaded SWBs exceed the average MAR of 21.5 PE-Ci, so having one at the 560 PE-Ci WAC and one at the 160 PE-Ci 95th percentile would be a rare occurrence. 9) In practice, SWBs are most often used as overpacks for drums. Overpacked drums provide more protection, would lower the DR used in the effective ARF/RF calculation, and would result in less unconfined burning. 10) The emergency response program addresses protection of the co-located workers (Key Element 15-3). The above factors were considered, in addition to the absence of any practical control.

Risk Outlier Summary: Considering all the perspectives discussed above, the SBRT concludes that the consequences and risks of the above five risk outliers are judged to be lower than presented in the DSA. In approving DSA/TSR Revision 5, DOE accepts the overall hazards evaluation results and concludes that adequate protection has been provided.

Calculations and Supporting Documentation: Calculations documenting or supporting the hazard evaluation and accident analysis were reviewed in detail for consistency with applicable DOE guidance and were concluded to be acceptable. The SBRT review involved an appropriate Subject Matter Expert (SME) to ensure consistency with and application of applicable codes and standards. Because of their significant importance in the hazard evaluation and development of the DSA/TSR, the following calculations and support documentation were specifically evaluated by DOE SMEs:

- Statistical MAR
  - As authorized by DOE-STD-5506-2007, consequences for events were calculated using a statistical averaging of MAR throughout the entire facility. Further detail is provided below in the Improvements section.
- Fire Hazards Analysis and related Fire Suppression System documentation
  - Due to the significant importance of fire and the related evaluation of controls following the fire event of February 2014, a SME was recruited from the DOE complex to perform a complete review of the supporting calculations and documents.
- Meteorological Protocol
  - The facility elected to utilize Option 3 of DOE-STD-3009-2014 which requires specific approval of the protocol by the Safety Basis Approval Authority (SBAA). In addition, due to restrictions on the SBAA role, concurrence was required. The DOE-EM, Chief Nuclear Safety Staff, provided an SME to support this review. Further detail on this is discussed below in the Improvements section.
- Hazards Analysis (WIPP-021) and Consequence Calculations
  - Due to this Safety Basis being a complete re-write applying, for the first time, DOE-STD-3009-2014 requirements, the hazards evaluation and many consequence calculations were reviewed in detail by the SBRT SMEs, including personnel who helped author the requirements.
- DSA Supporting Calculation WIPP-058
  - Several issues were identified subsequent to the approval of the Fire Hazards Analysis (FHA) Revision 7 and WIPP-038 Revision 1 that affected development of the hazard and accident analysis for the DSA Revision 5. Rather than revising the FHA, a supporting calculation (WIPP-058) was prepared to resolve SBRT issues, to support the DSA, and to be incorporated in the next FHA update (WIPP-058 changed some of the FHA evaluations and conclusions).

Summary of Identified TSR Controls: All controls in the above tables required to protect facility workers or co-located workers from potential high or moderate consequences applying DOE-STD-3009-2014 and DOE-STD-5506-2007 guidance are identified as Safety Significant (SS). SS designation ensures the controls will be included in TSRs.

The TSR controls identified, along with their applicable safety function, are summarized in Table ES-5. Details on controls are found in sections 3.4 and 3.5 of the SER and taken from Chapter 5 of the DSA, Revision 5. To ensure the implementation of the controls shown in the table is compliant with DOE-STD-3009-2014 guidance and requirements, Chapters 4 and 5 of DSA/TSR, Revision 5 have been completely rewritten and the required safety functions, functional requirements and performance criteria have been developed and accepted by DOE.

Table ES-5 Summary of Technical Safety Requirement Controls

Control	Safety Function
Passive Engineered Controls – Design Features	
WHB Structure	**PREVENT** (due to non-combustible construction and structural qualification) release of radiological material from the WHB due to: • High wind/tornado • Seismic • Fire • Roof loading
Waste Hoist Support Structure	**PREVENT** a radiological material release due to an uncontrolled Waste Conveyance movement from: • High wind/tornado • Seismic • Fire • Roof loading
Shielding • **Facility Cask Loading Room (FCLR)** • **Cask Unloading Room (CUR)** • **Transfer Cell**	**MITIGATE** radiation exposure to worker through: • robust construction • shielding
Vehicle Barriers	**PREVENT** vehicle impacts or external fires from reaching WHB and impacting waste a barrier that provides: • standoff distance • substantial resistance to impacts.
Facility Pallet	**PREVENT** direct flame impingement on CH Waste Containers in a pool fire to mitigate a release of radiological material.
RH Facility Casks	**PREVENT** release of internal radiological material and **MITIGATE** radiation exposure to worker • robust construction • shielding

Table ES-5 Summary of Technical Safety Requirement Controls

Control	Safety Function
Type B Shipping Package	**PREVENT** release of internal radiological material and **MITIGATE** radiation exposure to worker • robust construction • shielding
UG Fuel and Oil Storage Areas	**PREVENT** flammable or combustible liquid hazard from affecting TRU Waste due to substantial separation distance.
Panel 6, and Panel 7, Room 7 Bulkheads	**MITIGATE** the release of radiological material from an exothermic chemical reaction within a known non-compliant CH Waste Container located in Panel 6, or Panel 7, Room 7.
Active Engineered Controls/Specific Administrative Controls (SACs) – Limiting Conditions for Operation (LCO)	
Contact-Handled (CH) Waste Handling Confinement Ventilation System (CVS) • **to include WHB Battery Exhaust System CVS**	**MITIGATE** the consequences of radiological material releases from the WHB by filtering air from the CH Bay, Room 108, CLR, TRUDOCK, and battery venting area prior to its release to the environment.
Waste Handling Building (WHB) Fire Suppression System (FSS)	**PREVENT** a small fire from becoming a large fire in the WHB by detecting fires and discharging water on the affected area.
Aboveground Liquid-fueled Vehicle/Equipment Prohibition	**PREVENT** fuel pool fires from affecting CH Waste by: • prohibiting liquid-fueled vehicles/equipment in the CH Bay and/or Room 108. • prohibiting liquid-fueled vehicles/equipment in the Waste Shaft Access Area.
Waste Hoist Brakes	**PREVENT** damage to TRU Waste Containers by reducing the likelihood of an uncontrolled Waste Conveyance movement.
UG Ventilation Filtration System (UVFS)/Interim Ventilation System (IVS) • **to include 309 Bulkhead Operability during Download of Waste Containers**	**MITIGATE** the consequences of radiological material releases from the UG by: • filtering UG exhaust air prior to its release to the environment • providing directional airflow toward the Waste Face and away from workers in an active Disposal Room.
Underground (UG) Vehicle/Equipment FSSs	**PREVENT** a pool fire in the UG by automatically detecting and suppressing developing fires associated with engine compartment and/or fuel and hydraulic line leaks.
UG Liquid-fueled Vehicle/Equipment Control	**PREVENT** vehicle/equipment pool fires involving CH Waste Containers due to vehicular collisions by: • limit of two Liquid-fueled Vehicles/Equipment within 25 feet of CH Waste Face. • assuring personnel are observant of the activities and can readily respond to upset conditions • alert UG facility workers of conditions potentially requiring evacuation in order to reduce consequences.

Table ES-5 Summary of Technical Safety Requirement Controls

Control	Safety Function
UG Lube Truck Operations	**PREVENT** a large fuel pool fire from impacting waste by preventing the lube truck from being within 200 feet of the CH Waste Face in an active panel or the Waste Shaft Station when CH Waste is present in the Waste Shaft Station.
WIPP Waste Acceptance Criteria	**INITIAL CONDITION** – Protect safety analysis assumptions of TRU Waste shipped to WIPP as to: • nature • quantity • confinement
Administrative Controls – Directive Action SACs	
Pre-operational Checks of UG Vehicle(s)/Equipment	**PREVENT** pool fires involving CH Waste Containers due to vehicle/equipment leaks and collisions by ensuring equipment operating near CH Waste is checked for: • braking • steering • leaks • cleanliness
Vehicle Exclusion Zone (VEZ)	**PREVENT** pool fires due to leaks and/or collisions by restricting the number and operation of UG vehicles during CH Waste transport.
Waste Conveyance Operations	**PREVENT** vehicles, equipment, and/or loads from dropping down an open Waste Shaft and impacting Waste Containers by: • requiring the presence of the conveyance when preparing to load or off-load • prohibiting access to the shaft when Waste is being moved in the Waste Shaft.
Fuel Tanker Prohibition	**PREVENT** tanker truck pool fires involving TRU Waste Containers by ensuring that Fuel Tankers are precluded from the WHB Parking Area Unit
CH Bay Alternative Barrier Provisions	**PREVENT** impacts by vehicles and/or fires adjacent to the southwest wall of the CH Bay by maintaining control of liquid-fueled vehicles/equipment in and around the exclusion zone when the concrete Vehicle Barriers are not fully installed.
Attendance of Vehicles/Equipment in the RH Bay	**PREVENT** pool fires that could degrade WHB structural steel columns resulting in a building collapse by assuring personnel are observant of the activities and can readily respond to upset conditions.
Transuranic (TRU) Waste Outside the WHB	**PREVENT** release of radiological material when TRU Waste (excluding site derived TRU Waste) is located outside of the WHB by ensuring all waste is in Type B Shipping Package when outside of the WHB.
Real-Time Monitoring at Panel 6 and Panel 7 Room 7 Isolation Bulkheads	**MITGATE** radiation exposure to FW in the UG by providing real-time detection and promptly alert workers to high airborne radioactive concentrations.

Additional DSA and TSR Revision 5 Improvements: DSA/TSR Revision 5 affords numerous improvements and changes from Revision 4. Some of these improvements were driven by the results of the AIB reports and the corresponding recovery plan. Key aspects of these improvements are summarized here.

- **Significant Improvement to Hazards Analysis.** The entire Hazards Analysis was re-performed. As such, new control suites were selected; prior controls were adjusted, in some cases, to use more robust equipment or programs; and less effective controls were eliminated.
- **Significant Improvement to Functional Analysis.** Systems that were identified as controls received updated and more detailed system evaluations. Performance criteria for safety SSCs were developed in a rigorous manner consistent with DOE-STD-3009-2014.
- **Statistical MAR.** WIPP elected, with DOE concurrence, to apply the approved statistical methodology in DOE-STD-5506 to evaluate the material at risk (MAR) in the new hazard analyses. Experience over almost 15 years of facility operation had demonstrated that prior analyses which assumed maximum allowed MAR loading in each waste container resulted in unrealistic over-estimates of the actual risk of facility operation. The new MAR methodology is being implemented with sufficient retained conservatism to ensure a bounding perspective on the hazards of facility operation. Specific checks deemed necessary to ensure that unintentional concentration does not occur and that the statistics remain representative for future waste packaging by generators throughout the DOE Complex have been incorporated into DSA, Revision 5 via a new Key Element in Chapter 18.
- **Conservative MET Data modeling protocol.** NWP elected to utilize the Option 3 modeling protocol to support site/facility-specific values in atmospheric dispersion modeling (see section 3.2.4.2 of DOE-STD-3009-2014). DOE reviewed the submittal and concluded that it meets the criteria and guidance provided in DOE-STD-3009-2014, and an adequate technical basis is provided for the receptor locations, meteorological data (including proposed more conservative use of MET data), modeling tools, and modeling parameters. DOE concurrence was documented (Letter, Dana Bryson, CBFO, to Phillip Breidenbach, NWP, “Department of Energy Concurrence with WIPP Dispersion Modeling Protocol,” 15:0026, 9/29/2015).
- **Improved WAC compliance through first-in-complex WAC SMP.** Chapter 18, Waste Acceptance Criteria Compliance Program, is a new chapter written in SMP format for Revision 5. This reflects the importance placed on the WIPP WAC as an initial condition for the hazards analysis.

  Options to ensure WAC compliance for wastes packaged offsite were limited to administrative type controls. To ensure reliable compliance, a mix of new controls and multiple layers of independent verification was adopted to preclude a repeat event like the radiological release accident of February 2014. This was done in conjunction with strengthening the LCO for detecting and responding to any future noncompliance with the WIPP WAC. This SMP utilizes Key Elements included in the TSR to ensure the new measures are applied as intended.

  Chapter 18 summarizes the National TRU Program (NTP) process from generator site to WIPP emplacement, clarifying the significant WAC compliance role within the purview of the WIPP M&O contractor and the interface with DOE-managed programs. Because some aspects of the NTP are outside of the WIPP DSA control, this SMP concentrated on specific additional layers or safety measures that the WIPP contractor, by themselves, could complete to ensure/verify compliance with all WAC requirements. These measures would be in addition to other safety measures being independently implemented by the NTP. The chapter includes the following improvements and increased rigor:

- o Independent verification that each waste stream meets the enhanced Acceptable Knowledge process.
- o Independent review of documents associated with a shipment to ensure compliance with the WIPP WAC.
- o Independent review of a sampling of waste radiography media and visual examination records.
- o Independent assessment/audit of generator sites.

- **Significant SMP improvements.** Weakness in Safety Management Programs (SMPs) was identified as a significant factor contributing to the occurrence and progression of the February 2014 accidents. Compensatory measures were adopted early in the recovery process and significant effort focused on improving SMP performance.
  - o The Radiation Protection Program had never had to deal with the significant spread of contamination prior to the accident, but developed into a functioning program performing required entry monitoring and control, postings, routine dress-out, decontamination, and down-postings as the contamination boundary moved deeper into the mine (limited to the areas of highest original contamination).
  - o The fire protection program developed and demonstrated its ability to control combustibles in the underground, ensure equipment cleanliness and required maintenance, and provide the fire watch capabilities necessary to permit initial operation of needed diesel fueled equipment. A new FHA was prepared and implemented; necessary upgrade projects were chosen and are being implemented for equipment automatic fire suppression (for both waste handling and non-waste handling vehicles posing a significant fire risk), automatic fire suppression in specific underground areas, improved fire response capability, and a personnel notification system capable of both locating and communicating with individuals throughout the underground. Additionally, the FP SMP identifies a new Key Element for formal fire protection engineer combustible control inspections.
  - o While the ground control required to maintain underground habitability lapsed initially after the accidents, subsequent recovery efforts have restored most areas and demonstrated the capability to sustain habitability going forward.
  - o Emergency response has also made significant progress with training in the use of self-rescuers, improved planning, and regular drills. In addition, a new Emergency Operations Center was recently commissioned at the Skeen-Whitlock Building.

  Chapters 13, Human Factors, and 16, Decontamination and Decommissioning, were determined not to be required based on DOE-STD-3009-2014 criteria and were deleted.

- **Incorporation of more robust SMP Key Elements.** The SMP program descriptions were strengthened in Revision 5 of the DSA to consolidate the gains that had been made during recovery. DOE elected to build on this success in DSA/TSR, Revision 5, by specifying specific program Key Elements for emphasis and to guide further program strengthening. These discretionary elements, specifically incorporated in TSRs, are thus given increased emphasis in program implementation driven by their inclusion in AC 5.6.1 as well as the new requirement for tracking and trending in the criteria for a programmatic breakdown of an SMP in AC 5.4.2. The new Key Elements address:

- Radiation protection
- Hazardous Material Protection
- Equipment inspection and maintenance
- Conduct of Operations
- Fire protection
- Ground control
- Procedures
- Training
- Password protection of SS programmable logic controllers
- Emergency management
- SSC configuration management
- WIPP WAC compliance (the new Chapter 18 discussed above).

Detail on each of the Key Elements is found in SER section 3.7. Prior Key Attributes (KAs) were retained in the program description chapters for Revision 5 but will likely be removed for the next major revision since this is not required by DOE-STD-3009-2014.

- **Incorporation of DSA related safety requirements from 30 CFR 57.** Applicable requirements of the mining law, 30 CFR 57, are dispersed throughout the SMPs, and DOE reviewers concluded that they are adequately represented. For example:
  - Ground control
  - Access requirements
  - Emergency Response
  - Life Safety
- **More rigorous backfit analysis for equipment chosen as new Safety SSC.** Some structures, systems, and components selected for SS designation were not originally purchased and installed to the applicable requirements. Two key examples include
  - Underground Ventilation Filtration System (UVFS).
  - Various instruments relied upon to report the facility status in the Central Monitoring Room (CMR).

  Planning for the utilization of these systems has been guided by backfit analyses that focus on specific requirements for a compliant system that are not met. Where practical, deficiencies have been corrected. If this was not done, compensatory measures have been identified and built into the DSA/TSR Revision 5 to ensure adequate performance for the credited safety function. DOE has specifically reviewed and accepted these compensatory measures.

- **Use of an in-process review concept with safety basis experts.** The preparation of the new Safety Basis benefited from in-process, detailed review provided by safety basis experts supporting the SBRT from across the DOE Complex.
- **Incorporation of recommendations from outside organizations.** The preparation of the new Safety Basis benefited from constructive comments from outside oversight organization and the insight from the AIB.
- **WIPP Operator/Engineer input.** The preparation of the new Safety Basis benefited significantly from early engagement of WIPP operators and engineers who provided real-time feedback/suggestions on potential control suites and addressing challenges associated with control suite selection and ultimate implementation.

Closure of PISAs: Six open Potential Inadequacies in the Safety Analysis (PISAs) are being closed by DSA/TSR Revision 5. Three resulted from the February 2014 accidents, while three involved technical issues in the WHB identified during the DSA update. Following the accidents in February 2014, Evaluations of the Safety of the Situation (ESSs) were written as needed to support

- facility reentry
- accident investigation
- housekeeping and decontamination
- diesel-fueled vehicle operation
- closures of Panel 6 and Panel 7, Room 7
- HEPA filter replacement
- electrical outages needed for maintenance
- IVS installation

These activities originally had an associated ESS that, ultimately, were all merged into a consolidated ESS combining active portions of the prior ESSs. In addition, an ESS was developed for a WHB Fire Suppression PISA. Each of these documents afforded controls conservatively selected to ensure safe performance of the necessary investigation and recovery activities until the cause, investigations, and corrective actions progressed to the point that a permanent safety basis change became practical. Revision 5 is that change and it supersedes the remaining ESSs. Another safety basis document developed as a supplement to DSA Revision 4, NS-SBS-2014-01 Revision 0, Shipping Container Venting Operations, was approved to support recovery and it too is being superseded.

The affected PISAs and the justification for closure are provided in Table ES-6.

Table ES-6 Justification for Closure of Open PISAs

PISA Number	Description	Justification for Closure
14-0001	Following the fire event of February 2014, a PISA was identified for the following hazards as potentially not addressed: • The likelihood of UG liquid-fueled vehicle fires as evaluated in the WIPP DSA may not have been conservative. • The performance of fire suppression systems on UG liquid-fueled vehicles may not have been adequate.	• A broad spectrum of fire scenarios addressed in updated HA. • TSR level controls (LCO) for UG Vehicle FSS (plus additional protective controls) upgraded and incorporated into DSA/TSR. • New Key Elements added o KE 11-1 o KE 11-3 o KE 11-5 o KE 11-7 o KE 11-8 o KE 11-9 o KE 11-12
14-0002	Following the radiological release event of February 2014, a PISA was identified for the following hazards as potentially not adequately addressed or controlled • The safety functions of the UG ventilation system, filtration and radiation monitoring systems, relied upon for protection of the FW, CW, and MOI, were not adequately identified and protected in the WIPP DSA. • Performance of Ground Control inspections in accordance with 30 CFR Part 57, Subpart B, "Ground Control" were suspended following the events and were thus not being performed.	• New DSA requires constant HEPA filtration. • UG ventilation system upgraded to SS. • New TSR level controls (LCO/SAC) for UG ventilation system, HEPA filtration, and radiological monitoring. • Ground Control included as Key Elements o KE 11-10 o KE 11-11

Table ES-6 Justification for Closure of Open PISAs

PISA Number	Description	Justification for Closure
14-0007	Based on new information gained during the investigation into the radiological release, a PISA was identified for improper mitigation and packaging of untreated nitrate waste salts with the following hazards potentially not adequately addressed: • Drums from the LA-MIN02-V.001 waste stream could increase the probability of an accident (internal deflagration in contact-handled (CH) waste container in UG) previously evaluated in the existing safety analysis • The existing safety analysis of an internal deflagration event (bounding non-explosion internal energetic event) assumed the material at risk (MAR) of a single waste container, but did not bound the actual release in the event.	• Scenario addressed in updated HA to include adjustments to MAR, number of containers, probability, and consequences. • New SS DF for closure barriers for panels containing MIN02 waste. • New TSR level control for radiological monitoring. • Improvement to LCO associated with non-compliant waste. • Added new SMP (Chapter 18) to increase robustness of WAC controls/initial condition to include Key Elements o KE 18-1 o KE 18-2 o KE 18-3 o KE 18-4
15-005	The WHB fire suppression riser operability criteria (flow and pressure) may not suffice to ensure the described safety function for the actual supply piping configuration.	• TSR level controls (to include associated calculations and system evaluation) for WHB FSS upgraded and incorporated into DSA/TSR.
15-006	The design feature WHB floor slope was not correct.	• Updated HA no longer credits floor slope. • DSA/TSR now credits alternate controls to protect building columns. • DSA Section 3.6 commits to installation of column fire barrier.
15-008	The WHB HEPA filter banks for the vent hoods used for the TRUDOCK and TRUPACT III exhaust system previously thought (in error) to have exhausted through the credited CH Bay HEPA filtration system.	• New TSR LCO created.

<u>Vulnerabilities and Cross Cutting Reviews:</u> As a final test of the suitability of revised DSA/TSR to support successful restart of waste receipt and emplacement, potential vulnerabilities were identified and subjected to cross-cutting reviews of the documents.

- **Reduced Ventilation Flow:** Following the events of February 2014, the DOE recovery plan for waste emplacement resumption is built around the installed filtered ventilation capacity and a practical near-term modification, the Interim Ventilation System (IVS), to be in service for waste emplacement resumption that will approximately double ventilation capacity. The available ventilation capacity, even when IVS is operational, is much less than prior operations that utilized much higher volumetric flow of unfiltered air. The decision to rely on HEPA filtered ventilation is both an improvement and a potential vulnerability. Until a new permanent ventilation system is available, the facility will operate with less than half the ventilation flow that had been previously available to support waste emplacement. The limited available ventilation capacity for initial resumption of waste receipt and emplacement is addressed in this SER and determined to be sufficient.
- **Post-Accident Fire Protection Strategy:** The salt haul truck fire in February 2014 revealed numerous aspects of preparation for fires that were less than adequate. Table ES-7A provides a high level summary of the Fire Protection elements in the revised DSA/TSR to demonstrate that together they afford a coherent strategy for dealing with the important risk of fire in the WIPP facilities, especially the UG.
- **Post-Accident Strategy for Radiological Release Minimization:** The radiological release accident in February 2014 revealed numerous aspects of preparation for such a release that were less than adequate. Table ES-7B provides a high level summary of pertinent elements in the revised DSA/TSR to demonstrate that, together, they afford a coherent strategy for dealing with the important risk of radiological release both within and from the WIPP facilities, especially the UG.
- **Additional Responses to AIB Findings and Recommendations:** The thorough AIB investigations provide a valuable check list of considerations pertinent to the determination of readiness to restart. Table ES-7C provides a high level summary of pertinent aspects of the revised DSA/TSR that are responsive to the AIB reports. The complete revision of the safety basis to comply with DOE-STD-3009-2014 addresses the primary AIB safety basis issues.
- **Implementation:** As with any safety basis change, implementation is recognized as critical to achieve the intended benefits. Key implementation considerations for this safety basis change are summarized in Table ES-7D. Together they afford a coherent strategy for realizing the safety benefits afforded by the revised DSA/TSR.

Table ES-7A: POST-ACCIDENT FIRE PROTECTION STRATEGY

- **Maintain UG equipment to limit fire risk, utilize high temperature hydraulic fluid, and provide automatic fire suppression of up-to-date design for diesel-fueled waste handling equipment (LCO) and for other diesel-fueled equipment posing significant fire risk anywhere in the UG (SMP KE).**
- **Segregate other significant UG fire hazards such as UG fuel storage to ensure no fire impact on waste (TSR DF); maintain rigorous UG combustible control (SMP KE); install localized fire suppression systems to limit fire risk in storage areas (SMP KE).**
- **Ensure effective preventive controls for postulated liquid fuel fires that might become too large to safely accommodate. Utilize multiple, diverse control strategies (TSR) for prevention: equipment maintenance and automatic fire suppression, vehicle access limits, and attendant spotters to take actions limiting fire growth at the incipient stage and protecting workers.**
- **Ensure capabilities to safely accommodate fires that may occur anywhere in the UG:**
    - **Utilize facility pallets (TSR DF) to prevent container lid losses that lead to higher radiological consequences.**
    - **Ensure HEPA filtration (TSR LCO) for mitigated fires that cause doses exceeding control selection guidelines.**
    - **Utilize defense-in-depth to further limit the potential for contamination spread from the UG (Table ES-7B).**
    - **Improve provisions to ensure worker safety including evacuation planning, training, access to protective equipment, and enhanced communication capability allowing for evacuation route changes if needed (SMPs and KEs).**

Table ES-7B: POST-ACCIDENT RADIOLOGICAL RELEASE MINIMIZATION STRATEGY

- **Incorporate lessons learned from MIN-02 WAC noncompliance with new controls to prevent recurrence (new Chapter 18 and SMP KEs).**
- **Implement Fire Protection Strategy with effective preventive controls to minimize fire probability, fire size, and the potential for waste impacts (Table ES-7A).**
- **Ensure HEPA filtration without excessive smoke loading for mitigated fires that cause doses exceeding control selection guidelines (TSR LCO).**
- **Ensure defense-in-depth margins to further reduce the potential for radiological release from the facility:**
    - **Test and maintain two HEPA stages to greater than 99% efficiency (TSR LCO), removal effectiveness far above the TSR LCO minimum operability criterion of 99% per unit.**
    - **Ensure an effective Radiation Protection Program; require it to provide contamination control addressing potential upcasting from the UG, especially when confinement ventilation is not operable for an extended period (SMP KE).**
    - **Ensure an effective Emergency Planning Program:**
        - **Strengthen emergency response planning, training, and drill requirements to ensure public and personnel protection even if a release does occur (SMP and KEs).**
        - **Require it to preplan and implement responses for lofted smoke and radiological release from the Waste Shaft Station that may be caused by an extremely unlikely large pool fire (SMP KE).**

Table ES-7C: RESPONSES TO AIB FINDINGS AND RECOMMENDATIONS

- **Complete revision of the safety basis to comply with DOE-STD-3009-2014, ensuring AIB concerns with inappropriate administrative controls as initial conditions and inadequate bases for determining mitigated events to be beyond extremely unlikely are addressed.**
- **Implement the Fire Protection Strategy (Table ES-7A).**
- **Implement the Radiological Release Minimization Strategy (Table ES-7B).**
- **Ensure significant improvements to the SMPs, emphasizing maintenance, conduct of operations, fire protection, training, quality assurance and emergency response, while incorporating newly defined KEs in the TSR.**
- **Implement the DOE recovery plan developed following the accidents (September 30, 2014), including the decision to utilize filtered ventilation for the underground (UG) waste handling and disposal areas.**
    - **Place the IVS in service to ensure adequate filtered flow for resumption of waste receipt and emplacement.**
    - **Ensure the implications of reduced flow relative to prior operating experience are recognized and managed appropriately.**
- **Incorporate additional AIB lessons learned including:**
    - **An exemption addressing the need for fire suppression throughout the UG**
    - **Integrate real-time monitoring into the control strategy including a SAC that utilizes Continuous Air Monitors (CAMs) outside the Panel 6 and Panel 7, Room 7 closure barricades and an SMP KE for other CAM applications.**
- **Continue improvements not tied to restart such as safe havens.**

Table ES-7D: IMPLEMENTATION STRATEGY

- **Utilize a rigorous contractor Implementation Validation Review (IVR) process with CBFO participation/oversight to achieve compliance with both the letter and intent of the new DSA/TSR.**
- **Implement DSA/TSR Revision 5b provisions applicable to operations without waste receipt and emplacement promptly after approval, providing an opportunity to hone and demonstrate compliance while the facility is in an exceptionally low risk configuration.**
- **Utilize an Authorization Agreement to control allowed activities both prior to and after successful completion of an Operational Readiness Review (ORR) for restart of waste receipt and emplacement.**
- **Utilize the interim implementation period to both test compliance with DSA/TSR provisions and prepare for demonstrations needed for the ORR.**
- **Plan for and conduct a rigorous ORR to support restart of waste receipt and emplacement:**
    - **Ensure unique provision of Chapter 18 are in place, tested, and consistent with the status of National TRU Program corrective actions.**
    - **Ensure provisions to manage the available ventilation maintain LCO compliance and worker safety throughout occupied areas of the UG both during waste emplacement activities and when waste emplacement is suspended to permit other activities.**
    - **Ensure pre-start ORR findings are resolved and closure is verified.**
    - **Update Authorization Agreement in conjunction with the authorization to begin waste receipt and emplacement.**

DSA/TSR Approval Process: CBFO plans to utilize an Authorization Agreement in conjunction with the implementation of DSA/TSR Revision 5b principally to restrict waste receipt and emplacement pending the successful performance of an ORR. The Authorization Agreement is written to address environmental, regulatory, and safety requirements applicable to facility operations, as well as any other conditions applicable to implementation prior to or following the ORR that are otherwise not ensured by DSA and TSR, Revision 5b.

Restrictions: The following additional restrictions are planned to continue even when waste receipt and emplacement are authorized:

- Prohibition on receipt of certain POCs and all CCOs until issues discussed in SER section 3.3.5 are resolved;
- Prohibition on RH waste receipt and emplacement;
- Prohibition on startup of SVS.

Conclusion: In summary, the DSA/TSR Revision 5 affords substantial strengthening of the WIPP safety basis in compliance with DOE-STD-3009-2014 and DOE Guide 423.1-1B requirements and guidance. This DSA/TSR also specifically addresses and resolves AIB issues identified in reports.

The SBRT identified conditions of approval that included directed page changes affecting various sections in the DSA and TSR to address a few issues noted by the SBRT. These directed page changes are specifically identified in SER section 5.0 and included in Enclosure 1. Revision 5b of the DSA/TSR, incorporating these changes, will be retransmitted to CBFO for information and is approved for implementation. Restart of waste receipt and emplacement is subject to the Authorization Agreement requirements for an ORR. The Revision 5 DSA/TSR documents have undergone an appropriate review in accordance with DOE-STD-1104-2014 and are concluded to provide an acceptable basis for the restart of waste receipt and emplacement at WIPP, ensuring the nuclear facility can be operated safely with respect to the workers, the public, and the environment.

ACRONYMS/ABBREVIATIONS

AC	Administrative Control
AIB	Accident Investigation Board
ARF	airborne release fraction
ASCE	American Society of Civil Engineers
Bq	becquerel
CAM	continuous air monitor
CBFO	Carlsbad Field Office (DOE)
CCO	criticality control overpack
CCP	Central Characterization Program
CED	Committed Effective Dose
CFR	Code of Federal Regulations
CH	contact-handled
Ci	curie
CLR	conveyance loading room
Cm	centimeter
CMR	Central Monitoring Room
CNS	certified but not shipped
CUR	Cask Unloading Room
CVS	confinement ventilation system
CW	co-located worker
DBE	design basis earthquake
DBT	Design Basis Tornado
DCF	Dose Conversion Factor
D/EBA	design/evaluation basis accidents
DF	design feature
DID	defense in depth
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-EM	DOE Office of Environmental Management
DOT	U.S. Department of Transportation
dP	differential pressure
DR	damage ratio
DSA	Documented Safety Analysis
EA	DOE Office of Enterprise Assessment
EBA	evaluation basis accident
FCLR	Facility Cask Loading Room
FDT^s	Fire Dynamics Tools
FHA	Fire hazards analysis
FPP	Fire Protection Program
FSM	facility shift manager
FSS	Fire Suppression System
ft	foot/feet
FW	facility worker
gpm	gallons per minute
HEPA	high-efficiency particulate air

hr	hour
IC	Initial Condition
ICRP	International Commission on Radiological Protection
IVS	Interim Ventilation System
KA	Key Attribute
kcfm	kilo cubic feet per minute
KE	Key Element
LANL	Los Alamos National Laboratory
lb	pound
LCO	Limiting Conditions for Operation
LPF	Leak Path Factor
LWFC	light-weight facility cask
MACCS2	MELCOR Accident Consequence Code System 2
M&O	management and operating (contractor)
MAR	material at risk
MOI	Maximally Exposed Offsite Individual
MOD	moderate
mph	miles per hour
mrem	millirem
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association
NPH	Natural Phenomenon Hazard
NRC	Nuclear Regulatory Commission
NTP	National TRU Program
NWP	Nuclear Waste Partnership LLC
ORR	operational readiness review
OSHA	Occupational Safety and Health Administration
PGA	Peak Ground Acceleration
PISA	Potential Inadequacy in the Safety Analysis
POC	pipe overpack container
psig	pounds per square inch gauge
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RF	respirable fraction
RH	remote-handled
RLC	removable lid canister
RPP	Radiation Protection Program
SAC	Specific Administrative Control
SB	safety basis
SBAA	Safety Basis Approval Authority
SBRT	Safety Basis Review Team
SC	safety class
SEI	Structural Engineering Institute
SER	safety evaluation report
SFPE	Society of Fire Protection Engineers
SIH	standard industrial hazard
SLB2	standard large box 2
SME	Subject Matter Expert
SMP	safety management program

SRS	Savannah River Site
SS	safety significant
SSCs	structures, systems, and components
Sv	sievert
SVS	Supplemental Ventilation System
SWB	standard waste box
SWB-OP	overpacked SWB
TDOP	ten-drum overpack
TED	Total Effective Dose
TMF	TRUPACT Maintenance Facility
TRAMPAC	TRU Waste Authorized Methods for Payload Control
TRU	transuranic
TRUDOCK	TRUPACT-II Unloading Dock
TRUPACT-II	Transuranic Package Transporter Model II
TRUPACT-III	Transuranic Package Transporter Model III
TSR	technical safety requirement
UG	underground
USGS	United States Geological Survey
USQ	Unreviewed Safety Question
UVFS	Underground Ventilation Filtration System
VEZ	vehicle exclusion zone
VOC	volatile organic compound
WAC	Waste Acceptance Criteria
w.g.	water gauge
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
yr	year

1.0 INTRODUCTION

1.1. PURPOSE

As required by *Code of Federal Regulations* Title 10, Part 830 (10 CFR 830), "Nuclear Safety Management," the purpose of this Safety Evaluation Report (SER) is for U.S. Department of Energy (DOE) to document (1) the sufficiency of the documented safety analysis for the Waste Isolation Pilot Plant (WIPP), a Hazard Category 2 DOE nonreactor nuclear facility, (2) the extent to which the contractor has satisfied the requirements of Subpart B of 10 CFR 830, and (3) the basis for approval by DOE of the safety basis for the facility, including any conditions for approval. The safety basis consists of DOE/WIPP 07-3372, Revision 5a, *WIPP Documented Safety Analysis* (DSA) and DOE/WIPP 07-3373, Revision 5a, *WIPP Technical Safety Requirements* (TSR). DSA/TSR Revision 5a was formally transmitted to CBFO for approval by transmittal letter AA:16:01045, Subject: Resubmittal of the Waste Isolation Pilot Plant Documented Safety Analysis, Revision 5a for Approval, dated April 18, 2016, from Mr. Philip J. Breidenbach, Project Manager, Nuclear Waste Partnership LLC (NWP), to Mr. Todd Shrader, Manager, Carlsbad Field Office (CBFO). The results of the hazard analysis and the supporting scoping calculations are presented in supporting documents that are incorporated into the DSA by reference and are thus also considered to be a part of the safety basis. The document revisions were prepared in accordance with 10 CFR 830 Subpart B requirements, applying the safe harbor methodology specified in DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*.

This SER documents the required review of the complete Revision 5a submittal in accordance with the guidance provided in DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. Thus, it provides the DOE Safety Basis Approval Authority (SBAA) with the documented bases for approving those safety basis documents to support the restart of waste receipt and emplacement at WIPP, ensuring the nuclear facility can be operated safely with respect to the workers, the public, and the environment.

1.2. FACILITY IDENTIFICATION, BACKGROUND, AND MISSION

WIPP is a Hazard Category 2 non-reactor nuclear facility for waste disposal located on 10,240 acres in Eddy County, New Mexico, 26 miles east of Carlsbad. The WIPP mission is to provide safe and permanent disposal of government-owned transuranic (TRU) and TRU mixed wastes. The WIPP repository is located approximately 2150 feet underground in a stable, ancient salt formation. The WIPP site is located in an area of low population density used primarily for cattle grazing and the development of potash, oil, and gas resources. No mineral resource development is allowed within the WIPP site boundary, with the exception of existing leases in the southwest corner of the site. WIPP is administered by the DOE Carlsbad Field Office (CBFO). NWP is the management and operating contractor (M&O) for the DOE.

WIPP began receipt and disposal of contact-handled (CH) waste (waste with less than 200 mrem/hr on contact) in March 1999 and of remote-handled (RH) waste (waste with a radiation level of equal to or greater than 200 mrem/hr but less than 1,000 rem/hr on contact) in January 2007. WIPP operations to support the mission include the review of documentation for appropriately packaged and certified waste to authorize receipt, authorization to ship waste, receiving of the waste on site, removal of waste from shipping containers inside an above ground facility, indoor staging of received waste, transfer of waste to the underground (UG) for emplacement, emplacement of the waste in constructed disposal panels divided into rooms, closure of rooms and panels when filled, and maintenance of both above ground and underground facilities, all in compliance with applicable nuclear safety and environmental requirements. Low-hazard experiments unrelated to waste disposal but utilizing the shielding afforded by the underground are conducted in the north end away from the waste disposal area. WIPP is unique among DOE Office of Environmental Management (EM) nuclear facilities in that it is subject to requirements of 30 CFR 57, "Mineral Resources: Mine Safety and Health Administration – Safety and Health Standards Underground Metal and Nonmetal Mines" through a memorandum of understanding.

The WIPP site is divided into surface structures, shafts, and subsurface structures and is designed to receive, handle, and emplace both CH and RH waste. The WIPP surface structures support the receipt of TRU waste from DOE generator sites. The Waste Handling Building (WHB) is the surface location for the unloading of generator-site prepared waste containers from DOE-owned shipping containers built to U.S. Department of Transportation (DOT) Type B requirements and certified by the U.S. Nuclear Regulatory Commission (NRC). The CH and RH waste containers are transferred from the surface to the UG through the waste shaft using the waste shaft conveyance. The surface entry/egress from the waste shaft conveyance and the waste hoist system and support structure are within the WHB. The CH and RH waste containers are removed from the waste shaft conveyance at the waste shaft station in the UG and are moved along a predetermined transport path to their final disposal location.

Three additional shafts connect the surface to the UG: an air intake shaft, with limited personnel evacuation capacity; the salt shaft, with the backup hoist utilized for both personnel access and the removal of bulk salt during mining operations; and the exhaust shaft connected to the Underground Ventilation Filtration System/Interim Ventilation System (UVFS/IVS) high-efficiency particulate air (HEPA) filters and exhaust fans.

For nuclear safety modeling purposes, the WIPP site boundary established by the Land Withdrawal Act is used to calculate consequences to the public that could result from accidental radiological release from the wastes. The nearest site boundary from either the WHB or the UG exhaust shaft is approximately 2.9 kilometers.

Operations were suspended at WIPP on February 5, 2014, following a fire that occurred in the UG involving a salt haul truck. This event was investigated by both DOE and NWP. DOE Accident Investigation Report, *U.S. Department of Energy Accident Investigation Report, Underground Salt Haul Truck Fire at the Waste Isolation Pilot Plant, February 5, 2014*, was issued on March 13, 2015, and included 22 Conclusions and 35 Judgments of Need focusing on maintenance practices, conduct of operations, and emergency response. The root cause of the fire was determined to be a parking brake that did not fully release and overheated ("EIMCO Loader/Hauler Vehicle Fire Origin and Cause Investigation Findings and Recommendations," issued July 28, 2015).

On February 14, 2014, a radioactive release event occurred in the UG due to an exothermic reaction in a drum non-compliant with the WIPP Waste Acceptance Criteria (WAC), involving a radiological release to the environment on the order of 5E-4 Ci. No worker or public dose limits were exceeded and the release was substantially below the annual release limits for the WIPP site.

Phase 1, Radiological Release Event at the Waste Isolation Pilot Plant on February 14, 2014, was issued on April 22, 2014, and included 31 Conclusions and 47 Judgments of Need. The report identified weaknesses in the existing safety basis and safety management programs (SMPs). Following the completion of a survey of the affected panel and room and assessment of the accident release mechanisms, the Phase 2 report was issued on April 16, 2015, and included 24 Conclusions and 40 Judgments of Need. The *U.S. Department of Energy Accident Fire Forensic Analysis of the Radiological Release Event at the Waste Isolation Pilot Project on February 14, 2014*, was issued by DOE on April 6, 2015. This report afforded detailed information on the nature of the drum failure that occurred and on the extent of fire damage affecting the array following drum failure. The hazard analysis in DSA, Revision 5a builds on the technical insights presented in the report.

Potentially Inadequate Safety Analyses (PISAs) were declared for both the UG vehicle fire and the radiological event. Unreviewed Safety Question (USQ) determinations associated with the PISAs were positive and, in accordance with 10 CFR 830.203 and DOE Guide 424.1-1B, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements*, a number of Evaluations of the Safety of the Situation (ESSs) were submitted to DOE over a period of time that reflected the then current understanding of the situation and its impact on the safety basis along with appropriate controls. ESSs were written as needed to support site habitability, UG reentry, accident investigation, housekeeping and decontamination, diesel-fueled vehicle operation, closures of Panel 6 and of Panel 7, Room 7, HEPA filter replacement, electrical outages needed for maintenance, IVS installation, a consolidated ESS combining active portions of the prior ESSs, and an ESS for WHB Fire Suppression. Each of these documents afforded controls conservatively selected to ensure safe performance of the necessary investigation and recovery activities until the cause investigations and corrective actions progressed to the point that a permanent safety basis change became practical. The ESSs still in effect are written to supplement the DSA and TSR, Revision 4, and thus will be superseded upon implementation of Revision 5b.

The WIPP M&O contractor, NWP, has finalized corrective action plans for both the UG fire and the radiological release. Major changes include operation in filtration mode as the norm, and enhancements to fire protection, emergency management, radiation protection, conduct of operations, maintenance and configuration management, and other facility programs. Various upgrades to specific structures, systems, and components (SSCs), including Safety Management Program (SMP) support equipment, were made or are being made. The details of the corrective action plans are outlined in the *Waste Isolation Pilot Plant Recovery Plan*. Corrective actions relied upon to ensure the safe restart of waste receipt and emplacement are required by the DSA/TSR Revision 5a and noted as applicable in this SER. Significant decontamination activities, including encapsulation, have taken place to support continued UG recovery operations. Recovery also included extensive maintenance ("bolting") of the salt structure to ensure the stability of ceilings (called "backs") and walls (called "ribs") and to deal with floor heaving.

1.3. WIPP DOCUMENTED SAFETY ANALYSIS HISTORY AND APPROACH

The DSA and TSR, Revision 5a, were developed to support the restart of waste receipt and emplacement at WIPP following suspension of these activities since the February 2014 accidents. Consistent with the recovery plan developed following the accidents (*Waste Isolation Pilot Plant Recovery Plan*, September 30, 2014, Revision 0), proposed restart addresses DSA-applicable lessons learned from these accidents and includes reliance upon filtered ventilation from the UG waste handling and disposal areas, an approach that was chosen for recovery and adopted to minimize the risk of future radiological release from the UG.

This SER evaluates the DSA and TSR, Revision 5, documents as a comprehensive upgrade to the safety basis, including new hazard and accident analysis and significant changes to the control set in the TSR.

Revision 0 of DOE/WIPP 07-3372, *Waste Isolation Pilot Plant Documented Safety Analysis* (DSA), and of DOE/WIPP 07-3373, *Waste Isolation Pilot Plant Technical Safety Requirements* (TSR), were approved by CBFO in September 2008 (DOE/CBFO-08-3385). These new documents combined for the first time separate DSAs and TSRs for CH and RH operations. In addition, they were supported by new hazards and accident analysis, implementing the guidance of DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, for the first time, together with other improvements. Revision 1 was approved in February 2009 (DOE/CBFO-09-3427) to incorporate corrections and facilitate implementation of Revision 0. Revision 2 was approved in January 2011 (DOE/CBFO-10-3459) to incorporate control changes based on a reassessment of credited controls, design features, and an overly conservative fire model. Revision 3 was approved in May 2011 (DOE/WIPP 11-3467) to incorporate use of the TRUPACT-III shipping container. Revision 3a, incorporating Page Change 001, was approved in June 2011 (DOE/WIPP 11-3467, Revision 1) to incorporate a control change needed to facilitate implementation of Revision 3. Revision 4 was approved in August 2013 (DOE/WIPP 11-3467, Revision 3). This revision was a broad annual update resulting in numerous changes throughout the document, including changes affecting the accident analysis and the TSR controls. WIPP DSA and TSR Revision 5a, the subject of this SER, is the first complete revision since Revision 0. This SER will supersede the prior SERs identified, beginning with the one for Revision 0.

Revision 5a of the DSA and TSRs also supersedes ESS-2015-01, Revision 1a, the consolidated ESS for recovery operations, NS-SBS-2014-01 Revision 0, *Shipping Container Venting Operations*, and ESS-2015-02, Revision 0a, as approved to address the PISA for WHB Fire Suppression System (FSS) operability criteria. This PISA and the other two written to address the floor slope and TRUDOCK ventilation system are being closed by Revision 5a.

NWP, with CBFO concurrence, is planning to implement Revision 5b of the DSA and TSRs shortly after approval, before waste receipt and emplacement are authorized. Doing so will help the M&O contractor both prepare for and demonstrate readiness to perform work in accordance with the new DSA and TSR during the subsequent Operational Readiness Review planned as prerequisite to waste receipt and emplacement.

2.0 REVIEW PROCESS

The DOE safety review process is documented in DOE/CBFO-15-3351, *Safety Basis Review Plan for Revision 5 of the Waste Isolation Pilot Plant Documented Safety Analysis (WIPP 07-3372), and Technical Safety Requirements (WIPP 07-3373)*. This plan and the resulting review records implement applicable requirements of CBFO Management Procedure (MP) 4.11, *Safety Basis Review Procedure*, Revision 6.

To facilitate implementation of DOE-STD-3009-2014 and, more importantly, to help ensure timely preparation of an approvable safety basis to support WIPP restart, DOE elected to charter their Safety Basis Review Team (SBRT), built on the concept of an Integrated Project Team in DOE-STD-1189-2008 as referenced in DOE STD-1104-2014. The charter is Attachment 1 in the plan. The intent was for the SBRT to provide in-process review during the M&O contractor's DSA and TSR development and thereby help ensure the final product meets

DOE expectations. The SBRT membership and supporting subject matter experts (SMEs) identified in the plan were drawn from CBFO and DOE-EM resources in part to ensure knowledgeable expertise, including working familiarity with the applicable requirements and the WIPP facility.

The review process was then broken into three phases:

Phase 1 Applicable as NWP developed or revised input documents (calculations, hazard analysis, etc.) and created DSA/TSR chapters and sections. During this phase, as each DSA or TSR chapter or section was developed, the designated SBRT point of contact for that section engaged with NWP to provide real-time comments for NWP consideration at their discretion. The DOE point of contact drew upon designated SMEs as needed for an adequate review. Comments were not formally logged and NWP did not formally respond to them. At the end of this phase, NWP conducted its own independent review of each DSA/TSR chapter/section prior to finalizing a “high quality draft” for formal DOE review.

Phase 2 To review the high quality draft for compliance with applicable DOE requirements and standards, the SBRT points of contact again drew upon designated SMEs as needed. Formal comments were generated during this phase and were documented. NWP tracked, addressed, and formally responded to the comments. The SBRT point of contact coordinated interactions between NWP and the reviewers as needed to resolve the comments. The high quality draft sections were additionally provided to DOE-EM, the DOE Office of Enterprise Assessment (EA), and Defense Nuclear Facilities Safety Board (DNFSB) personnel for independent, external review. Comments from external reviewers were forwarded to the SBRT points of contact for evaluation and vetting for inclusion in the current DSA or for inclusion in a future revision to the Safety Basis. Comments to be resolved in the current DSA were forwarded to NWP for formal resolution, again coordinated by the SBRT points of contact. Comments deemed mandatory, as confirmed by the SBRT Leads when necessary, were resolved prior to final submittal of the DSA and TSR, Revision 5, on February 29, 2016. Comments judged to afford improvements that could be safely deferred to a future revision were identified as such and tracked for later inclusion.

Phase 3 This phase addresses preparation of the SER, which began in parallel with Phase 2 and was finalized after the DSA/TSR was formally transmitted by NWP. The SBRT alone was responsible for the final development of the SER, based on review of the submitted documents, again with support from SMEs as needed. Phases 1 and 2 were planned to minimize the need for further comments in Phase 3, although some issues not fully resolved in Phase 2 were continued for resolution in Phase 3. These final comment resolutions resulted in the contractor’s submittal of DSA/TSR Revision 5a on April 18, 2016. This SER addresses approval of the submitted Revision 5a final documents.

Checklists are provided in the plan to help ensure both the completeness of the review and the appropriate focus on applicable DOE requirements for the DSA, TSRs, “shall” statements from DOE-STD-3009-2014, and the SER.

The “in-process review” of draft documents as they were developed allowed for early engagement of the SBRT and provided an opportunity to resolve disagreements in a timely fashion. The final DSA and TSRs reflect the results of extensive comment dispositions and interactions between NWP and DOE. External reviewers contributed to this process, but the bases for closing their comments were ultimately determined by the SBRT.

The plan includes features to maintain appropriate independence in the SER preparation process, beginning with NWP responsibility for preparing the documents and the chosen comment resolution approaches. The SBRT Leads for the SER were not directly involved in the in-process review. Each SER input was checked by an SBRT member not involved in the preparation of that section or the corresponding in-process review. Once the SER was developed, an independent DOE external review of the SER was conducted by an off-site, recognized nuclear safety expert. The associated final SER and NWP safety basis documents were also presented to a DOE-EM senior advisory board for concurrence; the DOE-EM review involved a panel with a broad charter to question the SBRT on the review and the bases for its conclusions. Upon DOE-EM concurrence, the completed SER was presented to the CBFO Safety Basis Approval Authority (SBAA) for approval.

3.0 BASES OF APPROVAL

The following DOE requirement and guideline documents constitute the principal bases for approval of WIPP DSA/TSR, Revision 5a:

- 10 CFR 830, *Nuclear Safety Management.*
- DOE O 420.1C, *Facility Safety.*
- DOE-STD-3009-2014, *Preparation Of Nonreactor Nuclear Facility Documented Safety Analysis*.
- DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities.*
- DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*.
- DOE-STD-1186-2004, *Specific Administrative Controls.*
- DOE-STD-1027-92, Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*.
- DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C, Facility Safety.*
- DOE G 423.1-1B, *Implementation Guide For Use In Developing Technical Safety Requirements.*

3.1. BASE INFORMATION

The SBRT reviewed the WIPP DSA/TSR Revision 5a preparation process, completeness and general content for sufficiency in supporting the approval bases. As confirmed during in-process review, NWP assembled a team of experienced DSA and TSR preparation personnel, supported by facility management, engineering and operation personnel as necessary to prepare documents compliant with the applicable requirements. Overall, NWP demonstrated a strong commitment to developing a comprehensive safety basis for resuming WIPP waste receipt and emplacement through the resources they applied to the DSA development effort and their responsiveness in addressing DOE comments and issues throughout the development process. The SBRT concludes that submitted documents contain the necessary information with adequate detail and quality to support the required DOE review.

The DSA executive summary affords an acceptable overall perspective on the purpose of the document and the principal changes being made in this revision. DSA/TSR Revision 5a is generally based on the WIPP configuration as of December 2015, but there are some in-process upgrades not complete as of December 2015 that are relied upon for the safety basis. These are noted as applicable in the SER. The remaining base information addressing the site, facility and mission is addressed in the following section.

3.2. SITE AND FACILITY INFORMATION

DSA Revision 5a, Chapter 1, provides the required site description and characteristics consistent with the original design basis on which operation of the facility was approved. The DOE review verified consistency with the facility design basis and also that the required 10-year review of Natural Phenomena Hazards (NPH) analyses had been performed as required in 2009. No NPH updates were identified based on that review.

DOE further evaluated the Design Basis Earthquake (DBE). DSA sections 1.5.1.2 and 1.5.1.3 discuss the seismic risk and DBE for the facility. The seismic risk analysis relies primarily on information in Chapter 5 of the WIPP geological characterization report published in 1978, SAND78-1596, *Geological Characterization Report, Waste Isolation Pilot Plant Site, Southeastern New Mexico*. This analysis was completed in the early days of probabilistic seismic hazard analysis, but when compared with more recent seismic hazard information, its conclusions are conservative. A conclusion in SAND78-1596 states, “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 g." Although not explicitly stated in SAND78-1596, the implication is that this acceleration refers to a peak ground acceleration (PGA), or a zero period acceleration, rather than an acceleration at a specific engineering frequency of interest. DSA section 1.5.1.3 states that SAND78-1596 has the most conservative calculated estimate of the 1,000-year acceleration at WIPP as 0.075 g. The origin of this statement is not clear, as Figure 5.3-6 in SAND78-1596 indicates the 1,000-year ground motion is approximately 0.06 g.

Both the DOE-STD-1020-2002 and DOE-STD-1020-2012 revisions of *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, require that WIPP facilities classified as Performance Category 2 or 3, or Seismic Design Category 2 or 3, use the 2,500-year ground motion as the design basis earthquake ground motion. The DSA refers to the 1,000-year ground motion, but no current DOE requirements mention the 1000-year ground motion as a design consideration. The 2008 and 2014 U.S. Geological Survey (USGS) national seismic hazard maps, as well as ASCE/SEI 7-10, all indicate a 2,500-year PGA value of less than 0.1 g for the WIPP site. DSA section 1.5.1.3 states that for conservatism, a PGA of 0.1 g is selected for the WIPP design basis ground motion, and both the WHB and the TRUPACT Maintenance Facility (TMF) are constructed to withstand this ground motion. As 0.1 g PGA exceeds the design basis ground motion mandated by the current and the previous versions of DOE-STD-1020, the SBRT concludes that the seismic designs of the WHB and TMF are adequate.

In 2015 the USGS published Open File Report 2015-1070 on incorporating induced seismicity into the 2014 national seismic hazard model. Induced seismicity, also called non-tectonic earthquake, occurs largely as a result of oil and gas exploration and production. The USGS identified 17 specific zones of induced seismicity across the United States, and one of these, named Dagger Draw, is near the WIPP site. As demonstrated by Figure 3c in the report, the number of earthquakes associated with the Dagger Draw zone is quite small. Based on the maps in Figures 12 through 17 of the report, which incorporate non-tectonic events into the national hazard map, no perceptible increase in the WIPP seismic hazard results from the Dagger Draw events. This report provides confidence that the WIPP seismic design remains conservative when considering induced seismicity.

The SBRT also confirmed the validity of the original judgment that the seismic surface DBE of 0.1g would have little impact at the underground elevation. The DBE discussion references the Pratt et al. (1978) paper which the SBRT found to provide a reasonable basis for the conclusion that UG damage from the WIPP DBE is likely to be negligible. The case can be further supported by citing the Sanchez (1998) study on ground motion measurements at WIPP, both on the surface and in the UG, from two regional earthquakes in 1992 and 1995.

The SBRT review concluded that Chapter 1 is acceptable as submitted.

DSA, Revision 5a, Chapter 2 was updated from Revision 4 to describe: the accidents which occurred in February 2014; the changes made to the UG ventilation system, including reliance on filtration, description of upcasting, addition of the IVS, and construction of the SVS; the Panel 6 and Panel 7, Room 7 closures to confine potentially reactive waste that is not compliant with the WIPP WAC; relocation of the UG fuel storage and oil storage areas; the seismic monitoring system and its link to the WHB ventilation tornado dampers; the central monitoring room; changes to fire protection features, including new localized UG fire suppression systems; and design details pertinent to the PISAs affecting the WHB ventilation and fire suppression systems. DSA Chapter 2 descriptions were judged limiting in some areas, e.g., description of the waist hoist brakes, but details were added to DSA Chapters 4 and 5 or incorporated by reference to system design descriptions that were judged adequate to support the DSA development and the DOE review process.

Overall, the SBRT concludes that the DSA provides sufficient base information in terms of facility and waste operation descriptions to support identification of the hazards and the selection of controls relied on for public, worker and environmental protection. Specifically, adequate correlation is established between the physical facility and its description in the DSA and the information presented is sufficient to support both the safety analysis and the development of an effective set of TSR controls.

3.3. HAZARD AND ACCIDENT ANALYSIS

The hazard analyses and accident analyses contained in a DSA are the foundation upon which the facility controls (i.e., TSRs including safety SSCs, Specific Administrative Controls [SACs], and other administrative controls and programmatic commitments) are established. The objective of the SBRT review of this portion of the DSA is to assure that it contains sufficient information with appropriate references to supporting details, and to ensure the completeness of the hazards and accident analysis and the consistency of the logic used throughout the analysis process.

In accordance with guidance from DOE-STD-1104-2014, this section provides an overall summary of the hazards and accident analysis methodology, assumptions, and results. These results derive the need for, and the safety classification of, preventive and mitigative controls to be addressed in the TSRs. The goal of the review is to ensure that the safety basis is comprehensive relative to hazards presented and is based on a consistent, substantiated logic. DOE-STD-1104 addresses evaluation of the following to determine the adequacy of the hazard and accident analyses:

- Hazard Identification
- Hazard Categorization
- Hazard Evaluation
- Hazard Evaluation Control Selection
- Accident Analysis
- Defense-in-Depth
- Beyond Design/Evaluation Basis Accidents
- Planned Design and Operational Safety Improvements

3.3.1. Hazard Identification

The DOE technical review of the adequacy of hazard identification focused on information presented in DSA sections 3.3.1.1 and 3.3.2.1. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- The hazard analysis includes hazard identification that specifies and estimates the hazards, both man-made and natural, in terms of type, quantity, and form of radioactive and other hazardous materials.
- The chemical screening process applied is consistent with DOE-STD-3009 requirements.

The 2008 CH/RH DSA Revision applied an integrated hazard identification process to systematically identify hazards and energy sources for multiple program needs, including the nuclear safety basis, fire hazards analysis required by DOE O 420.1B, *Facility Safety*, occupational safety and health required by 10 CFR 851, Worker Safety and Health Program, and emergency planning required by DOE O 151.1C, *Comprehensive Emergency Management.* Development of the DSA Revision 5a required confirming and updating the previously identified hazards, and results are documented in WIPP-007 Revision 6, *Hazard Identification Summary Report for WIPP Operations*.

During hazard identification, information was gathered about the various process hazards that might lead to accident scenarios. The information gathering process included physical walk-downs, reviews of facility operating data and information, and discussions with SMEs. The physical walk-down, guided by facility experts, consisted of a comprehensive tour of the facilities and planned internal and external activities. Facility data and information reviews included the latest system design descriptions and inventory information, supporting operational safety studies, and consultations with system engineers and process and analytical experts. The hazard identification process also reviewed past occurrences, and specifically addressed the UG vehicle fire and radiological release events from the UG that both occurred in February 2014.

Hazards of interest to the nuclear safety basis associated with WIPP operations include material handling of waste containers, rotating machinery, high voltage, compressed gases, confined spaces, radiological and non-radiological hazardous materials, ionizing and non-ionizing radiation, noise levels, mechanical and moving equipment dangers, working at heights, construction, and mining operations of disposal panels. Waste-handling operations at the WIPP do not involve high temperature and pressure systems, or electromagnetic fields. In addition to the 10 CFR 851 worker protection regulation, which encompasses adherence to Occupational Safety and Health Administration (OSHA) requirements, selected Mine Safety and Health

Administration (MSHA) standards are implemented for routine occupational hazards. These hazards and energy sources are summarized in DSA Table 3.3-5, Hazard Identification Summary.

The information gathering process resulted in a comprehensive list of potential facility hazards by type, location, and indication of magnitude of the hazard when appropriate. This list was then screened using guidance in DOE-STD-3009-2014, section A.1, to eliminate standard industrial hazards (SIHs) that are not considered in DSA hazard and accident analyses, except where they may be initiators or contributors to a release of radioactive or hazardous material, or have the ability to impact the safe operation of the facility (e.g., inability to perform a Specific Administrative Control).

*A*s discussed in the DSA section 3.3.1.1.3, the WIPP-purchased chemical inventory was initially evaluated for screening per the guidance in DOE Guide G 151.1-2, *Technical Planning Basis, Emergency Management Guide*, as summarized in the DOE/WIPP-08-3378, *Waste Isolation Pilot Plant Emergency Planning Hazards Assessment (EPHA)*. A "snapshot" of the chemical inventory at the time of the screening is included as an appendix to WIPP-007. Results are documented in DSA section 3.3.1.1.3 stating that "All items in the purchased chemical inventory meet at least one of the DOE Guide 151.1-2 criteria … ." and also that "Using the criteria of DOE-STD-3009-2014 section A.2, the chemicals in the WIPP Chemical Inventory that do not screen out would still not result in a release that would exceed the PAC-1 for Maximally Exposed Offsite Individual (MOI) or PAC-2 for the co-located worker consequence thresholds. Thus, while the DSA does not state that all chemicals in the purchased chemical inventory screen out per the DSA criteria, it concludes that none would exceed the low consequence threshold for the MOI or co-located worker. This was based on qualitative determination that the quantities were not significant. Consequences from bulk chemical releases were then not estimated in the hazard evaluation. The SBRT scanned the list of purchased chemicals and concurs with this conclusion. These purchased chemicals are expected to be adequately controlled to protect the co-located worker, public, and environment per the hazardous material protection program described in the DSA Chapter 8. Although not addressed in the DSA discussion, the SBRT judges that the DSA Chapter 8 should adequately protect the facility worker for this purchased chemical inventory. The DSA also states that "Bulk chemicals used onsite are stored away from radiological material and cannot contribute to the release of radiological material."

Chemicals associated with TRU-mixed waste were evaluated in the same manner as for the previously approved revisions to the DSA, as summarized in the DSA section 3.3.1.1.3 as follows:

> "Of the chemical constituents associated with the EPA Hazardous Waste Numbers that may be present in the TRU Mixed Waste per the *Waste Isolation Pilot Plant Hazardous Waste Facility Permit* (HWFP) and polychlorinated biphenyls (PCBs) per the EPA PCB Conditions of Approval (EPA 2011), only beryllium powder did not screen out as there are multiple TRU Waste Containers that contain beryllium in a solid form. The bulk of beryllium material in the TRU Waste is in solid form (i.e., not powder) and would not be dispersible due to an insult of a TRU Waste Container. Since the predominant and most probable hazard in TRU Waste is radioactive material, any release of beryllium would be coincident with a release of radioactive material. The chemical hazard consequences due to the accidental release of any material intermixed with TRU Waste and released simultaneously due to an insult of a TRU Waste Container are less than the radiological consequences of the same event; therefore, the controls derived for the radiological

event are considered to prevent/mitigate any chemical release. The WIPP WAC identifies the permissible constituency of TRU Waste Container contents with the intent to ensure that incompatible mixtures are not allowed (in addition to vented substantial containers), thereby preventing internal container fires and deflagrations."

This statement reflects the DOE and M&O contractor previous safety basis position that chemical constituents that co-exist with radioactive material are expected to have consequences bounded by the radiological consequences and would be adequately controlled by the credited preventive and mitigative controls for radiological releases. Therefore, chemical consequences from hazardous constituents mixed with TRU waste were not separately evaluated in the hazard evaluation. This approach was updated, however, for volatile organic compounds (VOCs) in DSA Revision 5a as discussed below.

VOCs are identified in WIPP-007 as a hazardous material associated with TRU waste containers. Recent VOC monitoring outside panels or disposal rooms with closure barriers installed has detected elevated concentrations in drifts that may not have adequate natural airflow or active ventilation (note that periodic VOC monitoring of the WHB is also required by the SMP in recognition of this hazard). This hazard is associated with normal operations involving continuous venting and accumulation of VOC gases in the closed rooms or panels, and is controlled by the Hazardous Material Protection Program described in DSA Chapter 8. However, the SBRT recognizes this situation as an "expected operational event" addressed in DOE-STD-5506-2007, section 3.4, that warrants further hazard evaluation. The SBRT also interprets this hazard in the UG associated with leakage from closed rooms and panels as being governed by DOE-STD-3009-2014, section A.2. Thus, the hazard cannot be screened out and the required evaluation is provided below in section 3.3.3. A directed change (see SER section 5) requires the DSA hazard identification to clarify that VOC hazards were not screened out. VOCs must be subjected to hazard evaluation due to their unique situation caused by concentration of leakage from a large number of waste containers within the enclosed spaces. These spaces are never occupied, but VOCs may leak into the adjacent occupied spaces, including drifts without assured ventilation.

The SBRT reviewed WIPP-007 and provided comments, which were adequately resolved. The SBRT relied upon individual members' understanding of the WIPP facility and hazards based on previous onsite WHB and UG tours, inspections, and surveillances, as well as from other CBFO SMEs experience at the site. WIPP-007 identifies the energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials. The SBRT concludes that hazard identification for the nuclear safety basis is a comprehensive, systematic process by which facility hazards are identified, recorded, and screened. The hazard analysis includes hazard identification that specifies and estimates the hazards, both man-made and natural, in terms of type, quantity, and form of radioactive and other hazardous materials.

3.3.2. Hazard Categorization

The DOE technical review of the adequacy of hazard categorization focused on information presented in DSA section 3.3.2.2. Overall, the SBRT gave consideration to whether the following expectation was met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- The initial and final hazard category for the facility is determined consistent with DOE-STD-1027-92, Change Notice No. 1. Any differences between the final hazard category and the initial hazard category are explained.

The WIPP facility is classified as a DOE Hazard Category 2 nonreactor nuclear facility. Facility categorization was performed consistent with DOE-STD-1027-92, Change Notice 1. Based on the lowest single waste container inventory limit of 80 plutonium-239 equivalent curies (PE-Ci), the WIPP radiological inventory exceeds the DOE-STD-1027-92 plutonium-239 threshold quantity for nuclear Hazard Category 2. There are no differences between the final hazard category and the initial hazard category.

3.3.3. Hazard Evaluation

The SBRT technical review of the adequacy of hazard evaluation focused on information presented in DSA sections 3.3.1.2 and 3.3.2.3. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- The methodology used for hazard analysis is clearly identified and appropriate (e.g., techniques chosen and implemented consistent with the Center for Chemical Process Safety *Guidelines for Hazard Evaluation Procedures*), including supportable input assumptions and criteria, and correct application of analytical tools used as part of the process.
- The hazard analysis evaluates all activities for which approval is sought, is consistent in approach with safe harbor methodologies or approved alternate methods, and identifies preventive and mitigative hazard controls for the spectrum of hazards evaluated.
- The hazard analysis evaluates normal, abnormal, and accident conditions, including natural and man-made external events, and identifies the energy sources or processes as well as any alternate pathways that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials. The hazard analysis results are clearly characterized in terms of public safety, defense-in-depth, co-located worker safety, facility worker safety, and environmental protection. The logic behind assessing the results in terms of safety significant SSCs, SACs, and designation of TSRs is understandable and internally consistent.

Any identified hazard not screened out as a SIH or a chemical hazard that could initiate or worsen a radiological or chemical release was evaluated by representative hazard scenarios (events) in the process hazards analysis. Hazards were systematically identified and qualitatively assessed to evaluate the potential operational, external, and natural phenomena events that can cause the identified hazards to develop into hazardous conditions (hazard events or scenarios).

DOE-STD-5506-2007 provides analytical assumptions and methods, as well as hazard controls to be used when developing safety basis documents for TRU waste facilities in the DOE Complex. It also provides supplemental technical information to the DOE-STD-3009-2014 safe harbor methodology that is specific to TRU waste operations, so that contractors can formulate, implement, and maintain safety bases for TRU waste operations consistently and compliant with 10 CFR Part 830, *Nuclear Safety Management*, Subpart B, *Safety Basis Requirements*. DOE-STD-3009-2014 was issued subsequent to DOE-STD-5506-2007 and, since it is the safe harbor methodology, any newer guidance or requirements it provides take precedence over DOE-STD-5506-2007.

3.3.3.1. WIPP Hazard Evaluation Summary

The DSA hazard evaluation methodology and techniques used to identify controls are described in DSA section 3.3.1.2 and in the supporting WIPP-021, Revision 5, *Hazard Analysis for the Waste Isolation Pilot Plant Transuranic Waste Handling Safety Basis*. The WIPP DSA hazard evaluation employs a hybrid approach incorporating elements of the What-If/Checklist and Preliminary Hazard Analysis methods that qualitatively rank hazards by likelihood (frequency of occurrence) and considers the significance of their consequences. Consequence levels are ranked as Low, Moderate or High. Accident likelihoods are assigned to four bins: Anticipated, Unlikely, Extremely Unlikely, and Beyond Extremely Unlikely. The risk ranking approach is based on four bins, from "I" for highest risk to "IV" for the lowest risk. This methodology is consistent with DOE-STD-5506-2007 and DOE-STD-3009-2014 Table A-1, *Qualitative Risk Ranking Bins*, which qualitatively describes the ranking of risk into situations of major concern (Risk Class I), situations of concern (Risk Class II), and situations of minor or minimal concern (Risk Class III or IV, respectively).

WIPP-021 describes that the hazard analysis process involved a team of knowledgeable individuals from multiple disciplines from WIPP Operations, Engineering, and support staff. DOE-STD-3009-2014 and DOE-STD-5506-2007 emphasize that the expertise and experience of the team is of primary importance in establishing the credibility of the analysis since these assessments are to be qualitative in nature. The hazard evaluation team participants for the upgrade to support the DSA Revision 5a are listed in WIPP-021, as well as participannts for previous revisions to the hazard analysis. In addition, WIPP Operations provided extensive support to the development of the DSA Chapter 4 controls, the DSA Chapter 5 derivation of TSRs, and the TSRs limits, action statements, and bases.

The hazard evaluation process consisted of an unmitigated evaluation of hazard event consequences to facility workers, co-located worker represented at 100 m from the facility stack for a surface release or from the UG release point, and the offsite public. Events were qualitatively evaluated for likelihood and consequences without the benefit of preventive or mitigative controls, with the exception of initial conditions. However, dose consequence modeling was performed to support the qualitative risk binning approach.

The unmitigated hazard evaluation credits specific Initial Conditions (ICs) to estimate likelihood and consequences. These are specific assumptions regarding the facility and its operations that are used in defining hazard and accident scenarios. They relate to facility-specific passive features (i.e., no active mechanical or human involvement) such as facility construction, and to assumptions made regarding waste container types and configurations, inherent or otherwise established inventory restrictions, facility configuration commitments, WIPP WAC compliance requirements, and operational process specific commitments. Initial conditions are summarized in DSA section 3.3.2.3. The identified ICs are ensured with appropriate TSR protection. The SBRT concluded that credit taken for initial conditions in the unmitigated hazard evaluation in WIPP-021 met the applicable requirements and that the initial conditions were evaluated for safety classification and included as required in TSRs.

The safety significance of crediting passive design features such as the WHB structure was evaluated to determine whether failure could result in consequences to the public that would warrant safety class designation. The Beyond Design/Evaluation Basis Accident analysis in WIPP-019 evaluated collapse of the WHB structure, and radiological dose estimates were adjusted for 95th percentile dispersion conditions, confirming that the Evaluation Guideline would not be challenged.

The results of the unmitigated hazard evaluation were used to identify the events that require further evaluation in the mitigated hazard evaluation for events posing significant risk to workers, and in subsequent accident analysis for events that may have consequences to the public that could challenge or exceed the 25 rem Evaluation Guideline. The unmitigated hazard evaluation resulted in selection of controls (SSCs or SACs) for the protection of workers based on the safety-significant criteria from DOE-STD-3009-2014 (facility worker and co-located workers). SACs were selected per the criteria in DOE-STD-1186-2004, *Specific Administrative Controls*. After control selection, a mitigated hazard evaluation was performed to demonstrate that adequate preventive and mitigative features were selected to reduce the unmitigated Risk Class I and II event risk for applicable receptors.

The SBRT concludes that the hazard analysis methodology described above is consistent with the guidance in DOE-STD-3009-2014 and DOE-STD-5506-2007 and represents a proper application of the graded approach to a facility of the type and complexity of WIPP.

The process hazard analysis results are presented in DSA section 3.3.2.3. The DSA evaluated the activities, equipment, and facility features described in DSA Chapter 2, and considered normal, abnormal, and accident conditions, including natural and man-made external events. It consistently applied the likelihood, consequence, and risk binning to evaluate unmitigated hazard events. Mitigated cases were evaluated by crediting preventive and mitigative controls to reduce risks.

The results of the hazard analysis and the supporting scoping calculations are presented in supporting documents that are incorporated into the DSA by reference and are thus considered to be a part of the safety basis. The hazard evaluation table in WIPP-021 provides identification of the selected controls and features that are credited to prevent or mitigate the consequences of each of the hazardous events that are Risk Class I or Risk Class II for any receptor. Unmitigated consequences identified in WIPP-021 are based on analyses in the following supporting documents:

- WIPP-001, Revision 9, *WIPP DSA Fire Event Accident Analysis Calculations*
- WIPP-017, Revision 8, *Waste Isolation Pilot Plant (WIPP) Documented Safety Analysis (DSA) Loss of Confinement (LOC) Event Hazard Analysis (HA) and Accident Analysis (AA) Calculations*
- WIPP-018, Revision 8, *Waste Isolation Pilot Plant (WIPP) Documented Safety Analysis (DSA) Explosion Event Hazard Analysis (HA) and Accident Analysis (AA) Calculations*
- WIPP-019, Revision 7, *WIPP DSA External Event and Natural Hazard Phenomena (NHP) Event Hazard Analysis (HA) and Accident Analysis (AA) Calculations*
- WIPP-051, Revision 3, *Scoping Calculations for MIN02-V.001 Waste for Closure of Panels 6 and 7*
- WIPP-054, Revision 0, *WIPP Dispersion Modeling Protocol*

Control selection was based upon the general principles stated in DOE-STD-3009-2014, section 3.3, Hazard Controls and the stated hierarchy of controls, which gives preference to passive engineered safety features over active ones, engineered safety features over ACs or SACs, and preventive over mitigative controls. Controls were selected based upon the judged effectiveness and relative reliability of the selected control(s) to accomplish the defined safety function. Additional controls were added if the effectiveness or relative reliability of the selected control(s) was deemed inadequate to reduce the risk to an acceptable level.

In evaluating identified hazard events and accidents, conservative assumptions were made to provide bounding consequences, qualitatively for the unmitigated hazard evaluation (supported by some dose consequence modeling) and mitigated hazard evaluation, and quantitatively for the subsequent accident analysis. The radiological consequences were qualitatively assessed for all receptors, but the assessment was guided by radiological dose consequence calculations to bin the consequences (High-Moderate-Low) for the co-located worker and public. The consequence methodology and scoping calculations are further discussed in DSA section 3.4 and evaluated in this report in the accident analysis SER section 3.3.5 below. These include, but are not limited to, conservative values for likelihood estimates, container inventories, material at risk (MAR), damage ratio, airborne release and respirable fractions, leak path factor, and air transport modeling assumptions. The use of conservative assumptions to bound the full range of possible hazard and accident scenarios provides reasonable assurance that: (1) the safety envelope of the WIPP facility is defined; (2) the design of the facility is adequate in response to the hazard events and accident scenarios analyzed; and (3) the TSRs assigned will provide adequate protection of the public, workers, and environment.

As described in WIPP-021, a total of 641 hazard events were evaluated for the unmitigated hazard evaluation and grouped into 167 unique and representative radiological events for evaluation from all the major types of accidents, NPH, and external events, as summarized in DSA Table 3.3-6, Listing of Unique and Representative Hazard Evaluation Events, and Table 3.3-7, Categorization of Hazard Evaluation Events. Of these, 47 events are identified in DSA Table 3.3-9, Hazard Evaluation Events Requiring Further Evaluation, as having unmitigated Risk Class I or II to one or more of the receptors, requiring further mitigated hazard evaluation or accident analysis. The evaluation that follows addresses both the events that were screened out and then the ones that were evaluated for control selection.

- **<u>Hazard Evaluation of Events Screened Out or Low Consequences:</u>**

  Many hazard events are not carried forward for further evaluation in DSA Table 3.3-9 because they are screened out as Risk Class III/IV, Low consequence to all receptors, not plausible per DOE-STD-3009-2014, or external event frequency of occurrence less than 1E-6/yr. Further evaluation and control selection is not required for hazard events that are screened out. Their screening may be based on credited ICs, design specific assumptions, calculations, and/or physical characteristics of the WIPP site. Justifications for screening these events are provided in the DSA after that table. The SBRT reviewed the following specific hazard event decisions to ensure that additional controls were not required:

  – Postulated criticality events (CH/RH-OA-14-002a, CH/RH-UG-14-001a, CH/RH-UG-14-003a, and RH-WHB-14-002a) involving the TRU Waste during Waste Handling or disposal are determined to be incredible events based on *Nuclear Criticality Safety Evaluation for Contact-Handled Transuranic Waste at the Waste Isolation Pilot Plant* (WIPP-016) and for *Nuclear Criticality Safety Evaluation for Remote-Handled Waste at the Waste Isolation Pilot Plan* (WIPP-020). The Nuclear Criticality Safety Evaluations address both CH and RH Waste to ensure that the CH and RH processes will remain subcritical under normal and credible abnormal conditions per DOE Order 420.1C and DOE-STD-3007-2007 in accordance with the guidance of DOE-STD-3009-2014.

  – A flammable gas explosion in a filled panel (CH/RH-UG-05-005a) was judged to be Beyond Extremely Unlikely based on historical monitoring, e.g., DOE/WIPP 12-3492-2, *Semi-Annual VOC, Hydrogen, and Methane Data Summary Report for Reporting Period July 1, 2012 through December 31, 2012*. The waste in a filled panel creates hydrogen and other flammable gases such as methane. The drums are vented before being sent to WIPP to allow these gases to escape the confines of the drum and reduce the probability of a drum deflagration. Analyses included in Appendix I1 of the WIPP

Resource Conservation and Recovery Act (RCRA) Part B Permit Application address the expected maximum generation rates in filled panels. The analyses evaluated drum gas generation rates for both methane and hydrogen. For methane, it would take five years to reach 1 percent concentration or 20 percent of the lower flammability limit within a single drum. For hydrogen, the concentration is less than 1 percent or 25 percent of the lower flammability limit in a single drum after five years. The gas exiting the confines of the drums would collect in a filled panel at lower concentration than the source drum. Based on the generation rates, it is not anticipated a filled panel would reach its lower flammability limit within the operational lifetime of the facility. Once in the panel the gases could escape from the panel because the rooms are not airtight and do have limited air leakage. This fact alone is enough to justify a Beyond Extremely Unlikely designation. Additional considerations for this type of accident include the 12-foot-thick block and mortar explosion-isolation wall to be installed at some time for each closed panel as described in DSA, Section 2.4.4.6, and the lack of an evident ignition source for any flammable gas that may accumulate (drum vents are typically made of materials that impede the production of static electricity).

– A flammable gas explosion in the CH Bay due to hydrogen generation from the charging stations (CH-WHB-05-001a) was judged to be Beyond Extremely Unlikely. An analysis (WP 09-CN3031, *Hydrogen generation by fork-truck rechargers in CH Bay of WHB*) evaluated the hydrogen generation rate of the fork-truck recharging station in combination with the CH Bay volume and CH Waste Handling Confinement Ventilation System flow rates and determined that it would require 126.67 hours to reach a hydrogen concentration of 1% by volume with absolutely no ventilation.

– Fire and internal container deflagration events involving RH Waste in a canister contained within the RH Waste Cask/LWFC are judged to be Low consequences to all receptors. The Facility Cask/LWFC protects the contained TRU Waste Canister from exposure to flame and reduces the consequences of this event to Low and Risk Class III for all receptors.

– An UG fuel storage explosion with fire propagating to an active Waste Disposal Room resulting in release of radiological material. (CH/RH-UG-05-002a) is judged in WIPP-021 to be anticipated at the source but would not result in a release The non-combustibility of salt and the distance separating the active mining portion of the UG from the Waste Transport Path and active disposal panels (IC) would impede a fire in one portion of the UG propagating over a large distance to another portion of the UG. An explosion involving the UG Fuel Storage or Oil Storage location (IC) propagating into an active disposal room or disposal route is judged to be Anticipated but the SBRT judges such an explosion with fire to be incapable of propagating into an active disposal room or disposal route based upon the IC of separation of the UG Fuel and Oil Storage location from TRU Waste in the UG. An explosion is not expected as diesel fuel, which is a normally a hydrocarbon mixture of thousands of individual compounds with a carbon number between 9 and 23, is generally an NFPA 30 Class II combustible liquid with a flashpoint between 100°F and 140°F although some diesel products have a flash point above 140°F. The boiling temperature of diesel fuel generally ranges between 300°F and 640°F. Diesel fuel is not stored in the UG under pressure or processed above its flash point. The ambient temperature in the UG is normally less than 100°F.

– A fire away from the Waste Disposal Areas (i.e., construction, mining, north ventilation circuit) and Waste Transport Path (CH-UG-04-001a) propagating to an active disposal room or Waste Transport Path resulting in release of radiological material is judged to be a Beyond Extremely Unlikely event due to the non-combustibility of the salt (initial assumptions) in the UG and the distances from TRU Waste. WIPP-023, *Fire Hazard Analysis for the Waste Isolation Pilot Plant*, postulates multiple scenarios for UG fires. A pool fire originating a distance of 25 feet from TRU Waste was qualitatively judged to have negligible effect on the TRU Waste Containers due to the multiplicity of conditions that must exist to result in the containerized waste burning with a resulting release. The areas addressed by this event are significantly greater than the 25 foot distance.

– Insults to Type B Shipping Packages in the Outside Area or in the WHB are judged to result in no release because the events are within the Type B Shipping Package design protected as an IC.

– Large fires and loss of confinement events involving RH Type B Shipping Packages in the WHB RH Bay were deemed to result in no release because of the protection provided by the RH Type B Shipping Packages (protected as an IC). Likewise, an internal deflagration or over-pressurization of a RH canister or waste drum within an RH Type B Shipping Package (IC) were deemed to result in no release.

– Events involving a high wind or tornado impact of the WHB (CH/RH-WHB-21-001a and CH/RH-WHB-22-001a) are judged to be no release. Tornado or high wind generated missiles could result in a release (CH/RH-WHB-21-002a and CH/RH-WHB-22-002a); however, these missile events were evaluated to be Low consequences which did not warrant further evaluation. The Design Basis Tornado (DBT) construction of the WHB is adequate to protect the TRU Waste from damage and therefore, a consequence of no release is justified. Since HEPA filtration is not required for a tornado event, the tornado dampers installed to protect the HEPA filters for the WHB do not require designation as a safety control.

– An event involving a high snow loading of the WHB (CH/RH-WHB-23-001a) is judged to entail no release. The roof loading design and construction of the WHB is adequate to protect the TRU Waste from damage.

– An event involving an external or NPH initiated event leading to a catastrophic failure of the Waste Hoist Tower and resulting in a loaded Waste Conveyance dropping down the Waste Shaft (CH/RH-WHB-20-002a) is judged to have a frequency of Unlikely due to the potential NPH initiators; however, the ICs of design and construction of the Waste Hoist Tower (i.e., DBE, tornado, high winds, and snow loading) in coincidence with the Waste Hoist Support Structure are judged to be sufficient to result in no significant impact to the loaded Waste Conveyance. Therefore, a consequence of no release is justified.

– The likelihood of a range fire propagating to the WHB (CH/RH-WHB-19-001a) and resulting in a release of radioactive materials was also determined to be Beyond Extremely Unlikely based upon the WIPP Property Protection Area being of noncombustible construction (e.g., paved/graveled) and the IC of the WHB, including the Waste Hoist Tower, being constructed of noncombustible materials.

– Aircraft impacting waste containers in the WHB or the DOT Type B Shipping Package outside area is an external event that is less than 10^{-6} per year per WIPP-008, *Estimate of Aircraft Crash Frequency at the Waste Isolation Pilot Plant*) based on the methodology outlined in DOE-STD-3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities*.

- External offsite vehicles colliding with Waste Containers within the WHB (CH/RH-WHB-17-001a) is deemed to be not plausible due to the distance of public access roads from the WHB and the fenced WIPP Property Protection Area.
- An event involving a gas pipeline explosion offsite impacting (CH/RH-EXT-18-001a) waste is judged to be Extremely Unlikely with no release. The distances separating the WHB and the evaluated hazards in combination with the TRU Waste being in Type B Shipping Packages (IC) are sufficient to prevent the postulated events from causing a release.
- An event involving a direct radiation exposure in the WHB (CH/RH-WHB-13-001a2) is judged to be Low consequences. RH Waste is handled in the FCLR, Transfer Cell, and CUR which have thick concrete walls to provide shielding for workers (use of these facilities is protected as an IC). This IC protects facility workers during the processing of RH Waste in these areas.
- An event involving a direct radiation exposure (CH/RH-OA-13-001a) from waste in outside areas is judged to result in Low consequences to all receptors. All TRU Waste shipped to WIPP is required to comply with the WIPP WAC. In the outside area, TRU Waste is contained in Type B Shipping Packages (IC) which are designed to protect the public from radiation exposure during transport of TRU Waste on public roadways. The Radiation Protection Program (RPP) surveys TRU Waste receipts prior to entry to the site protected area.

The DSA states that these events were reviewed to determine whether any associated controls warranted safety classification even though the event was unmitigated Risk Class III or IV. No events were determined to require the identification and classification of additional controls beyond the stated Initial Conditions except for a control requiring that TRU Waste outside of the WHB be in a closed Type B Shipping Package. This protects that IC and ensures that any TRU Waste outside of the WHB is protected by the Shipping Package as described above.

The SBRT concurs with these events being screened out based on Risk Class III/IV, Low consequences to all receptors, not plausible per DOE-STD-3009-2014, or external event frequency of occurrence less than 1E-6/yr as applicable. No additional TSR controls are warranted.

- **Hazard Evaluation of Events Requiring Further Evaluation:**

SER Table 3.3-1, Representative and Unique Hazard Evaluation Events Requiring Safety Significant Controls**,** presents the bounding scenarios based on the results of the unmitigated and mitigated assessment of likelihood, consequences to all receptors, risk ranking, and credited controls to prevent or mitigate them. This was created from the DSA Table 3.3-9 summary of unmitigated Risk Class I or II events, WIPP-021 hazard evaluation tables, and scoping calculations of radiological consequences.

- **Table 3.3-1. Representative and Unique Hazard Evaluation Events Requiring Safety Significant Controls**

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
E-1: Fire Events										
UG: Waste Disposal Room Fires										
CH/RH-UG-01-001a Vehicle fuel/hydraulic leak with pool fire CH drums or SCs, 10/123 lid loss, MAR 870	A	H	H (220 rem)	L	I	I	III	EU L IV	RH Facility Casks [IC], Vehicle Automatic Fire Suppression System (FSS) [P], UG Ventilation Filtration System (UVFS/IVS) [M]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P], and – Notification [M]
CH-UG-01-003a2 Vehicle fuel/hydraulic leak with pool fire CH drums or SCs, 10/123 lid loss, MAR 870	A	H	H (<220 rem)	L	I	I	III	EU L IV	Vehicle Automatic FSS [P], UVFS/IVS [M]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P], and – Notification [M]
CH/RH-UG-01-004a Vehicle collision and pool fire SWB-OPs,9 crush, 27 seal failure, MAR 7039	U	H	H (430 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P], Limit Vehicles ≤ 25 ft Waste Face [P]
CH-UG-01-003a1 Vehicle collision and pool fire, plus transporter SWB-OPs, 9 crush, 50 seal failure, MAR 1.0E+4	U	H	H (470 rem)	L	I	I	III	BEU H III	Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Limit Vehicles ≤ 25 ft Waste Face [P], Vehicle Attendance – Spotter [P]

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH/RH-UG-01-007a1 Lube truck collision and pool fire CH drums with SCs, 66 crush, 85/1034 lid loss, MAR 6863	U	H	H (1.1E+3 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Lube Truck Prohibited when waste present [P], Vehicle Attendance – Spotter [P]
CH/RH-UG-01-007a2 Lube truck fuel/hydraulic leak with pool fire	A	H	H (<1.1E+3 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Lube Truck Prohibited when waste present [P], Vehicle Attendance – Spotter [P]
CH/RH-UG-02-002a1 Ordinary combustible fire adjacent to waste 1 SLB2, MAR 560	A	H	M (73 rem)	L	I	II	III	A L III	RH Facility Casks [IC], UVFS/IVS [M]	
UG: Vehicle Exclusion Zone Fires										
CH/RH-UG-01-002a1 CH & RH vehicles crash and pool fire SWBs, 2/4 crush, MAR 762	U	H	H (280 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Vehicle Exclusion Zone (VEZ) [P], Vehicle Attendance – Spotter [P]
CH-UG-01-002a1 2 CH vehicles crash and pool fire SWBs, 4/8 crush, MAR 847	U	H	H (290 rem)	L	I	I	III	BEU H III	Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], VEZ [P], Vehicle Attendance – Spotter [P]

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH/RH-UG-01-007a3 Lube truck collision and pool fire SWBs, 2/4 crush, MAR 762	U	H	H (280 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], VEZ [P], Vehicle Attendance – Spotter [P]
CH/RH-UG-01-007a4 Lube truck fuel/hydraulic leak with pool fire CH drums, 4/28 lid loss, MAR 286	A	H	H (140 rem)	L	I	I	III	EU L/M IV/III	RH Facility Casks [IC], Vehicle Automatic FSS [P], Facility Pallet [M]	UG Vehicle Pre-Op. Check [P], VEZ [P], Vehicle Attendance – Spotter [P] and – Notification [M]
CH/RH-UG-01-002a2 Vehicle fuel/hydraulic leak with pool fire CH drums, 4/28 lid loss, MAR 286	A	H	H (140 rem)	L	I	I	III	EU L/M IV/III	RH Facility Casks [IC], Vehicle Automatic FSS [P], Facility Pallet [M]	UG Vehicle Pre-Op. Check [P], VEZ [P], Vehicle Attendance – Spotter [P] and – Notification [M]
CH-UG-01-001a Vehicle fuel/hydraulic leak with pool fire CH drums, 4/28 lid loss, MAR 286	A	H	H (140 rem)	L	I	I	III	EU L/M IV/III	Vehicle Automatic FSS [P], Facility Pallet [M]	UG Vehicle Pre-Op. Check [P], VEZ [P], Vehicle Attendance – Spotter [P] and – Notification [M]
CH/RH-UG-02-002a2 Ordinary combustible fire adjacent to waste	A	H	M (73 rem)	L	I	II	III	A L III	RH Facility Casks [IC], UVFS/IVS [M]	Vehicle Attendance – Notification [M]
UG: Waste Shaft Station Fires										
CH/RH-UG-01-002a3 Vehicle collision and pool fire	U	H	H (280 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P]

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH-UG-01-002a2 CH vehicle and Transporter crash and pool fire	U	H	H (290 rem)	L	I	I	III	BEU H III	Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P]
CH-UG-01-002a3 Vehicle fuel/hydraulic leak with pool fire CH drums, 4/28 lid loss, MAR 286	A	H	H (140 rem)	L	I	I	III	EU L/M IV/III	Vehicle Automatic FSS [P], Facility Pallet [M]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P], and – Notification [M]
CH/RH-UG-01-007a5 Lube truck collision and pool fire SWBs, 2/4 crush, MAR 762	U	H	H (280 rem)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P]	UG Vehicle Pre-Op. Check [P], Lube Truck Prohibited when waste present [P], Vehicle Attendance – Spotter [P]
CH/RH-UG-01-007a6 Lube truck fuel/hydraulic leak with pool fire SWBs, 2/4 crush, MAR 762	A	H	H (280 rem)	L	I	I	III	EU L/M IV/III	RH Facility Casks [IC], Vehicle Automatic FSS [P], Facility Pallet [M]	UG Vehicle Pre-Op. Check [P], Lube Truck Prohibited when waste present [P], Vehicle Attendance – Spotter [P] and – Notification [M]
CH/RH-UG-01-005a1 Forklift carrying 300 gal fuel tank enters open Waste Shaft and falls onto Waste Hoist Conveyance, and pool fire in the sump 4 SWB-OPs, 4.2 rem MOI drop, 3.1 rem MOI fire, MAR 2111	EU	H	H (810 rem)	M (7.3 rem)	II	II	III	BEU H III (M/IV for MOI)	RH Facility Casks [IC], Waste shaft access configuration [IC]	Vehicle/Equipment Operation Prohibition [P], Waste Conveyance Control [P]

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH/RH-UG-01-005a2 Vehicle collision or Transporter backs up and falls down shaft from Waste Shaft Station to sump and pool fire	U	H	H (qualitative)	L	I	I	III	BEU H III	RH Facility Casks [IC], Vehicle Automatic FSS [P for collision only]	UG Vehicle Pre-Op. Check [P], Vehicle Attendance – Spotter [P] Waste Conveyance Control [P]
CH/RH-UG-02-002a3 Ordinary combustible fire adjacent to waste	A	H	M (73 rem)	L	I	II	III	A L III	RH Facility Casks [IC], UVFS/IVS [M]	Vehicle Attendance – Notification [M]
Waste Handling Building Fires										
CH/RH-WHB-01-001a Pool fire at CH-RH Bay roll-up door CH drums, 23/218 lid loss, MAR 3054	U	L	H (270 rem)	L	III	I	III	EU L/M IV/III	Facility Pallet [M], WHB FSS [P]	
CH-WHB-01-001a1 Vehicle fuel/hydraulic leak with pool fire CH drums, 13/119 lid loss, MAR 847	A	L	H (190 rem)	L	III	I	III	U L/M III/II	WHB FSS [P], Facility Pallet [M]	Vehicle/Equipment Operation Prohibition [P]
CH-WHB-01-001a2 Vehicle fuel/hydraulic leak with pool fire at Waste Collar area 28 CH drums	A	L	H (<190 rem)	L	III	I	III	EU L/M IV/III	WHB FSS [P], Facility Pallet [M]	Vehicle/Equipment Operation Prohibition [P]
CH/RH-WHB-04-001a External fire breaches WHB 224 CH drums, MAR 1491	U	L	M (84 rem)	L	III	II	III	EU L/M IV/III	RH Facility Casks [IC], WHB Design (noncombustible & curbing) [IC], WHB FSS [P]	

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH-WHB-04-001a Ordinary combustible fire in CH Bay/Room 108 10 SWBs, MAR 890	U	L	M (49 rem)	L	III	II	III	EU L/M IV/III	WHB Design (noncombustible & curbing) [IC], WHB FSS [P]	
CH/RH-WHB-04-002a Tanker Truck fire breaches WHB 26 SWBs, MAR 1236	U	L	M (68 rem)	L	III	II	III	BEU L/M IV/IV	RH Facility Casks [IC], WHB Design (noncombustible & curbing) [IC], Vehicle Barriers 25 ft from WHB [P] WHB FSS [P]	Fuel Tanker Prohibition [P]
CH/RH-WHB-04-003a Fire in Waste Hoist Tower results in dropping waste down shaft 4 SWB-OPs, MAR 2111	EU	H	H (340 rem; from WIPP-019 NPH-initiated hoist failure)	L	II	II	IV	BEU H III	RH Facility Casks [IC], WHB Design (noncombustible & curbing) [IC], Waste Hoist Structure [IC], WHB FSS [P]	
CH/RH-WHB-02-002a Ordinary combustible fire adjacent to waste 1 SLB2, MAR 560	A	L	M (62 rem)	L	III	II	III	U L III	RH Facility Casks [IC], WHB FSS [P], CH Confinement Ventilation System (CVS) [M]	
CH-WHB-02-001a Ordinary combustible fire after electric vehicle collision 4 SWBs, MAR 762	A	L	M (85 rem)	L	III	II	III	U L III	WHB FSS [P], CH CVS [M]	
CH-WHB-02-001a Same as above, but in Waste Collar Area with door 140 closed 4 SWBs, MAR 762	A	L	M (85 rem)	L	III	II	III	U L/M III/II	WHB FSS [P]	

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH-WHB-04-005a 2 electric vehicles crash 181 CH drums, MAR 1227	A	L	H (230 rem)	L	III	I	III	U L III	WHB FSS [P], CH CVS [M]	
RH-WHB-01-006a Pool fire in Hot Cell RH canister, MAR 240	A	L	M (26 rem)	L	III	II	III	A L/M III/II		
RH-WHB-03-001a Ordinary combustible fire in Hot Cell Complex 9 RH drums, MAR 720	A	L	M (79 rem)	L	III	II	III	A, L/M, III/II		
Internal Container Fires										
CH/RH-UG-02-001a Ordinary combustible fire in noncompliant waste container UG 1 SWB/SLB2, MAR 560	A	H	M (73 rem)	L	I	II	III	A L III	RH Facility Casks [IC], UVFS/IVS [M]	Vehicle Attendance – Notification [M]
CH/RH-WHB-02-001a Ordinary combustible fire in WHB noncompliant waste container 1 SWB/SLB2, MAR 560	A	L	M (62 rem)	L	III	II	III	A L III	RH Facility Casks [IC], CH CVS [M]	
CH-WHB-03-001a Ordinary combustible fire in noncompliant waste container in Shielded Storage Room 1 SWB, MAR 560	A	L	M (62 rem)	L	III	II	III	A L III	CH CVS [M]	

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
E-2: Deflagration										
CH/RH-UG-06-001a Deflagration/Over-pressurization of noncompliant drum in Vehicle Exclusion Zone 6 CH drums, MAR 151	A	H	L (20 rem)	L	I	III	III	A L III	RH Facility Casks [IC]	Suspect Container Response [M]
CH-UG-06-001a Deflagration/Over-pressurization of noncompliant drum outside closed disposal room 60 CH drums, MAR 483	A	H	M (37 rem)	L	I	II	III	A L III	UVFS/IVS [M]	Suspect Container Response [M]
CH-UG-06-002a Exothermic chemical reaction in closed disposal room 60 MIN-02 drums, MAR 30.5 + 479 in 59 drum fire	A	H	H (830 rem)	L	I	I	III	A L III	UVFS/IVS [M]	Isolation Bulkheads [M], Active Radiation Monitoring [M]
CH-WHB-06-001a Deflagration/Over-pressurization of noncompliant drum in CH Bay 6 CH drums, MAR 151	A	H	L (17 rem)	L	I	III	III	A L III		Suspect Container Response [M]
E-3: Loss of Confinement Events										
CH/RH-UG-09-003a Forklift puncture at Waste Face 2 POC/CCO, MAR 1836	A	L	M (29 rem)	L	III	II	III	A, L III	UVFS/IVS [M]	
CH/RH-UG-10-003a Pressurized container impacts CH waste container in the UG 4 SWB-OPs, MAR 2111	A	L	M (27 rem)	L	III	II	III	A, L III	UVFS/IVS [M]	

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			
CH/RH-UG-10-004a Uncontrolled movement of Waste Hoist Conveyance 4 SWBs, MAR 763	EU	H	H (400 rem)	L	II	II	IV	BEU H III	Waste Hoist Structure [IC], Waste Hoist Brakes [P]	
CH/RH-UG-10-005a Vehicle carrying waste drives into Waste Collar and falls down shaft onto Waste Hoist Conveyance at the Waste Shaft Station 8 SWB-OPs, MAR 2727	EU	H	H (1.3E+3 rem)	M (5.3 rem)	II	II	III	BEU H III (M/IV for MOI)	RH Facility Casks [IC], Waste shaft access configuration [IC]	Waste Conveyance Control [P]
E-6: Externally-, E-7: NPH-, E-8: Other-Initiated Events										
CH/RH-WHB-20-001a Lightning strikes WHB and damages waste container 1 SWB, MAR 560	U	L	M (62 rem)	L	III	II	III	U L III	WHB Design (noncombustible & curbing) [IC] CH CVS [M]	
CH/RH-WHB-25-001a Design Basis Earthquake and fire 320 SWBs impacted, 2 SWBs in fire with MAR 720	U	L	M (97 rem)	L	III	II	III	U, L/M, III/II	RH Facility Casks [IC], WHB Design (DBE qualified, noncombustible & curbing) [IC]	

Event Number(s)	Unmitigated Likelihood[1]	Unmitigated Consequences[2]			Unmitigated Risk[6]			Mitigated FW and/or CW Likelihood, Conseq., Risk Class[7]	Safety Significant Structures, Systems, and Components (SSCs) [type of control][8]	Specific Administrative Controls (SAC)[9] [type of control]
		FW[3]	CW[4]	MOI[5]	FW	CW	MOI			

Notes:

1. Likelihood: A = Anticipated U = Unlikely EU = Extremely Unlikely BEU = Beyond Extremely Unlikely
2. Consequences: H = High M = Moderate L = Low
3. FW = Facility Worker
4. CW= Co-located Worker at 100 m
5. MOI = Maximally-exposed Offsite Individual at 2.9 km
6. Risk Class:
   I = Combination of conclusions from risk analysis that identify situations of major concern
   II = Combination of conclusions from risk analysis that identify situations of concern
   III = Combination of conclusions from risk analysis that identify situations of minor concern
   IV = Combination of conclusions from risk analysis that identify situations of minimal concern
7. No unmitigated consequences were evaluated to be High to the MOI, and two events are Moderate, slightly exceeding the 5 rem threshold; these events are considered to challenge the DOE-STD-3009-2014 Evaluation Guideline, and require accident analyses and consideration for safety class controls.
8. Type of control: IC = Initial condition credited in unmitigated analysis P = Prevention M = Mitigation
9. WIPP Waste Acceptance Criteria (WAC) is credited as an IC for all scenarios, although some evaluate a specific assumed WAC noncompliance.

Two hazard events in Table 3.3-1, both involving Waste Hoist drops, entail public consequences that exceed the 5 rem threshold criterion described in DOE-STD-3009-2014 as challenging the Evaluation Guideline. These events therefore required accident analysis as summarized in SER section 3.3.5.

Directed changes (see SER section 5) apply to three hazard events in the above table, CH-WHB-01-001a1 (a pool fire), CH/RH-WHB-02-002a, and CH-WHB-02-001a (both ordinary combustible fires). The changes correct DSA section 3.3.2.3 hazard event summaries and credited controls; corresponding changes in WIPP-021 are also directed. An additional directed change requires the deletion of credit for the WIPP WAC as an IC in drum deflagrations from WIPP-021.

Controls selected above for the UG and WHB hazard evaluation events suffice to reduce the mitigated event to Risk Class to III (minor concern) or below, consistent with guidance in DOE-STD-3009-2014 and DOE-STD-5506-2007, with five exceptions. These five events remain "risk outliers" in that the credited controls result in a mitigated Risk Class of II (situation of concern). These events, and the proposed justification for DOE to determine that adequate protection has nevertheless been achieved, are summarized in Table 3.3-2, Summary of Risk Outlier Events. None of these mitigated events exceed the 100 rem DOE-STD-3009-2014 criterion for co-located workers.

Table 3.3-2. Summary of Risk Outlier Events

Pool Fire in WHB Hot Cell Complex (hazard event RH-WHB-01-006a) is postulated as anticipated with co-located worker unmitigated consequences of 26 rem (moderate) and qualitatively assessed low consequences to facility workers and the public. No controls are identified for this event so the mitigated consequences are the same as the unmitigated, which is Risk Class II for the co-located worker. **Basis for adequate protection:** This decision reflects a judgment that the Hot Cell Complex, while not credited, affords a robust barrier to radiological release; the 10-160B mission for which the hot cell was designed is not currently being authorized (limiting the potential for material at risk to be present based on the 72B mission), and the installed filtered ventilation system, previously credited in DSA Revision 4, minimizes the actual release potential. In addition, the DSA notes that there are no ignition sources and any that might be introduced will be controlled (SMP Key Element 11-2) in the Transfer Cell nor are combustibles (liquid or ordinary) used to support operations in the cell and any that might be introduced will be controlled (Key Element 11-2), and the RH Waste Canister is inside an RH-72B Shipping Package with the inner lid in place. It also notes that the consequences of this event are evaluated to be slightly above the Moderate threshold for the co-located worker. Additionally, the emergency response program addresses protection of the co-located workers (Key Element 15-3).
An ordinary combustible fire adjacent to waste containers in the WHB RH Hot Cell Complex (hazard event RH-WHB-03-001a) is postulated as anticipated with co-located worker unmitigated consequences of 79 rem (moderate) and qualitatively assessed low consequences to facility workers and the public. No controls are identified for this event so the mitigated consequences are the same as the unmitigated, which is Risk Class II for the co-located worker. **Basis for adequate protection:** This decision reflects a judgment that the Hot Cell Complex, while not credited, affords a robust barrier to radiological release; the 10-160B mission for which the hot cell was designed is not currently being authorized (limiting the potential for material at risk to be present based on the 72B mission), and the installed filtered ventilation system, previously credited in DSA Revision 4, minimizes the actual release potential. In addition, the DSA notes that there are no ignition sources in the Transfer Cell and any that might be introduced will be controlled (SMP Key Element 11-2) nor are combustibles (liquid or ordinary) used to support operations in the cell and any that might be introduced will be controlled (Key Element 11-2). Additionally, the emergency response program addresses protection of the co-located workers (Key Element 15-3).

An ordinary combustible fire adjacent to waste containers in the WHB Waste Collar Area after vehicle collision (hazard event CH-WHB-02-001a) is postulated as anticipated with co-located worker unmitigated consequences of 85 rem (moderate) and qualitatively assessed low consequences to facility workers and the public. For this event, the WHB FSS is credited as a preventive control. The corresponding mitigated event is unlikely with moderate consequences to co-located workers and Risk Class II. **Basis for adequate protection:** The concern is limited to the case where the fire occurs in the Conveyance Loading Room (CLR) after Door 140 is closed; otherwise, the CH Waste Handling Confinement Ventilation System would provide filtration, reducing consequences to low and Risk Class III. Although the dose is in the middle of the moderate consequence bin, both the nature of the operations being conducted in the small room and the combustible control requirements of SMP Key Element 11-2 limit the presence of ordinary combustibles in the Waste Shaft Access Area. Further, the WHB FSS covers this area and risk dominant results are only possible if its failure is assumed. Finally, ignition probability is limited per Key Element 11-5, the outside doors are closed impeding release to the outside prior to settling, and the CH waste pallet is only in this area for a limited period of time (minutes). In the event that CH Waste could not be immediately downloaded, it would be returned to the CH Bay. Additionally, the emergency response program addresses protection of the co-located workers (Key Element 15-3).
Pool fires in CH Bay involving diesel fuel or combustible hydraulic fluid spilled via hydraulic leaks (hazard event CH-WHB-01-001a1) is postulated as anticipated with co-located worker unmitigated consequences of 190 rem (high) and qualitatively assessed low consequences to facility workers and the public. The identified preventive control is the WHB FSS. The preventive AC of prohibiting liquid-fueled vehicles in the CH Bay and Room 108 when CH Waste is present outside of closed Shipping Packages provides additional frequency reduction (1/2 frequency bin); however, the mitigated frequency of this event remains Unlikely. The Facility Pallet is credited as a mitigative control reducing consequences to co-located workers to moderate (58 rem) and Risk Class II. **Basis for adequate protection:** The DSA adequate protectionarguments include a key factor judged to ensure that seal failure will not occur in all stored drums as assumed in the analysis: not all containers would be exposed to the flame front (an analysis assumption) as some would be shielded from the heat of the fire by other containers. The SBRT notes further that the WHB CVS will initially provide effective filtration (although eventual failure due to excessive smoke loading is predicted); as CVS flow slows, the closed facility doors will delay radiological release and increase the potential for settling. Additionally, the emergency response program addresses protection of the co-located workers (Key Element 15-3).
The design basis earthquake (DBE) and fire in the WHB (hazard event CH/RH-WHB-25-001a) is postulated as unlikely with co-located worker unmitigated consequences of 97 rem (moderate) and qualitatively assessed low consequences to facility workers and the public. The WHB structure and TRUDOCK crane seismic designs are credited as an initial condition as is the RH Facility Cask when applicable. No other controls are identified for this event so the mitigated consequences are the same as the unmitigated, which is Risk Class II for the co-located worker. **Basis for adequate protection:** The calculated co-located worker dose is just below the high threshold of 100 rem based on a conservative analysis consistent with accident analysis source term and radiological consequence methods, therefore, safety significant controls are not required for protection of the co-located worker per DOE-STD-3009-2014. However, for Risk Class II events with moderate consequences, safety significant controls should be considered per DOE-STD-5506-2007. Given minimal margin to the high threshold, the SBRT weighed the issue of risk acceptance carefully and based its final judgment on the following considerations from the DSA and the WIPP-019 supporting calculation: 1. The seismic plus fire event is conservatively analyzed as in the unlikely bin for the unmitigated case. From SAND 78-1596, the most conservative calculated estimate of the 1,000-year acceleration at the WIPP is 0.075 g. For additional conservatism, a peak design acceleration of 0.1 g was selected for the WIPP Design Basis Earthquake to design the SSCs to withstand. The frequency of a 0.1 g earthquake would be lower than 1E-3/yr, approaching the 1E-4/yr upper range for the Extremely Unlikely bin. Considering the normal lack of transient combustibles, a conditional probability on the order of 0.1 for a seismic-induced fire would clearly reduce the frequency of occurrence of a seismic plus fire event to an Extremely Unlikely bin, which would reduce the mitigated risks to Risk Class III. 2. The seismic plus fire event is conservatively analyzed for unmitigated consequences. Although all 80 Waste Assemblies are included in the impact contribution to the unmitigated dose, most of the contribution to the 97 rem estimate is from the seismic-induced fire involving two direct-loaded SWBs. a. The 97 rem to CW is predominantly from the fire involving two SWBs, one at WIPP WAC 560 PE-Ci and the other at 95th percentile 160 PE-Ci. b. Two SWBs bound fires exposing more containers due to an anomaly associated with the DOE-STD-5506-2007 pool fire methodology as demonstrated by the DSA calculation involving 8 SWBs (DOE-STD-5506 allows a use of DR of 0.5 for > 2 SWBs in a pool fire.) c. Normal operations do not require a large quantity of ordinary combustibles that could fuel a fire to expose

multiple waste containers and SMP Key Element 11-2 requires that combustibles be minimized consistent with operational requirements. However, the unmitigated analysis assumes that some amount of unspecified transient combustibles could be present to cause confined burning within 2 SWBs, in addition to the small quantity (1%) assumed displaced from the SWBs that burns unconfined.

3. The DSA and WIPP-019 provides perspective that a likely source of combustibles that could fuel a fire to expose one or two SWBs being loaded onto a Facility Pallet during unloading a TRUPAC-II, is a hydraulic fluid leak from the TRUDOC cranes even though they are seismically qualified. The crane has approximately 2.4 gallons of Mobilegear 630 lubricant in three separate reservoirs (hoist gear box, trolley gear box, bridge gear box) that are assumed to leak and accumulate in a pool near two SWBs.
    a. Direct flame impingement from some unknown source would be required to ignite a gear lubricant pool due to its flashpoint of greater than 392 °F (Mobilegear is a combustible, not flammable liquid).
    b. In the unlikely event that lubricant is ignited, all of it has to leak and accumulate close enough to an SWB so that 50% of the fuel energy is absorbed by the SWB in order to increase the temperature of the SWB and cause pyrolysis of the assumed combustible contents.
    c. The radiant energy from this pool fire could increase the temperature in a single SWB from 70 °F to 389 °F. The auto-ignition temperature of paper is 425-475 °F and the auto-ignition temperature of plastic is higher than paper. Thus, even with these conservative assumptions, the energy released during the fire event would not be sufficient to cause a confined burn in one SWB.
    d. Evaluating a single SWB with confined and unconfined burning assuming the 560 PE-Ci WAC limit would result in 76 rem to the CW, closer to the middle of the moderate consequence bin.
4. The DSA provides another risk perspective if the inventory is less than the WAC loading limit. The dose to CW becomes 23 rem for an SWB at 95th percentile loading of 160 PE-Ci, which is a low consequence and would result in mitigated Risk Class III.

In addition, the SBRT added the following considerations:

5. The 0.01 DR for impact to all waste containers in the WHB is applied to estimate the fraction of unconfined burning, i.e., 1%, consistent with the methodology applied to vehicle impact plus fire scenarios. This methodology is not directly from DOE-STD-5506-2007, however, it is judged to be conservative to account for an impact event that breaches a metal container and expels some fraction of contents that are assumed to be combustible wastes. The 0.01 DR for impact to waste containers from overhead equipment that falls from DOE-STD-5506-2007 code-of-record earthquake represents damage from ventilation ductwork, fire suppression system piping, lighting and electrical conduit, etc., that result in an airborne release from a spill. Although breach of 55-gal drums by falling equipment is possible, such a fall may not breach SWBs due to their more rugged construction, and if it does result in airborne releases from the impact vibration (spill), it is not likely to crush the SWBs, an effect necessary to expel 1% of the contents. In addition, overhead equipment that can fall and impact waste containers in the WHB is limited.
6. Since the WHB withstands the design basis earthquake, even if the filtration system stops working, the release from the facility would be considerably lower due to gravitational settling within the building and air exchange over a prolonged release due to ambient conditions. This alone would be sufficient to reduce the 97 rem to a low consequence due to application of an 8-hr release duration (instead of the DOE-STD-3009-2014 default X/Q) and allowing for deposition within the building.
7. The assumption that the contents of the 2 direct-loaded SWBs are 100% combustible is also very conservative. Historical averages show that about 20% of direct-loaded SWBs have combustible contents above 50% and less than 10% of direct-loaded SWBs have combustible contents exceeding 90%. Most often, direct-loaded SWBs have a mix of combustible and noncombustible contents. Noncombustible contents lower the ARF/RF for confined burning inside the SWBs and reduce predicted doses.
8. Another perspective is that less than 5% of direct-loaded SWBs exceed the average MAR of 21.5 PE-Ci, so having one at the 560 PE-Ci WAC and one at the 160 PE-Ci 95^{th} percentile would be a rare occurrence.
9. In practice, SWBs are most often used as overpacks for drums. Over-packed drums provide more protection, would lower the DR used in the effective ARF/RF calculation, and would result in less unconfined burning.
10. The emergency response program addresses protection of the co-located workers (Key Element 15-3).

The above factors were considered, in addition to the absence of any practical control.

Considering the perspectives discussed above, the SBRT concludes that the consequences and risks of these five hazard events would be lower than presented in the DSA. In approving DSA/TSR Revision 5a, DOE accepts the overall hazards evaluation results and concludes that adequate protection has been provided.

3.3.3.2. WIPP Hazard Evaluation Supporting Details

DOE's review of the hazard evaluation conclusions was contingent on the review of numerous assumptions and detailed methodologies presented in the DSA and supporting documents. Highlights of the DOE review are presented below for topics determined important for the SBRT review of the hazard evaluation. These topics include: evaluation of fire related hazard events (including calculations that support control identification and implementation); modeling of exothermic chemical reactions; evaluating loss of confinement events in the waste shaft; evaluating a bounding seismic event in the WHB with a fire; evaluating chemical hazards to facility workers posed by VOC emissions from emplaced waste in closed panels or rooms; re-evaluation of roof fall in the UG; and identification of events screened out from further hazard evaluation.

- **Fire Events Hazard Evaluation:**

  Fires involving containerized wastes have the greatest potential for radiological consequences as they can lead to a breach of waste containers and also provide mechanisms to disperse radiological material. Table 3.3-7, Categorization of Hazard Evaluation Events, shows that approximately one-third of the 167 representative and unique hazard scenarios are fires, and more importantly, that about 80% of the 47 unmitigated Risk Class I or II events are fire events. Conservative determination of potential fire sizes and their waste impacts requires model details not explicitly governed by applicable guidance. The following section provides additional discussion of the DSA fire evaluation and its assessment by the SBRT.

  NWP developed an upgraded WIPP-023, Revision 7, *Fire Hazard Analysis for the Waste Isolation Pilot Plant*, and issued it in August 2015 in time to support the hazard and accident analyses for the DSA. The Fire Hazard Analysis (FHA) was extensively revised to address issues identified from investigation of the February 5, 2014, fire involving the UG salt haul truck, the subsequent corrective actions implemented in response to this fire, the Radiological Event of February 14, 2014, the Phase 1 and 2 DOE Accident Investigation Reports for the radiological release, and their associated corrective actions. The updates also ensured compliance with applicable DOE Fire Protection Program requirements[1]. The rigor of this update process is illustrated by the identified need for an exemption to the DOE O 420.1C requirement for fire suppression throughout the UG and for a life safety equivalency combining NFPA provisions for surface and underground facilities. The SBRT found that the FHA and DSA have been appropriately coordinated, meeting the requirement of DOE Order O 420.1C that the FHA be integrated into the safety basis documentation.

  The FHA summarizes the fire models used for DSA Revision 5a to model surface and UG fire events. Many of these models were initially developed to support CH-RH-DSA Revision 0 in 2008. During DSA preparation subsequent to the FHA approval, NWP elected to address questions which arose related to fire modeling in a new calculation, WIPP-058, *DSA Supporting Calculation, Fuel Spill, HEPA filter Plugging, Fire Compartment Over-Pressurization, Facility Pallet Survivability, Lube Truck Standoff Distance , Waste Array Fire Spread, and Internal Drum Event Fire in CH Bay and Along Waste Transport*. The new

[1] It should be recognized that fire protection program deficiencies that could arise are continuously evaluated and addressed through other DOE oversight mechanisms. Issues such as system impairments are managed in accordance with the program and would be addressed within the safety basis to the extent they affect explicit Technical Safety Requirements or rise to the level of a systematic breakdown of the program (i.e., TSR violation).

calculation format facilitated the changes needed to support the DSA hazard evaluation and demonstrate the adequacy of selected hazard controls and will be incorporated into the next revision of the FHA.

Potential fires that could lead to radiological releases have been extensively evaluated since the design phase and subsequent to operational startup in 1999. Greater emphasis was placed on evaluation of fires that could lead to radiological releases during the development of the CH/RH DSA Revision 0 in 2008, and continued during later DSA revisions. The most recent set of supporting documents for the DSA Revision 5a as related to fire events is summarized in Table 3.3-3. These supporting documents were reviewed as necessary for the SBRT to accept qualitative hazard evaluation and quantitative radiological dose calculations in DSA Chapter 3. Some calculations have broader applicability than just fire hazards evaluation; aspects of these calculations, for example, support control selection and implementation and were also reviewed by the SBRT fire protection SME. Based on satisfactory resolution of comments on these documents, the SBRT concurs with these technical evaluations as related to supporting the DSA Chapter 3.

Table 3.3-3. Fire Analysis Supporting Documents for DSA

Document #	Rev. #	Date	Title or Description	How used in DSA Hazard & Accident Analysis
WIPP-001	9	4/16	DSA Hazard and Accident Analysis Calculation for Fire Events	Dose calc
WIPP-003	1	9/08	Waste Handling Equipment Fire Severity Analysis	Superseded by WIPP-036
WIPP-004	1	9/08	Evaluation of a 13-ton Forklift Fire Exposure to Waste in the WHB	Input to WIPP-014
WIPP-005	2	6/10	Estimation of WIPP Vehicle Fire Size and Heat Flux to Waste	Superseded by WIPP-036
WIPP-006	0	6/08	Evaluation of a Tractor-Trailer Fire Exposure to Structure of WHB	Input to WIPP-021 and WIPP-001
WIPP-007	6	4/16	Hazard Identification Summary Report for WIPP Operations	Input to WIPP-021
WIPP-014	0	6/08	WHB Fire Exposure Modeling	Superseded by WIPP-037
WIPP-015	0	6/08	UG Fire Exposure Modeling	Superseded by WIPP-038
WIPP-019	7	4/16	DSA Hazard and Accident Analysis Calculation for External and NPH Events (includes Range Fires)	Dose calc
WIPP-021	5	4/16	Washington TRU Solutions, LLC, Unmitigated Hazards Analysis for WIPP	Qualitative consequences
WIPP-023	7	8/15	Fire Hazard Analysis for the Waste Isolation Pilot Plant	FHA input to DSA Chapter 3, 4, & 5
WIPP-031	0	2/10	DSA Hazard and Accident Analysis Calculation for Events Involving Releases from the Gamma Shielded Container	Dose calc
WIPP-032	0	2/10	Fire Analysis of the Shielded Container for the Waste Isolation Pilot Plant, Carlsbad, New Mexico	Input to WIPP-001
WIPP-036	2	4/11	Evaluation of Fire Involving Waste Handling Equipment	Input to WIPP-001

Document #	Rev. #	Date	Title or Description	How used in DSA Hazard & Accident Analysis
WIPP-037	1	10/10	Container Damage Due to WHB Waste Handling Equipment Fire	Input to WIPP-001
WIPP-038	1	9/15	Container Damage Due to UG Waste Handling Equipment Fire	Input to WIPP-001
WIPP-042	0	12/10	DSA Hazard and Accident Analysis Calculation for Events Involving Releases from the Standard Large Box 2	Dose calc
WIPP-047	0	1/13	Comparison Evaluation of Additional Vehicle Fire in the WHB RH Bay	Input to WIPP-001
WIPP-050	0	4/14	Source Term and Maximum Dose Values for Exhaust Filter Removal	Dose calc Input to WIPP-021
WIPP-051	3	12/15	Scoping Calculations for MIN01-V.001 Waste for Closure of Panels 6 and 7	Dose calc
WIPP-055	0	6/15	Airborne Release Rate to the Environment from an Acute UG Event with no filtration	2-hr release
WIPP-057	3	4/16	Statistical Parameters for Bounding MAR Limits at the WIPP	Bounding MAR assumptions
WIPP-058	2	4/16	DSA Supporting Calculation, Fuel Spill, HEPA filter Plugging, Fire Compartment Over-Pressurization, Facility Pallet Survivability, Lube Truck Standoff Distance , Waste Array Fire Spread, and Internal Drum Event Fire in CH Bay and Along Waste Transport.	Input to WIPP-001 and DSA Chapter 4
WIPP-ETO-B-183	0	4/15	WHB CH Airborne Contamination Clearance Rate	1-hr release

Fuel Pool Fire Modeling: Vehicles with combustible liquids were a significant hazard that led to several safety significant controls. In particular, two types of scenarios were evaluated involving pool fires that impacted waste containers: vehicle crashes and fuel leaks not involving a crash. The fire calculation methodology for estimating the number of waste containers involved in pool fires is significant to the evaluation of hazard events. The methodology was developed in 2010 for the CH/RH DSA, Revision 2, and is primarily documented in WIPP-036. The DSA Revision 5a scoping dose calculations apply that same methodology. Key aspects of the fire modeling methodology addressed by the SBRT review include:

Liquid Fuel Quantity: Pool fires are postulated to develop principally from release of the combustible liquid content of the waste handling vehicles (forklifts, etc.) used in TRU waste handling operations. For WIPP fire modeling, a significant vehicle impact is assumed to result in the rupture of the largest single combustible liquids tank (whether the largest tank is diesel fuel or hydraulic fluid) and the resulting spill spreads to the depth and pool size discussed below. A spill may also be initiated by a significant leak without a collision. Following the spill and pool formation ignition is assumed with no explicit mechanism required. This is a known conservatism as diesel fuel is difficult to ignite and the high temperature hydraulic fluid specified by the FHA for WIPP equipment is even more resistant to ignition. Tire ignition (discussed further below) and involvement of other combustibles on the vehicle, including the second tank are possible but would occur after the first tank volume is consumed (70 sec in WHB; 162 sec in the UG). Therefore, these would not contribute to the diameter of the postulated fire. That is, although these other combustibles could eventually be involved, they cannot generate a larger pool size. Multiple combustible liquid tank breaches do not occur simultaneously (i.e., not within the 70-162 seconds necessary for them to contribute to the effective pool size). To confirm the suitability of this model, the SBRT verified that safety basis documents for TRU waste in the DOE Complex generally assume that only the vehicle fuel tank is breached by a collision, and the hydraulic oil reservoir is not considered in determining the size of the pool.

Even when rupture of or spill from the single largest tank is assumed, it does not spill 100% of the fuel or hydraulic fluid it contains. The combustible mass available for burning is reduced by 25% over the full tank volume (Section 5.1 of Calculation WIPP-036 Revision 2). This approach is based on the National Fire Protection Association (NFPA) Fire Protection Handbook (Section 12.5) which provides the methodology for evaluating the participation of combustibles in a fire when they are fully or partially surrounded by a metal enclosure (referred to as a “derating factor”), as is the case for the WIPP vehicles. A similar methodology based on the NFPA derating guidance, also referenced in DOE-STD-5506-2007 (Appendix C), establishes a participation fraction depending on whether the combustibles are free (no enclosure), partially enclosed (enclosed on 5 sides), or completely enclosed (enclosed on all 6 sides). The metal enclosures reduce the combustion efficiency below the standard efficiency of 70% gross efficiency representative of free burning combustibles. This is principally evident with liquid combustibles in heavy metal tanks, i.e., the effect is that a portion of the liquid fuel (generally 25% for metal tanks) does not become involved in the fire. Finally for additional perspective, the Joyeux fire test data of 1980 automobiles in fires are judged representative of the WIPP UG equipment because those cars had more steel than newer models that use more plastics, and support the 75% participation model.

Pool Depth and Size: The WIPP approach to establish a pool fire size and depth involves the use of engineering judgment and interpreting the methodologies of three available documents: - DOE-STD-5506-2007, the SFPE Handbook of Fire Protection Engineering, and 40CFR68, Chemical Accident Prevention Provisions.

- WIPP uses a model for fuel pools on a concrete floor (2.8 mm depth per the SFPE Handbook method) that is consistent with prevailing practice throughout the DOE Complex, although depths vary among the DOE sites. Since a 70 second fire engulfing a 55-gal waste drums is established as a criterion for lid loss and ejection of combustible contents in DOE-STD-5506-2007, most of the depths for spills on a concrete floor varied from 2.8 mm to 3.3 mm depending on whether the depth was calculated by fuel properties such as mass loss rate or mass burning (regression) rate or whether the depth was assumed such as a 0.25 in. based on spill testing. One exception was a depth of 4.7 mm on a concrete floor determined by the mass burning rate of diesel fuel, but such a model would result in only about half the WIPP pool size. It should be noted that diesel fuel properties can vary significantly, as discussed in the WIPP-058 Revision 2 (see further discussion below). The original 2008 WIPP fire modeling established conservative estimates of diesel fuel density, mass loss rate, etc., based on the Hanford fire testing of drums and analyses at other DOE sites. The WIPP pool fire methodology for concrete surface results in a pool area and number of waste containers that is comparable (within 10%) to most of the other DOE sites. The

SBRT concludes that such a difference is not significant to control selection and functional classification in the hazard evaluation.

- The WIPP UG floor presents a unique situation not encountered elsewhere in the DOE Complex as the salt can be somewhat porous and the surface is not as level or flat as a typical concrete floor. The concrete fuel pool thickness model (2.8 mm), which is derived to maximize the potential for lid loss, was judged too conservative for the WIPP UG. The alternate EPA methodology which recommended a pool thickness of 1 cm was judged potentially non conservative. The WIPP UG pool depth was chosen as 6.4 mm, the average of the two depth determination methods, judged conservative for application on an uneven salt surface. While there is greater uncertainty in the degree of conservatism ensured by this model, the SBRT again concluded that the range of possible variation was not significant to control selection and functional classification in the hazard evaluation.

Contribution from tires: Consideration was given to pooling of molten tires, prior to finalizing the pool size (footprint) consistent with the spill characteristics outlined in DOE-STD-5506-2007. The WIPP-003 Revision 1 considered that the Hansen test data indicates that a pool begins forming outside the original dimensions of the tire in about 10 minutes. At that point the tire is considered to influence (increase) the size of the pool fire. Including a melting tire increases the area of the pool available to engulf waste drums. For WIPP, the single largest tire set is modeled as contributing to the pool size. It is recognized that other tire sets may be ignited but they are expected to reach the 10 minute burning point well after consumption of the liquid fuel spill. More tires might be involved only if the combustible liquid tanks breach after multiple tire sets burn for longer than 10 minutes, but the propagation between tire sets necessary for this to occur is non-mechanistic without burning liquid pools to spread the fire.

Impact on waste: Once the pool size is established, the WIPP-037 Revision 1 and WIPP-038 Revision 1 calculations provide a graphical modeling methodology for estimating the number of drums and SWBs that would be involved in a pool fire or exposed to the thermally-damaging radiative flux of an exposure fire for various events (e.g., spill-caused pool fires and collision-caused pool fires). Previous graphical solutions in WIPP-014 and WIPP-015 are superseded by the new ones. The methodologies for establishing the fire size and the standoff distance from which a fire would impact a drum or SWB are based on fire exposure methodologies generally defined in the SFPE Handbook of Fire Protection Engineering. The method for counting and tabulating affected drums and SWB's is from DOE-STD-5506-2007.

Pool fires are postulated to cause damage by two mechanisms as defined in DOE-STD-5506-2007. These are lid ejection and seal failure. Ordinary combustible fires and pool fires present a heat flux exposure hazard to nearby TRU waste containers; heat flux without direct flame impingement is evaluated to result only in seal failure. The extent of waste container damage for either of the mechanisms is governed by the fire's diameter since the pool thickness is chosen to ensure an adequate duration for lid failure when flame impingement is involved. The model includes a reduction in combustion efficiency that allows the heat release rate (HRR) curves to closely resemble test generated HRR curves for similar combustible packages (the Joyeux fire tests of 1980's cars) in lieu of maximum theoretical Peak HRR. Further discussion of heat flux modeling for other fires is included in the review of WIPP-058 below.

The SBRT concludes that the overall conservatism in the fire modeling is sufficient for the hazard evaluation and to ensure appropriate identification and functional classification of required controls.

WIPP-058 Fire Analysis: Several issues were identified subsequent to the approval of the FHA Revision 7 and WIPP-038 Revision 1 that affected development of the hazard and accident analysis for the DSA Revision 5a. Rather than revising the FHA, a supporting calculation was prepared to support the DSA, and for incorporation in the next FHA update as it changed some of the FHA evaluations and conclusions. These additional fire evaluations are provided in WIPP-058, Revision 2, *DSA Supporting Calculation, Fuel Spill, HEPA filter Plugging, Fire Compartment Over-Pressurization, Facility Pallet Survivability, Lube Truck Standoff Distance, Waste Array Fire Spread, and Internal Drum Event Fire in CH Bay and Along Waste Transport*. The purposes of this analysis include determining:

(1) Potential impact of fuel spill scenarios,

(2) Potential for hydrocarbon fires plugging of HEPA filters,

(3) Potential for fire compartment over pressurization once HEPA filters are plugged,

(4) Survivability of the facility pallet when subjected to a pool fire,

(5) Required standoff distance of the Lube Truck from the UG waste,

(6) Fire propagation in the waste array,

(7) Fire propagation from an internal drum deflagration or exothermic chemical reaction in the CH Bay and along the waste transport path, and

(8) Survivability of selected WHB unprotected structural columns for exposure to a hydrocarbon fire exposing the columns and determination of the time involved for the structural columns to reach a temperature where the required strength can no longer be relied upon.

This calculation provides analysis of fire protection issues associated with DSA Revision 5a. Some were for the DSA Chapter 3 hazard and accident analysis, such as evaluating specific pool fire scenarios, fire propagation in the waste array, and collapse of the WHB due to a pool fire exposing unprotected structural steel columns, and other calculations were developed for the DSA Chapter 4 performance criteria of safety significant SSCs such as fire sprinkler response, facility pallet survivability, and a vulnerability related to plugging HEPA filters and over-pressurizing compartments, and the appropriate standoff distance for the lube truck to ensure fuel spills and pool fires would not affect waste.

The analysis is based on use of industry accepted principles developed primarily in the Society of Fire Protection Engineers (SFPE) *Handbook of Fire Protection Engineering* (multiple editions were used), National Fire Protection Association (NFPA) *Fire Protection Handbook* (19th edition, 2003), and other fire science literature. To evaluate fire resistance of structural steel columns in the WHB, the analysis applied the methodology described in Chapter 8 of *Structural Design for Fire Safety* by Andrew H. Buchanan (2001).

For estimating the exposure to waste containers, pool sizes, sprinkler response times, and compartment pressurizations, WIPP-058 also used the Microsoft Excel® spreadsheets provided by the U.S. Nuclear Regulatory Commission with the NUREG-1805, *Fire Dynamics Tools (FDT^s) Quantitative Fire Hazard Analysis Methods for the*

Nuclear Regulatory Commission Fire Protection Inspection Program, (2004; spreadsheet Version 1805.1, 2011). The quantitative methods, known as "Fire Dynamics Tools" (FDT^s), were developed for analyzing the impact of fire and fire protection systems in nuclear power plants. The FDT^s were developed using state-of-the-art fire dynamics equations and correlations that were preprogrammed and locked into Microsoft Excel® spreadsheets. The majority of the original FDT^s were developed using principles and information from the SFPE *Handbook of Fire Protection Engineering*, the NFPA *Fire Protection Handbook*, and other fire science literature. Each FDT^s spreadsheet also contains a list of the physical and thermal properties of the materials commonly encountered in nuclear power plants, and are used when applicable to the WIPP analysis.

The WIPP-058 methodology section discusses the FDT^s analytical methodology in generic terms and references the published source for key relationships affecting WIPP results. The model foundations are empirical in nature, but provide quantitative bounding of the applicable fire parameters with the conservatism appropriate for safety basis analysis. Validation associated with the relationships is addressed in NUREG-1824, *Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications* (2007). Per the contractor's engineering calculation process, checking and confirming the entries and thus the analysis was performed to comply with the spreadsheet verification process provided with the NUREG-1805 documentation. In addition, the spreadsheets were confirmed to provide the correct results for documented test cases in NUREG-1805 prior to use. The SBRT concurs that this addresses appropriate quality assurance requirements associated with using Microsoft Excel® for performing engineering analyses.

WIPP-058 researched diesel fuels available from the petroleum industry and the range of properties involved and explains why the diesel properties used in previous WIPP safety basis fire protection analyses remain conservative through examples evaluated. The WIPP safety analysis work started in 2008 for the CH-RH-DSA Revision 0 was based in part on the Hughes and Associates, Inc., fire testing and analysis of waste containers for the Hanford Site in the mid 1990's. At that time physical information for diesel fuel was scarce in the technical literature and at the present time is only slightly better since properties vary widely based on the blend. Hughes and Associates assumed values associated with kerosene as representative of diesel fuel. The WIPP safety analysis work in 2008 was basically in the opposite direction using heavy fuel oil properties as representative of diesel fuel. Examples of varying fuel properties are provided to compare the difference this makes in the analysis for a 40 gallon, 70 second duration fire, based on total spill area, total fire heat release, fire pool diameter, Heskestad and Taylor flame heights, and regression (burning) rate – results of pool depths varied from 2.8 mm (WIPP) to 3.7 mm (Chevron fuel). The WIPP-005 input provides the greatest involved area for a fire event of the same duration. Using these WIPP-005 inputs for the WIPP-058 calculation provide compatibility with past WIPP safety basis fire protection analyses and generally provides conservative results that envelope commercial market diesel fuel. Thus, while the assumed combination of fuel properties does not corresponding to any diesel fuel product available on the commercial market, is does provide conservative analysis results appropriate for safety basis use.

Metal facility pallets are evaluated in a qualitative manner for survivability during pool fire exposure and for maintaining the ability to shield waste containers on the pallet from direct flame contact with the pool fire that could cause lid loss and incremental radiological release. The pallets are 9 inches high and provide contact with the lower portion of the pool fire just above the floor. Except for 8 three-inch diameter hold down holes, the pallet is closed over the top and bottom surfaces. These hold down holes are located away from the pallet edge and away from waste package locations on top of the pallet. This metal facility pallet on a flat surface would obstruct development of the flame structure and entrainment of combustion air in the pallet area, resulting in a much lower temperature of the pallet bottom that would not result in major deformation of the pallet. Typical radiant heat flux from a pool fire is 120 kW/m^2 at direct flame contact corresponding to a maximum flame temperature of approximately 1830°F. ASTM A240, Type 304 steel melts at temperatures of 2550-2650°F and is credited as having an intermittent service temperature of 1600°F with the room temperature tensile strength of 84,000 psi dropping to 24,000 psi at 1600°F. The Type 304 steel is typically heat treated after welding in the range of 1900-2050°F. Therefore, the expected maximum flame temperature of a pool fire is less than the typical heat treat temperature of ASTM A240, and well below the melting temperature of the unloaded edges of the metal facility pallet. The calculation also concludes that the metal facility pallet will survive expected pool fires under a small portion of the pallet, such as exists when on the underground transporter trailer. Based on these qualitative perspectives, the use of metal facility pallets provides protection for stored waste drums from direct flame impingement and structural support of waste containers during an evaluated pool fire. The pallets are evaluated in a quantitative manner to provide waste container shielding in a pool fire of unspecified duration with no lid loss for compliant waste containers. Seal failures from the waste containers are not precluded, however, and based on the scoping radiological dose calculations, the Facility Pallet was credited to mitigate consequence to the co-located worker to Moderate.

WIPP-058 evaluates HEPA filter plugging potential for the UVFS, IVS, combined IVS and UVFS, the confinement ventilation systems (CVS) for the CH bay and the RH bay. The methodology is based on similar approaches applied at other DOE sites, however, includes a 40% deposition in the WHB and 50% deposition in the UG of smoke prior to reaching the HEPA filters. Several references from experiments, other fire analyses, and published papers were provided to justify those deposition factors, and the SBRT concurs that the justification is adequate. Plugging is defined as occurring when a HEPA filter, assumed already loaded to its end of life differential pressure (4” water gauge [w.g.]) is incrementally loaded to its minimum capacity (10” w.g.), a threshold for about 50% flow reduction even if the filter remains intact. The results are basically that burning in excess of 34 gallons with just the UVFS operating presents a concern for HEPA filter plugging; the IVS system presents a concern for HEPA filter plugging with a little more than 29 gallons of diesel fuel burning if both filter trains are operating (if only one train is operating, then 14.5 gallons of burning diesel fuel could plug the filter – the TSR was revised to not rely on single train operation). Combined the IVS and UVFS operating together can present a concern for total HEPA filtering becoming plugged with burning of in excess of 63 gallons of diesel fuel but with the realistic probability that due to potential differential flow patterns in the system one side of the system (IVS or UVFS) could plug long before the other side. An important conclusion is that the plastic material used in the waste array and the amount exposed for potential burning during fire events is far less than the amount of plastic required to be burned in order to present a threat for HEPA filter plugging. However, because of these low estimates of plugging HEPAs, the mitigated analysis for some fire events emphasized crediting preventive controls to minimize the quantity of fuel involved or even to drive the mitigated likelihood to Beyond Extremely Unlikely and Risk Class III, while other scenarios that could not achieve this, credited preventive controls to achieve a mitigated Extremely Unlikely likelihood and credited the Facility Pallet to reduce the co-located worker consequences to Moderate, which resulted in Risk Class III.

The CH Bay and RH Bay pool fire potential was evaluated for four different fires in each compartment, which included:

(1) A 70 second fire in accordance with DOE-STD-5506 analysis methodology.

(2) A maximum fire that can occur prior to the sprinkler system activating within 70 seconds (note, the sprinkler system cannot be credited with suppressing the fire since the fire is a hydrocarbon fire and the hydrocarbon material can float on the water surface. However the sprinkler system does provide some suppression, cooling for the compartment, protecting the building and controlling of the fire until final suppression by other means such as fire response.)

(3) A more likely fire associated with the vehicle footprint. The sprinkler system in the RH Bay would not be expected to respond to this fire (due to sprinklers located at a substantially higher elevation in the RH Bay than in the CH Bay), but the CH Bay system would be expected to activate and provide some benefit (including smoke limitation).

(4) A minimum size fire to activate the sprinkler system, with the fire size in the RH Bay being much higher. This provided perspectives on a fire burning without activating the sprinkler system and with enough fuel to plug the HEPA filters for the compartment and determine the rate of pressure rise from the fire. For each compartment, the pressure rise is reasonably fast and would result in and unmonitored release path for fire gasses. For both compartments this requires burning in excess of 20 gallons of diesel fuel.

The analysis determined the survival times for selected WHB columns in the common wall between the CH and RH Bay and level 5 of the Waste Hoist Tower that could be exposed to a hydrocarbon and to an ASTM "standard" fire. The analysis concluded that it is not considered possible for any postulated fire to result in structural collapse of the Waste Hoist Tower.

A combined RH and CH Bay fire was evaluated due to the existence of a roll-up door between the compartments, assuming that the fire splits between compartments. The CH Bay side sprinkler system responds faster than the RH Bay system which will not respond for many events. The results of a hydrocarbon fuel pool fire fully engulfing the structural column near the rollup door for various column sizes, varied from 7.2 to 8.2 minutes in the RH Bay and from 4.8 to 5 minutes in the CH Bay, demonstrated that collapse was not possible for the short duration pool fires on a level concrete surface. For a longer-duration 10-minute "metered spill" (leak) from the Haulotte Manlift and prolonged burning of the tires near the roll-up door columns that only exposes one side of the columns, column failure varied from 9.5 to 10.7 minutes in the RH Bay (the side with the overhead motor requiring maintenance), which is qualitatively concluded that it is not expected to cause any structural damage to the WHB considering the flame height having direct contact with about one-third of the column height. In addition, an evaluation of the maximum "normal" associated with the vehicle footprint fire next to a column for the common wall between the CH Bay and the RH Bay will not cause damage to the WHB structure. Nevertheless, due to the uncertainties associated with the inputs for the unprotected structural steel columns, such as emissivity for single side exposure, the DSA acknowledges a vulnerability in the Chapter 4 performance evaluation and credits an Attendant SAC as a compensatory measure, and DSA section

3.6 commits to "Installation of a protective fire barrier (e.g., fire retardant insulation, curbing) for WHB steel support columns located near CH/RH Bay roll-up door, as required." The Attendant responsibilities are defined in the DSA Section 4.5.13, and are further evaluated in SER sections 3.5, 3.6, and 4.0 (LCO 3.3.8, Vehicle/Equipment Control). Responsibilities include visual observance of conditions that could result in potential collision risk and vehicle/equipment anomalies or malfunctions (e.g., leaks, ignition sources, presence of smoke) that could result in a pool fire and taking appropriate action, including alerting the vehicle/equipment operator. Although not a defined responsibility for the Attendant, that individual may decide to respond to an incipient fire, as allowed by the Fire Protection Program and training provided, however, the Attendant does not serve the function of a Fire Watch as explained in the DSA Table 4.5.13-2.

WIPP-058 also evaluated the waste array combustible exposure and the potential for internal waste array fire spread in the event of a drum deflagration or exothermic chemical reaction. The exposed combustible material area and likely spread of fire by continuity of combustible path was used with graphical arrangement of waste packages to determine the number of potentially impacted waste containers in a representative arrangement of 55-, 85-, and 100-gallon drums. The fires that can occur involving the exposed combustible material surfaces are relatively small and do not present the potential of flame spread by radiant exposure. The possible impact of poly-propylene sacks loaded with MgO on these results was evaluated, but concluded to be insignificant. The slow growth rates of the fires are not adequate to cause drum lid ejection. However, there is likely flame contact over a third of the exterior drum surface such that lid seal failure cannot be ruled out. In addition, flame spread can occur through dripping of melted plastic, vertical flames and combustible continuity all of which can spread the flames within the array. The results identify the potential to cause lid seal leakage in 29 drums with a 30th drum being the initiating event drum through internal excursion for the 7-pack 55 gallon drum waste packaging. For the 85 gallon drum waste array packaging, the potential is for 59 drums to experience lid seal failure with a 60th drum being the initiating event drum through internal excursion. For the 100 gallon 3-packs, the most restrictive arrangement geometry exists and the potential is for 17 drums to experience seal leakage failure with an 18th drum being the initiating event drum through internal excursion. To bound these results from a radiological consequence perspective, WIPP-001 assumed that 59 55-gal drums experience lid seal failure in a propagating fire, combining the higher number of affected 85-gal drums and the more common 55-gal size.

In addition, an internal drum event can occur during staging in the CH Bay and while along the waste transport path to final placement in the UG. Should such an event occur, two additional drums on the same level as the initiating drum could experience seal leakage due to burning of exposed combustible material and the initiating drum experiencing lid ejection (7 pack). If the second level is above the internal event drum, the resulting combustible material burning, three drums directly above could also experience seal failure. The total result is five drums with seal failure and one drum experiencing an internal event. A similar exposure would result with the 85 gallon drum 4 packs and the 100 drum 3 packs. For the four packs, the internal event drum could ignite adjacent exposed combustibles exposing two additional drums on the event level to seal failure. If double stacked, these fires could ignite similar areas above exposing three drums to seal failure. This then results in a total of five drums with seal failure and one drum with an external event.

Fire Event Conclusions: The SBRT concludes that the FHA and DSA have been appropriately coordinated to meet the requirement of DOE Order O 420.1C that the FHA is acceptably integrated into the safety basis documentation. The supporting calculations were reviewed as necessary for SBRT approval of the conclusions of the qualitative hazard evaluation and quantitative radiological dose calculations for the DSA Chapter 3. Based on satisfactory resolution of comments on these documents, the SBRT concurs with these technical evaluations as support document for DSA Chapter 3. The SBRT also concluded that the fire modeling is acceptably based on proven methodology, approaches and assumptions and/or sound engineering judgment, and adequately supported; the overall conservatism in the fire modeling is sufficient for the hazard evaluation and to ensure appropriate identification and functional classification of required controls. The SBRT Fire Protection Engineer reviewed these calculations and concluded that the adjusted conservatism is justified and agrees with the methodology and approach used.

- **Exothermic Chemical Reactions Hazard Evaluation:**

As discussed in the WIPP Accident Investigation Board (AIB) Phase 2 Report, forensic evidence of the energetic event from February 2014 demonstrates that this accident may not be explicitly addressed in the existing DSA Revision 4 and guidance in DOE-STD-5506-2007. This chemical reaction was concluded to be a rapid drum over-pressurization and resulting fire of ejected salts. The hazard associated with the contaminated nitrate salts (an oxidizer) mixed with organic kitty litter exists in Panels 5 and 6 and Panel 7 Room 7, even though interim closure barriers have been installed to confine the hazard.

From the AIB report, drum 68660 vented hot gases that ignited over a few seconds ejecting an unknown fraction of contaminated nitrate salt/kitty litter, the burning of which, while suspended in air, is expected to be the major contributor to the total airborne release. Multiple release mechanisms were likely involved in the WIPP event, such as burning of material while suspended in air; ejection of material that did not ignite while suspended in air; unconfined burning of material after it deposited nearby (i.e., no longer airborne), and burning of the remaining material in the drum.

NWP and the SBRT had extensive interactions regarding how to conservatively model this event for the DSA Revision 5a. The final methodology proposed by NWP was accepted by DOE (Letter: Suzanne W. Hunt, CBFO Contracting Officer, to Phillip Breidenbach, NWP, July 28, 2015, Contract DE-EM0001971, Nuclear Waste Partnership LLC, Contracting Officer Direction to Implement Judgment of Needs from the AIB Phase II Report into Documented Safety Analysis/Technical Safety Requirements Documents). The technical basis for release estimates follows.

Photographic evidence produced by Project REACH in support of the AIB following the radiological release at WIPP, along with a subsequent experiment conducted by Los Alamos National Laboratory (LANL) demonstrates that virtually all contents of a drum experiencing an exothermic reaction as sustained by the drum containing nitrates and Swheat Scoop® in the WIPP UG could have been ejected. This becomes the starting point for evaluating the exothermic release.

Additional evaluation of photographic evidence collected after the Radiological Release and the event modelling in the Technical Assistance Team and AIB Reports described the most likely scenario as an ongoing exothermic reaction resulting in thermal runaway and over-pressurization resulting in a two second ejection and three second expanding flame front. This resulted in partial burning of airborne material and continued unconfined burning of material in open air after deposition on horizontal surfaces.

Assuming 50% of the material to have burned as light combustibles (similar to paper) in an updraft as presented in DOE-HDBK-3010-94 Section 5.2.1.3 would result in a bounding ARFxRF of 0.4. This would leave the remaining 50% to burn as unconfined combustibles on horizontal surfaces which from DOE-HDBK-3010-94 would result in an ARFxRF of 0.01. Combining of the factors results in an overall release as a result of the exothermic reaction of 0.205 (i.e., DRxARFxRF).

Summary of contributions to release:

Overall Drum Effective Release Fraction From Exothermic Chemical Reaction

Release Phenomenon	Fraction Ejected From Drum	Fraction Burning While Suspended	Fraction Burning After Settling	ARF	RF	Effective Release Fraction
1. Burning while suspended in air	1.0	0.5		4E-1	1.0	4.0E-01
2. Ejected combustibles burning after settling	1.0		0.5	1E-2	1.0	5.0E-03
Overall effective release fraction =						**0.205**

Note: Based on how a hydrogen deflagration in a 55-gallon drum is modeled as summarized in DOE-STD-5506-2007 Table B-18, the contribution from flexing in air prior to igniting that burns unconfined after settling outside the drum is not included since its contribution is negligible (0.5 * 1E-3 ARF * 0.1 RF = 5E-5 effective release fraction, or 0.02% increase).

Since the Handbook did not contain a comparable model, DOE directed NWP to apply this model to ensure DSA, Revision 5a was conservative until new guidance could be developed. WIPP-051, Revision 3, *Scoping Calculation for MIN02-V.001 Waste for Closure of Panels 6 and 7*, applied this model to estimate the radiological dose to the co-located worker and MOI from these drums located within closed panels and rooms. Actual inventories of the LANL drums were used for the maximum loaded drum in each room and included evaluation of a subsequent fire that propagates throughout the array involving 59 additional drums, as determined by the WIPP-058 analysis. That calculation also evaluated involvement of 5 additional drums on a Facility Pallet if the event occurred in the WHB or while in transport to the UG. The SBRT concluded that these events were conservatively modeled for the purpose of control selections and safety classification.

- **Events in the Waste Shaft Access Area Hazard Evaluation:**

The Waste Shaft extends about 2,150 feet from the surface to the Waste Shaft Station and includes a sump that extends about 100 feet further. These elevation distances pose a unique hazard that must be carefully addressed for WIPP since drops over these distances could shatter waste containers or start fires. In addition, the strategy for filtered ventilation in this area relies on the WHB CVS while door 140 is open to the waste shaft collar on the surface and on the UVS/IVS in the UG during waste downloading. LCO 3.2.4 ensures downflow in the waste shaft and filtered exhaust from the Waste Shaft Station during waste download. The available ventilation cannot overcome the natural ventilation pressure that would be generated by a fire in the waste shaft, however, and this vulnerability must be considered when evaluating waste shaft hazards.

Potential fires were evaluated in the Waste Shaft Access Area that could cause a radiological release that may not be filtered by the CH CVS, as discussed above. Loss of confinement events could also occur in the Waste Shaft Access Area, the most significant being a drop of a load of waste containers down the shaft, but such an event would be filtered through the UVS/IVS. A bounding event initiated in this area is the drop of a 300 gallon diesel fuel tank being transported to the UG that falls down the shaft with the forklift carrying it and impacts waste on the Waste Conveyance at the Waste Shaft Station resulting in a large fire. That event is evaluated as an Evaluation Basis Accident and is further discussed in Section 3.3.5 of this SER.

Uncontrolled movement of the Waste Conveyance was also evaluated in the hazard evaluation which could result in a drop of waste containers down the shaft or uncontrolled upward movement to crash into the hoist drum and upper frame attached to the Waste Hoist Support Structure. Waste Hoist Brakes work in conjunction with the Waste Hoist Support Structure to control movement of the conveyance up and down the Waste Shaft. This prevents an uncontrolled drop of a loaded Waste Conveyance by reducing the likelihood of uncontrolled conveyance movement with or without power available to the controls. The Waste Hoist braking system is credited for a mitigated beyond extremely unlikely determination and Risk Class III for event CH/RH-UG-10-004a. It should be noted that the original Safety Analysis Report for startup of WIPP in 1999 and the previous DSAs relied upon a failure mode and effects analysis of the hoist system and a fault tree analysis of the brake system to conclude that hoist failures resulting in a radiological release were not credible events that warranted evaluation of TSR controls. This approach is no longer consistent with DOE-STD-3009-2014 for operational accidents unless special provisions for probabilistic risk assessment are invoked and complied with (this has not been done for WIPP). The prior failure mode and effects analysis for the Waste Hoist System (WIPP/WID 96-2178) calculated failure of the hoist at less than 1E-06 per year (in part due to design redundancy and safety features). Per the DSA section 2.4.4.1.1, there are six hoist head ropes, any two of which can support the weight of the shaft conveyance, the counterweight, and the maximum shaft conveyance load. There are three tail ropes that are used to approximately balance the weight of the six head ropes, and four guide ropes for the conveyance and two guide ropes for the counterweight. Tension on the guide ropes is maintained by weights on the bottom of each rope. A fault tree for failure of the braking system resulted in a very low probability of failure (approximately 1E-7) to operate (*WIPP Waste Hoist Brake System Analysis*, Revision 2, April 1996). The brake failure calculated probability may not be easily defensible (e.g., it appears to credit administrative programs that are not fully characterized). The new evaluation of the drop accident credits the brake system for a qualitative likelihood reduction of only one frequency bin which is defensible, and sufficient to reduce the scenario to beyond extremely unlikely.

The Waste Conveyance Control SAC requires the Waste Conveyance Car to not enter the Waste Shaft Collar Room unless the Waste Shaft Conveyance is present; once the Waste Shaft Conveyance is loaded with waste, the Waste Shaft Access doors are required to be closed and remain closed while waste is present in the Waste Shaft; and, once lowered to the UG, the Waste Shaft Conveyance is required to remain present at the Waste Shaft Station until the waste load is moving away from the Waste Shaft. Additionally, the Waste Shaft Conveyance is required to be present at the Waste Shaft Station prior to bringing TRU Waste into the station for uploading. This reduces the likelihood for vehicles, equipment, and/or loads to drop down an open Waste Shaft into the shaft sump. The Waste Conveyance Control SAC is credited for a mitigated beyond extremely unlikely determination and Risk Class III for event CH/RH-UG-10-005a event. The waste shaft access configuration is an Initial Condition for these events as it is designed to preclude inadvertent top entry into the waste shaft.

- **Seismic Event Hazard Evaluation:**

WIPP-019 Section 4.24, *Event CH/RH-UG-25-001A – Seismic Event Results in Fire Involving CH and RH Waste*, evaluated a seismic event affecting the UG and concluded that it is not vulnerable to NPH events that could have an impact on the disposed waste containers. The UG is 2,150 ft below the surface and is not affected by a 0.1 g acceleration at the surface defined for the Design Basis Earthquake for the WHB. Mine experience and studies on earthquake damage to UG facilities (Pratt et al. 1978) show that tunnels, mines, wells, etc. are not damaged for sites having peak accelerations at the surface below 0.2 g. This has been the safety basis position since WIPP was designed and constructed, and is also described in the DSA section 1.5 (see Section 3.2 of this SER).

However, the WHB is vulnerable to NPH events that can in turn have an impact on the waste containers within the WHB. The Design Basis Earthquake is a "code of record" seismic event as described in DOE-STD-5506-2007 that results in overhead equipment impacting waste since the structure is designed to withstand the 0.1 g surface acceleration. This event is evaluated in WIPP-019 section 4.25, Event CH/RH-WHB-25-001A – Seismic Event Damages WHB Resulting in Fire Involving CH and RH Waste, and was selected as an Evaluation Basis Accident and is further evaluated in Section 3.3.5 of this SER.

The WIPP design affords a seismic detector that can be used to determine the magnitude of actual events at the site. A broad network of detectors in the surrounding area can also be monitored on line to provide similar information. The seismic detector is designed to trip closed the tornado damper in the WHB, isolating the building for an event that might exceed the DBE. Neither the seismic hazard evaluation nor the Beyond Design Basis seismic event for the WHB rely on this design feature.

- **Roof Fall Hazard Evaluation:**

WIPP-021 and WIPP-019 revised the previous DSA Revision 4 hazard evaluation of roof fall events in the UG, and evaluated one in an active disposal room and another during transport. Because required ground control cannot be maintained once waste is emplaced in the UG disposal rooms, there is a potential for localized sections of the roof to fall and impact disposed waste containers. The WIPP design anticipates the disposal rooms eventually to close around the waste due to salt creep, but a ceiling slab breaking off and falling is possible. From the top of the waste disposal array to the bottom of the roof is approximately 3 ft. While the roof does not have far to fall before reaching the waste disposal array, depending on the height of the slab, the impact on the waste array could be enough to cause container deformation. The impacted drums will experience a vertical crush but not to the extent they would if they were not a part of the tightly packed waste disposal array. The array will work together as a single unit and the resulting impact is modeled as a moderate impact. A credible event is postulated to impact 30 waste assemblies in the waste stack (ten columns in three tier stacks). In WIPP-019, the bounding statistical MAR estimate is from POCs/CCOs due to their WAC limit and powder form of material, the impact is conservatively modeled with a DR of 0.01 after the collapse of a substantial structure for POCs as recommended in DOE-STD-5506-2007 (as opposed to the previous damage assessment based on energy considerations of static axial crush test data in Section 4, Waste Drum Damage Due to Roof Fall, in PLG-1167, *Analysis of Roof Falls and Methane Gas Explosions In Closed Rooms and Panels*), a 6E-4 ARF*RF is applied for powders together with a 1.0 leakpath factor. This resulted in Low consequences to the co-located worker and MOI, and the facility worker was also assessed to experience low consequences. The SBRT concluded that the analysis addressed concerns regarding roof fall identified in the February 2014 radiological release Accident Investigation Phase 1 Report, and noted that the 30 waste assembly MAR estimate is sufficiently conservative, as it would have to increase by more than an order of magnitude (i.e., on the order of 400) to exceed the CLW High Consequence threshold and require safety significant controls.

- **VOC Emissions Hazard Evaluation:**

  As stated in Section 3.3.1 of this SER, the hazard associated with VOC offgasing from CH waste containers in an active or closed room or panel was not screened out of the hazard evaluation. The DSA qualitatively evaluated this hazard for two expected operational events: (1) continuous leakage from vented CH waste containers in an active Disposal Room and minimal leakage of gases from closed Disposal Rooms (event NA-UG-13-004a); and (2) continuous leakage from closed areas that may expose facility workers in the immediate working area outside the closure barrier in a drift or in an open Disposal Room, including consideration of a roof fall event that slightly pressurizes the room and drives higher concentrations into the drift and into an active disposal room (event NA-UG-13-005a).

  Both events involving exposure of UG facility workers to VOCs are evaluated as required and are judged to result in Low consequences even without active ventilation. The basis provided in the DSA is as follows:

  > An event involving exposure of UG facility workers (NA-UG-13-004a) to gases (e.g., VOCs) emanating from CH Waste containers in an active Disposal Room and minimal leakage of gases from closed Disposal Rooms is judged to result in Low consequences even without active ventilation. The gradual accumulation and diffusion of vapors outside vented containers would not create an atmosphere of a significant toxic hazard (e.g., high acute toxicity over a sufficient exposure duration) that would meet the DOE-STD-3009-2014 expectation of an event requiring SS controls due to significant chemical exposure, serious injury, or fatality. While DOE STD-3009-2014 does not specify threshold limits for facility workers (as it does for the co-located worker and public), the facility worker exposure is qualitatively assessed to be below a concentration associated with life-threatening health effects over a sufficient exposure duration (e.g., a peak 15 minute time-weighted average air concentration is used for co-located worker and public determination of exceeding PAC-3 and PAC-2 levels, respectively). Historical sampling of VOCs in the UG, in accordance with provisions of the HWFP, has detected elevated levels which were primarily associated with areas of inadequate airflow from the UVFS. Without forced ventilation that is normally available in these areas, only natural mechanisms for dispersal and removal are available such as diffusion and limited circulation induced by pressure changes. Only infrequent entries are made into these areas. High levels of VOC concentrations have been measured in areas with low or no active airflow but were observed to quickly dissipate; however, only a fraction of the temporary peak concentration is attributed to potentially toxic VOCs. This experience supports a judgement that the potential for VOCs in these dead legs entails pockets of VOC concentration well below the levels behind the closure barriers and easily dissipated when disrupted. No potential for sustained high exposure to facility workers is identified based on this experience. Chapter 8.0, "Hazardous Material Protection," establishes requirements for surveys of areas for air quality and determines the level of PPE required, if any, prior to performance of work and a Key Element (KE 11-13)[2] for UG Air Quality Monitoring is specified in Chapter 11.0, "Operational Safety." Therefore, a consequence of Low to the facility worker is justified on a qualitative basis.
  >
  > An event involving exposure of UG facility workers (NA-UG-13-005a) to gases (e.g., VOCs) forced from within a closed Disposal Room and into occupied areas of the UG is

[2] A directed change (see SER section 5) requires this KE to be moved to Chapter 8 as KE 8-1.

judged to be Low consequences. Gases diffusing from Waste containers in closed Disposal Rooms gradually accumulate in a closed Disposal Room. A closed Disposal Room is isolated from occupied areas of the UG by installation of a barricade that both prohibits access and blocks ventilation to the filled Disposal Room. If a roof fall were to occur in an adjacent closed Disposal Room, additional VOCs could be forced out compared to normal leakage due to the movement of air within the closed Disposal Room; however, the air movement would only last for a few seconds and would limit the volume of gas that could be forced into occupied areas of the UG (PLG-1167). No significant release to the occupied areas is predicted. The vapors forced into occupied areas of the UG would not create an atmosphere of a significant toxic hazard (e.g., a peak 15-minute time-weighted average air concentration is used for co-located worker and public determination of exceeding PAC-3 and PAC-2 levels, respectively), and therefore the concentrations to exposed facility workers in the UG is qualitatively judged to not result in a fatality, serious injury, or significant chemical exposure as defined by DOE-STD-3009-2014. Chapter 8.0, "Hazardous Material Protection," establishes requirements for surveys of areas for air quality and determines the level of PPE required, if any, prior to performance of work and a Key Element (11-13)[2] for UG Air Quality Monitoring is specified in Chapter 11.0, "Operational Safety." Therefore, a consequence of Low to the facility worker is justified on a qualitative basis.

The SBRT concurs with the above qualitative hazard evaluation. The SBRT also notes that the PLG-1167 report calculated that a roof fall in a closed room causes a pressure rise for only a fraction of a second as the ceiling separation creates a vacuum in the void space from the falling salt slab that backfills rapidly with air from the headspace in the closed room; this effect limits the amount of VOCs that may be puffed past the closure barricades. The Key Element is:

KE 8-1: Establish provisions to monitor and control air quality to ensure underground workers are protected from volatile organic compounds; protective measures include posting hazardous areas, establishing monitoring requirements, ensuring local ventilation, and requiring personnel protective equipment such as respiratory protection as needed.

3.3.3.3. Summary of Hazard Evaluation Conclusions

In summary, the SBRT concludes that the hazard analysis:

- Evaluates all activities for which approval is sought;
- Is consistent in approach with safe harbor methodologies from DOE-STD-3009-2014 and DOE-STD-5506-2007;
- Appropriately applies screening of standard industrial hazards and chemical hazards consistent with DOE-STD-3009 requirements;
- Uses methodology determine the MAR for hazards and accident analysis that is clearly defined, compliant with DOE-STD-5506 requirements, and affords sufficient margin to minimize the risk of Potential Inadequacies in the Safety Analysis when shipments resume, considering the higher MAR that may be expected from SRS (see SMP Key Element 18-5 to periodically verify MAR assumptions);
- Identifies preventive and mitigative hazard controls for the spectrum of hazards evaluated;

- Evaluates normal, abnormal, and accident conditions, including natural and man-made external events, and identifies the energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials; and
- Clearly characterizes hazard analysis results in terms of public safety, defense-in-depth, co-located worker safety, facility worker safety, and environmental protection

The above conclusions are dependent upon the resolution of issues noted by the SBRT that involve inconsistencies between the supporting documents and the presentation of that information in Chapter 3. Where changes were deemed necessary because of their importance to the safety basis (e.g., major discrepancies or potential to create a PISA situation), they are included as directed page changes as described in SER section 5. These changes have been discussed with and accepted by the M&O contractor.

3.3.4. Hazard Evaluation Control Selection

The DOE technical review of the adequacy of preventive and mitigative controls selected from the hazard evaluation focused on information presented in DSA section 3.3.2.3. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- If required, safety significant SSCs, SACs, and associated TSRs have been identified for preventing and/or mitigating events that may cause worker fatalities or serious injuries; may potentially exceed the worker/co-located worker radiological consequence thresholds or the applicable "significant" public and co-located worker toxicological thresholds; or are determined to provide major contribution to defense-in-depth. The facility worker's mobility or ability to react to hazardous conditions is not used as the sole or primary basis for determining facility worker impacts.
- Logic behind assessing the results in terms of safety significant SSCs, SACs, and designation of TSRs is understandable and internally consistent.

The methodology for control selection is consistent with DOE-STD-3009-2014 and DOE-STD-5506-2007. Safety SSCs and SACs were identified to prevent and/or mitigate worker and public risk by applying the preferred and alternate controls listed in DOE-STD-5506-2007 for each accident type. When these controls were not available for selection, an alternative control was selected based on the specified control functions in the standard. Safety significant controls were selected in accordance with the requirements and guidance in DOE-STD-3009-2014, augmented with the application of using risk rankings as required by DOE-STD-5506-2007. As explained in Chapter 3 of the WIPP DSA, any potential for an offsite exposure greater than 5 rem is considered to challenge the offsite Evaluation Guideline in accordance with DOE-STD-3009-2014 for the unmitigated consequence analyses, and consideration of the need for safety class controls is warranted.

The design of WIPP and its processes includes numerous controls to protect the facility worker from hazards. Radioactive material can create an inhalation hazard through release by fire, deflagration, loss of confinement, or a direct exposure hazard. A philosophy of prevention is taken with many of the accidents and hazards whenever possible at the WIPP. While the prevention of accidents is preferable over mitigation, much of the hazard and accident prevention is accomplished using SACs and passive design features rather than relying on an active engineered safety SSC to prevent accidents. Mitigative engineered features were applied as available, including the new emphasis on HEPA filtration of potential releases from the UG. The following summaries of control strategies from the DSA section 3.3.2.5 are provided below, and expanded from addressing only the facility worker to including all receptors.

Fires: The first level of preventing fires is ensuring that TRU waste complies with the WIPP WAC. This control prevents fires in that TRU waste container contents are restricted (e.g., liquids, pyrophorics, chemical characteristics, flammable gas generation). The WAC also mitigates fires in that the container is of noncombustible (i.e., metal construction) and the MAR per container is bounded, thereby limiting consequences. Additionally, the noncombustible construction of the WHB and the noncombustible salt of the UG prevent the propagation of fires. The RH waste cask/light weight facility cask (LWFC) and the facility pallet protect the RH waste containers, as applicable, from exposure to fires and thereby limit the involvement of TRU waste in fires and/or limit the release of radiological material if involved in a fire. Fire prevention also entails the fire suppression systems on vehicles and equipment in the UG and in the WHB. Performance of pre-operational checks on vehicles in proximity to TRU waste containers, controlling the number of vehicles operating in proximity to TRU waste containers, controlling the waste transport path, prohibiting the UG lube trucks from disposal rooms and the Waste Shaft Station when CH waste is present, prohibiting liquid-fueled vehicles from the CH Bay, Room 108, and the Waste Shaft Access Area when CH waste is present, vehicle barriers protecting the southwest CH Bay wall, and attendance of vehicles/equipment in proximity to TRU waste containers in the UG, all work to prevent the occurrence of fires and/or to allow detection, mitigation, and evacuation of workers when necessary.

For facility workers, mitigation of fires is accomplished by either self-observation and egress when personnel are in position to observe the condition without being incapacitated and evacuate or, in the event of a fire in the UG, by the vehicle/equipment Attendant initiating the notification of facility workers of adverse conditions so that they can evacuate. For co-located workers, the public, and the environment, the applicable HEPA filtration system is the primary means to reduce consequences, which also provides defense-in-depth for protection of the public and environment.

Explosions/Deflagrations: The first level of preventing explosions is ensuring that TRU waste complies with the WIPP WAC. This control prevents explosions in that TRU waste Container contents are restricted (e.g., liquids, pyrophorics, chemical characteristics, flammable gas generation). The WAC also mitigates explosions in that the container is noncombustible (i.e., metal construction) and the MAR per container is limited thereby limiting consequences.

For facility workers, mitigation of explosions/deflagrations is accomplished primarily by the WIPP WAC to ensure that TRU waste containers will not be subject to deflagrations. When unloading a payload from the Type B shipping package, waste assemblies are inspected for indications of noncompliance. Through visual examination and radiological surveys of TRU waste packages, suspect containers are isolated and a response plan developed. Waste generators may also notify WIPP of potential WIPP WAC noncompliance. WIPP would respond by identifying the location of the affected container(s), isolating them, and developing a response plan in accordance with the Waste Acceptability Control (LCO 3.7.1). Isolating a container involves prohibiting movement of the container or within the vicinity of the container until the situation is reviewed and a plan developed to safely resolve the condition. For co-located workers, the pubic, and the environment, the applicable HEPA filtration system is the primary means to reduce their consequences.

Loss of Confinement: The first level of preventing loss of confinement is ensuring that TRU waste complies with the WIPP WAC. This control prevents loss of confinement events in that TRU waste Containers provide resistance to impacts (e.g., metal construction). The WAC also mitigates in that the MAR per container is limited thereby limiting consequences. The RH waste cask/LWFC protects the RH waste containers from impacts and thereby prevents the release of radiological material. The Waste Hoist is a conveyance for movement of TRU waste to the UG. Prevention of loss of confinement also entails pre-operational checks on vehicles in proximity to

TRU waste containers, controlling the number of vehicles operating in proximity to TRU waste containers, controlling the waste transport path, and controlling the Waste Conveyance and its braking system.

For facility workers, mitigation of radiological material releases is accomplished by either self-observation and egress when personnel are in position to observe the condition and evacuate or, in the event of a loss of confinement in the UG, by the vehicle/equipment attendant initiating the notification of facility workers of adverse conditions so that they can evacuate. For co-located workers, the public, and the environment, the applicable HEPA filtration system is the primary means to reduce consequences.

Direct Exposure: The first level of preventing direct exposures is ensuring that TRU Waste complies with the WIPP WAC. This control prevents direct exposures in that TRU Waste is packaged as either CH waste (container surface doses below 200 mrem/hr, allowing contact with containers) or RH waste (container surface doses exceeding 200 mrem/hr, which require shielding). For RH waste, the Type B shipping packages protect the worker prior to unloading. The Hot Cell Complex shielding reduces doses to workers during Hot Cell Complex operations, and the RH waste cask/LWFC protects the worker by dose reduction during transport to the UG and emplacement. Over-exposure of workers is also prevented through the Radiation Protection Program and Hot Cell Complex access control, specified as Key Elements in DSA Chapter 7.0.

External Events-, Natural Phenomena Hazards-, and Other-Initiated Hazard Events: The first level of prevention is ensuring that TRU waste complies with the WIPP WAC. This control prevents exposure in that TRU waste containers are constructed to provide resistance to impacts. The WAC also mitigates in that the MAR per container is limited, thereby limiting consequences. The RH waste cask/LWFC protects the RH waste containers from impacts and thereby prevents the release of radiological material. The Waste Hoist is a conveyance for movement of TRU waste to the UG. The WHB is designed for design basis NPH events.

For facility workers, mitigation of radiological material releases from these events is accomplished by either self-observation and egress when personnel are in position to observe the condition and evacuate or, in the event of a loss of confinement in the UG, by the vehicle/equipment attendant initiating the notification of facility workers of adverse conditions so that they can evacuate.

Safety Management Programs: The DSA section 3.3.2.5 provides a summary of how SMPs protect the workers, the public, and the environment, and identifies their Key Elements selected either from the hazard evaluation tables or determined to be important as described in DOE-STD-3009-2014. The SMPs are described in DSA Chapters 6 through 18. SMPs enhance worker safety by ensuring that personnel are properly trained to perform their jobs, personnel are provided with necessary protective equipment, and records of personnel exposure are maintained. SMPs provide accident mitigation for facility workers by providing personnel protection to facility workers who are trained to know and identify hazardous conditions and to take self-protective actions upon detection of adverse conditions. The SMPs provide protective equipment, training, and instructions for accepted work practices.

Hazard Evaluation Control Selection Conclusions: Between the hazards analysis and the accident analysis, 14 safety significant SSCs (with 19 different credited functions), and 12 SACs (with 13 credited functions) were credited in the hazard evaluation to reduce the co-located worker or public risk ranking of the 47 bounding scenarios. The DSA Table 3.3-10, Credited Control Summary, summarizes the preventive and mitigative controls derived by the hazard and accident analysis. A directed change (see SER section 5) requires that E-3, Loss of Confinement, be added as an event requiring mitigation by the UVFS/IVS in Table 3.3-10.

Additional SACs were derived by the DSA Chapter 4 performance evaluation to establish compensatory measures for safety significant SSC vulnerabilities. These controls are further evaluated in Section 3.4 of this SER.

Based on the accident analysis described below and the magnitude of the potential radiological releases from accident scenarios, and given the remote location of the WIPP and the approximate 2.9 km distance to the public site boundary and its 95th percentile dispersion conditions, no safety class SSCs or SACs were designated to protect the public. The suite of safety significant controls provides adequate protection of the public, and the environment.

The SBRT concludes that safety significant SSCs, SACs, and associated TSRs have been identified for preventing and/or mitigating events that may cause worker fatalities or serious injuries, or may potentially exceed the worker/co-located worker radiological consequence thresholds or the applicable “significant” public and co-located worker toxicological thresholds. The logic behind assessing the hazard evaluation results in terms of safety significant SSCs, SACs, and designation of TSRs is understandable and internally consistent. Based on the information provided, including DSA Chapter 3 and the supporting documents, the selected controls are assessed as effective in providing the degree of prevention or mitigation for which they are being credited. For example, the SSCs credited with mitigation (WHB CVS HEPAs, UVFS/IVS HEPAs, facility pallet) achieve the stated reduction in consequences. No safety significant controls were deemed warranted to meet the major contribution to defense-in-depth criterion. The facility worker’s mobility or ability to react to hazardous conditions is not used as the sole or primary basis for determining facility worker impacts.

3.3.5. Accident Analysis

The DOE technical review of the adequacy of accident analysis focused on information presented in DSA section 3.4. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- The methodology used to determine the MAR used in hazards and accident analysis is clearly defined, compliant with DOE-STD-5506 requirements, and affords sufficient margin to minimize the risk of PISAs when shipments resume, considering the higher MAR that may be expected from SRS.
- Accident analysis is performed for an adequate set of design/evaluation basis accidents (D/EBAs) having unmitigated offsite consequences that have the potential to challenge the Evaluation Guideline.
- The accident analysis methodology is clearly identified and appropriate, including identification of initial conditions and assumptions. The technical basis for source term values is provided, valid, and appropriate for the physical situation being analyzed. The completeness and level of detail in the technical basis should increase as the parameters depart from the default or bounding values described in the Part 830 safe harbor methods. Supporting calculations and technical documents are identified, where appropriate, and reviewed for critical aspects of safety controls, where appropriate.
- The modeling protocol, if used to support site/facility-specific values in atmospheric dispersion modeling (see Section 3.2.4.2 of DOE-STD-3009-2014), meets the criteria and guidance provided in DOE-STD-3009-2014, and an adequate technical basis is provided for the receptor locations, meteorological data (including proposed more conservative use of meteorological data), modeling tools, and modeling parameters.

- The justification and technical basis (see DSA section 3.2.4.2) for use of an alternate 100 m CW X/Q (atmospheric dispersion parameter) in lieu of the default 3.5×10^{-3} sec/m^2 has been reviewed and accepted as appropriate.
- Probabilistic risk assessments, related tools, and probabilistic calculations (if used) are used in a manner consistent with the applicable provisions of DOE-STD-1628-2013, *Development of Probabilistic Risk Assessments for Nuclear Safety Applications*, and supplements the qualitative/deterministic processes for hazard assessments and hazard control development.
- Accident analysis clearly substantiates the findings of hazard analysis for the design/evaluation basis events and demonstrates the effectiveness of safety class SSCs, if needed to prevent or reduce the likelihood of accidents or mitigate dose consequences below the Evaluation Guideline.
- Safety class SSCs, SACs and associated TSRs have been identified for preventing and/or mitigating events that exceed the Evaluation Guideline.

Only two of the 47 bounding hazard events were selected from the hazard evaluation as evaluation basis accidents (EBAs) for the purpose of safety-class SSC or SAC determinations for protection of the public. These two EBAs involve a liquid-fuel pool fire from a drop down the Waste Shaft, and a drop of a forklift carrying a facility pallet of waste down the Waste Shaft impacting waste on the Waste Conveyance at the Waste Shaft Station. Other fire, explosion, loss of confinement, NPH and external events have low estimated consequences to the MOI and do not warrant further accident analysis. Accident analysis results were compared to the 25 rem Evaluation Guideline to determine the need for safety class SSCs or SACs to protect the public.

Accident Analysis Methodology

For nuclear safety modeling purposes, the WIPP site boundary established by the Land Withdrawal Act is used for modeling consequences to the public that could result from accidental release of TRU waste contaminants. The nearest site boundary from either the WHB or the UG exhaust shaft is approximately 2.9 kilometers. This change from the previous safety basis documents that relied on an exclusion area with a minimum distance of 285 m was adopted for the CH/RH DSA Revision 0, and was coordinated with the WIPP emergency preparedness and security programs in 2008 to assure that DOE can adequately exercise its control over the WIPP property to protect the public in the event of an accidental release.

The accident analysis methodology is summarized in the DSA section 3.4.1. The SBRT determined that the calculation of accident dose as a product of MAR, damage ratio (DR), airborne release fraction (ARF), respirable fraction (RF), leak path factor, atmospheric dispersion factor, breathing rate, and dose conversion factor is consistent with the methodology required by DOE-STD-3009-2014 and the additional guidance for TRU waste handling facilities from DOE-STD-5506-2007 when applicable. The selection of MAR for each accident scenario is scenario-dependent and is well supported by calculations. The air transport/dispersion code used to calculate the atmospheric dispersion factors is the MELCOR Accident Consequence Code System 2 (MACCS2), version 1.13.1, which is a DOE Central Registry toolbox code. Additional discussions of some these consequence analysis parameters follow. This accident analysis consequence methodology was also applied for the scoping calculation identified above to calculate dose to the MOI and CW for the purpose of assigning the qualitative consequence levels for the hazard evaluation.

The radiological accident analysis and hazard evaluation scoping calculations document the assumptions related to MAR, DR, and ARF/RF. Conservative values for the source term parameters were primarily selected from guidance in the DOE-STD-5506-2007. Where no guidance is provided in the standard, technical justification for values selected is documented in the scoping calculations. The following discussions address the more significant issues associated with these parameters.

MAR: The MAR for a particular scenario is expressed as a product of the number of waste containers or waste container assemblies involved in the postulated event and the bounding activity associated with the waste container/waste container assembly. The TRU waste container and waste container assembly is dependent on the type (CH or RH) and form of the waste. According to DOE-STD-5506-2007, TRU wastes are a variety of physical and compositional forms including combustible, noncombustible, cemented or vitrified, and in some cases, bulk powders or contaminated soils. Drummed TRU wastes are typically small-sized, actinide (principally plutonium and americium), surface-contaminated combustible and noncombustible materials.

The CH MAR is dependent on multiple factors, which leads to a number of possible CH waste configurations, which were analyzed for each hazard event and accident analysis. For example, a vehicle explosion in the WHB CH Bay could involve waste in drums in 3-pack, 4-pack, or 7-pack configurations; pipe overpack containers (POCs) or Criticality Control Overpacks (CCOs) in 7-packs, shielded container assemblies, direct-loaded Standard Waste Boxes (SWBs), or Standard Large Boxes (SLB2s); or drums overpacked in other drums, SWBs, SLB2, or ten-drum overpacks (TDOPs). Additionally, the waste form dictates the inventory of each container. These various waste configurations were grouped into six waste configurations as bounding and representative of CH waste for calculating doses for each scenario involving CH waste, of which four involve waste drums (direct-loaded CH drums, POCs or CCOs, shielded containers, and drums with solidified or vitrified waste).

The previous DSA accident analysis methodology, as well as the qualitative hazard evaluation, was changed to apply the DOE-STD-5506-2007 statistical approach to establish bounding MAR for the hazard events and accidents. DSA Table 3.4-1, Material at Risk Limits Based on Entire Waste Container Population, provides the results for all containers already emplaced in the UG, currently staged in the WHB, and certified but not shipped (CNS) containers in the DOE Complex. DSA Table 3.4-2, Material at Risk Limits Based on SRS Waste Container Population, provides more conservative estimates based on the Savannah River Site (SRS) population of emplaced plus CNS containers that were used for all the scenario calculations. Certified containers for shipment to WIPP are still located at the generator or characterization sites; however, this population is of interest as a picture of what can be expected to come to WIPP in the short term after waste handling operations have resumed at the site.

The technical basis for this statistical analysis is provided in WIPP-057, Revision 3, *Statistical Parameters for Bounding MAR Limits at the WIPP*. The statistical MAR analysis is used for accident scenarios that involve multiple containers. The bounding MAR Limit from DOE-STD-5506-2007, Table 4.3.2-1, *Bounding MAR Limits for TRU Waste Operations*, for fully characterized waste containers is one container at WIPP WAC, a second container at the 95th percentile value, and the remaining containers at average (mean) value.

SRS statistics are generally used because the mean and standard deviation for all containers, except POC, is higher for SRS waste when compared to the general population statistics derived for waste containers from all the shippers to the WIPP including CNS waste data. WIPP-057 explains the selection process and why some SRS values were not selected, e.g., higher values may be associated with less dispersible waste forms. The mean value and 95th percentile value for SRS POC waste are lower than the POC values from the general population; therefore, the general population POC values were used in this analysis. There is no statistical analysis for RH waste, therefore the MAR values in the WIPP WAC are used for RH waste analysis. The SBRT and external reviewers commented on the development of the statistical MAR approach, and after resolution of comments, the SBRT concurs with the application of the statistical MAR rather than assuming every container is at the WIPP WAC limit.

One concern that must be addressed when using the DOE STD-5506-2007 MAR methodology is whether the scope of operations could unintentionally concentrate MAR in future shipments of containers inconsistent with statistical MAR assumptions and the methodology prescribed in the DOE Standard. Two scoping calculations are included in WIPP-057, one looking backwards at the already emplaced wastes to determine whether this situation has inadvertently occurred, and the other looking forward based on future shipments using the CNS population. To address the potential MAR statistical issues, the bounding fire event involving a pool fire with the lube truck at the waste face was used for comparison since ejection of combustible contents from a large population of drums has the highest consequences.

- The pool fire with the lube truck at the waste face was re-evaluated using actual historical waste inventories, and compared to the DSA evaluation based on the SRS statistics. The average 55-gallon drum MAR value for each room in the underground was compared to the SRS site statistics. In the cases where the average MAR was greater than the SRS 55-gallon drum statistical value from Table 11 of WIPP-057, that room was selected for analysis in WIPP-057, Appendix 5 to evaluate inadvertent groupings of MAR. The conclusion was that the WIPP-001 analysis continues to be the bounding analyses, even when compared to rooms that have a greater average MAR value per 55-gallon drum involved in the fire due to the emplacement of different container types throughout the underground.
- Another variation of this backward-looking analysis considered the historical loadings from high-MAR drums from the Mound Site Pu-238 decommissioning, which are located on the top tier of one of the disposal rooms. This evaluation concluded that the SRS statistics bound the dose consequences when applying the DOE-STD-5506 pool fire modeling approach based on 25% of the top tier containers subject to lid loss and ejection of contents. However, if the DOE-STD-5506-2007 algorithm is not followed for lid-loss of containers and the highest loaded 25% drums are selected, then the doses would be higher.
- Related to the potential for unintentionally concentrated future shipments of problematic containers, containers were considered that are located at generator sites and that have been certified for shipment to the WIPP. The purpose of this analysis was to identify certified containers that could result in a change to the statistical values of all containers in Table 10 and of only SRS containers in Table 11 of WIPP-057 and use this perspective to identify shipments that could unintentionally concentrate MAR. These cases are discussed in WIPP-057, Appendix 5. From the analysis, it was concluded that the future shipments remain bounded by the SRS data used from Table 11 and the bounding fire event evaluated with the SRS data continues to be the bounding event.

In order to provide added assurance that future shipments will not intentionally or inadvertently result in higher MAR than analyzed, Key Element 18-5 is included in the DSA Chapter 18, as discussed in section 3.7 of this SER. This Key Element requires periodic verifications, e.g., supporting DSA annual updates and groupings of payload shipments to maintain the statistical MAR assumptions Key Element 18-5 includes provisions to ensure that future MAR issues will be identified with sufficient lead time to allow revisions to the DSA should they ever be required.

Another issue with establishing bounding MAR estimates was the lack of evaluating the powder form of TRU waste in certain containers in other than POCs and CCOs. This was resolved by evaluating scenarios involving RH waste powders in drums and RH canisters, and justifying why powders in other CH waste containers are bounded by the current analysis, when considering the WIPP WAC fissile inventory limits, existing non-combustible waste streams in the CNS population for high-MAR outliers, or how contaminated soils are bounded. Future campaigns related to decommissioning of DOE nuclear facilities and equipment that processed Pu-238 may not be bounded by the current analysis; however, application of Key Element 18-5 is expected to identify high-MAR containers prior to receiving groupings of payloads that would otherwise not be bounded by the current analysis and to ensure they are not unacceptably comingled.

Also related to POCs is the issue that fire and drop testing were based on an assumption of the waste being in the form of nonreactive powders or contaminated noncombustible materials. Loading POCs with contaminated combustible waste has the potential to cause higher radiological releases from the inner pipe component. Current testing of POCs with combustible materials in pool and exposure fires is being performed by the same Sandia National Laboratories group that performed the initial POC fire tests in support of an update to DOE-STD-5506-2007. Until testing results are available, a footnote “d” was added to DSA Table 3.3-8, Waste Container Types and Standard Waste Assembly Configurations, and it references DSA section 3.6, which discusses a revision to WIPP WAC to prohibit this configuration, along with some other waste forms that were identified in response to corrective actions for the February 2014 radiological release. However, some of the radiological scoping dose calculations were not revised to include this same clarification and imply that POCs are approved for all waste forms, even those which are not authorized.

The scoping dose consequence calculations document assumptions related to maximum loading in the WHB, how certain waste container configurations bound others, and crediting DOT Type B shipping containers to prevent releases.

DR: From DOE-HDBK-3010-94, the DR is that fraction of material actually impacted by the accident conditions. Waste containers are damaged by fires; explosions; loss of confinement events, including drops, punctures, and crushes; and external and NPH events. DRs vary based on general severity level, waste container type, and waste container contents. The DRs applied to each event are shown on DSA Table 3.4-3, Waste Container Damage Ratios, and are in general consistent with DOE-STD-5506-2007, section 4.4; these DRs are not further addressed in this SER.

Where no applicable recommendations were provided in DOE-STD-5506-2007, or where interpretations were necessary, technical justifications are provided in the radiological scoping dose calculations. After extensive comment resolution interactions with the DSA authors, the SBRT concurs with these justifications. A summary of the more important elements of the justifications for these DRs follows (see the supporting dose calculations for the entire justifications), first presented for individual containers, then addressed by type of hazard or accident scenario, which introduces different considerations:

SLB2: The SLB2 damage ratio is treated equivalent to SWB for impacts. This assumption is predicated on the design of the SLB2 as a bolted lid container of similar construction to the SWB. The SLB2 is a vented stainless steel container with bolted lid that occupies the same space as four waste assemblies on a facility pallet. The SWB is a DOT Type 7A steel-fabricated box with a lap-welded bottom and an internally flanged, bolted closure lid. The SWB is approximately 71 inches long, 54 inches wide, and 37 inches high. The SLB2 is a DOT Type 7A steel-fabricated box with a lap-welded bottom and an internally flanged, bolted closure lid. The SLB2 is approximately 108 inches long, 69 inches wide, and 73 inches high. Both the SWB and SLB2 have a bolted closure lid except that the SLB2 is a larger container than the SWB. The SLB2 is judged to have the same DR as the SWB because both the containers are steel, with the same lid closure mechanism. The Seal Failure Fire DR for two or more SLB2s is 0.5 and a DR of 1.0 for one SLB2. This assumption is predicated on the size, capacity, and design of the SLB2 as a bolted lid container. The internal size of the SLB2 has drum capacity equivalent to two SWBs. The internal capacity of the SLB2 can hold eight or more drums which is based on the DOE-STD-5506-2007 assumption for SWBs to hold four drums. This would mean that two SLB2s is equivalent to more than 10 drums or three SWBs and therefore the 0.5 damage ratio would be applicable. A DR of 1.0 is assumed for one SLB2 involved in a fire.

<u>SWB-OP</u>: The overpack design provides a factor of two reduction in the impact DR as compared to a drum DR as suggested on page 42 of DOE-STD-5506-2007, which also applies to overpacked SWBs (SWB-OPs). For fire events, a 0.1 DR is credited for overpacks as recommended in DOE-STD-5506-2007, section 4.4.3.2.

<u>POCs</u>: The POCs are assigned a DR of zero for impacts and fires based on their robust design, as recommended in the DOE-STD-5506-2007 for most of the scenarios. The POC was assumed to have a DR of 0.5 for free-fall down the Waste Shaft and a DR of 0.01 for substantial crushing when impacted by other falling objects or collapse of the building. A facility pallet has two waste assemblies stacked in two tiers (28 POCs). A DR of 0.01 for substantial crushing of a POC as in collapse level event per DOE-STD-5506-2007, Table 4.4.5-1 is used for uncontrolled movement of the Waste Hoist resulting in its falling down the shaft or crashing into the superstructure. A considerably higher DR of 0.5 is used for half the waste assemblies (one layer of each pallet) that are impacted when a waste pallet is dropped down the Waste Shaft on another waste pallet sitting at the bottom of the shaft (note that 1.0 DR is assumed for 55-gal drums and other DOT Type A containers). The other half will suffer crushing with a DR of 0.01, similar to a collapse-level event.

Regarding fires, DOE-STD-5506-2007 states "POCs involved in storage and room fires need not be further evaluated in an accident analysis." Thus, a DR of zero is assigned to POCs in a liquid fuel-pool fire (see exception below regarding drop of a 300 gal diesel fuel tank down the shaft). A POC containing a nonreactive powder form of material and not combustible waste was tested and is the basis for information in DOE-STD-5506-2007. In response to the February 2014 event at WIPP, additional waste stream issues have been identified in the DOE Complex. These issues include oxidizers which led to the February 2014 radiological release, high wattage waste, and POC confinement (containing combustible waste materials, excluding radiological control materials and packaging materials normally used to load these containers). Evaluation of these issues is ongoing within the DOE Complex and resolutions are not well defined as of the issue date of this SER. Therefore, WIPP is prohibiting receipt of these suspect waste streams and POCs (containing combustible waste materials, excluding radiological control materials and packaging materials normally used to load these containers) until resolutions are determined and incorporated into supporting calculations, changes to the WIPP WAC, if needed, and the DSA. This commitment is described in the DSA section 3.6.

<u>CCOs</u>: The impact and fire DRs for CCOs are similar to performance of POCs. This assumption is predicated on the CCO drop and impact testing information provided in the TRUPACT-II Safety Analysis Report. However, there are no thermal testing data for CCO similar to POC, so additional justifications are provided in WIPP-001. The radiological scoping dose calculations provide a technical basis based on CCO and POC test data, by considering the similarities and differences in the interior packaging of the two containers. The SBRT concurs with those evaluations. However, due to the uncertainty associated with

the lack of the fiberboard insulation in the CCO, additional testing is being conducted with CCOs by the same Sandia National Laboratories group performing the new POC fire testing in support of an update to DOE-STD-5506-2007. Should results not confirm this fire-related assumption, additional revisions to the DSA will be necessary. Therefore, WIPP is prohibiting receipt of these suspect CCOs until resolutions are determined and incorporated into supporting calculations, changes to the WIPP WAC, if needed, and the DSA. This commitment is described in the DSA section 3.6.

Solidified/Vitrified Wastes: The impact DR of solidified/vitrified waste container is half of drum DR. According to DOE-STD-5506-2007, significant release of non-dispersible wastes, such as those that have been vitrified or solidified with concrete in metal containers, would require higher-energy input to release the wastes than is available from mechanically initiated spills such as container punctures, drops, or falls. In order to consider the non-dispersible nature of waste in source term determination the highest DR drum was reduced to half as indicated in footnote d in DOE-STD-5506-2007, Table 4.4.4-1.

Drums containing solidified and vitrified waste involved in fires are not addressed directly within DOE-STD-5506-2007. The standard does, however, address overpacked waste and notes in section 4.4.3.2 that the heat sink associated with an overpack of sound integrity would warrant a fire DR 0.1. The heat sink associated with solidified or vitrified waste would be comparable if not greater than waste within an overpack. Additionally, the solidified or vitrified waste would contain lower levels of VOCs than other waste types; thus, the waste containers containing these materials are less likely to produce the pressure required to result in seal failure.

RH Waste Canister: The RH MAR waste configuration is limited to RH waste drums either overpacked in a 72-B RH canister or loaded into a 10-160B shipping container or a 72-B RH canister direct-loaded with waste. For the RH canister with nested metal drums, a significant release from potential venting through the outer container seal is not expected. Lid loss will not occur for a direct-loaded RH waste container with a welded lid, or the removable lid canister (RLC) during deflagration (DOE-STD-5506-2007) because these are the only configurations allowed by the RH TRU Waste Authorized Methods for Payload Control (TRAMPAC). The pressure generated from the outside fire affecting an RH waste canister would be lower than the deflagration pressure because the high temperature from the fire event would damage the RH canister gasket and relieve the pressure. Therefore, lid loss would not occur in a RH canister during a fire. When the direct-loaded RH waste drums or direct-loaded RH canisters are outside the 10-160B or 72-B shipping container or facility cask, the RH waste drums involved in a liquid fuel-pool fire are modeled in the same manner as direct-loaded CH waste drums. When the direct-loaded RH drums are modeled within the RH canister, or canisters are within a facility cask during the liquid fuel-pool fire, they are assumed to only experience seal failure and are modeled with a DR of 0.1.

RH Facility Casks: The RH facility cask and light-weight facility cask are assigned the same impact and fire DRs as overpacked waste containers.

Shielded Container: The impact DR of shielded container is half of drum DR. The shielded container is a vented carbon-steel and lead cylindrical structure with a removable lid designed to hold an inner 30-gallon container of RH waste. The shielded container meets DOT 7A Type A requirements of 49 CFR 178.350. There are two metal containers that have to fail before the radioactive waste is impacted. Therefore, half of drum DR is appropriate for shielded containers, an overpack, to credit the second robust steel container.

The shielded container has a DR of 1.0 or 0.5 for dropping a waste pallet down the waste shaft on another waste pallet sitting at the bottom of the waste shaft. The shielded container is a robust container and a factor of 2 reduction is considered reasonable for this container as compared to an overpacked drum or SWB-OP (DOE-STD-5506). A DR of 0.5 for substantial crushing is conservative when considering that an SWB has a DR of 0.1 for a collapse level event per Table 4.4.5-1 of DOE-STD-5506.

Shielded container fire scenarios were analyzed in WIPP-032, which concludes shielded containers exposed to nearby pool or ordinary combustible fires could experience uneven heating of the lead lining along with weakening of the outer container shell resulting in a breach of the container outer shell, and loss of melted lead lining through the breach. Shielded containers involved in a long-duration, fully engulfing pool fire could be breached in a similar manner. A DR of 0.5 is applied to arrays of 10 or more shielded containers involved in an exposure or fully engulfing pool fire. A DR of 1.0 is applied for arrays of less than 10 shielded containers, and to shielded containers which experience impact followed by fire.

DOT Type B Shipping Containers: Shipping packages have been designed for hypothetical transportation accidents and certified as Type B shipping packages when the containers are sealed. For outside events (not in the WHB), the shipping packages are not opened and are modeled as being within their design criteria, and a DR of 0 is applied.

When the closed shipping packages are within the WHB, they are considered inside the impact and fire testing parameters (DR of 0 is applied) for most scenarios. According to DOE-STD-5506-2007, shipping packages that meet current Type B criteria normally are expected to survive facility fires typical of those that may occur in the DOE Complex where TRU wastes are stored or handled. However, for fires inside the WHB, closed shipping containers are damaged due to the buildup of heat that may occur in an enclosed building. A DR of 0.01 is assigned for exposure to flammable liquid fuel-pool fires and large ordinary combustible fires. Taking the drum overpack testing into account, the overpack of sound integrity DR is reduced by a factor of ten for fire events as discussed above. This additional factor of ten takes into account the overall robustness of the design. Thus, for fire scenarios involving a shipping container inside the WHB and containing waste, the DR becomes 0.01 for direct-loaded drums, SWBs, and RH canisters; 0.005 for overpack containers and solidified/vitrified waste drums; and 0 for drums containing POCs and CCOs (WIPP-001).

Once opened, the shipping packages still protect their contents from releasing radionuclides into the atmosphere from impact events. A shipping package without its lid still provides some protection from fires, so a 0.01 DR for seal failure from fires is assumed because the RH canister or drums are shielded from exposure fires by the sides of the shipping package.

POC Fire DR = 0: The DSA Chapter 3 and WIPP-001 scoping dose calculation apply a DR of zero to POCs in a pool or facility exposure fire, as permitted by the DOE-STD-5506-2007. Crediting a zero DR results in a zero airborne source term in the scoping calculations. This in turn implies that there are no potential radiological consequences, which is not a correct interpretation based on the 1997 SNL fire testing results, SAND97-0368, Testing in Support of On-Site Storage of Residues in the Pipe Overpack Container. The SNL testing demonstrated that POCs will experience seal failures under certain conditions; however, this has been interpreted as a zero DR for evaluation of POCs in fires. The basis of a DR of zero is summarized in DOE-STD-5506-2007 Section 4.4.3.2, as follows:

> "In the case of POCs, the containers are designed in a manner that precludes their failure during expected storage area fires. Four POCs were subjected to Type B protocol thermal tests as summarized in Appendix C. The associated 150 MW fuel pool fire caused the one outer 55-gallon drum of a POC package with a metal filter to experience lid loss[9]. This occurred within the first three minutes of the fire. Post-fire

inspection showed the pipe component seal and filter gasket to be damaged. Associated leak rate testing of this POC showed a total leak rate of 24 cm^3/s at a differential pressure of 87 kPa. This leak rate was later associated with an ARF of 6E-6 for the bounding material type in POCs (i.e., powder)[10]. It should be noted that inspection of the POC packages remaining intact revealed that the POCs did not experience temperatures above 200°F and remained leak tight. Therefore, POCs involved in storage and room fires need not be further evaluated in an accident analysis. However, engulfing fuel pool fires that last longer than 30 minutes exceed the testing conditions and may cause sufficient impact to POCs to warrant assessing the release."

Footnotes:
[9]The other POC packages had plastic filter seals, which melted during the fire.
[10]See Appendix C discussion.

The above conclusion that POCs do not warrant evaluation to storage and room fires is based on important caveats associated with the SNL tests such as containing noncombustible TRU waste form (e.g., powder) inside the 6 inch or 12 inch pipe component, and exposure to pool fires lasting less than 30 minutes. For WIPP, the DSA evaluated pool fires in the WHB, during transport, and in the Disposal Rooms as a 70-second fire to maximize the pool area and number of direct loaded 55-gal drums that could result in lid loss and ejection of combustible wastes. Additionally, without physical features to contain a pool fire, the duration in TRU waste areas will be very short on the order of a minute or two depending on the surface conditions that allow pooling on a flat surface to some depth. The SNL test resulted in initial lid loss within the first three minutes, so lid loss and ejection of the fiberboard spacer exposing the top of the pipe component is recognized to occur, as does the potential for some leakage.

What is not clearly stated in the DOE-STD-5506-2007 discussion is that the 6E-6 ARF implies a very small release and resulting radiological consequences. The basis for the 6E-6 ARF is from a 2000 Rocky Flats report NSTR-001-97 Revision 3, Evaluation of Pipe Overpack Containers for TRU Waste Storage, which is reproduced as follows:

"In the case of the POC in a fire, the particulates must slowly leak out through gaps/holes in the O-ring or filter gasket, or through the filtered vent. The appropriate ARF would correspond to a relatively low rate of air flow past contaminated waste. The DOE handbook on release fractions (DOE, 1994; p 4-56) indicates that when PuO_2 powder is heated and air flows past it at a speed of 0.1 m/s for one hour, the total fraction of PuO_2 released is $6x10^{-6}$; this would be an airborne release rate and must therefore be multiplied by the duration of the heating to get the ARF. In the case of residues (a form of contaminated waste), the radioactive component is a combination of very small particles of pure PuO_2 (or other Pu compounds) and contaminant clinging to the other solid material. The ARF for residues may therefore be expected to be lower than that for PuO_2 powder, but this effect will be ignored. The air flow rate within the pipe component must be low and the rate of 0.1 m/s in the experiment noted above is probably too high. (A flow of 0.1 m/s for one hour corresponds to a distance of 360 m traveled by the air. Since the pipe component has an inside length of 0.635 m (25 inches), 360 m corresponds to over 500 pipe lengths. Furthermore, the helium leak test, which had a pressure differential of 81 kPa - much larger than would happen with the pipe component in a fire - had a flow of 24 cm^3/s, or an interior velocity of dV/dt/A, where dV/dt = 24 cm^3/s and A is the cross-sectional area within the pipe that is available for air flow, say 1% of the cross section ($0.01\ \pi\ r^2 = 0.01\ \pi\ 32 = 0.28\ inch^2 = 1.8\ cm^2$), giving an airflow velocity of $(24\ cm^3/s) / (1.8\ cm^2) = 13\ cm/s \approx 0.1\ m/s$. (For a more realistic pressure differential the airflow rate would be much lower.) Nevertheless, this airflow velocity will be assumed so that the experimental value can be used, and to be conservative. Finally, the Type B fire test is for half an hour, which would therefore correspond to an ARF half that noted above. Nevertheless, an ARF of $6x10^{-6}$ can used, to be conservative."

The above report also considered a 0.01 RF for Rocky Flats residues that were characterized, and a weighted leakpath factor for the unfiltered leakage and filtered flow through the HEPA vent filter; however, neither are credited in the 6E-6 ARF. Another perspective related to not further evaluating POC in fires is that although the WAC inventory limit for a POC is more than 20 times that of a 55-gal drum of direct loaded waste, there is approximately a factor of 100 difference in the ARF/RFs (5E-4 for 55-gal drum seal failures), thus a net difference of about a factor of 5. This is without crediting a RF, e.g., Rocky Flats residues (powders) credited a 0.01 RF based on it characterization data that results in about a factor of 500 smaller release estimate for POCs. Even without characterization data, DOE-HDBK-3010-94 has assumed a RF of 0.1 for bulk powders due to difficulty in accident stresses de-agglomerating the bulk pile, which is still about a factor of 50 less release for POCs. This RF perspective, however, would not apply to contaminated noncombustible waste, so the difference would be about 5 times smaller release than from 55-gal drums.

As discussed in DSA Section 3.6, POCs containing combustible waste will be restricted by a change to the WAC. POCs containing this waste form, as well as with empty pipe components, are currently being tested at SNL, and when results are available, insights should be available to confirm the original POC test results as well as the suitability of allowing combustible wastes in POCs. If SNL documented results indicate POC vulnerabilities for the combustible waste or current allowable waste forms, appropriate DOE actions are expected to determine whether the new information warrants evaluation per the PISA process.

The SBRT conclusion is that application of the zero DR for POCs in fires is appropriate as allowed by DOE-STD-5506-2007; however, it should not be interpreted as no release and no potential for radiological consequences, which are expected to be low to all receptors. The DSA evaluation of fires involving direct loaded 55-gal drums bound the potential consequences from releases from POCs, and especially those POCs currently stored in the WHB due to their low radiological inventories and their noncombustible waste form as discussed in DSA Section 3.6.

The following addresses DRs for specific hazard and accident scenarios that warrant further discussion than above for the different container types:

Vertical Drum Crush: The vertical drum crush DR (0.5), used when containers are impacted by other heavy items falling on them such as a TRUDOCK crane drop of a payload or a TRUPACT-II lid, is taken from the standard's discussion of pallet drop testing of a TRUPACT-II payload (DOE-STD-5506-2007, page 42, paragraph 3). The vertical crush DR for a SWB and a RH canister is the same as vertical crush DR for a drum, 0.5. The drum has a gasket for outer drum lid closure. According to the CH TRAMPAC, a SWB is closed by a neoprene or equivalent gasket and steel screws. According to the RH TRAMPAC, a RH canister has a fixed lid or a removable lid with a gasket. This shows that the SWB and the RH canister are of more robust design than a drum. Therefore the vertical crush DR of a drum is applicable to the SWB and RH canister.

Panel/Room Closure Barrier: WIPP-051 Rev. 3, *Scoping Calculations for MIN02-V.001 Waste for Closure of Panels 6 and 7*, calculates an airborne release of radioactive material into the disposal path from behind a closure barrier such as the substantial barrier (i.e., salt pile against the face of the drums that includes a ceiling-mounted brattice cloth to retard airflow) and the steel isolation bulkhead as described in DSA Section 2.4.4.6, Panel Closure System, or use of multiple steel bulkheads instead of a substantial barrier. This "initial source term" that leaks around the seals of the steel bulkhead results in potential consequences to the facility workers in the drift and is available for in-facility transport down the airflow exhaust path and up the 2,150 ft ventilation shaft resulting in a release to the environment that may expose co-located workers and the public. For this in-facility transport path, a LPF of 1.0 is assumed in the DSA accident analysis (i.e., no reduction due to gravitational settling, impaction on surfaces, or other deposition mechanisms) that is consistent with the DOE-STD-3009-2014 guidance for an unmitigated analysis. The initial source term calculation credits a 0.1 reduction factor for the closure barrier, which provides the outer confinement boundary. This 0.1 reduction factor is interpreted to be the equivalent to a Material-at-Risk and Damage Ratio adjustment per the guidance from the DOE-HDBK-3010, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, to estimate the source term that would be released to the WIPP Underground and be available for transport to the surface and release to the environment. In this sense, the bulkhead and barrier act similar to the outer boundary of an overpacked waste container.

<u>*Waste Hoist Conveyance Uncontrolled Movement*</u>: The scenarios for uncontrolled movement of the waste hoist conveyance and for drop down the waste shaft use a DR of 1.0 for drums, SWBs, SLB2s, and RH canisters. A DR of 0.5 is applied to solidified/vitrified waste given that this waste is judged to suspend fewer particles than other waste types. The uncontrolled movement of the waste hoist conveyance uses a DR of 0.5 for SWB-OPs, and shielded containers (SCs), which is consistent with DOE-STD-5506-2007 (section 4.4.4) of allowing a factor of two credit for overpacked containers. A DR of 0.01 is applied to POC/CCOs given that these containers are of robust design and inside drums with additional packaging that should afford some protection in the half-mile long drop. The drop down the waste shaft scenario for POC/CCOs uses a DR of 0.5 for half the containers and for the other half a DR of 0.01.

<u>*Drop Down Waste Shaft*</u>: The drop down the waste shaft scenario for SWB-OPs, SCs uses a 1.0 DR for half the containers and for the other half a DR of 0.5. The SWB-OP has a DR of 1.0 or 0.5 for dropping a waste pallet down the waste shaft on another waste pallet sitting at the bottom of the shaft. The SWB-OP has a DR of 1.0 or 0.5 for dropping a waste pallet down the waste shaft on another waste pallet sitting at the bottom of the waste shaft. SWB-OP is a robust container and a factor of 2 reduction is considered reasonable for these containers as compared to a SWB (DOE-STD-5506-2007). A DR of 0.5 for substantial crushing of SWB-OP is conservative because SWB has a DR of 0.1 for a collapse-level event per DOE-STD-5506-2007, Table 4.4.5-1).

<u>*Explosion Impact*</u>: The DR of POC and CCO from shrapnel or the impact (pressure wave) caused by flammable gas explosion is same as the DOE-STD-5506-2007 puncture DR for POC and CCO. The mass of shrapnel created by a flammable gas explosion that would impact POC or CCO would be significantly smaller than the mass of forklift tine that causes a puncture in these containers. The speed at which the forklift travels and causes a puncture is significantly less than speed at which shrapnel could impact a POC or CCO. The overall momentum of the forklift tine and the shrapnel would be similar, as would the damage caused . It is judged that pressure wave impact would be significantly less than shrapnel impact. Therefore, a puncture DR for pressure wave impact is conservative.

<u>*Firearm Puncture*</u>: The DR for a firearm puncture and roof/rib bolt puncture is 10% of the DOE-STD-5506-2007 forklift tine puncture DR. A 3-ton capacity forklift has an approximate tine area of 62 cm^2 (8.9 cm diameter). A bullet has a small area relative to a forklift tine. The roof/rib bolt has a diameter of about 1 inch and is about 6 inches long. The roof/rib bolt

has a higher mass than a bullet, but its velocity is much lower at impact than a bullet. The much greater mass of a forklift and its tines compensates the significantly higher velocity of the bullet when it impacts the waste container. The significantly smaller area of the bullet and roof /rib bolt is judged to provide a 10% reduction in the damage ratio.

Impacts Followed by Pool Fire: Waste containers in this category of events are first impacted by a vehicle or piece of equipment. The vehicle/equipment spills its fuel during the impact and a subsequent fire occurs. Since the waste containers that are impacted by the vehicle/equipment are assumed to spill a portion of their contents, this portion of material (DR) may burn in an unconfined manner and care is taken in assigning ARF/RF values to the event. The DRs associated with the fire portion of the event are the same as those used in modeling fires without impacts for undamaged drums. However, caution is given to assigning a seal failure DR value to a waste container that has lost its lid or container integrity as part of the impact portion of the event. DRs of less than 1.0 are only applied to undamaged waste containers in impact events. The impact DR is used to determine what fraction of waste from containers involved in the collision burns unconfined with the remainder undergoing seal failure. The approach discussed in preceding sentences was applied to all containers except for Overpack Containers, Shielded Containers, Solidified/Vitrified Waste Containers, and for the forklift with the fuel tank falling down the Waste Shaft onto a waste pallet at the bottom as discussed in WIPP-001, Appendix A (see next discussion). This assumption is predicated on a DR of 0.5 assigned to overpacked drums for the fire portion of impact with fire calculation due to the outer container preventing direct flame impingement of the inner container resulting in an inner container seal failure equivalent to assumed seal failure applied to 10 or more drums. Solidified/vitrified waste containers are treated differently given that unconfined burning is not postulated due to the compact nature of this waste, which does not support the basis of loosely strewn cellulosic material for unconfined burning.

WIPP-001 Appendix A - Damage Ratio (DR) for Waste Containers for Event CH/RH-UG-01-005a and Drop of Liquid Fuel and Pool Fire at Bottom of Waste Shaft EBA: This scenario is a drop of an electric forklift with 300-gallon diesel tank through the waste hoist on a waste pallet sitting at bottom of the waste shaft on a conveyance resulting in impact and subsequent fire. Appendix A establishes the DRs for drums, SWBs, and SLB2s that are impacted by the long drop and subsequent fire. It also credits an approximately 2.8-inch thick steel plate on top of the waste hoist and the steel cage on the conveyance in determining the fraction of combustible waste ejected with subsequent unconfined burning. A subsequent fire could occur but its intensity would be closer to combustible material fire than a pool fire. In addition, any ejected mass of waste will be covered by accident debris. This situation meets the criteria of confined burning presented in DOE-STD-5506-2007, section 4.5.2 and DOE-HDBK-3010-94, section 5.2.1.1. As stated in DOE-HDBK-3010-94, section 5.2.1.1, waste in piles is modeled as confined burns based on “the presence of more substantial material surrounding the contaminated, combustible waste would limit the availability of oxygen and force particles generated in the interior of the mass to pass through the ash/residue formed prior to release.” For unconfined burning, one must postulate that there is enough energy generated by the container crush to eject waste far from the debris field and distribute it so that piles are not formed. The impact of the forklift with a 300 gallon diesel fuel tank on waste containers could eject a certain mass of waste from the container as they are rapidly crushed. If the container has any small, discrete pieces of waste, these would be ejected from the container and would most likely stay as composite mass because of low air pressure developed due to sudden container compression of the failed container. The amount of waste ejected would depend on the waste container and its failure mode. It is expected that a 55-gallon drum with its crimped lid would have the highest ejection percentage, followed by SWB/SLB2 (due to the bolted lid configuration), followed by overpacked containers having the lowest ejected percentage due to the double container configuration. Most of the ejected waste from the inner container would remain or be shielded by the outer container for an overpack container. Even though most, if not all, of the ejected waste would burn as confined waste but it is conservatively assumed that a part of it burns as unconfined waste. The remaining fraction burns as a confined waste. WIPP-001 Appendix A provides the basis for the impact DRs and the fraction used for unconfined burn for various containers, which are summarized as follows.

- 55-gallon drums – It is conservatively assumed that the DR for the impact is 1.0. Assuming that the 55-gallon drum fails during forklift impact, most of the radioactive material would be either in the drum or covered by debris that would undergo a confined burn. It is an engineering judgment that about 10% of the radioactive material may undergo unconfined burn, which is same as the DR of 0.1 for collapse of a substantial building in DOE-STD-5506-2007, while the remaining would undergo confined burn.
- SWB/SLB2 -- The construction of the SWB and the SLB2 (e.g., thicker steel than the 55-gallon drum and screw configuration) make them more robust than a 55-gallon drum. It is conservatively assumed that the DR for the impact is 1.0. Assuming that the SWB/SLB2 fails during forklift impact, most of the radioactive material would either remain in the container or be covered by debris and thus it would undergo a confined burn. It is an engineering judgment that about 5% of the radioactive material may undergo unconfined burn while the remainder would undergo confined burn.
- SWB-OP -- CH-TRU waste may be loaded into as many as four 55-gallon drums and overpacked in an SWB. An impact DR of 0.5 (half of drum DR) is assumed based on the DOE-STD-5506-2007, page 42, which states that a factor of two credit is believed to be a reasonably conservative estimate, because two metal containers should provide some added protection for drop events. Since most of the radioactive material would be either in drum or covered by debris that would undergo a confined burn, it is an engineering judgement that about 2.5%, half of SWB percentage as allowed by DOE-STD-5506, of the radioactive material may undergo unconfined burn while the remaining would undergo confined burn.
- Due to their robust construction, POCs and CCOs are unlikely to fail, but a conservative DR for the impact of 0.01 is assumed. If the POC/CCO fails during forklift impact, most of the radioactive material would be either in the container or covered by debris, and thus it would undergo a confined burn. Even though, a significantly lower quantity would be available to burn as unconfined material, it is conservatively assumed that 1% of the radioactive material may undergo unconfined burn, which is same as the DR of 0.01 for collapse of a substantial building in DOE-STD-5506-2007; the remainder would undergo a confined burn.

NPH DRs: The last two rows in WIPP-019, Table 3-4 show additional waste container DRs used for a NPH building collapse that are taken from DOE-STD-5506-2007, section 4.4.2, specifically Table 4.4.5-1, based on the WIPP facility being of substantial construction. (As a conservative approach for this document, the WHB is considered a substantial construction due to the concrete on the roof, even though some of the exterior walls are of moderate construction.)

ARF/RF: The ARF*RF values that were used in the analysis of postulated events were taken directly from DOE-STD-5506-2007 (section 4.5, Table 4-5.1) and are summarized in DSA Tables 3.4-4, Airborne Release Fraction*Respirable Fraction from DOE-STD-5506-2007, and 3.4-5, Mechanical Insult Airborne Release Fraction*Respirable Fraction from DOE-STD-5506-

2007. Those ARF/RFs that are consistent with the DOE-STD-5506-2007 do not warrant further discussion in this SER, except if a few cases as described below. Where no applicable recommendations were provided in DOE-STD-5506-2007, or where interpretations were necessary, technical justifications are provided in the radiological scoping dose calculations. The SBRT concurs with these justifications. These ARF/RFs and a summary of their justifications are presented below.

Pool Fires with Drum Lid Loss: From DOE-STD-5506-2007, lid loss and content ejection only happen with drums directly loaded with contaminated combustible solids; for these drums, 25 percent of the drums on the top tier are assumed to experience lid loss. The ARF*RF for lid loss and content ejection is a combination of the fire ARF*RF inside and outside the drum as well as ARF*RF from flexing in air. DOE-STD-5506-2007 specifies that 33 percent of the contents are ejected and that 67 percent of the contents stay in the drum. Thus, the effective ARF*RF for lid ejection/content loss and fire is 3.7E-3 (0.33*1E-2 + 0.33*1E-4 + 0.67*5E-4).

Impact with Subsequent Fire: For those events involving vehicle impact (low-stress event), the DR from the vehicle impact portion of the event becomes the fraction burning unconfined in the fire portion of the event. The remaining fraction of the waste in the container is subject to the confined burning ARF*RF assumption given in DOE-STD-5506-2007 as 5E-4. For example, drums crushed by a vehicle traveling at a low speed are assigned a DR of 0.1. The effective ARF*RF for the impact and fire involving the impacted drums is 1.45E-3 (0.1*1E-2 + 0.9*5E-4). Containers experiencing a low stress DR of 0.01 are given an effective ARF*RF 6.0E-4 (0.01*1E-2 + 0.99*5E-4).

These ARF*RFs apply to containers that are not considered overpacked in accordance with the WIPP WAC unless the inner container is of sound integrity. In overpacked containers, the outer container will absorb most of the energy from the impact and a portion of the release from the inner container will be contained in the annulus area between the inner and outer containers. A DR of 0.5 is assigned to overpacked containers for the fire portion of the calculation due to the outer container preventing direct flame impingement of the inner container resulting in an inner container seal failure equal to more than 10 drums equivalent seal failure. For overpack containers involved in these events the effective ARF*RF for a fire involving moderate impacted containers is 9.8E-4 (0.05*1E-2 + 0.95*5E-4), and for a fire involving low impacted containers, the ARF*RF is 5.5E-4 (0.005*1E-2 + 0.995*5E-4).

Seismic with Subsequent Fire: For the seismic event with a subsequent fire involving direct-loaded CH drums or SWBs, the DR from the building-collapse portion of the event becomes the fraction burning unconfined in the fire portion of the event. For drums or SWBs impacted by a code of record design basis seismic event (DR = 0.01), the effective ARF*RF for the fire involving the impacted drums is 5.95E-4 (0.01*1E-2 + 0.99*5E-4). For drums or SWBs impacted by a building collapse during a Beyond DBA (DR = 0.1), the effective ARF*RF for the fire involving the impacted drums is 1.45E-3 (0.1*1E-2 + 0.9*5E-4). For overpack containers involved in these events the effective ARF*RF for a fire involving moderate impacted containers is 9.8E-4 (0.05*1E-2 + 0.95*5E-4) and for a fire involving low impacted containers the ARF*RF is 5.5E-4 (0.005*1E-2 + 0.995*5E-4). These ARF*RFs are also used for events where there is a collateral damage from falling debris and the building does not collapse in a seismic event.

Spill vs. Impact to Powders: There was some confusion regarding high- vs low-energy impact ARF/RFs as shown on DOE-STD-5506-2007, Table 4.5-1. The SBRT discussed the ARF/RF for impacting powders and concluded that the 1E-3 ARF/RF should only apply to high-energy impacts as discussed in section 4.5.3.2 of the standard. Section 4.5.3.1 on spills and low-energy impacts does not provide a basis for 1E-3 ARF/RF for low-energy impacts as implied by Table 4.5-1 (i.e., two values are not listed like they are for contaminated wastes in containers), and instead recommends that the 6E-4 free-fall spill value is bounding for this level of stress based on the spill experiments. Therefore, this is interpreted to apply to low-energy impacts. The introduction to section 4.5.3.2 distinguishes that stresses higher than those associated with spills and low-energy impacts warrant a higher ARF/RF. DOE-HDBK-3010 was researched for a basis for using 1E-3 ARF/RF for low-energy impacts to containers with powders, or using the 6E-4 ARF/RF from spills for such impacts, and did not find any relevant discussions. Instead, the DOE-HDBK-3010-94 discussion on page 4-9 and section 4.4.3.3.2 recommends 1E-4 ARF/RF for "powder held in cans failed by debris" as used in an example in its Section 7.3.1.2, which is also the same recommendation for large debris hitting uncontained bulk powders "due to the difficulty of deagglomerating powders" (both citations are on page 4-85). Since DOE-HDBK-3010 is recommended in DOE-STD-3009-2014, it takes precedence over release fractions recommended in DOE-STD-5506-2007 and can be applied even though it is less conservative than what DOE-STD-5506-2007 recommends.

Shielded Containers: The analysis in WIPP-032 concludes a reasonable estimate for the release fraction for shielded containers is 6.1E-08 and should be used in safety analysis calculations for long duration, fully engulfing pool fires, exposure fires, and all fires preceded by impact to the shielded container. Based on the DR discussion, all postulated fire event source terms can be broken into two sub-source terms (lid loss/content ejection and seal failure). Some events add a third part for vehicle/equipment impact.

Deflagration in a RH-Canister-Direct Loaded: Lid loss will not occur for a direct-loaded RH waste container with a welded lid, or the removable lid canister (RLC). The RLC has a very robust lid closure mechanism using grooved tabs (like the TRUPACT-II) and lock pins in lieu of bolting (DOE-STD-5506). The RLC lid closure mechanism could use a gasket (RH-TRAMPAC). The high temperature from the deflagration event could damage the gasket of the RH canister. The subsequent fire initiated by deflagration could cause a confined burn of the contaminated combustible waste of 240 PE-Ci (WIPP WAC Limit). Additionally, a subsequent fire will be limited by the availability of oxygen remaining after the deflagration or in-leakage through damaged seals (DOE-STD-5506-2007). In DOE-STD-5506-2007, an ARFxRF of 5.0 E-4 for confined burning and a DR of 0.5 and LPF of 1.0 are used in calculating a source term of 6E-2 PE-Ci and a fire DR of 0.1 is reasonable for a RH-TRU canister containing waste containers (e.g., three 30-gallon drums or three 55-gallon drums); therefore a DR of 0.5 is used for the RH Canister-Directly Loaded.

MOI Modeling Protocol: DSA section 3.4.1.6, Dose-per-Activity Modeling, addresses the development of a site-specific dispersion analysis to assess potential radiological consequences to the public. The approach is based on Option 3 from DOE-STD-3009-2014, Section 3.2.4.2. Public consequences are determined for a hypothetical MOI located at the site boundary, or farther distance of maximum consequence if an elevated or buoyant release is evaluated (no WIPP scenarios were elevated). The analysis is based on the approximate 2.9 km minimum distance to the public site boundary, rather than probabilistically weighting the analysis using the actual distances and meteorology for all 16 sectors.

The DSA Revision 5a dispersion analysis applies the previously DOE-approved DSA Revision 4 dispersion analysis that is based on MACCS2, a DOE Central Registry toolbox code. Guidance document DOE-EH-4.2.1.4, *DOE MACCS2 Computer Code Application Guidance for Documented Safety Analysis*, and additional requirements from DOE-STD-5506-2007 were applied. The dispersion analysis was recently revised to incorporate a site-specific determination of surface roughness and the dry deposition velocity for particulates, and was the basis for the DSA Revision 4 radiological consequence analyses. A series of calculation documents were prepared to support the current and previous revisions of the DSA to document how the dispersion analysis was performed.

In preparing DOE SERs for prior DSA revisions, and as part of the assessment of the basis for approval of the DSA, the SBRT reviewed the dispersion analysis and accepted its adequacy for calculating dose estimates to the public and the CW. Each of the revised DSAs was approved by the SBAA.

NWP submitted a WIPP modeling protocol for DOE approval (Letter: Robert L. McQuinn, NWP, to Jose R. Franco, CBFO, 4/30/2015, “Submittal of the NWP Dispersion Modeling Protocol,” AA:15:01072, UFC:1410.00). This submittal became WIPP-054, *WIPP Dispersion Modeling Protocol*. Since the DOE previously approved the dispersion analysis for the WIPP DSA, and NWP concluded the analysis met the requirements for an Option 3 dispersion modeling protocol, a “modeling protocol walkthrough” referencing the WIPP supporting engineering calculations was developed by NWP for approval by the SBAA.

The DOE SBAA approved the WIPP modeling protocol (Letter: Dana C. Bryson, CBFO, to Philip Breidenbach, NWP, 9/29/2015, “Department of Energy Concurrence with WIPP Dispersion Modeling Protocol”), which included a basis for approval as an attachment. The DOE basis for approval describes the DOE technical review of the Option 3 MOI dispersion modeling protocol and provides a basis and recommendation that the SBAA approve the modeling protocol as submitted.

The review of the modeling protocol for MOI dispersion analysis was performed by staff from the DOE Headquarters Office of Environmental Management Chief of Nuclear Safety, with support from core members of the SBRT. Since there are no specific review criteria or bases for approval for a modeling protocol in DOE-STD-1104-2014, the review approach was to address the technical adequacy of the submittal to meet the guidance in DOE-STD-3009-2014, section A.7, Dispersion Modeling Protocol.

The DOE Office of Nuclear Safety Basis and Facility Design (DOE AU-31) is developing additional guidance to meet the expectations of DOE-STD-3009-2014, Appendix A.7 for inclusion in a forthcoming *Hazard and Accident Analysis Handbook*. In the interim, a draft of that guidance was used to address 17 steps associated with an acceptable modeling protocol. Based on assessment of the 17 elements presented, the DOE determined that the WIPP modeling protocol addresses the section A.7 guidance of DOE-STD-3009-2014. In addition, the DOE concurs that the MOI dispersion analysis that is based on the 95th percentile dispersion factor assuming the minimum site boundary distance, and a ground level release, is conservative. The SBRT concludes that the WIPP modeling protocol meets the criteria and guidance provided in DOE-STD-3009-2014, and an adequate technical basis is provided for the receptor locations, meteorological data, modeling tools, and modeling parameters.

Further supporting approval of the modeling protocol, in 2008 the DOE documented its basis for approval in the SER for the CH-RH DSA Revision 0 of the initial application of the MACCS2 model and dispersion analysis, which included a review conducted for the SBRT by an independent SME in radiological dispersion analysis in the DOE Complex. In 2013, NWP used the same SME to provide an independent review of the changes in the surface roughness and deposition velocity parameters used in GENII and MACCS2, which was approved by DOE in the SER for the CH-RH DSA Revision 4.

As noted in the DOE assessments provided in the DOE basis of approval in the WIPP modeling protocol approval letter, NWP has committed to revising the WIPP-002, WIPP-010, and WIPP-

011 supporting documents and DSA Revision 5a to better align with DOE-STD-3009-2014 and specifically address the following:

- Update maps to incorporate additional information regarding site- and facility-specific elements, including clarifying the site map to show the location of the MOI, clarifying the site boundary distances for each sector, and providing a local map that highlights local land use (Topic #4).
- Clarify the location of the meteorological towers on the site map (Topic #8).
- Identify the types of accidents that correspond with each different release duration. The different accident types were clarified and, as explained in the "WIPP Assessment" in the submitted modeling protocol, justification is being developed to support modeling 2-hour releases from supporting ventilation flow calculations for the UG and Waste Handling Building (Topic #12). Note, however, that a subsequent decision was made to model the WHB releases as one-hour releases.
- Ensure MACCS2 models plume meander by incorporating an expansion factor that is calculated based on release duration (Topic #13). Of note, the justification for release durations provided in Topic 12 would also support the justification for plume meander. With the justification in Topic #12, the information provided is adequate for assessment of the dose consequences to the MOI. See below discussion on release duration.

The SBRT SMEs reviewing the MOI modeling protocol concurred with the M&O contractor's proposal to address resolution of these comments in future updates to the supporting MACCS2 analyses. The resolutions do not affect the dispersion results and use in developing the unit dose conversion factors (rem/Ci released).

Release Durations: One of the parameters for input to the MACCS2 dispersion model is a release duration, which has the effect of crediting plume meander that lowers the centerline concentration and radiological dose estimates as a function of travel distance. The WIPP scoping calculations of unmitigated dose to the CW and MOI assumed four release durations:

1. Two hours release duration for most releases from the UG and the WHB when not breached by the accident;
2. Twenty minutes for those accidents that breach the WHB and for upcasting from the Waste Hoist Shaft due to a fire event;
3. Eight hours for release from a closed panel; and
4. Three minutes for the Beyond DBE evaluation of collapse of the WHB.

The treatment of release durations in the MACCS2 code for all but the 8-hour release is discussed in WIPP-002 Revision 3 (revised to address release durations, compared to Revision 2 that was submitted with the MOI Modeling Protocol) and WIPP-010 Revision 1. The 3-minute release duration assumption for a collapsed structure represents an instantaneous release and is consistent with the MACCS2 time base input parameter, which is associated with the horizontal and vertical dispersion coefficient models chosen for the WIPP evaluation.

The 2-hour release duration is based on the nominal assumption recommended in DOE-STD-3009-2014, section 3.2.4.2. The 2-hour assumption was initially established by DOE in Change Notice 1 to DOE-STD-3009-1994 issued in 2000 that provided guidance for dispersion and dose assessment to evaluate the unmitigated dose to the MOI for comparison to the 25 rem Evaluation Guideline. Neither version of Standard 3009 provides a technical basis for the 2-hr assumption. DOE-STD-3009-1994, Change Notice 1 referred to the application of the NRC

Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*.

Regulatory Guide 1.145, and NUREG/CR-2260, *Technical Bass for Regulatory Guide 1.145*, do not provide a technical basis for 2-hour release duration. However, the purpose of those documents was to evaluate releases from nuclear power plants for compliance with 10 CFR 100. Regulatory Guide 1.145, section 1.3, "Calculation of χ/Q Values at Exclusion Area Boundary Distances," states: "Relative concentrations that can be assumed to apply at the exclusion area boundary for 2 hours immediately following an accident should be determined.[4]" Footnote 4 referenced 10 CFR 100.11, "Determination of exclusion area, low population zone, and population center distance," and its Section 100.11(a)(1) states "An exclusion area of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 25 rem[2] or a total radiation dose in excess of 300 rem[2] to the thyroid from iodine exposure."[3]. Therefore, the original basis for 2-hour release duration is to establish an exposure period for the MOI dose calculation as established by the NRC regulation. It appears that for evaluation of releases from an accident at a nuclear power plant, the NRC requirement inherently assumes that the public would not be exposed to a longer duration release (e.g., would be protected by the site's emergency plan).

Since an unmitigated analysis is not a "parking lot" scenario and DOE-STD-3009-2014 allows crediting passive design features in order to establish a meaningful scenario, a release inside a building without crediting an active ventilation system will take an extended time to migrate from the building. Assuming the nominal 2-hr release duration as recommended in DOE-STD-3009-2014 for unmitigated releases from a building without crediting ventilation is conservative and compliant with the most recent DOE guidance.

The SBRT questioned whether the 2-hr release duration is conservative for an instantaneous or short-duration release such as from a drum deflagration or loss of confinement accident due to vehicle impact or puncture by a forklift tine. In response, a calculation was developed for the WHB, *WHB CH Airborne Contamination Clearance Rates* (ETO-B-183), to justify that the 2-hr release duration would be conservative. This calculation evaluated the effect of active ventilation on the release rate as a more conservative approach than assuming natural air exchange with the ambient environment as the driving mechanism for the release. A simplified exponential dilution model based on the volume of the CH Bay and air exchange rate was developed to estimate the air clearance rate. Even though this calculation assumes that the exhaust HEPA filters, prefilters, and roughing filters are not installed, relying on exhaust fans running could be viewed as not consistent with a DOE-STD-3009-2014 unmitigated analysis. However, the alternative is to assume no active ventilation, in which case only leakage from the WHB would occur as driven by air exchange due to ambient atmospheric conditions outside the building and those ambient conditions inside the WHB. For that type of unmitigated analysis, the DOE-STD-3009-2014 nominal 2-hour release duration is conservative.

The WHB air clearance calculation served as additional confirmation that with forced ventilation and no filtration (i.e., all filters absent), it demonstrated that it takes a significant amount of time for most of the release to vent from the WHB. The exponential dilution model is similar to what is recommended by the NRC in NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, for the airflow input to its derivation of a leakpath factor code to evaluate in-facility transport (other phenomena such as deposition are included in that model).

[3] That requirement applied to license applications prior to 1/10/97; after that time, 10 CFR 100.21 "Non-seismic siting criteria," § 100.21(c)(2), requires an equivalent 2-hr requirement as stated in 10 CFR 50.34 "Contents of applications; technical information," § 50.34(a)(1)(ii)(D)(1).

The dilution model shows that approximately 53% of the airborne is released in 20 minutes, 90% within 1 hour, and 95% within 1.3 hours. The SBRT requested a review of the calculation by ventilation system SMEs from DOE/ORP and DOE/RL, who concurred that the 2-hour release duration would not be conservative and offered recommendations to address the concern (Zachary Peterson, Elaine Diaz, and Mark Hahn, *Ancillary Review of Waste Isolation Pilot Plant Ventilation Calculation Conservatism Regarding A 2-Hour Environmental Release Duration,* Revision 1, 3/14/2016).

NWP considered the DOE SMEs' recommendations and reduced the release duration assumption to 1-hour for releases from the WHB if not breached for evaluation of the MOI unmitigated consequences. Assuming that 100% of the release occurs within 1-hour is viewed by the SBRT as sufficiently conservative, and is more conservative than the nominal 2-hour release duration recommended in DOE-STD-3009-2014 for unmitigated analysis. NWP revised the scoping calculations to document the change in assumption and that significant releases over shorter periods are bounded by the 1-hour assumption based on how the MACCS2 accounts for time in the plume meander equation.

A similar calculation was developed for releases from the UG, WIPP-055, *Airborne Release Rate to the Environment from an Acute Underground Event with No Filtration*. A model was developed based on the February 14, 2014, radiological release by statistical analysis of the effluent sampling data at Station A at the surface prior to the HEPA filters. It applied an exponential dilution model similar to the WHB air clearance model, but addressed additional considerations such as a direct release from Panel 7, Room 7, an indirect release from other locations, and resuspension of deposited contamination as the plume traveled to the surface. However, one of the constraints of the analysis is that it was based on 60 kcfm total flow from the UG, and noted that the model would be affected by higher flows. With the addition of the IVS to increase flow to about 114 kcfm, and since an active disposal room will have between 40 to 60 kcfm rather than the very low flow that occurred during the February 14, 2014 radiological release after switch to filtration, the air clearance rate would be faster than the model predicts.

That model cannot be easily adjusted for the higher flow. As demonstrated by the release event, it may take a long time for the leading edge of a contaminated plume to travel to the surface, which allows for a significant amount of mixing with the volume of the UG along the transport path that in effect will elongate the contaminated plume in the UG and prolong the release. Rather than relying on an adjustment to the WIPP-055 model, if that is technically feasible, application of the 2-hour release duration assumption from DOE-STD-3009-2014 is considered conservative since without active ventilation, the emission would be expected to occur very slowly due to ambient atmospheric conditions at the surface and in the UG (via any of the four shafts).

An 8-hour release duration was only used for one scenario involving release from a closed panel, and was calculated based on interpolation of MACCS2 outputs from the 2-hour release duration results. This is documented in WIPP-051, Revision 3, section 3.8. The equation was derived from Equation 2.17 for plume meander together with Equations 2.37 and 3.11 from the MACCS Model Description document. The plume meander equation in the MACCS document is expressed in terms of the effect on the lateral dispersion coefficient and the other two equations demonstrate that the plume centerline concentration and inhalation dose (dominant contributor to the TED) are inversely proportional to the lateral dispersion coefficient. Therefore, the TED plume meander equation used in the interpolation mirrors the plume meander in the MACCS document, but with TED parameters replacing lateral dispersion coefficient parameters and with the exponent set to a value of -0.25 for release durations greater than 1 hour, with the negative sign to account for the relationship to plume concentration. This resulted in an 8-hour TED of 184 rem/Ci and 0.78 rem/Ci for CW and MOI, respectively. The SBRT concluded that these results were reasonable, and within the range of what MACCS2 would generate if the model was run for the 8-hour duration.

Atmospheric Dispersion for Co-located Worker: For evaluation of the CW at 100 m from the WHB, the default χ/Q value of 3.5E-3 s/m^3 as required by DOE-STD-3009-2014 is applied. This is appropriate due to the substantial size of the WHB associated with the application of the default value. For evaluation of the CW at 100 m for a release from the UG, the default χ/Q value is not appropriate due to the small size of the exhaust plenum, consistent with the guidance in DOE-STD-3009-2014 for modeling releases without a substantial structure. Therefore, the MACCS2 code was used to model the 100 m dose, which results in a more conservative χ/Q than the default value. A ground level release is assumed.

The following are the conservatisms used in the site specific modeling protocol for onsite worker at 100 meter:

- Used highest unit curie dose value from the 5 year of meteorological data instead of average of the 5-year value recommended by DOE-STD-3009-2014
- ICRP-72 value used for worker (@ 100 m) instead of ICRP-68 value recommended by DOE-STD-3009-2014
- One micron activity median aerodynamic diameter (AMAD) Pu-239 particle used for worker doses instead of 5 micron AMAD Pu-239 particle.

Radiological Dose Estimates: The following information is from WIPP-002, Revision 3, updated slightly when referencing DOE-STD-3009-2014. The assumed breathing rate (BR) is 3.33E-3 m3/s as required by DOE-STD-3009-2014. The cloudshine EDE and groundshine EDE dose conversion factors within the file are taken on Federal Guidance Report 12. The inhalation and ingestion CED dose conversion factors within the file are based on the International Commission on Radiological Protection (ICRP) Publication 72 in accordance with DOE-STD-3009-2014. The ICRP 72 values were taken from the ICRP issued compact disc dose coefficient database. From the compact disc database, the inhalation and ingestion CED dose conversion factors were maximized for conservatism. The inhalation CED value chosen was that for an adult exposed to 1 micron AMAD particles of plutonium in an unspecified chemical compound (Type M lung absorption class). The inhalation CED DCF for Pu-239 (Type M, 1 micron) is 5E-5 Sv/Bq. Although not used in the analysis, the highest plutonium-239 ingestion CED value was selected.

Accident Analysis Results

As stated in the introduction to this section, only two of the 47 bounding hazard events were selected from the hazard evaluation as EBAs for the purpose of safety-class SSC or SAC determinations for protection of the public. These two EBAs involve a liquid-fuel pool fire from a drop down the Waste Shaft, and a drop of a forklift carrying a facility pallet of waste down the Waste Shaft impacting waste on the Waste Conveyance at the Waste Shaft Station.

Drop of Liquid Fuel and Pool Fire at Bottom of Waste Shaft EBA: The DSA hazard evaluation of event CH/RH-UG-01-005a1 was a representative event for a pool fire at the Waste Shaft Station resulting from the drop of liquid-fuel (e.g., forklift, forklift with 300-gallon diesel tank) down the Waste Shaft while waste is present. This is an operational fire event that occurs at the bottom of the waste shaft during emplacement of waste assemblies. This event considers that a facility pallet of waste assemblies is sitting on the waste conveyance at the bottom of the waste shaft waiting to be transported for its final emplacement in the UG.

An inadvertent drop of a liquid-fuel source onto a loaded Waste Conveyance, pool formation, and ignition was qualitatively assessed as extremely unlikely, with high unmitigated consequences to CWs and facility workers, and moderate consequences to the public. Credited preventive controls in the mitigated hazard analysis reduced the likelihood to beyond extremely unlikely. However, since the unmitigated consequence to the MOI could exceed the 5 rem threshold as identified in DOE-STD-3009-2014 section 3.3.1, this hazard event warrants further evaluation in the accident analysis to determine the need for safety class controls.

The DSA hazard evaluation documented the basis for the unmitigated extremely unlikely determination which was primarily due to the Waste Shaft Access Configuration IC that prevents direct access to the Waste Shaft. This event was conservatively evaluated as an extremely unlikely event although, in addition to the credited control, multiple features such as the shaft access doors, fences, and upended rails protect entry to the Waste Shaft Collar. When downloading waste, liquid-fueled vehicles and equipment are not allowed in the CLR, and once the Waste Conveyance is loaded, the Conveyance Loading Car is removed from the conveyance, the chain link gate at the Waste Shaft is closed, and Door 156 is closed prior to lowering the conveyance. The door remains closed until the conveyance is off-loaded at the Waste Shaft Station. The process deviation to result in this event would consist of a sequence of many unlikely human actions or errors for which there is no reason or motive. DSA section 3.4.3.1.1 amplifies the sequence of activities involved and their estimated durations to accomplish, and concluded that it would require 27 to 38 minutes to accomplish the activities (with intentional pre-staging of required equipment) when only 10 to 15 minutes is expected to be available. A directed change (see SER section 5) requires a correction of the basis given in DSA section 3.4.3.1.1 for the unmitigated extremely unlikely frequency to include the waste access configuration IC.

In the event that a vehicle and/or equipment managed entry into the Waste Shaft while a loaded Waste Conveyance was present, the fall of the object would be attenuated through intermittent contact with the shaft, any liquid would be disbursed, and the substantial metal structure of the Waste Conveyance itself would prevent or significantly limit any damage to the waste containers themselves. Impact of the waste containers is considered to be a high-speed crush and the dispersal of liquid fuel during the fall or its impact with the Waste Conveyance prevents formation of a significant fuel pool but could cause burning of some fuel and waste.

The MAR in the event involves a loaded CH facility pallet or an RH waste cask. The IC of the RH facility cask/LWFC limits the RH contribution to the event consequences, the WIPP WAC IC ensures the waste constituency and its confinement within a metal container of sound integrity.

The bounding ST for this event involves one CH facility pallet with SWB-OPs. The SRS statistical MAR analysis from DSA Table 3.4-2, is used in the methodology recommended by DOE-STD-5506-2007. The first SWB-OP is at the inventory limit of 1,200 PE-Ci, the second container has a 95th percentile value of 603 PE-Ci, while the other two SWB-OPs involved are at the average MAR of 154 PE-Ci. The SWB-OPs damaged by the impact are given a DR of 0.5 and a DR of 1.0 for their subsequent unconfined and confined burning.

The SWB-OPs impacted by the crush are given an ARF*RF of 2E-3 with a subsequent effective ARF*RF of 7.38E-4 for 2.5% unconfined burning, as justified in an appendix to WIPP-001. An LPF of 1 is assumed for the unmitigated analysis. The resultant source term for this postulated event is 3.6 PE-Ci.

This event could result in a chimney effect up the waste shaft, therefore a 20-minute TED release value of 2.0 rem/Ci is used for the MOI. The unmitigated inhalation radiological dose to the MOI is 7.3 rem (WIPP-001). This slightly exceeds the 5 rem threshold of DOE-STD-3009-2014 for challenging the 25 rem Evaluation Guideline.

No preventive engineered feature is identified. The following administrative preventive SAC reduce the likelihood of this event from extremely unlikely to beyond extremely unlikely:

- Once the Waste Shaft Conveyance is loaded with waste, the Waste Shaft Access Door 156 shall be closed and remain closed while waste is present in the Waste Shaft. This reduces the likelihood for vehicles, equipment, and/or loads to drop down an open Waste Shaft into the shaft sump.
- The aboveground liquid-fueled vehicles are prohibited from being present in the Waste Shaft Access Area when CH waste is present.

The DSA concluded that:

> "The above administrative preventive SAC provides a safety significant function because the MOI dose of 7.3 rem which slightly exceeds the 5 rem threshold for MOI. The use of conservative DRs, ARF*RF, and the release duration used for dispersion analysis supports the conclusion of controls not requiring a classification of SC."

After extensive comment-resolution interactions with the DSA authors, the SBRT concurs with the above accident analysis and the justification that safety class controls are not required.

Drop Down Shaft EBA: The DSA hazard evaluation of event CH/RH-UG-10-005a is the representative event for a loss of confinement at the Waste Shaft Station resulting from the drop of a vehicle or equipment (e.g., forklift) down the Waste Shaft causing a radiological release. This event considers that a facility pallet of waste assemblies is sitting on the waste conveyance at the bottom of the waste shaft waiting to be transported for its final emplacement in the UG. The bounding scenario for this loss of confinement in the waste shaft is dropping a forklift with a waste pallet onto a waste pallet sitting on the waste conveyance at the bottom of the waste shaft. The falling payload and its associated vehicle would impact the steel structure on top of the waste conveyance and then the waste containers on the conveyance would have a high stress. They could subsequently free fall another 100 feet to the bottom of the waste shaft.

An inadvertent drop of a forklift carrying a facility pallet of waste falling onto a loaded Waste Conveyance was qualitatively assessed as extremely unlikely with high unmitigated consequences to co-located workers and facility workers, and moderate consequences to the public. Credited preventive controls in the mitigated hazard analysis reduced the likelihood to beyond extremely unlikely. However, since the unmitigated consequence to the MOI could exceed the 5 rem threshold as identified in DOE-STD-3009-2014 section 3.3.1, this hazard event warrants further evaluation in the accident analysis to determine the need for safety class controls.

The DSA hazard evaluation documented the basis for the unmitigated extremely unlikely determination which was primarily due to the Waste Shaft Access Configuration Initial Condition that prevents direct access to the Waste Shaft, although the EBA analysis also states that the sequence of activities that must transpire for this event to occur with CH Waste are similar to the ones discussed above for the Drop of Liquid Fuel and Pool Fire at Bottom of Waste Shaft EBA where instead of a fuel tank, a waste pallet is dropped. A directed change (see SER section 5) requires a correction of the basis given in DSA section 3.4.3.2.1. for the unmitigated extremely unlikely frequency to include the waste access configuration IC.

The MAR involved in the event involves two CH facility pallets or two RH waste canisters. The IC of the RH facility cask/LWFC limits the RH contribution to the event consequences, the WIPP WAC IC ensures the waste constituency and its confinement within a metal container of sound integrity.

The bounding source term for this event involves two CH facility pallets with SWB-OPs. The SRS statistical MAR analysis from DSA Table 3.4-2 is used in the methodology recommended by DOE-STD-5506-2007. The first SWB-OP is at the inventory limit of 1,200 PE-Ci, the second container has a 95th percentile value of 603 PE-Ci, while the other six SWB-OPs involved are at the average MAR of 154 PE-Ci. Half of SWB-OPs have a DR of 1.0 (for impact from drop down the shaft) and the others have a DR of 0.5 for catastrophic stress, similar to the damage expected from collapse of a substantial construction building per the DOE-STD-5506-2007 DRs.

The falling payload and its associated vehicle would impact the steel structure on top of the waste conveyance. The ARF*RF for this scenario is 2E-3 for a high energy stress of contaminated combustible solids, and applies to both the SWB-OPs falling onto the Waste Conveyance and the SWB-OPs on the Waste Conveyance being crushed. An LPF of 1 is assumed for the unmitigated analysis. The resultant source term for this postulated event is 4.8 PE-Ci.

The direction of airflow is normally down the Waste Shaft during waste emplacement, however, the unmitigated analysis does not credit the active UVFS/IVS and assumes that the release exits up the waste shaft over two hours, and applies the 1.1 rem/Ci TED release value to estimate dose to the MOI. The unmitigated inhalation radiological dose to the MOI is 5.3 rem (WIPP-017). This slightly exceeds the 5 rem threshold of DOE-STD-3009-2014 for challenging the 25 rem Evaluation Guideline.

There are no preventive engineered features for this event. Instead, an AC is credited with reducing the likelihood for the event 1 frequency bin. This control selection is due to the sequence of barriers (e.g., access doors, gates, pivot rails) which must be aligned and administrative actions required to be taken by the toplander to provide access to an open waste shaft. Therefore, a full frequency bin reduction is taken for this AC and the mitigated frequency of this event is reduced to beyond extremely unlikely. The following administrative preventive SAC reduces the likelihood of this event from extremely unlikely to beyond extremely unlikely:

- Once the Waste Shaft Conveyance is loaded with waste, the Waste Shaft Access Door 156 shall be closed and remain closed while waste is present in the Waste Shaft. This reduces the likelihood for vehicles, equipment, and/or loads to drop down an open Waste Shaft into the shaft sump.

This control is credited with reducing the event likelihood due to the sequence of barriers (e.g., access doors, gates, pivot rails) which must be aligned and administrative actions required to be taken by the toplander to provide access to an open waste shaft. Therefore, a full frequency bin reduction is taken for this control, and the mitigated frequency of this event is reduced to beyond extremely unlikely.

The DSA concluded that:

> "The above administrative preventive SAC provides a safety significant function because the MOI dose of 5.3 rem which slightly exceeds the 5 rem threshold for MOI. The use of conservative DRs and ARF*RF supports the conclusion of controls not requiring a classification of SC."

After extensive comment-resolution interactions with the DSA authors, the SBRT concurs with the above accident analysis and the justification that safety class controls are not required.

<u>Accident Analysis Conclusions:</u> The SBRT reached the following conclusions regarding the accident analysis of Design/Evaluation Basis Accidents:

- Accident analysis is performed for an adequate set of design/evaluation basis accidents having unmitigated offsite consequences that have the potential to challenge the Evaluation Guideline. Only one fire and one shaft drop EBA slightly exceeded 5 rem to the MOI.

- The accident analysis methodology, as well as the hazard analysis methodology, is clearly identified and appropriate, including identification of initial conditions and assumptions.
- The technical basis for source term values is provided, valid, and appropriate for the physical situation being analyzed, for the EBA presented in DSA section 3.4 of the accident analysis, as well as in scoping calculations to estimate the dose to the co-located worker and MOI to assign qualitative consequence levels for the hazard evaluation in WIPP-021 and summarized in DSA section 3.3. The scoping dose calculations provided adequate technical justifications for parameters that were not provided in, or departed from, the default or bounding values described in DOE-STD-3009-2014, DOE-HDBK-3010-94, and DOE-STD-5506-2007. Supporting calculations and technical documents are identified, and were reviewed for critical aspects of safety controls, including ICs, where appropriate.
- Accident analysis clearly substantiates the findings of hazard analysis for the design/evaluation basis events.

Probabilistic risk assessments, related tools, and probabilistic calculations were not used in a manner subject to the applicable provisions of DOE-STD-1628-2013, *Development of Probabilistic Risk Assessments for Nuclear Safety Applications*, to supplement the qualitative/deterministic processes for hazard and accident analysis and selection of preventive and mitigative controls.

3.3.6. Defense-in-Depth

The DOE technical review of the adequacy of defense-in-depth focused on information presented in DSA section 3.3.2.4. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- Determining the adequacy of defense-in-depth rests on being able to conclude that postulated events and accidents are controlled with appropriate levels of defense-in-depth that are applied such that several layers of protection are used to prevent the release of radiological or hazardous materials to the environment.
- Non-safety significant controls on the hazard evaluation tables that constitute “other hazard controls” per DOE-STD-3009-2014, section 3.3.3 are appropriately identified.

Defense-in-depth controls are also identified in DSA/TSR Revision 5a as required both to provide added assurance of worker protection (both facility workers and CWs) and to minimize any facility radiological release to protect the public and the environment. DSA section 3.3.2.4 summarizes the defense-in-depth approach to hazard controls, which include layers of protection provided by safety significant SSCs, SACs, and SMPs. The safety significant SSCs and SACs are described and evaluated in DSA Chapter 4.0, carried forward to Chapter 5.0, and protected in the TSRs. The SMPs and associated key elements are also carried forward to the TSRs. The TSRs impose controls to protect the ICs, SSCs, SACs, and SMPs that provide protection for all receptors.

The DSA describes the specific controls credited for protection for workers and the MOI as either preventing or mitigating each event as identified in WIPP-021 hazard analysis, and that the remainder of the preventive and mitigative features for a specific event identified in the hazard evaluation tables provide defense-in-depth for that event. Not all available design or administrative features are credited. Features were selected based on providing the greatest protection for workers and the MOI, and additional controls were selected if required to prevent/mitigate different initiators for representative events within the hazard evaluation. The DSA section 3.3.2.5 on facility worker safety also noted that SMPs, such as Radiation Protection, Operational Safety, Training, and Emergency Preparedness, provide additional defense-in-depth for protection of workers.

The DSA also states that SMPs summarized in DSA Chapters 7.0 through 18.0 support the defense-in-depth strategy by establishing programmatic and facility-specific requirements that directly or indirectly help to ensure an acceptable level of safety at WIPP. These programs and requirements directly influence safety by ensuring that the facility and systems are designed, constructed, and maintained to acceptable standards, the facility hazards are understood and controlled to protect the workers, measures are taken to prevent accidents, and properly qualified and trained personnel are responsible for facility operation. The SMP chapters identify Key Elements to be addressed by these programs to ensure protection of workers. These Key Elements are summarized in the DSA section 3.3.2.5, Facility Worker Safety, and are identified in each of the SMP chapters.

The SBRT concludes that the defense-in-depth and the facility and co-located worker safety discussions in DSA sections 3.3.2.4 and 3.3.2.5 appropriately capture “other hazard controls” as discussed in DOE-STD-3009-2014 section 3.3.3, without specifically calling them out as such. No additional controls are being imposed by this SER. The DOE expectation is that these other hazard controls will be managed per SMPs.

The DSA evaluated the remaining controls that were not specifically credited to reduce the unmitigated likelihood or consequences for at least one event, and concluded that none were determined to be a major contributor to defense-in-depth. Therefore, no additional controls beyond those identified in section 3.3.2.3 were designated as safety significant SSCs or SACs. The SBRT concurs with this conclusion that no additional controls meet the “significant contribution to defense-in-depth” criterion for safety significant controls based on the DOE-STD-3009-2014 selection criteria.

For the DSA, a worker is defined as any person onsite, including workers in the WHB and UG, workers in other buildings onsite, and visitors under access control. The DSA section 3.3.2.5 summarizes that the hazard evaluation for TRU Waste Handling identified a number of Waste Handling process hazards that could potentially result in worker injury or exposure to radiological and non-radiological HAZMAT, and that reduction of the risk to workers from accidents is accomplished at the WIPP primarily by SSCs (active and passive) and ACs that reduce the frequency or consequences of hazardous events. This is consistent with 10 CFR 830.205 and the defense-in-depth philosophy. Applicable controls specifically providing protection to both facility and co-located workers were selected in the hazard evaluation for each of the major release categories. See section 3.3.4 of this SER for a summary of credited controls to protect the workers, MOI and environment.

DSA section 3.3.2.6 notes that the potential for radiological releases is minimized by those preventive and mitigative design features and administrative controls identified in section 3.3.2.3, including safety SSCs, SACs, and other hazard controls. The features that provide defense-in-depth also provide environmental protection. Additional protection from hazardous materials and waste is described in DSA Chapter 8.0. The SBRT concurs that environmental protection was adequately addressed in the DSA per the DOE-STD-3009-2014 expectations, and that there are no other pathways that required evaluation for protection of the environment. One of the most significant changes regarding environmental protection is the TSR requirement for UVFS/IVS filtration during waste emplacement in the UG.

The SBRT concludes that postulated events and accidents are controlled with appropriate levels of defense-in-depth that are applied such that several layers of protection are used to prevent the release of radiological or hazardous materials to the environment. These defense-in-depth controls along with credited safety significant SSCs and SACs, provide adequate protection of workers, the public, and the environment by preventing or mitigating potential hazard events or accidents.

3.3.7. Beyond Design/Evaluation Basis Accidents

The DOE technical review of the adequacy of Beyond Design/Evaluation Basis Accidents (Beyond D/EBA) focused on information presented in DSA section 3.5. Overall, the SBRT gave consideration to whether the following expectation was met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- Beyond Design/Evaluation Basis Accidents are adequately considered in the DSA. If mitigated off-site dose estimates for postulated D/EBA accidents are close to the Evaluation Guideline, impacts from a spectrum of accidents are presented (i.e., as opposed to only evaluating seismic hazards) along with a discussion of controls and actions available to mitigate consequences. Note: For more complex facilities, it is acceptable for these accidents to be described in a separate, controlled document that is referenced in the DSA.

The DSA section 3.5 evaluates Beyond EBAs which are those accidents with more severe conditions or equipment failures than are estimated for the corresponding design/evaluation basis accident in DSA section 3.4, or hazard events evaluated in the DSA section 3.3. The DSA evaluated four Beyond EBAs:

1. NPH events that would be beyond the design basis of the WHB that results in a building collapse, including a seismic event with a subsequent fire, and an NPH event leading to a Waste Shaft Tower collapse;
2. Failure of multiple noncompliant containers;
3. Exothermic reactions in the WHB, during transport, or in an active disposal room; and
4. UG Collapse/Catastrophic Roof Fall

The DSA concluded that the Beyond EBA evaluation shows that there are no cliff edge effects, and that the highest radiological consequence to the MOI is 4.3 rem; therefore there is no need for cost-benefit evaluation of improvements, modifications, or enhanced emergency management response capabilities.

The radiological consequence analysis was the same as that used for the EBA analysis with the exception of changing the dispersion to average conditions rather than the 95th percentile. This is consistent with the guidance in DOE-STD-3009-2014. This lowered the MOI estimated dose by about a factor of 3. With appropriate adjustments for the difference in dispersion analysis assumptions, insights from the Beyond EBA calculations were also used to determine the safety significance of credited ICs such as the WHB not collapsing due to NPH events (see section 3.3.3 above).

The SBRT concludes that Beyond Design/Evaluation Basis Accidents are adequately considered in the DSA and concurs with the DSA evaluation.

3.3.8. Planned Design and Operational Safety Improvements

The DOE technical review of the adequacy of planned design and operational safety improvements focused on information presented in DSA section 3.6. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- Where planned operational improvements are identified in the DSA, interim controls are identified if required to provide adequate protection, and assigned appropriate safety classification.
- Corrective actions committed in response to the February 2014 fire and radiological release events are evaluated and determined to be: 1) required by the new DSA; 2) deferred as operational improvements with adequate justification; or, 3) justified as not significant for the DSA.

DSA section 3.6 addresses planned operational improvements:

- Upgrading of differential pressure instrument loops reporting to the CMR to address vulnerabilities identified during the backfit analysis.
- Installation of CAMs at the entrance and exit of Panels 6 and 7 (total of 4 CAMs) that communicate with the CMR.
- Installation of protective fire barrier (e.g., fire retardant insulation, curbing) for WHB steel support columns located near CH/RH Bay roll-up door, as required. (Note that a DSA requirement for an attendant affords an accepted compensatory measure until this upgrade is in place).
- Evaluate the WHB fire suppression system vulnerability identified in DSA Table 4.4.3-2 related to overall system demand during fire hydrant testing, and implement system or operational improvements as necessary.
- Upgrading the WIPP fire water supply and distribution system (e.g., supply tank, fire pumps, pump house, fire water supply lines) to meet DOE O 420.1C, *Facility Safety*, DOE-STD-1066-2012, *Fire Protection*, and current national fire codes.

In addition, the following longer term option is being pursued but is recognized to be contingent upon DOE approval of the budget and project management baseline:

- A longer-term permanent ventilation system that will significantly improve the UVFS HEPA filtration capacity to support normal UG operations. The two options currently being considered for the permanent ventilation system are: (a) new exhaust shaft for mining operations and use of the existing exhaust shaft with additional filtration capacity for full waste disposal operations; and (b) existing exhaust shaft with filtered ventilation sufficient for full mining and waste handling operations.

The DSA also addresses the possibility that operational changes may be required in response to the February 2014 event and additional waste stream issues that may be identified in the DOE complex. These issues may include such items as oxidizers (RCRA D001) which led to the February 2014 radiological release event, high wattage waste, and POC/CCO confinement (containing combustible waste materials other than the radiological control materials and packaging materials normally used to load these containers). Analysis of issues is ongoing within the DOE Complex and resolutions are not well defined as of the issue date of this DSA. Therefore, WIPP is prohibiting receipt of these suspect waste streams and POC/CCOs through the WIPP WAC until resolutions are determined and new applicable analysis incorporated into this DSA and the WIPP WAC is revised to accept these materials again.

The SBRT concludes that appropriate planned improvements are summarized in the DSA, and that interim controls are identified to provide adequate protection including plans to revise the WAC and provisions in Chapter 18 to exclude suspect wastes pending completion of the WAC revision, if necessary.

Fire suppression systems that are being provided to support the Fire Protection exemption[4] to DOE Order 420.1C requirements for fire suppression throughout the underground are omitted, but their completion will be driven by the exemption itself. Exemption submission is planned to support initial implementation of DSA/TSR Revision 5a and the exemption approval is planned to support the restart of waste emplacement. Future startup of the SVS and the resumption of RH waste emplacement are to be addressed with future updates to the DSA/TSR Revision 5a and are judged to be adequately addressed elsewhere in the DSA, this SER, and the Authorization Agreement. No other planned improvements as related to the DSA hazard and accident analysis or derivation of TSR controls are deemed necessary for Revision 5a.

3.4. SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS (SSCs)

The DOE technical review of the adequacy of safety SSCs focused on information presented in DSA Chapter 4. Overall, the SBRT gave consideration to whether the following expectations were met consistent with DOE-STD-1104-2014 and DOE-STD-3009-2014:

- The safety SSCs are identified, described, and are consistent with the logic presented in the hazard and accident analyses.
- Safety functions for safety SSCs are defined with clarity and are consistent with the bases derived in the hazard and accident analyses.
- Safety systems are clearly described to include essential components needed to meet the safety function. The boundaries of safety SSCs and support systems are clearly defined and interfaces with other SSCs are described.
- Support SSCs are clearly described and designated as safety class or safety significant for cases where their failures prevent safety SSCs or SACs from performing their safety functions.
- Functional requirements and performance criteria are defined such that, when met, they ensure that the safety functions can be performed when needed.
- A system evaluation demonstrates that the system can meet applicable performance criteria thereby ensuring the functional requirements are met under postulated accident conditions (e.g., elevated temperatures and pressures) and the required safety functions are fulfilled. The evaluation contains an engineering evaluation with a supportable basis.
- Key assumptions are identified so that appropriate TSR protection can be developed or derived (such as in limiting conditions of operations (LCOs), design features, and SACs).

Safety-related SSCs are presented in DSA Chapter 4, Safety Structures, Systems and Components. Based on the results of the DSA hazard evaluation, no safety class SSCs were identified. A total of 14 safety-significant SSCs (five active and nine passive) are presented in DSA Table 4.4.1, Summary of Safety Significant Controls. Consistent with requirements of DOE-STD-3009-2014, the DSA table summarizes the safety functions, functional requirements,

[4] Installation of water based fire suppression equipment supplied from the surface is impractical given the elevation difference and the difficulty in dealing with a large water inventory once introduced into the UG; moreover, fire suppression throughout the UG is unnecessary given the non-combustible salt construction.

and performance criteria for each SSC, as well the hazard scenarios for which each SSC is credited.

A summary of the salient information from DSA Table 4.4.1, as well as results of system evaluations and the TSR attributes selected in DSA Chapter 4 are presented below in Table 3.4-1.

Table 3.4-1. Summary of Safety Significant SSCs

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
Waste Handling Building-Passive (DSA section 4.4.1)	To prevent radiological material releases due to seismic induced collapse of the Waste Handling Building (WHB).	The WHB is designed to withstand a DBE with 0.1 g peak ground acceleration (PGA).	Meets PC-2 criteria (0.06 g) of DOE-STD-1020-2002. Analytical basis referenced in the DSA. Basis in WIPP Calculation document 15-009 and M-07455080-Z.	• WHB NPH Design (Design Basis Earthquake with 0.1g PGA, Design Basis Tornado of 183 mph winds and straight line wind of 110, snow/ice load of 27 lb/ft^2) • TMF and Support Building designed and constructed to not affect WHB in NPH events • Non-combustible construction of external walls and curbing • Route to Waste Shaft prevents direct unencumbered path for vehicles
		The Transuranic Package Transporter (TRUPACT) Maintenance Facility (TMF) (Building 412) is designed to withstand a DBE with 0.1 g PGA.	Meets the DBE criteria. Analytical basis referenced in the DSA (CS-41-D-851 and CS-41-D-852).	
		The main lateral-force-resisting structural members of the Support Building are designed to withstand a DBE with 0.1 g PGA.	Meets the DBE criteria. Analytical basis referenced in the DSA (CS-45-D-481)	
	To prevent radiological material releases due to high winds, tornadoes, and/or wind /tornado generated induced collapse of the WHB.	The WHB is designed for DBT of 183 miles per hour (mph) winds with a translational velocity of 41 mph, tangential velocity of 124 mph, a maximum rotational velocity radius of 325 feet, a pressure drop of 0.5 pounds per square inch (psi) and a pressure drop rate of 0.09 psi per second.	Meets PC-2 criteria of DOE-STD-1020-2002. Analytical basis referenced in the DSA (CALC 15-009).	
		The WHB is designed to withstand straight-line wind of 110 mph, at 30 feet above ground.	Meets PC-2 criteria of DOE-STD-1020-2002. Basis referenced in the DSA (CALC 15-009).	
		The TMF (Building 412) is designed to withstand a DBT.	Meets DBT. Analytical basis referenced in the DSA (CS-41-D-802).	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
		The main lateral-force-resisting structural members of the Support Building are designed to withstand a DBT.	Meets DBT. Analytical basis referenced in the DSA (CS-45-D-481).	
	To prevent radiological material releases due to snow/ice roof loading induced collapse of the WHB.	WHB roof is designed to withstand 27 pounds per square foot (lb/ft^2) of snow/ice load.	Meets PC-2 criteria of DOE-STD-1020-2002 (10 lb/ft^2). Analytical basis referenced in the DSA (CALC 15-009).	
		TMF roof is designed to withstand 27 lb/ft^2 of snow/ice load.	Meets PC-2 criteria of DOE-STD-1020-2002 (8 lb/ft^2). Analytical basis referenced in the DSA (CS-41-D-124).	
		The Support Building roof is designed to withstand 10 lb/ft^2 of snow/ice dead load.	Meets PC-2 criteria of DOE-STD-1020-2002 (10 lb/ft^2). Analytical basis referenced in the DSA (ETO-Z-244).	
	To prevent radiological material releases due to propagating fires through the structure from externally initiated fires or through roof collapse from credible internal fire scenarios.	Construction of external WHB walls and curbing shall ensure external fires do not propagate to areas inside the building.	NFPA 804 compliant concrete curbing. FHA (WIPP-023) conclusions on fire propagation.	
		WHB shall not collapse as a result of credible fire scenarios.	Evaluated in WIPP-058. Vulnerability identified with structural columns in RH Bay. Operational improvements planned. Compensatory measure identified and protected in SAC.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	To prevent radiological material releases due to loss of confinement from vehicle/equipment drop down the Waste Shaft.	The route of vehicle/equipment to the Waste Shaft shall prevent a direct, unencumbered path to the Waste Shaft.	Right angle access to CLR from other rooms. Limited straight-line distance. Protection from Waste Conveyance SAC (Door 155 and 156 closures)	
Underground Vehicle Fire Suppression System-Active (DSA section 4.4.2)	To automatically detect and suppress developing stage fires associated with engine compartment and/or fuel and hydraulic line leaks, thereby reducing the likelihood of pool fires involving CH waste.	The FSS components shall be located in a position to preclude a direct impact vehicle collision.	Qualitative analysis based on positioning of FSS away from vulnerable impact areas and slow speeds of UG vehicles.	FSS on UG vehicles/equipment required by NFPA-122 hazard evaluation and selected for use in WSS when CH waste is present, in VEZ and when transporting CH Waste from VEZ to Waste Face, and other vehicles/equipment to be operated ≤ 200 feet of the CH Waste Face: • The detection system shall detect developing stage fires associated with the engine compartment and/or fuel and hydraulic line leaks. • Upon detection of a developing fire, the FSS shall discharge a fire suppressant into the engine compartment and designated heat source locations to extinguish the fire. • Upon activation of the extinguishing systems, the
		Automatic detection shall be designed and installed in accordance with NFPA 17, Chapter 9, "Requirements for pre-engineered systems."	NFPA 17 design requirements ensures required features are designed and tested in accordance with pre-engineered systems.	
		Automatic actuation of the fire suppressant shall be designed and installed in accordance with NFPA 17, Chapter 9, "Requirements for pre-engineered systems."	NFPA 17 design requirements ensures required features are designed and tested in accordance with pre-engineered systems.	
		Automatic shutdown of vehicle fuel delivery system shall be designed and installed in accordance with NFPA 17, Chapter 9, "Requirements for pre-engineered systems."	NFPA 17 design requirements ensures required features are designed and tested in accordance with pre-engineered systems.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
				engine shall shut down automatically.
WHB Fire Suppression Building-Active (DSA section 4.4.3)	To prevent a small fire from becoming a large fire causing the release of radiological materials in the WHB by detecting fires and discharging water on the affected area, thereby reducing the likelihood of large fires.	The WHB FSS shall be designed and installed in accordance with NFPA 13	Commensurate with DOE SS criteria for FSS. (Basis discussed in WIPP-023). One vulnerability noted on fire water pumping capability.	• One unobstructed flow path from Fire Water Storage Tank 25-D-001A to the applicable Process Area sprinklers. • Two fire pumps (45-G-601 and 45-G-602) with a capability to deliver ≥ 490 gpm to the Room 108 riser at ≥ 120 psig. • Fire pump auto-start capability at a set point ≥ 125 psig. • Greater than or equal to 72,180 gallons of fire water available in Fire Water Storage Tank 25-D-001A. • Level indication for Fire Water Storage Tank Loop 25F00601 (Level transmitter, 456-LT-006-001, CMR indicator, AK0601, and Local indicator, 456-LI-006-001)
		Flow path is unobstructed from the fire water supply to the two credited WHB risers.	Manually set and verified in accordance with NFPA 25. Analysis in ETO-Z-229.	
		Fire water pumping capability of 490 gallons per minute (gpm) at greater than or equal to 120 psig to the most demanding riser (Room 108) in the WHB.	Demand can't be met when considering firefighting hose usage. System vulnerability during hydrant testing. Analytical bases in WIPP-023, ETO-Z-229, ETO-Z-209, ETO-Z-230, ETO-Z-227.	
		Fire pump auto-start capability with a set point greater than or equal to 125 psig.	Calculated and referenced basis in ETO-Z-230.	
		Greater than or equal to 72,180 gallons of fire water available.	Basis related to tank capacity shown to have margin compared to required flow rates and duration required for the system.	
Facility Pallet-Passive (DSA section 4.4.4)	To prevent direct flame impingement on CH Waste Containers in a pool fire to mitigate a release of	Facility pallets shall be constructed of ASTM A240, Type 304 steel in a manner such that the pallet 1) has no through hole penetrations that would allow direct flame contact with the container surfaces, and 2) will support the weight of the CH waste container load in a pool fire.	Technical basis evaluated in WIPP-058. Meets structural requirements and assures drum exposures below 40 kw/m^2	Facility Pallets shall provide a stainless steel surface, excluding 8 tie-down penetrations, that provides a contiguous flame barrier preventing direct flame impingement on the bottom of the CH Waste Containers, and has a

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	radiological material.			robust construction.
Underground Ventilation Filtration System-Active (Section 4.4.5)	To mitigate the consequences of radiological material releases internal container fires or deflagrations, over-pressure, fires involving ordinary combustible materials, fires associated with fuel leaks near the Waste Face (limited in size due to other preventive controls) and loss of confinement events to acceptable levels by (1) filtering UG exhaust air prior to its release to the environment, and (2)	The UVFS/IVS HEPA filtration shall provide filtration efficiency of ≥ 99 percent when challenged with poly-dispersed aerosol particles with a diameter of 0.3-0.7 microns aerodynamic equivalent diameter.	Design adequacy assessment (09-BF1005) against DOE O 420.1C. ASME N510 efficiency Test.	• Minimum of one UVFS exhaust fan or two IVS exhaust fans in service. • Operable HEPA filter unit(s) in service and properly aligned with exhaust fan(s). • Differential pressure across each in service HEPA filter bank ≤ +3.89 inches w.g. and ≥ +0.31 inches w.g. locally. • In service HEPA filter unit efficiency of ≥ 99%. • Differential pressure ≤ -0.09 inches w.g. in the UG as measured across the 308 Bulkhead, which represents the air flow direction from E-140 towards E-300 and the Exhaust Shaft. • Differential pressure ≥ +0.14 inches w.g. in the UG Waste Shaft Station area as measured across the 309 Bulkhead during downloading of Waste Containers on the Waste Shaft Conveyance, which represents the airflow direction from between the 309 Bulkhead wall (W-30) to
		Differential pressure across HEPA filter banks of ≤ +4.0 inch water gauge (w.g.) and ≥ +0.20 inches w.g.	DP Value based on DOE-HDBK-1169-2003. Filter loading from fires evaluated in WIPP-058. Acceptable when considering Vehicle FSS operation. System evaluation in 09-BF1006)	
		The differential pressure across the 308 Bulkhead is ≤ -0.05 inches w.g. (defined as air moving from E-140 towards S-400 and the Exhaust Shaft) and verifying the flow direction entering the Active Disposal Room.	Design adequacy assessment (09-BF1000) against DOE O 420.1C. Ventilation modeling report	
		The differential pressure across the 309 Bulkhead is ≥ +0.05 inches w.g. (defined as air moving from the inside of the BH309 chamber to the Waste Shaft Station) during downloading of waste containers when the Waste Shaft Conveyance is in use to transport TRU Waste.	Design adequacy assessment (09-BF1001) against DOE O 420.1C. Ventilation modeling report.	
		Airflow shall be monitored at the intake of an Active Room while occupied.	Qualitative evaluation based on performance of BH 308. Ventilation modeling report.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	providing directional airflow toward the Waste Face and away from workers in an active Disposal Room.			S-400. • Airflow into the Active Room while occupied. • Operable differential pressure transmitters, CMR alarm indications, and local gauges. • One UVFS exhaust fan and two IVS exhaust fans in service during downloading of Waste Containers. • Airflow at Waste Shaft Station is towards the 308 Bulkhead.
WHB Confinement Ventilation System (DSA section 4.4.6)	To mitigate the consequences of radiological material releases from non-NPH fire events to acceptable levels by filtering air from the CH Bay, Room 108, or CLR prior to its release to the environment.	The CH WH CVS HEPA filtration shall provide filtration efficiency of > 99 percent when challenged with poly-disperse aerosol with 0.3-0.7 micrometer aerodynamic equivalent diameter.	Design adequacy assessment as part of DNFSB 2004-2 evaluation and backfit analysis (09-BF1003). ASME N510 efficiency test.	• One exhaust fan (41-B-816 or 41-B-817) in service. • One operable HEPA filter unit (41-B-814 or 41-B-815) in service. • Differential pressure across each in service HEPA filter bank less than or equal to +3.90 inches w.g. and greater than or equal to +0.30 inches w.g. locally. • In service HEPA filter unit efficiency of greater than or equal to 99%. • Differential pressure less than or equal to -0.04 inches
		Differential pressure across HEPA filter banks of ≤ 4 inches w.g.	DP Value based on DOE-HDBK-1169-2003). Filter loading from fires evaluated in WIPP-058. Acceptable when considering Vehicle FSS operation.	
		The TRUDOCK/TRUPACT-III Exhaust filtration shall provide filtration efficiency of ≥ 99 percent when challenged with poly-disperse aerosol with 0.3–0.7 micrometer aerodynamic equivalent diameter.	ASME N510 efficiency test.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
		The pressure in the CH Bay and Room 108 is ≤ -0.01 inches w.g. with respect to ambient air pressure.	Design adequacy assessment against DOE O 420.1C. Impacts from fires evaluated in WIPP-058.	w.g. in the CH Bay and less than or equal to -0.04 inches w.g. in Room 108, with respect to ambient outside air pressure. • Operable differential pressure instrumentation, CMR alarm indications, and local gauges. • Battery Exhaust System exhaust HEPA filter unit (41-B-979 and 41-B-834) efficiency of greater than or equal to 99%. • Differential pressure across each in service Battery Exhaust System HEPA filter bank less than or equal to +3.92 inches w.g. and greater than or equal to +0.28 inches w.g. locally.
Waste Hoist Brakes-Active (DSA section 4.4.7)	To prevent damage to TRU waste containers by reducing the likelihood of an uncontrolled Waste Conveyance movement that results in a loss of confinement	The brakes shall apply adequate pressure by the brake pads on the rotor disc to stop a maximally loaded conveyance within 30 feet of travel distance after application of the brakes.	Calculated and referenced basis (ETO-H-228). Capable of stopping conveyance design loads within 30 feet consistent with MSHA requirements.	The brakes shall apply adequate pressure by the brake pads on the brake disc to stop a maximally loaded conveyance within 30 feet of travel distance after application of the brakes. The Waste Hoist Brake System automatically applies the brakes upon loss of hydraulic pressure as a result of conveyance over
		The Waste Hoist Brake System automatically apply the brakes upon loss of hydraulic pressure due to loss of electric power, or conveyance over speed.	Calculated and referenced basis (ETO-H-228). Emergency dump valves fail safe and actuate upon loss of power. Over speed trip based on highly reliable mechanical Lilly Controller.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	and the release of radiological materials.	Brake pad material is ≥ 0.5 inch thick.	Brake pads can meet safety functions with as little as 0.5 inches per manufacturer. Newly installed are 1 inch.	speed or loss of electrical power. Brake pad material is greater than or equal to 0.5 inch thick.
Underground Fuel and Oil Storage Areas-Passive (DSA section 4.4.8)	To preclude or eliminate the flammable or combustible liquid hazard resulting in a pool fire or explosion at either storage location from affecting TRU Waste through the provision of a substantial separation distance.	The physical locations of the UG fuel and UG oil storage areas shall be located at or north of the S-90 Drift.	Location ensures over 300 feet between WSS and S-90 drift which is far greater than distance of fuel pool footprint. Incapable of reaching waste containers. Documented in WIPP-023.	The UG Fuel and UG Oil Storage Areas shall be located at or north of the S-90 Drift.
Waste Hoist Support Structure-Passive (DSA section 4.4.9)	To prevent a radiological material release due to an uncontrolled Waste Conveyance movement that results in a loss of confinement, a fire, or an NPH initiated failure	The Waste Hoist Support Structure shall be designed for the vertical load combination of dead load, maximum payload, and forces transmitted from the hoisting ropes and tail ropes during normal operation.	Load bearing components are compliant with 30 CFR 57 requirements and ANSI-M11.1 to support dead loads and conveyance design payload of 45 tons. Minimum breaking strength of ropes designed to a factor of safety of at least 5.9, which satisfies MSHA requirements	The Waste Hoist Support Structure has robust non-combustible steel components and is designed to support the Waste Hoist and a maximum load conveyance under all normal, upset, and design basis NPH conditions.
		The Waste Hoist Support Structure shall be designed for a DBE of 0.1 g	Meets PC-2 criteria (0.06 g) of DOE-STD-1020-2002. Analytical basis (CALC 15-009)	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	of the Waste Hoist Support Structure by establishing a basis for the low (Unlikely (U) for NPH and Extremely Unlikely (EU) for uncontrolled movement and fires) unmitigated likelihood assignments.	PGA.	referenced in the DSA.	
		The Waste Hoist Support Structure shall be constructed of noncombustible materials and not subject to failure due to in-situ combustible loads.	FHA (WIPP-023) concluded that structure not compromised considering non-combustible construction and minimal in-situ combustibles. Also SS FSS available in the Waste Hoist Tower.	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
RH Facility Cask and Light Waste Facility Cask-Passive (DSA section 4.4.10)	To mitigate worker exposure to a high radiation source by reducing the gamma and/or neutron surface dose rates through the provision of robust shielding;	The closed RH facility cask/LWFC shall provide shielding such that the surface dose rate is ≤ 200 mrem/hour when transporting RH waste.	Design includes 4.75 inches and 2 inches of lead shielding in each cask respectively. Calculated and referenced basis (Radiological Control Position Paper 2002-03) in DSA to demonstrate more than sufficient.	• The closed RH Facility Cask/LWFC shall provide shielding such that the surface dose rate is ≤ 200 mrem/hour when transporting RH Waste. • The closed RH Facility Cask/LWFC shall prevent a breach of the enclosed RH Waste Canister when subjected to impacts. • The closed RH Facility Cask/LWFC shall have no penetrations to allow direct flame impingement on the contained RH Waste Canister. • The closed RH Facility Cask/LWFC shall prevent a breach when subjected to an internal RH Waste Canister deflagration.
	To prevent the release of radiological material due to fires, impacts, or internal RH Waste Canister deflagrations due to their robust construction reducing the likelihood for release of	The closed RH facility cask/LWFC shall prevent a breach of the enclosed RH waste canister when subjected to impacts.	Designed to applicable ASTM standards. Withstand drops of 102 inches. Robust construction sufficient for low energy impacts possible in the WIPP facility	
		The closed RH facility cask/LWFC shall have no penetrations to allow direct flame impingement on the contained RH waste canister.	Designed to ASTM standards. Robust construction does not have open penetrations.	
		The closed RH facility cask/LWFC shall prevent a release when subjected to internal RH waste canister deflagrations.	Robust construction. Weight of casks are 48,450 lbs (LWFC) and 67,000 lbs (RH Facility Cask). Qualitatively judged to	

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	radiological material.		be sufficient to withstand deflagrations.	
Type B Shipping Package-Passive (DSA section 4.4.11)	To limit the release of radiological material from fires, payload deflagration, and/or collisions due to its robust construction and qualification under accident conditions, thereby mitigating the consequences of an event, and its installed shielding on the RH 72-B packages reduces the likelihood for excessive gamma and/or neutron exposure to workers.	The Type B Shipping Package shall meet criteria of 10 CFR 71.	Design certification to 10 CFR 71 and associated open road testing criteria ensures packages are robust compared to stresses imposed by facility accidents.	Type B Shipping Package shall meet the criteria of 10 CFR 71
Facility Cask Loading Room, Cask Unloading	To mitigate worker exposure to a high radiation	The Facility Cask Loading Room (FCLR), Cask Unloading Room (CUR), and Transfer Cell walls, ceiling, floors, windows, shall provide	Significant concrete structures designed for canisters as high as 1000 rem/hr contact dose rate. More than sufficient to	FCLR, CUR, and Transfer Cell shall provide shielding such that the external dose is ≤ 200 mrem

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
Room, and Transfer Cell Shielding-Passive (DSA section 4.4.12)	source by providing permanent radiation shielding when RH waste canisters are not shielded by other SSCs (e.g., Type B Shipping Package, RH Facility Cask, or LWFC).	shielding such that the external dose rate is ≤ 200 mrem per hour.	ensure doses are less than 200 mrem. Basis documented in CS-41-B-003	per hour.

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
Panel 6 and Panel 7, Room 7 Bulkheads (DSA section 4.4.13)	To reduce the quantity of material that could be released from an exothermic chemical reaction within a CH waste container located in Panel 6, or Panel 7, Room 7, by creating static conditions that resist transmission of particulate and allow for gravitational settling.	The Panel 6, and Panel 7, Room 7 bulkheads are a solid noncombustible wall (except for flexible flashing) that is secured to the Panel opening (i.e., walls, ceiling, floor).	Radiant heat from event behind bulkhead less than critical radiant heat flux of flexible material used to seal periphery of bulkheads (most vulnerable part of bulkhead)	Panel 6 and Panel 7, Room 7 Bulkheads shall provide a solid noncombustible wall (except for flashing) that is secured to the Panel opening
Vehicle Barriers-Passive (DSA section 4.4.14	To reduce the likelihood for release of radiological material from CH Waste in the WHB due to impacts by vehicles and/or fires adjacent to the southwest wall of the CH Bay by providing a	A configured set of concrete barriers consisting of two sections; section one being a two-row barrier positioned approximately 5 feet west of the CH Bay/TMF common wall and extending south from the TMF south exterior wall a minimum distance of 25 feet, and section two being a single row barrier, positioned a minimum 25 feet south of the CH Bay southwest exterior wall extending between Airlock 100 to a point nominally 5 feet west of the CH Bay/TMF common wall to intersect	Calculated basis given for vehicle impacts on jersey barriers at the Exhaust Filter Building (ECO 13396). This along with qualitative basis on double row of barriers used to establish adequacy of barriers protecting CH Bay.	A configured set of concrete barriers consisting of two sections; section one being a double row barrier, with the base of the exterior barrier positioned approximately 5 feet west of the CH Bay/TMF common wall and extending south from the TMF south exterior wall a minimum distance of 25 feet, and section two being a single row barrier, positioned at least 25 feet south of the CH Bay southwest exterior wall extending west

SS SSC (Active/ Passive)	Safety Functions	Performance Criteria	System Evaluation (Summary of Basis)	TSR Attributes
	standoff distance from the CH Bay and substantial resistance to vehicular impacts.	with the double row of barriers. An opening with a gap ≤ 3 feet at the intersection of the east-west barrier and the double row of barriers is permitted. The nominal distances and configuration of the barriers are depicted in Figure 2.4-7, which shows nominal dimensions.		between Airlock 100 to a point approximately 5 feet west of the CH Bay/TMF common wall to intersect with the double row barrier. An opening with a gap ≤3 feet gap is permitted at the intersection of the two sections.

The SBRT review of the information of DSA Chapter 4, as summarized above, concludes that the designation of SSCs as safety significant follows directly and logically from the information developed in the hazard and accident analyses in Chapter 3. DSA Table 4.4-1 identifies the specific hazard events for which each SSC was credited, and it is in alignment with bothWIPP-021 and Chapter 3 presentation of the hazard events and credited control strategies.

Safety functions are presented for each SSC and have consistency with the hazard evaluation results in DSA Chapter 3. Safety functions are described with sufficient clarity in accordance with expectations in DOE-STD-3009-2014 section [4.4.X.1] to support the derivation of functional requirements and performance criteria imposed on the SSC to ensure it can meet the functional requirements. In each case, the safety function describes whether it is preventive or mitigative, and it identifies the type of accident(s) being addressed.

A description of each safety significant SSC is presented in Chapter 4, along with the boundaries and interfacing or support equipment or systems. The DSA does not identify any support systems that are credited or relied on for the safety significant SSCs to meet the safety functions. DOE-STD-3009-2014 requires a discussion of support systems, and safety classification where applicable, along with compensatory measures if the support systems cannot meet the required safety functions. Although some utilities such as electrical power distribution systems or battery power could be viewed as support systems, the DSA did not identify any hazard events for which the SSCs were credited that compromised these functions. Additionally, loss of power functions are protected in the TSR LCOs with measures that reduce the risks of system inoperability during such situations. Overall, the Chapter 4 information has sufficient clarity regarding the salient features and safety significant boundaries of each SSC. In some cases, references to system design description documents or DSA Chapter 2 are provided to supplement the system descriptions. This approach is permissible in DOE-STD-3009-2014 (Section [4.4.X.2]).

For each SSC safety function, the DSA identifies functional requirements that address the pertinent response parameters or stresses placed on the SSCs and explicit performance criteria. This information is consistent with the format and content expectations given in DOE-STD-3009-2014 sections [4.4.X.3] and [4.4.X.4].

The standard requires a system evaluation that demonstrates a safety SSC can meet applicable performance criteria when subjected to postulated accident conditions. This evaluation is presented in the DSA according to each performance criteria for a given safety SSC. The basis given in system evaluations to support safety SSC adequacy is summarized in the above SER Table 3.4-1. The SBRT determined that SSC performance evaluations address the sufficiency of the stated performance criteria, as well as the capabilities of the SSC to achieve the performance criteria when subjected to accident conditions. The system evaluations were supported by a comparison to relevant design codes and standards, or in some cases qualitative engineering judgment where it was sufficient to demonstrate system capabilities. In each case, the conclusions on SSC adequacy are supported by sound logic.

DOE-STD-3009-2014 section 3.4 requires that if the system evaluation determines that performance criteria are not met, the DSA must identify noted deficiencies and any compensatory measures necessary to ensure that SSC safety functions are accomplished. Issues were identified for several safety SSCs at the WIPP facility, and in each case, they were ameliorated by other SSC features or compensatory measures. A summary of each affected SSC and the measures taken to address the situation is provided below.

Underground Ventilation Filtration System/Interim Ventilation System (UVFS/IVS)

As described in DSA section 4.4.5.4, design adequacy assessments were performed as part of the process described in the *WIPP Backfit Analysis Process* (WP-CN.04). Backfit analyses are referenced in the DSA for the UVFS/IVS (09-BF1005), instruments used to monitor differential pressure (09-BF1000, 09-BF1001, 09-BF1003), and the Central Monitoring System (09-BF1003) that is relied on to communicate UVFS/IVS status to the Central Monitoring Room. The design adequacy assessments were performed against nuclear safety design criteria established in DOE O 420.1C, *Facility Safety* and DOE G 420.1A, *Nonreactor Nuclear Safety Design Guide*.

The conclusions reached in the backfit analyses were that the UVFS and IVS met the safety significant design criteria with the one exception being that IVS does not have a backup power connection. However, this limitation was judged to be acceptable because the DSA does not identify accidents for which there is a need for backup power within a certain period of time to meet the required safety functions. Other issues identified in the design adequacy assessment were related to system degradation and include corrosion of ductwork, single points of failure for the UVFS damper and fan control panel, degradation of the 860 fan transformers and control breakers, and salt buildup in the exhaust duct. While these issues don't prohibit the system from meeting required safety functions, they could impact reliability. As such, the need for enhanced monitoring and inspections of the UVFS/IVS conditions was identified and linked to a key element of the Initial Testing, In-Service Surveillance and Maintenance Program. The DSA also notes that UVFS/IVS operation is temporary, pending an operational improvement to install permanent system upgrades, as described in DSA section 3.6.

Based on the results of design adequacy assessments, the DSA also identified vulnerabilities related to instrument loops for monitoring the UVFS/IVS differential pressures across the HEPA filters, and at Bulkheads 308 and 309. Because these existing systems did not satisfy safety significant design criteria, compensatory measures included the installation and use of safety significant differential pressure transmitters that are independent of the instrument loops that report to the CMR. The gauges require local readings at the point of measurement, which is an operability requirement protected in the TSRs.

The UVFS/IVS performance evaluation related to maintaining DP across HEPA filter banks at less than 4.0 inches w.g. noted potential challenges from HEPA plugging from accidents involving large fuel pool fires near the waste face. WIPP-058 evaluated this condition and determined that burning as little as 29 gallons of diesel fuel could plug the IVS filter units. However, as noted in the performance evaluation, this issue is addressed by other safety significant controls that include SS fire suppression systems on vehicles having the quantity of fuel in question and specific administrative controls for vehicle attendants and vehicle inspections.

The DOE SBRT determined that the safety functions are adequately protected with the compensatory measures, enhanced monitoring and inspections of the UVFS/IVS components, and complementary safety significant controls already identified in the DSA. However, the team notes that the UVFS/IVS has a limited operational life, and permanent upgrades are necessary to maintain a reliable control strategy.

WHB Confinement Ventilation System

The design adequacy of the WHB Confinement Ventilation System (CVS) was stated in the DSA based on a previous assessment performed in accordance with DNFSB 2004-2, *DOE Ventilation System Evaluation Guideline for Safety-Related and Non-Safety-Related System* (referred to as the Ventilation System Evaluation Guide), as well as assessments performed in backfit analyses for the CVS DP instrument, 09-BF1002, and the CMS instrument, 09-BF1003. The results of these analyses were similar to the UVFS/IVS in terms of vulnerabilities in the instrument loops used for monitoring DP across the filters units in the CH Bay and Room 108 areas. This resulted in compensatory measures that included the installation and use of safety significant differential pressure transmitters that are independent of the instrument loops that report to the CMR.

The WHB CVS performance evaluation related to maintaining DP across HEPA filter banks at less than 4.0 inches w.g. noted potential challenges from HEPA plugging from accidents involving some large fires in the WHB. WIPP-058 evaluated this condition and determined that a significant quantity of ordinary combustibles would be required to challenge the HEPA filter integrity. Activation of the safety significant Fire Suppression System, as well as a specific administrative control that prohibits fuel powered vehicles in the CH Bay when waste is present, are complementary parts of the overall control strategy for fire events in the WHB for which the CVS is credited.

The DSA system evaluation also identified a potential vulnerability related to the Battery Charging Station/TRUDOCK Exhaust System. This system interfaces with the WHB CVS as described in DSA section 4.4.6.2, System Description, and provides a direct leak path from the WHB that must be filtered. As such, a performance criterion is identified in DSA Table 4.4.6-2, Performance Criteria and Performance Evaluation for the Contact-Handled Waste Handling Confinement Ventilation System, that requires the Battery Charging Station/TRUDOCK Exhaust System to provide filtration at an efficiency $\geq$ 99%, commensurate with the required efficiency of the WHB CVS HEPA filter units. The result of this compensatory measure is that the Battery Charging Station/TRUDOCK Exhaust System operability must be protected within the TSR. The SBRT identified a directed page change related to this system (see SER Section 5) and the specification of maximum and minimum differential pressure criteria applicable when the system is in use.

WHB Fire Suppression System

The design adequacy of the WHB Fire Suppression System (FSS) was evaluated in the DSA based in part on a comparison to the requirements of NFPA 13-1983. This is the code of record for the system and compliance demonstrates the system has sufficient water supply, appropriate discharge density, and appropriate sprinkler layout necessary to fulfill the DSA safety functions. As stated in DSA Table 4.4.3-2, Performance Criteria and Performance Evaluation for Waste Handling Building Fire Suppression System, the FSS meets the design criteria with one exception related to pumping capabilities. The DSA identified performance criteria of fire water pumping capability of 490 gallons/minute (gpm) at greater than or equal to 120 psig to the most demanding riser in the WHB. This criterion is met by the system, but the system is not capable of meeting the required demand during planned hydrant testing. This vulnerability is addressed in the TSR requirements (system is managed as inoperable during hydrant testing). In addition, the SBRT has identified directed page changes (see SER Section 5) in DSA Section 4.4.3.4 and 3.6 to address vulnerabilities associated with the FSS requiring further investigation of the hydrant vulnerabilities and associated system or operational improvements, as well as planned upgrades to the fire water supply and distribution system to meet the latest fire code design requirements.

While the reliability of the fire protection system is tied to the NPFA-13 design requirements, the performance evaluation notes degradation in the diesel pump such that it may not achieve the required flow and pressure demands. However, the safety function and associated performance criteria can be met with the electric-motor-driven pump. Impairments to the diesel pump are expected to be addressed in accordance with NFPA requirements and the fire protection program. A directed change (see SER Section 5) requires an update in DSA section 4.4.3.4 and 4.4.3.5 to describe that additional system redundancy and reliability is associated with the FSS design of two fire pumps and therefore, this configuration is included as a TSR attribute.

The DSA also notes that a backfit analysis (09-BF1003) was performed on the FSS that identified a vulnerability in the instrument loops used for monitoring the Fire Water Storage Tank level. This resulted in a compensatory measure that included the installation and use of a safety significant water level gauge that is independent of the instrument loops used to report tank level values to the CMR.

WHB Structure

The performance criteria stated for the WHB structure in DSA Table 4.4.1-2, Performance Criteria and Performance Evaluation for the Waste Handling Building Facility Structure Design, includes a requirement that the WHB shall not collapse as a result of credible fire scenarios. A vulnerability is identified relative to fuel pool fires in the RH Bay that could impinge upon structural support columns and cause failure, thereby impacting waste containers in the CH Bay. This conclusion is based on an analysis in WIPP-058. A future facility upgrade is planned to install fire protection features in the RH Bay as described in DSA section 3.6. In the meantime, a SAC is identified as a compensatory measure that requires fueled vehicles in the RH Bay to be attended whenever CH waste is located in the CH Bay outside of Type B shipping package.

Overall DOE SBRT Conclusions on Safety SSC Adequacy

The SBRT concluded that the DSA provided an adequate basis to demonstrate the capabilities and sufficiency of WIPP safety SSCs credited in the hazard evaluation. Information required by DOE-STD-3009-2014 is provided both in a summary table and for each SSC and is sufficiently clear. An evaluation of each SSC is provided that demonstrates its capabilities relative to its performance requirements. Finally, vulnerabilities (where applicable) in safety SSCs are identified and adequate compensatory measures established to ensure the required SSC safety functions are met.

The SBRT notes that the DSA identified several available features on safety SSCs that were described as part of the SSC design, but not explicitly determined to be necessary to achieve the safety function. These features improve overall safety performance and system reliability.

The SBRT concurs with DSA observations that such features are subject to Key Element 10-2 identified in Chapter 10 of the Initial Testing, In-Service Surveillance, and Maintenance Program.

3.5. SPECIFIC ADMINISTRATIVE CONTROLS

The DOE technical review of the adequacy of specific administrative controls (SACs) focused on information presented in DSA Chapter 4. Overall, the SBRT gave consideration to the following elements consistent with expectations of DOE-STD-1104-2014 and DOE-STD-3009-2014:

- Safety functions for SACs are defined with clarity and are consistent with the bases derived in the hazard and accident analyses.
- Functional requirements and performance criteria are defined such that, when met, they ensure that the safety functions can be performed when needed.
- A system evaluation demonstrates that the SAC can meet applicable performance criteria, thereby ensuring the functional requirements are met under postulated accident conditions.
- Rationale is provided when a SAC is used in lieu of safety SSCs.
- Key assumptions are identified so that appropriate TSR protection can be developed or derived (such as in limiting conditions of operations (LCOs), design features, and SACs).
- The SACs are readily understood and can be effectively implemented. The supporting SSCs and other administrative controls whose failure would result in an inability to complete the required SAC safety actions(s) are identified at the same level of safety significance as the SAC, or justification provided if not so designated.

SACs are presented in the DSA Chapter 4, Safety Structures, Systems and Components. Based on the results of the DSA hazard evaluation, no SACs were identified that provide the equivalent of a Safety Class SSC. A total of 13 SACs are presented in DSA Table 4.5.1, Summary of Specific Administrative Controls. This differs from the 12 SACs derived in DSA Chapter 3 because one additional SAC (attendance of liquid fueled vehicles in the RH Bay) was identified in Chapter 4 to address a vulnerability related to WHB structural weakness due to fire impacts. The table summarizes the safety functions, functional requirements, and performance criteria for each SSC, as well the hazard scenarios for which each SAC is credited.

A summary of the salient information for SACs presented in DSA Table 4.5.1, as derived in DSA Chapter 4, is presented below in SER Table 3.5-1. TSR attributes identified for each SAC are presented together with performance criteria, as the two align in the safety basis.

Table 3.5-1. Summary of Specific Administrative Controls

SAC	Safety Functions	Performance Criteria/TSR Attributes
Pre-Operational Checks of Vehicles and Equipment (DSA section 4.5.1)	To prevent vehicle/equipment pool fires involving CH waste containers by ensuring vehicles/equipment operating near CH Waste	As applicable, the following elements shall be verified prior to Waste Handling vehicles/equipment and non-Waste Handling vehicle/equipment operation within 25 feet of the CH Waste Face, operation in the VEZ, and/or operation in the Waste Shaft Station when CH waste is present:

SAC	Safety Functions	Performance Criteria/TSR Attributes
	are checked for such conditions as braking, steering, leaks, and cleanliness prior to being permitted to operate near CH waste to reduce the likelihood of pool fire formation due to leaks and/or collisions.	Brake operation Steering No excessive leaks Light(s) and horn operate Fluid levels within operating range Cleanliness
Limit of Two Liquid-fueled Vehicles/Equipment within 25 feet of Contact-Handled Waste Face (DSA section 4.5.2)	To prevent vehicle/equipment pool fires involving CH Waste Containers by limiting the number of liquid-fueled vehicles/equipment near the CH Waste Face; thereby reducing the likelihood for pool fires due to vehicular collisions.	No more than two liquid-fueled vehicles/equipment shall be present within 25 feet of the CH Waste Face.
Attendance of Liquid-fueled Vehicles/Equipment in the Underground (DSA section 4.5.3)	To prevent vehicle/equipment pool fires involving CH waste containers by assuring personnel are observant of the activities and can readily respond to upset conditions to reduce the likelihood for pool fires, and to alert UG facility workers of conditions potentially requiring their evacuation in order to reduce their consequences.	Liquid-fueled vehicles/equipment shall be attended in the Waste Shaft Station when transporting CH waste to or from the VEZ, when transporting CH waste in the VEZ, when transporting CH waste between the VEZ and the CH Waste Face, and within 25 feet of the CH Waste Face.
Aboveground Liquid-fueled Vehicles/Equipment Prohibition (DSA section 4.5.4)	To prevent fuel pool fires from affecting CH waste, liquid-fueled vehicles/equipment are prohibited in the CH Bay and/or Room 108, thereby reducing the likelihood of a fuel pool fire by the removal of a primary source of liquid-fuel.	Liquid-fueled vehicles/ equipment shall not be present in the CH Bay and/or Room 108 when CH waste is present and not in a closed Type B Shipping Package.
	To prevent fuel pool fires from affecting CH waste, liquid-fueled vehicles/equipment are	Liquid-fueled vehicles/ equipment shall not be present in the Waste Shaft Access Area when CH waste is present.

SAC	Safety Functions	Performance Criteria/TSR Attributes
	prohibited in the Waste Shaft Access Area, thereby reducing the likelihood of a fuel pool fire by the removal of a primary source of liquid-fuel.	
Vehicle Exclusion Zone (DSA section 4.5.5)	To prevent collisions and fires by restricting the number and operation of UG vehicles during CH waste transport, thereby reducing the likelihood for pool fires due to leaks and/or collisions.	A VEZ (i.e., area defined by the distance between the leading edge of the lead escort vehicle and the trailing edge of the lag escort vehicle and the nominal width of the drift) shall be established and maintained around the TRU waste being transported, shall prevent other vehicles/equipment from entering the VEZ except for repair, replacement, or CH Waste Transfer, and shall be maintained for the duration of the transport.
Underground Lube Truck Operations (DSA section 4.5.6)	To prevent a large fuel pool fire within 200 feet of the CH Waste Face in an active panel and to prevent a large pool fire within 200 feet of the Waste Shaft Station when CH Waste is present in the Waste Shaft Station; thereby reducing the likelihood of a pool fire by prohibiting the large total fuel source of the UG lube truck from entry into these areas.	A UG lube truck shall not be present within 200 feet of the CH Waste Face in an active panel. An UG lube truck shall not be in the Lube Truck Exclusion Zone when CH waste is present.
Waste Conveyance Operations (DSA section 4.5.7)	To prevent vehicles, equipment, and/or loads from dropping down an open Waste Shaft and impacting waste containers by reducing the likelihood of vehicle/equipment drops down the shaft through requiring the presence of the conveyance when preparing to load or off-load, and requiring access to the shaft to be prohibited when Waste is being moved in the Waste Shaft.	• The Waste Shaft Conveyance shall be present at the Waste Shaft Collar prior to moving waste into or out of the Waste Shaft Collar Room. • Waste Shaft Access doors 155 and 156 shall be closed when waste is being moved in the Waste Shaft. • The Waste Shaft Conveyance shall be present at the Waste Shaft Station prior to waste load entering the Waste Shaft Station when uploading. • The Waste Shaft Conveyance shall remain at the Waste Shaft Station until waste is loaded onto the waste transporter and the transporter is moving away from the Waste Shaft.
WIPP Waste Acceptance Criteria (DSA section 4.5.8)	To protect the assumptions of the safety analysis as to the nature, quantity, and confinement	• All objectives, performance and acceptance criteria for treatment and packaging of waste specified in the Technical Review Program Technical Review Plan shall be met.

SAC	Safety Functions	Performance Criteria/TSR Attributes
	of TRU waste shipped to WIPP.	• All objectives, performance, and acceptance criteria for characterization and certification specified in the Central Characterization Program (CCP) TRU Waste Characterization Quality Assurance Project Plan shall be met. • WAC excludes the shipment of waste streams having the Resource Conservation and Recovery Act of 1976 characteristic of ignitability, which includes prohibiting untreated oxidizers, and waste streams containing untreated materials having the RCRA characteristic of reactivity, and requires generator sites to document treatment for these characteristics and chemical compatibility on a waste stream basis. • WAC excludes waste streams packaged in POCs (containing combustible waste materials other than the radiological control materials and packaging materials normally used to load these containers) and all CCOs.
Transuranic Waste Outside the Waste Handling Building (DSA section 4.5.9)	To prevent the release of radiological material due to fires, explosions, collisions, and/or NPH events when TRU waste (excluding site derived TRU waste) is located outside of the WHB by reducing the likelihood for TRU waste containers to not be protected by a Type B Shipping Package when outside of the WHB.	TRU waste, excluding site derived TRU waste, aboveground and outside the WHB shall be in a closed Type B Shipping Package.
Fuel Tanker Prohibition (DSA section 4.5.10)	To prevent tanker truck pool fires involving TRU waste containers by ensuring THAT FUEL TANKERS Are precluded from the WHB Parking Area Unit, thereby reducing the likelihood for a pool fire involving a fuel tanker.	Fuel tankers shall not be present in the WHB Parking Area Unit.
Contact-Handled Bay Alternative Barrier Provision (DSA section 4.5.11)	To reduce the likelihood for release of radiological material from CH Waste in the WHB due to impacts by vehicles and/or fires adjacent to the southwest wall of the CH Bay by maintaining control of liquid-fueled	• Liquid-fueled vehicles/equipment shall be attended if inside the exclusion zone defined by the barriers. • When the vehicle barriers (Section 4.4.14) are not fully installed, liquid-fueled vehicles/equipment shall be attended when being moved in the WHB Parking Area Unit.

SAC	Safety Functions	Performance Criteria/TSR Attributes
	vehicles/equipment in and around the exclusion zone when the concrete vehicle barriers are not fully installed.	
Real-Time Airborne Monitoring at Panel 6 and Panel 7 Isolation Bulkheads (DSA section 4.5.12)	Real-time airborne radiological monitoring of the areas outside Panel 6 and Panel 7, Room 7 Isolation Bulkheads shall be conducted with methods that provide real-time detection and promptly alert workers to high airborne radioactive concentrations (i.e., in excess of acceptable exposure limits established in the WIPP 10 CFR 835 compliant Radiation Protection Program (RPP)	Real-time Monitoring of airborne radiological material in accordance with the WIPP RPP satisfying the 10 CFR 835 exposure limits shall be provided whenever one or more of the following areas are occupied. • Drift S-2180 and all areas south of drift S-2180. • E-300 between S-2180 and the exhaust shaft • Areas determined to be within the exhaust path of Panel 6 and/or Panel 7, Room 7 following changes in ventilation configuration Notification of an elevated airborne radiological concentration will be provided per the WIPP Notification requirements to alert workers to elevated airborne activity levels.
Attendance of Vehicles/Equipment in the RH Bay (DSA section 4.5.13)	To prevent pool fires that could potentially degrade of WHB structural steel columns resulting in a building collapse and release of radiological material from CH waste containers in the WHB by assuring personnel are observant of the activities and can readily respond to upset conditions to reduce the likelihood for pool fires.	Liquid-fueled vehicles/ equipment shall be attended in the RH Bay when CH waste is present in the CH Bay outside of closed Type B Shipping Packages.

The DOE review of the information in DSA Chapter 4, as summarized above, concludes that the designation of SACs follows directly and logically from the information developed in the hazard and accident analyses in Chapter 3. DSA Table 4.5-1 identifies the specific hazard events for which each SAC was credited, and it is in alignment with both WIPP-021 and Chapter 3 presentation of the hazard events and credited control strategies.

Safety functions are presented for each SAC and have consistency with the hazard evaluation results in DSA Chapter 3. SACs are primarily identified as preventive measures that reduce the likelihood of hazard events. However, one exception is a SAC related to the WIPP WAC that primarily protects ICs of the safety analysis. Also, a SAC that requires real-time airborne monitoring of radiological material near, or in the exhaust drifts of, Panel 6 and Panel 7, Room 7, is credited with mitigating Facility Worker consequences associated with a chemical reaction involving non-compliant waste in those locations. Safety functions are stated in accordance with expectations in DOE-STD-3009-2014 section [4.5.X.1], and are sufficiently clear to support the derivation of functional requirements and performance criteria imposed on the SAC to ensure it can meet the functional requirements.

A description of each SAC is presented in Chapter 4 with sufficient clarity to understand the actions and intent of each SAC. Consistent with expectations of DOE-STD-3009-2014 section [4.5.X.2], the DSA SAC descriptions also address whether there is dependency on SSCs to implement the SAC and whether the SAC was selected in lieu of an engineered feature. Only two SACs were identified with these characteristics. The Contact-Handled Bay Alternative Barrier Provision SAC requires vehicles to be attended by trained personnel when being moved in the WHB parking area or when in an established exclusion zone along the southwest wall of the CH Bay whenever safety significant vehicle barriers external to the WHB are not in their required configuration. This is permitted to support infrequent access to facility areas precluded by the barrier perimeter to support facility maintenance activities. In these situations, the SAC is credited as a compensatory measure until the required barrier configuration is re-established.

The SAC for Real-Time Airborne Monitoring at Panel 6 and Panel 7 Isolation Bulkheads requires monitoring in accordance with the WIPP Radiation Protection Program in specified areas vulnerable to an exothermic reaction in non-compliant containers in Panel 6 and Panel 7, Room 7. This SAC may involve the use of installed or portable Continuous Air Monitors (CAMs), local monitoring instrumentation, or personal monitors worn by one or more workers. Portable instruments are maintained in accordance with the Radiation Protection Program, and such equipment is not viewed as safety significant SSCs. However, the DSA states that installed CAMs are the preferred method for meeting the intent of the SAC. The CAMs are currently not capable of meeting the entirety of the safety functions as related to alerting workers in all affected areas of the underground. Operational improvements for this equipment are described in DSA section 3.6, and the real-time monitoring SAC in accordance with approved methods of the Radiation Protection Program is a compensatory measure until such improvements are completed.

For each SAC safety function, the DSA identifies functional requirements that address the pertinent response parameters or stresses associated with the SAC actions and explicit performance criteria. This information is consistent with the format and content expectations given in DOE-STD-3009-2014 sections [4.5.X.3] and [4.5.X.4]. The standard requires a system evaluation that demonstrates a SAC can meet applicable performance criteria. This evaluation is presented in the DSA according to each performance criteria for a given SAC and in all cases concludes that the SACs do not involve complex tasks or place unusual demands or stresses upon workers. With the exception of the SAC related to real-time monitoring near Panel 6 or Panel 7, Room 7, no SACs were identified that had a dependency on special equipment or SSCs in order to accomplish the safety function. The performance evaluations address the sufficiency of the stated performance criteria, as well as any unusual demands or complexity that are placed upon personnel to achieve the actions. The conclusions on SAC adequacy are supported by sound logic.

Overall DOE SBRT Conclusions on SAC Adequacy

The SBRT concluded that the DSA provided an adequate basis to demonstrate the sufficiency of WIPP SACs credited in the hazard evaluation. Information required by DOE-STD-3009-2014 is provided both in a summary table and for each SAC and is sufficiently clear. An evaluation of each SAC is provided that demonstrates it can be performed upon demand and within the time necessary to ensure the required SSC safety functions are met. A minor directed change (see SER section 5) was identified by the SBRT to ensure consistency between DSA Table 4.5-1, Section 4.5.12 and the TSR as related to the provisions of the real-time airborne monitoring control.

3.6. DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

The DOE technical review of the adequacy of the TSR Derivation for the hazard controls required by the hazard evaluation in DSA Chapter 3 and further described and developed in DSA Chapter 4 focused on the information presented in DSA Chapter 5. Overall, the SBRT gave consideration to the following elements consistent with expectations of DOE STD 1104-2014 and DOE STD 3009-2014:

TSRs are identified to ensure adequate protection of workers, the public, and the environment.

The bases for deriving TSRs are identified and described in the hazard analysis and safety SSC chapters (which include SACs) and are consistent with the logic and assumptions presented in the analysis.

The bases for deriving safety limits, LCS, LCOs, surveillance requirements, and administrative controls are provided as appropriate.

The facility modes are defined and those associated with TSRs are consistent with the hazard analysis and accident analysis.

The process for maintaining the TSRs current at all times and for controlling changes is defined.

The credited controls identified in the hazard analysis from DSA Chapter 3 and further described and developed in DSA Chapter 4 were evaluated in DSA Chapter 5, "Derivation of Technical Safety Requirements". SBRT review of Chapter 5 addressed consistency between the chapters, the placement and categorization of the controls in the facility TSR, and the control development to ensure its defined safety function; control development includes such aspects as defining conditions, required actions, and surveillance requirements. The chapter categorizes the credited controls into those requiring treatment in the TSR as Limiting Conditions for Operation (LCOs), Specific Administrative Controls (SACs), and Design Features (DFs). There were no Safety Limits or LCSs required. Safety Management Programs and associated Key Elements (KE) are also included in DSA Chapter 5, but their content is evaluated in Section 3.7 of this SER.

DSA Table 5.5.3 provided the listing of credited controls that are based upon the results of the hazard and accident analysis in DSA Chapter 3 and the further description and development of controls in DSA Chapter 4. The table specifically identifies the controls credited for various analyzed events in the hazard evaluation and the safety function of each control; required controls are then mapped against the specific LCOs, SACs and DFs. The presentation of the chapter in the WIPP DSA is in accordance with the outline in DOE STD 3009-2014. The presentation provides a consistent tie between the accident and SSC description chapters. The operability requirements for SSCs are detailed to support their inclusion in the TSR. The information in DSA Chapter 5 completes the demonstration that the selected controls comply with 10 CFR 830.205.

Table 3.6-1 below provides a summary of the TSR designation for SS SSCs and SACs included in DSA Chapter 5 and their placement in the TSRs

Table 3.6-1. Summary of Technical Safety Requirement Control Designation

Control	DSA Chapter 5 location	TSR Control Designation
LCO Designated Controls for Active SSCs		
Waste Handling Building (WHB) Fire Suppression System (FSS)	• Section 5.5.1	LCO 3.1.1
Underground (UG) Vehicle/Equipment FSSs	• Section 5.5.2	LCO 3.1.2
Contact-Handled (CH) Waste Handling (WH) Confinement Ventilation System (CVS)	• Section 5.5.3	LCO 3.2.1
UG Ventilation Filtration System (UVFS)/Interim Ventilation System (IVS)	• Section 5.5.5	LCO 3.2.3
309 Bulkhead Operability during Download of Waste Containers	• Section 5.5.6	LCO 3.2.4
WHB Battery Exhaust System CVS	• Section 5.5.7	LCO 3.2.5
Waste Hoist Brakes	• Section 5.5.8	LCO 3.8.1
LCO formatted SACs		
Aboveground Liquid-fueled Vehicle/Equipment Prohibition	• Section 5.5.9	LCO formatted SAC 3.3.2
UG Lube Truck Operations	• Section 5.5.12	LCO formatted SAC 3.3.5
UG Liquid-fueled Vehicle/Equipment Control Limit of two Liquid-fueled Vehicles/Equipment within 25 feet of CH Waste Face Attendance of Liquid-fueled Vehicles/Equipment in the UG	• Section 5.5.13	LCO formatted SAC 3.3.8
WIPP Waste Acceptability Control	• Section 5.5.20	LCO formatted SAC 3.7.1

Control	DSA Chapter 5 location	TSR Control Designation
Directive Action (DA) SACs		
Pre-operational Checks of UG Vehicle(s)/Equipment; Proximity to CH Waste Face	• Section 5.6.2.1	DA SAC 5.5.1
Transuranic (TRU) Waste Outside the WHB	• Section 5.6.2.3	DA SAC 5.5.3
Vehicle Exclusion Zone (VEZ)	• Section 5.6.2.4	DA SAC 5.5.4
Fuel Tanker Prohibition	• Section 5.6.2.5	DA SAC 5.5.5
Waste Conveyance Operations	• Section 5.6.2.6	DA SAC 5.5.6
CH Bay Alternative Barrier Provisions	• Section 5.6.2.7	DA SAC 5.5.7
Real-Time Monitoring at Panel 6 and Panel 7 Room 7 Isolation Bulkheads	• Section 5.6.2.8	DA SAC 5.5.8
Design Features		
WHB Structure	Section 5.7.1	DF 6.1
Facility Pallet	Section 5.7.3	DF 6.3
Waste Hoist Support Structure	Section 5.7.6	DF 6.6
UG Fuel and Oil Storage Areas	Section 5.7.7	DF 6.7
Facility Casks	Section 5.7.8	DF 6.8
Type B Shipping Package	Section 5.7.9	DF 6.9
Facility Cask Loading Room (FCLR), Cask Unloading Room (CUR), and Transfer Cell Shielding	Section 5.7.10	DF 6.10
Panel 6, and Panel 7, Room 7 Bulkheads	Section 5.7.11	DF 6.11
Vehicle Barriers	Section 5.7.12	DF 6.12

3.6.1 Derivation of Process Areas

DSA section 5.4.1 provides the derivation and development of the process areas based on the locations of the Facility where operations are performed and with consideration for the postulated hazard analysis events. These include the areas where significant amounts of radioactive material can be present. Each process area has a specific set of active SSCs that must be operable when entering into an applicable mode. The section identifies the CH Bay, Room 108, RH Bay, Hot Cell Complex, Outside Area, Waste Shaft Access Area, and the Underground. Each of these process area descriptions is discussed as to its boundaries and the operations that are performed there. Each of the process areas was verified to be described in DSA Chapter 2 in a manner consistent with its Chapter 5 definition. The SBRT determined that the various process areas were adequately described and would be appropriate for use in designating LCO applicability.

3.6.2 Derivation of Facility Modes

DSA section 5.4.2 provides the derivation and development of the various Facility Modes for the TSR. To aid in controlling application of WIPP Facility LCOs and other TSRs, operational MODEs were established that 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 operational control; and aid the operations staff in determining LCO applicability. Once defined, MODE changes are controlled to ensure pertinent safety functions for each applicable PROCESS AREA.

The MODEs are defined in DSA Table 5.4-2. The hierarchy of MODEs from the highest to the lowest in relation to hazards is WASTE HANDLING, WASTE STORAGE, and STANDBY for the above ground operations. The high to low hierarchy for the Underground operations is WASTE HANDLING and DISPOSAL. DSA section 5.4.2 discusses the operational activities that are allowed in each MODE and PROCESS AREA. MODE designations and changes are an administrative declaration made by the Facility Shift Manager (FSM) of the WIPP Facility.

In the WASTE HANDLING mode activities may include unloading, transferring, handling, storing, emplacing, retrieving, and loading of Waste, including site-derived, CH and RH waste as authorized. Any authorized activities are allowed in this Mode, including for example maintenance, repair, and inspections, as long as these activities are not in conflict with the requirements in the TSR. This Mode is applicable to the above ground and underground activities. The WASTE STORAGE mode allows CH and RH Waste to be physically present and outside a Closed Shipping Package in the WHB, but does not permit the waste to be handled, moved, or transported. Other activities, such as maintenance, repair, and inspections, are also allowed as long as these activities do not require waste handling or otherwise conflict with the requirements in the TSR. WASTE STORAGE mode is only applicable aboveground. The analogous MODE underground is DISPOSAL mode, in which CH and/or RH Waste may not be unloaded, moved through the Transport Path, (route below ground that the Waste travels during Waste Handling Activities) or emplaced in the Active Disposal Rooms. Other activities, for example mining, ground control, maintenance, repair, and inspections, are allowed as long as these activities do not require waste handling or conflict with the requirements in the TSR. The STANDBY mode is the safest mode for the WHB because CH or RH Waste, when present, is inside Closed Shipping Packages. Site-derived waste can be present outside a Closed Shipping Package, provided it is in a Waste Container with the lid Closed. A MODE equivalent to STANDBY is not practical in the underground.

The SBRT determined that the discussion was adequate to describe the various process modes, is consistent with the operations and hazards for chapter 3 analysis and would be appropriate for use in controlling LCO applicability.

3.6.3 Derivation of LCO Designated Controls for active SSCs

From Table 3.6-1 above, the LCO-designated controls address those SSCs that are active in their design and performance of credited safety functions. LCOs are the limits “that represent the lowest functional capability or performance level of SSCs required for safe operation (10 CFR 830.3).” More broadly, LCOs delineate the minimum conditions necessary to ensure that the Initial Conditions (ICs) assumed in the analysis remain intact, that the Operability of active SSC is controlled, or that the conditions of a SAC are met as applicable.

The LCOs for active SSCs at WIPP apply to fire suppression for the WHB and underground liquid fueled vehicles operating in proximity to waste, ventilation system for the WHB and underground, and waste hoist brakes. The active SSC LCOs can include equipment to monitor required SSC performance parameters and send an alarm signal to the CMR when action is needed to continue ensuring the required safety function. In other cases, such as the WHB FSS, UG vehicle FSS, or waste hoist brakes, automatic action may be initiated to complete the safety function. Surveillance Requirements (SRs) are provided to verify and ensure operability parameters of the components are met for each of the LCO-related attributes.

3.6.3.1 WHB Fire Suppression System (FSS)

DSA Chapter 3 and 4 identify the WHB Fire Suppression System (FSS) in the CH-Bay and Room 108 as relied upon to prevent small fires from becoming large fires with the potential for a significant increase in radiological consequences. The WHB FSS was designed and is maintained to applicable NFPA requirements based on the facility code of record. The system relies upon an onsite fire water supply and fire water pumps that meet the applicable NFPA requirements. DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, “lowest functional capability or performance level of SSCs required for safe operation.” For the WHB, these requirements rely on a subset of the NFPA system requirements. DSA section 5.5.1 describes the derivation of the operability attributes of the WHB FSS that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. Because the WHB FSS is an active SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR. Per Revision 5a, an Operable FSS consists of one fire pump (of the two provided), an unobstructed flow path from the firewater storage tank to the system sprinklers, and an adequate water supply to be verified via required fire tank level instrumentation. In part, because the diesel fire pump has been out of service, DOE directed (see SER section 5) that the LCO be changed to require both fire pumps, with a new condition to address one being unavailable.

To support the performance criteria related to flow capability, one operable firewater pump is required to meet the credited safety function. Per NFPA requirements, there are two installed fire pumps (one electric-motor-driven and one diesel-engine-driven) for the WHB FSS that could complete this safety function. The operation of one pump represents the lowest functional capability or performance level of SSCs required for safe operation, but the LCO requires both to be operable. The pumping capability is maintained through the performance of periodic surveillance testing. In addition, the Fire Protection Program (FPP) commits to maintain each pump in accordance with the NFPA program, which includes additional testing. Thus, both pumps must be maintained per NFPA requirements by the FPP, and the required SRs are sufficient to establish LCO operability for either pump. As discussed below, the LCO affords required actions that will ensure acceptable safety for a WHB FSS outage of up to 31 days.

The chosen surveillance requirements ensure operability of either pump. For either pump to be considered operable it must be shown to deliver greater than or equal to 490 gallons per minute (gpm) at greater than or equal to 120 pounds per square inch gauge (psig) at the most demanding riser (Room 108). A hydrant flow test is used to verify the capability to deliver 490 gpm to the Room 108 riser at greater than or equal to 120 psig. The required pressure and flowrate at the Room 108 riser is proven by demonstrating a flow of greater than or equal to 500 gpm at a residual pressure of 141 psig at hydrants #12 and #13 (ETO-Z-230). Hydrant tests are used to determine the hydraulic capacity of the water supply system and to determine system operability as described in NFPA 291. As part of ETO-Z-229, Revision 1, two points were calculated to determine the necessary water flow and pressure that would prove enough water flow and pressure were available at the sprinkler riser in Room 108. These points are directly below two fire hydrants outside of the WHB. The SR verifies on an Annual basis that either of the two fire pumps can perform this function. The Annual Frequency meets the NFPA 25 requirements. The hydrant test which is performed every 5 years by NFPA standards was selected to be performed Annually because of its ability to provide quantitative values to judge pump operability.

Automatic start capability is also required at a system pressure no lower than 125 psig. The above maximum sprinkler demand of pressure and flowrate is documented in ETO-Z-229, Revision 1, Fire Pump Discharge Required to Operate WHB 5th Floor Sprinkler System. The set points for the individual pump auto-start pressure switches are calculated in ETO-Z-230, and set at greater than or equal to 125 psig in accordance with NFPA 20 which minimizes pressure excursions (i.e., water hammer events). When auto-started, each pump must demonstrate a run time in accordance with the code of record, but this capability is not included in the applicable SR. During the pump run, observations are made of normal operability parameters for a pump and associated engine. (e.g., fluid levels, pressures, temperatures, etc.). The run time for each pump and any abnormalities are recorded. This run time portion of the test ensures that pump performance issues are detected and provides assurance that the pump can run for the NFPA required time. To complete an auto-start test, the jockey pump is isolated from the supply line and the pressure is slowly lowered by opening a valve in the supply line. The system pressure at which the pump starts is recorded. The pressure gauge used must be calibrated and the reading must take instrument uncertainty of the gauge into consideration. A minimum frequency of weekly is required per NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems.

The diesel fire pump must have enough fuel available to run for at least 90 minutes at 100% of the rated pump capacity. The 90-minute requirement is based on NFPA 13-1983 (code of record). This translates to a fuel level in the existing tank of 11 inches. The SR requires a fuel level of greater than or equal to 12 inches conservatively accounts for errors in reading the fuel level (ETO-Z-230, WHB Operability Set Points). A weekly inspection of the diesel fire pump fuel tank (45-D-601) is required to verify that the tank has greater than or equal to 12 inches of diesel fuel available for the diesel-driven fire pump to be Operable. The fuel level is checked by reading a graduated dip stick. The 12-inch minimum fuel conservatively accounts for errors in reading the fuel level (ETO-Z-230, Revision 1). The Weekly Frequency has been determined to be adequate based upon operational experience; the test is typically performed after the weekly automatic pump start test.

The chosen surveillance requirements to demonstrate an adequate water supply to the sprinklers include a minimum available water volume in the firewater tank, Tank 25-D-001A, and an unobstructed flow path from the tank to each required riser. A water supply capacity of at least 72,180 gallons is required. The 72,180 gallon requirement is based on the maximum water demand (at any pressure) of 802 gpm for 90 minutes (WIPP-023, Fire Hazard Analysis for the Waste Isolation Pilot Plant (FHA)). The 802 gpm is based upon the hydraulic calculations for the Waste Hoist Tower 4th floor sprinkler systems, the bounding flow rate for any of the credited FSS areas in the WHB, and the 250 gpm hydrant hose stream flow rate. The 90-minute requirement is based on NFPA 13-1983 (code of record) (ETO-Z-230, WHB Operability Set Points). The required minimum tank level to ensure 72,180 gallons is 50%. This does include a

3 feet height for the position of the vortex plate in the tank; applying an instrument uncertainty (ETO-Z-230) results in an SR required indicated value of 51%. A directed change (see SER section 5) requires clarification in Chapter 4 of the reliance on NFPA 13-1983 as the code of record in determining the hose stream requirement.

The unobstructed flowpath to the risers is established monthly by verifying locked valve positions that both ensure the flow path is open and that water is not diverted from the chosen path. There are no valves that could obstruct flow between the risers and the sprinkler heads. All available flow paths have been analyzed to ensure the hydraulic requirements of the FSS can be met (ETO-Z-229, Revision 1). Verification of the chosen available path relies on periodic performance of valve alignment checks in accordance with NFPA guidance. Calculation ETO-Z-229 provides several flow paths that are adequate to satisfy a flow path from the Fire Water Storage Tank to the sprinklers. Verification that the valves for the credited path are correctly positioned is made by visually verifying that each of the valves are correctly positioned and locked during a walk down of the system. The frequency of monthly has been determined to be adequate based on NFPA 25 criteria for locked control valves and operational experience.

Level instrumentation is relied on to verify 51% level in the Fire Water Storage Tank (i.e., Level transmitter, 456-LT-006-001, CMR indicator, AK0601 and Local indicator, 456-LI-006-001). To address the vulnerabilities of the CMR loop instrumentation identified by backfit analysis, a local safety significant gauge has been provided at the existing level transmitter for the fire water tank level. Less frequent specified monitoring of the local gauge (Daily) complements more frequent checks of the CMR instrumented loop (each shift) to ensure sufficient level for operability. The Fire Water Storage Tank water level history demonstrates that it is stable with only gradual changes, well trended variations over time. Therefore, performance of this SR each shift is sufficient to ensure adequate fire water supply. The CMS/CMR loop for the level readings is viewed as a “backup” to the local indication. The SBRT review verified that the indicated values specified in the SR were correct for the tank level applying the uncertainty. A directed change (see SER section 5) addresses inconsistencies in the associated instrument uncertainties.

DSA section 5.5.1.2 provides details of surveillances to verify that the WHB FSS can perform its safety function of providing adequate pump flow, water supply, an unobstructed flowpath, and support instrument capabilities. Surveillance requirements were provided for each of the operability parameters listed in the control derivation section. The associated values used to support the LCO values have been included along with performance methodology drawn from applicable NFPA requirements for use during the test. The SBRT verified these values agree with those listed in the section discussion. The surveillance requirements involve pump flow tests: verification of unobstructed flowpaths, adequate water supply, and diesel fire pump fuel tank level; and instrument calibrations. The bases for the various SR frequencies are provided and were determined to be adequate.

A Main Drain Test for the CH Bay and Room 108 risers shall be performed Annually and upon any FSS valve alignment change that could impact the flow capability. The Main Drain Test for each riser provides reasonable assurance that the supply side of the system is correctly aligned and free of obstructions, and allows trending of the test results to monitor for degradation of the water supply system. The Main Drain Test results must show less than a 10% reduction of full flow pressure when compared to the previous satisfactory comparable test. The Frequency of Annually and upon any FSS alignment change is based on NFPA 25.

Annual calibration on the level indicators for the Fire Water Storage Tank (Level transmitter, 456-LT-006-001, CMR indicator, AK0601 and Local indicator, 456-LI-006-001) is specified. The

Annual Frequency meets the Calibration Frequency assumed in the associated instrument uncertainty analysis.

An Inspectors flow test is performed on a semiannual basis to verify flow can be obtained at the most remote section of the system. The FSS requires indication of water flow when the inspector's test valve is opened on each sprinkler branch. The CH Bay sprinkler system contains two inspector's test valves: FW-411-V-023 and FW-412-V-002 and the Room 108 system has one: FW-411-V-062. This SR opens the inspector's test valve on a Semi-annual basis and verifies water flow from the inspector's test connection orifice and is performed to verify that there is an unobstructed flow path in the piping from the riser to the sprinklers. The Semiannual Frequency meets the requirements of NFPA 25.

An internal visual inspection of the CH Bay and Room 108 risers is performed every five years of the internals (e.g., alarm valves, check valves, strainers, filters, orifices, and representative sample(s) of FSS piping) of the CH Bay and Room 108 risers. The SR verifies components operate correctly, move freely, and are in good condition, and fire suppression piping is free of excessive foreign material and unobstructed. A 5 Year frequency has been determined to be adequate based on NFPA criteria.

During the SBRT review, it was determined that a strategy of having two pumps available should be incorporated into the operability requirements of the LCO in order to support additional system redundancy and reliability. As such, directed page changes (See SER Section 5) require both pumps and separate LCO conditions for situations when either one or both are not available. Surveillance requirements, as well as bases for the system are also modified to reflect the new strategy.

3.6.3.2 Underground Vehicle/Equipment Fire Suppression Systems

DSA Chapter 3 and 4 identify the Underground Vehicle/Equipment Fire Suppression System (FSS) to automatically detect and suppress developing stage fires associated with the engine compartment, and/or fuel and hydraulic line leaks, thereby reducing the likelihood of pool fires involving CH Waste. The UG vehicles/equipment which require an automatic FSS were determined by the hazard evaluation completed per NFPA-122. WIPP-058, Revision 2, DSA Supporting Calculations, Fuel Spill, HEPA Filter Plugging, and Compartment Over Pressurization, identifies the fuel limits for the vehicles that require a FSS as those that may clog the HEPA filter units in fire event.

The FSS on the UG vehicles/equipment are specifically designed for each vehicle/equipment based on the fire hazards associated with the particular vehicle. The UG vehicle/equipment FSSs are installed by a qualified person and certified in accordance with the approved plans and the manufacturer's design, installation, and maintenance manual. UG vehicles/equipment FSSs meet the requirements of NFPA 17, Standard for Dry Chemical Extinguishing Systems, The UG vehicle/equipment FSSs are fully Factory Mutual and/or UL approved and comply with the requirements for pre-engineered FSSs. DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, "lowest functional capability or performance level of SSCs required for safe operation.

DSA section 5.5.2.1 describes the derivation of the operability attributes of the UG vehicle FSS that are required to verify the system can adequately perform its credited safety function. Because the UG vehicle FSS is an active SS SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR. The UG vehicle/equipment FSS is composed of a heat sensor system (fire detection); a control panel that interprets the heat detection cable output signals, initiates discharge of the system, initiates vehicle engine cutoff once the FSS is actuated, and performs diagnostic tests of the system; and status indicating lights. The control system for the FSS is a proprietary controller supplied by the manufacturer. The controller is fully enclosed and has no programming functions available to the end user with the exception of some temperature set point and time delay adjustments set by a certified installer. The distribution system is composed of piping or tubing that carries the extinguishing agent to nozzles located at each hazard area. The extinguishing agent is a dry chemical Type ABC fire suppressant powder which is stored in a container and is dispersed through the system via a pressurized gas.

There are two systems used in the facility: the Ansul and the Amerex System. Both systems operate in the same manner. The significant differences are with the suppressant supply. In the Ansul System there are two separate cylinders. One cylinder holds the dry powder extinguishing agent. The other cylinder holds the gas (nitrogen) that is used to propel the extinguishing powder through the system. The Amerex System uses a pressurized cylinder that holds the chemicals in two separate chambers. One chamber contains the credited dry chemical agent (Type ABC). The other chamber contains a liquid cooling agent designated by the manufacturer as a liquid based integrated cooling material.

An operable FSS consists of a Control Panel with functional status indicating light(s), temperature detection elements, an adequately charged suppressant system, distribution system to disperse the suppressant, and an automatic engine cutoff function. These elements for operability of the system were selected as critical indicators of an operable FSS from review of how the system works as presented in the manufacture's system description. However, there are no set values or quantitative criteria that are discussed in this section for the system.

DSA section 5.5.2.2 provides a discussion of the required surveillance testing to ensure equipment operability. In accordance with NFPA 17 requirements and the manufacturer's recommendations, normal and periodic maintenance (e.g., weekly, monthly, quarterly, semiannually, annually, or less frequent) is performed by a qualified manufacturer approved service technician. The technician completes the maintenance and functional tests per the FSS manufacturer's recommendations and instructions and the appropriate WIPP procedures. The WIPP Fire Protection Program (FPP) ensures the completion of all required inspections, maintenance, and tests at the intervals required by the NFPA or manufacturer's requirements. To support the operability determination for the systems, two surveillance requirements were selected from the evaluation of NFPA-17 and the manufacturer's manual.

A verification is performed before use each shift for any vehicles selected for use that are subject to the LCO applicability. The verification confirms that there is no indication that the automatic detection and/or actuation portions of the FSS are impaired and the system will function as expected in the event of a fire. The verification is confirmed visually by observing the Control Panel green status light on each vehicle. The Control Panel contains a diagnostic loop that verifies that the dry chemical suppressant has not been discharged and that all the components monitored by the Control Panel, are within specified tolerance. The discussion provides the operator actions used to verify the status for each of the two systems used at WIPP. The testing method described was verified by reviewing the manufacturer's manual. The green status light is the only light that is credited to verify system operability on both FSSs. The manufacturer guidance in the operating manual is that this verification be performed daily. Therefore, the performance of prior to use each shift is more frequent and determined to be acceptable.

A Semi-annual functional test was provided to verify the following components are operable: Control Panel with functioning green status indicating light, temperature detection elements; an adequately charged suppressant system; a distribution system for dispersing the suppressant; and the automatic engine cutoff system. Additionally, an inspection is completed to verify there is no evidence of caking of the Ansul System dry powder suppressant in the cylinder. The Semi-annual frequency is in accordance with the requirements of NFPA 17, and the manufacturer's recommendations, and is sufficient to demonstrate operability of the system. In accordance with NFPA 17 requirements and the manufacturer's recommendations, this test is to be performed by a qualified manufacturer approved service technician.

3.6.3.3 CH WHB CVS

DSA Chapter 3 and 4 identify the CH WHB CVS as relied upon to mitigate the consequences of radiological material releases from non-NPH fire events (pool fires, ordinary combustible material fires, vehicle collision with non-pool fire, internal CH Waste Container fires) by filtering air from the CH Bay, Room 108, and the CLR when Door 140 is open, prior to its release to the environment. The CH WH CVS consists of supply fans, dampers, exhaust fans, high-efficiency particulate air (HEPA) filter units, control systems, and instrumentation supporting system indications. For the exhaust capability, two CH WH CVS HEPA Filter Trains are available to provide the air filtration function. Each HEPA filter unit consists of one moderate efficiency filter bank and two in series HEPA filter banks. This system is configured to allow only one exhaust train to be in-service at a time. For each of the required operability parameters there is instrumentation that provides a remote indication and alarm in the CMR and a new local indication added to address vulnerabilities from the backfit analysis.

DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, "lowest functional capability or performance level of SSCs required for safe operation." DSA section 5.5.3 describes the derivation of the operability attributes of the CH WHB CVS that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. Because the CH WHB CVS is an active SS SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR. Section 5.5.2.1 indicates that the operability attributes for the system are one exhaust fan and one operable HEPA unit in-service, proper negative pressures in the applicable Process Areas (CH Bay and Room 108), and associated instrumentation monitoring the operability parameters. Surveillance requirements were provided for each of the operability parameters listed in the control derivation section. Section 5.5.2.2 provided the surveillances that ensure the CH WHB CVS can perform its safety function of providing adequate filtration and alarm capabilities. The associated values used to support the LCO values have been included along with performance methodology used during the test. These values were verified to agree with those listed in the section discussion. The surveillance requirements involve instrument calibrations, alarm functional testing for the CMR related equipment, verification of local DP readings, and HEPA filter testing in accordance with N510. The basis for the various SR frequencies is provided and was determined to be adequately defended in the section.

To provide the differential pressure (dP) requirements in the applicable process areas, the use of one exhaust fan is required. To ensure the fan exhaust is filtered, one operable HEPA filter is also required to be in-service. This arrangement of fan and filter provides the lowest functional capability for the system. Verification is performed daily to confirm that a CH WH CVS exhaust fan and an operable HEPA filter unit is in-service by visual observation as indicated on the CMR monitors. The daily surveillance is adequate due to high system reliability based on operational experience and the other daily verifications of adequate pressures for the process areas and HEPA units.

CH WH CVS Operability requires that a differential pressure is maintained of less than or equal to 0.04 inches w.g. in the CH Bay and Room 108 with respect to outside ambient air pressure as indicated on differential pressure local gauges. This value is based on a desired differential pressure of being less than outside ambient air pressure (i.e., -0.01 inches w.g.) (SDD HV00, Heating, Ventilation and Air Conditioning System, System Design Description) and applying an instrument loop uncertainty (CALC 16-007), which gives a value of –0.04 inches w.g. for both the CH Bay and Room 108. Verification of dP in the CH Bay and Room 108 differential pressure is performed daily by visual observation of the CH Bay and Room 108 Process Areas differential pressure local gauges. Surveillance frequency of the differential pressure indications is adequate based upon prior operational experience with conditions that could adversely affect maintaining adequate differential pressure in the CH Bay and Room 108.

To ensure that the exhaust air is adequately filtered, an operability attribute of having one HEPA filter unit in-service is required. The operable HEPA unit is based upon the in-service filter having the required dP range (+0.30 inches w.g to +3.90 inches w.g.) and an efficiency of greater than or equal to 99%. The maximum pressure value is based on a desired differential pressure of less than or equal to +4.0 inches w.g. and applying an instrument uncertainty (CALC 16-007, Room and HEPA Instrument Uncertainty), The minimum value is based on a desired differential pressure of greater than +0.20 inches w.g. and applying calculated instrument loop uncertainty (CALC 16-007) which ensures that the HEPA filter banks are not being bypassed. Verification of dP across each in-service HEPA filter bank of the in-service HEPA filter unit is performed daily by visual observation of the HEPA filter bank pressure differential transmitters' local gauges. Performance of an aerosol test of HEPA filter units 41-B-814 and 41-B-815 is required annually in accordance with ASME N510, Testing of Nuclear Air Treatment Systems to demonstrate that each HEPA filter unit has an efficiency of greater than or equal to 99%. The basis for the HEPA filter unit filter efficiency of at least 99% is to satisfy the hazard analysis assumptions and the Chapter 4 performance criteria. The HEPA filter unit has two banks in series and each bank is required to have the required dP and efficiency for the unit to be declared operable. The in-place leak test uses a poly-dispersed aerosol test (0.3–0.7 micron aerodynamic equivalent diameter) to determine the system efficiency accounting for the system components (i.e., gaskets, frame, housing, etc.) that are typically challenged. The test is performed under actual conditions and at operational airflow by qualified/trained individuals. The annual frequency is based upon ASME N510 guidance..

To support the HEPA filter operability verification and required dP in the process areas, dP instrumentation is provided for local reading and remote indication in the CMR. The section discussion for each of the differential pressure instrument values for the Process Areas and across the in-service HEPA filters lists the DSA Chapter 4 related performance criteria as its basis. Additionally, each of the required values has a discussion supporting the origination of the value (whether from engineering design documents or consensus standards) that was reviewed by the SBRT and determined to be adequate. The dP value for each of the required parameters was adjusted to support the specific instrument uncertainty calculations for use in the LCO operability determination in accordance with the TSR guide. Each instrument was supported with an uncertainty calculation that was referenced in the section. These adjusted values are contained in DSA Table 5.3.1 for the CMR alarm loop and DSA Table 5.3.2 for the local dP gauges. The adjustment of the values was made in a conservative manner to ensure the alarm setpoint can be set or verified to protect the performance criteria value.

To address the vulnerabilities of the CMR loop instrumentation identified in the associated backfit analysis, a new local safety significant gauge has been provided near the existing local dP transmitters supporting the HEPA filters and the Process Areas. This local gauge is independent from the dP transmitter and is credited to demonstrate operability for the various measured parameters because of the identified weaknesses in the CMR instrumented loop. The CMS/CMR loop alarm for the various dP readings is, however, also credited with providing continuous monitoring of the parameter through an alarm as it provides a “backup” to the local indications. Because of the different instrument loop uncertainty values for the CMR alarm loop and the local gauge, the instrument tables may present different values for the same measured parameter. However, the adjusted values are based upon the same required value from the performance criteria. The SBRT review verified that the acceptable values and alarm setpoints listed were correct for the various dP instruments after the uncertainty was applied. A directed change (see SER section 5) addresses inconsistencies in the associated instrument uncertainties.

To support the operability determination of the required instrumentation, the section describes calibrations and functional testing activities. An annual calibration on the instrumentation for each dP transmitter loop of DSA Table 5.5-1 and the local gauges specified in DSA Table 5.5-2 is used to verify Operability of the CH WH CVS. The loop elements that are calibrated include applicable pressure differential transmitters and pressure differential indicators as specified on the applicable calibration procedures. The calibration methods described in the section are adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended standard calibration frequencies for this type of instrumentation. An annual functional test on differential pressure alarm instrument loops of DSA Table 5.5-1 is required to confirm that each of the differential pressure transmitters and corresponding instrument loops provide accurate signal output to the CMS and result in an audible CMR alarm and visual indication of the applicable alarm. The Functional Test consists of injection of a simulated or actual signal into the instrument loop, at the input of the differential pressure transmitter. The functional test method described in the section is adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended instrument loop functional test frequencies for this type of instrumentation.

3.6.3.4 UVFS/IVS

DSA Chapter 3 and 4 identify the Underground Ventilation Filtration System/Interim Ventilation System (UVFS/IVS) as relied upon to mitigate the consequences of radiological material releases from internal container fires or deflagrations/over-pressurizations, fires involving ordinary combustible materials, and fires associated with vehicle fuel leaks near the waste face to acceptable levels. The UVFS/IVS is used to draw outside air into the UG through three shafts which is then exhausted through a single shaft by UVFS/IVS exhaust fans located on the surface. The air drawn down the Air Intake Shaft, Salt Handling Shaft, and the Waste Shaft is split into three separate air streams serving the construction, north area and TRU Waste disposal areas. The air drawn down the Waste Shaft using various fan arrangements serves the Waste Shaft Station operation and is exhausted directly to the Exhaust Shaft. The combined exhaust streams are drawn up the Exhaust Shaft, and discharged through the UVS/IVS HEPA filtration units.

The UVFS is comprised of three centrifugal exhaust fans, two identical HEPA filter units arranged in parallel, isolation dampers, and associated ductwork. Any of the UVFS exhaust fans can draw air from both HEPA filter units and only one fan is operated at a time to provide the

UG filtration function. Operation of more than one UVFS exhaust fan at a time could damage the HEPA filter units. The IVS is comprised of two skid mounted centrifugal exhaust fans, and two skid mounded HEPA filter units, isolation dampers, and associated ductwork. Each IVS exhaust fan can draw air from only one HEPA filter unit.

DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, “lowest functional capability or performance level of SSCs required for safe operation.” DSA section 5.5.5.1 describes the derivation of the operability attributes of the UVFS/IVS that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. Because the UVFS/IVS is an active SS SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR. Specifically, the section lists six operability requirements that must be in place. The operability requirements are associated with in-service fan and HEPA filter unit alignments, operable HEPA filtration, dP at the 308 bulkhead, directional airflow into an active room, and supporting dP instrumentation. Surveillance requirements were provided for each of the operability parameters listed in the control derivation section. DSA section 5.5.5.2 provides details of surveillances to verify that the UVFS/IVS can perform its safety function of providing adequate pressure, flow direction, HEPA efficiency, instrument alarm capabilities, and local dP reading. The associated values used to support the LCO values have been included along with performance methodology used during the test. These values were verified to agree with those listed in the section discussion. The surveillance requirements involve instrument calibrations, alarm functional testing for the CMR related equipment, verification of local DP readings and fan status, and HEPA filter testing in accordance with N510. The basis for the various SR frequencies is provided and was determined to be adequately defended in the section.

To provide the differential pressure (dP) requirements in the Underground, the use of one of the allowed exhaust fan arrangements is required. The various exhaust fan and filter alignments provide the required ventilation flowrates for the various operations that are performed in the UG and provide flexibility to operations in maintaining the needed air flow requirements and the dP. The table is arranged to support the number of in-service fans so that the HEPA units are not experiencing greater than design flowrates. The table also addresses the prohibition of the operation of the 700 fans and the SVS. To ensure the fan exhaust is filtered, the compliment of operable HEPA filter arrangement is also required to be in-service. This arrangement of fan and filter provide the lowest functional capability for the system. Verification is performed daily to confirm that the in-service alignment of the UVFS/IVS exhaust fan(s) and operable HEPA filter unit complement is in accordance with DSA Table 5.5-3 by visual observation of the exhaust fan(s) and HEPA filter unit(s) operational status and alignment as indicated on the CMR monitors. The daily surveillance is adequate due to high system reliability based on operational experience and the other daily verifications of adequate pressures for the process areas and HEPA units.

To ensure that the exhaust air is adequately filtered, an operability attribute of having the required HEPA filter unit compliment in-service is required. The operable HEPA unit is based upon the in-service filter having the required dP range (+0.31 inches w.g to +3.89 inches w.g.) and an efficiency of greater than or equal to 99%. The maximum pressure value is based on a desired differential pressure of less than or equal to +4.0 inches w.g. and applying an instrument uncertainty (CALC 16-008, *Uncertainty of Mechanical Gauges for Differential pressure Measurements Across HEPA Filter Banks*), The minimum value is based on a desired differential pressure of greater than +0.20 inches w.g. and applying calculated instrument loop uncertainty (CALC 16-008) which ensures that the HEPA filter banks are not being bypassed, Verification of dP across each in-service HEPA filter bank of the in-service HEPA filter unit is performed daily by visual observation of the HEPA filter bank pressure differential transmitters' local gauges. Performance of an aerosol test of HEPA filter units is required annually in accordance with ASME N510, Testing of Nuclear Air Treatment Systems to demonstrate that each HEPA filter unit has an efficiency of greater than or equal to 99%. The basis for the HEPA filter unit filter efficiency of at least 99% is to satisfy the hazard analysis assumptions and the Chapter 4 performance criteria. The HEPA filter unit has two banks in series and each bank is required to have the required dP and efficiency for the unit to be declared operable. The in-place leak test uses a poly-dispersed aerosol test (0.3–0.7 micron aerodynamic equivalent diameter) to determine the system efficiency accounting for the system components (i.e., gaskets, frame, housing, etc.) that are typically challenged. The test is performed under actual conditions and at operational airflow by qualified/trained individuals. The annual frequency is based upon ASME N510 guidance.

The UVFS/IVS is designed to maintain a pressure differential between the UG Waste Handling Areas (disposal zone) and the non-Waste Handling Areas (e.g., construction zone) such that airflow is from the Waste Handling Areas is always directed to the filtered exhaust. The dP across the 308 Bulkhead is measured to verify that negative air pressure is maintained in the exhaust drift to draw air to the Exhaust Shaft. The ventilation study affords reasonable assurance that 308 bulkhead dP ensures filtered ventilation for the disposal zone for normal ventilation alignments and over a broad range of hypothesized misalignments including the effects of seasonal natural ventilation pressure. The SBRT concludes that this 308 bulkhead dP is a sufficient criterion to ensure the filtered ventilation is available as required when fans are operating in an allowed configuration. UVS Operability requires that a differential pressure is maintained of less than or equal to -0.09 inches w.g. across the 308 bulkhead. This value is based on a safety analysis differential pressure of being less than -0.05 as prescribed by the UVFS/IVS SDD (SDD VU00, *Underground Ventilation System Design Description*). Applicable instrument uncertainty calculations (CALC 15-029, *Loop Accuracy for a New Differential Pressure Transmitter at Bulkhead 308*, Revision 1) prescribe the instrument loop uncertainty values to be applied. Verification of the differential pressure at the 308 Bulkhead is accomplished by a pressure differential transmitter signal input to the CMR that provides an audible alarm. No additional SR is required for verification of the differential pressure at the 308 Bulkhead because it is audibly alarmed in the CMR, which is constantly manned to initiate required response actions. Therefore, periodic surveillance of local differential pressure values is not required.

Operability of the UVFS/IVS requires that airflow be drawn into the active room of the disposal panel and across the waste face away from the facility worker, while the room is manned. This condition provides assurance that the air is directed to the Disposal Panel exhaust drift. When the active room air pathway is present it directs air away from facility workers working at the CH waste face and provides protection in the event of a radiological release event. When the dP at the 308 Bulkhead is maintained negative and various bulkheads are adjusted for normal operations, the exhaust side of the active room is at a lower pressure than the inlet side of the active room. The bulkhead positions are not governed by the LCO but an acceptable configuration is confirmed by the specified air flow test. Because air flow moves from high pressure to low pressure, the air must move into the active room. The layout of the disposal room for waste emplacement includes bulkheads on the exhaust side that can control the airflow in the room and direct airflow towards the waste exhaust drift. Therefore, airflow in the appropriate direction across the waste face and away from personnel is ensured. No quantitative flow rate is necessary to achieve the operability requirements in that the performance criterion requires only directional flow. Verification of flow at the active room entrance is a direct representation of the flow into the room and across the waste face. The referenced ventilation study (DN-3590-29 Revision 4) demonstrates that while the 308 bulkhead dP is within its set-point only inadvertent unintended adjustments of the underground ventilation (e.g., opening of the 707 bulkhead separating the disposal and construction zones) could cause an air reversal in the active room depending on ambient weather conditions. Specified active room flow verification both prior to entry on a shift and when any ventilation adjustments are made precludes such a condition.

To ensure that the facility worker at the waste face of an active room is provided the required airflow, a verification of the presence of airflow is performed: 1) prior to manning the active room for each shift; and 2) following change of exhaust fan alignment, and 3) following change of ventilation bulkhead alignment that can affect the airflow to the active room. Indication of airflow into the active room can be obtained manually via calibrated anemometer airflow rate measurement or smoke/aerosol test confirmation of airflow direction into the active room. The anemometer flow rate measurement or smoke/aerosol test is taken in the intake drift of the active room while standing directly outside of the active room. Either method of flow verification is acceptable, but smoke testing is normally used for low conditions and anemometer for higher flow rates. The SBRT confirmed the surveillance method and frequency are adequate to demonstrate that the UVFS/IVS is operable and providing airflow into the active room to allow facility workers safe entry. With the verification of flow at the Active room entrance and the configuration of the other rooms in the Active panel, flow into the active room is the most representative of flow across the waste face.

To support the HEPA filter operability verification and required differential pressure (dP) in the process areas, dP instrumentation is provided for local reading and remote indication in the CMR. The section discussion for each of the differential pressure instrument values for the 308 bulkhead and across the in-service HEPA filters lists DSA Chapter 4 related performance criteria as its basis. Additionally each of the required values has a discussion supporting the origination of the value (whether from engineering design documents or consensus standards) that was reviewed by the team and determined to be adequate. The dP value for each of the required parameters was adjusted to support the specific instrument uncertainty calculations for use in the LCO operability determination in accordance with the TSR guide. Each instrument was supported with an uncertainty calculation that was referenced in the section. These adjusted values are contained in DSA Table 5.5.4 for the CMR alarm loop and DSA Table 5.5.5 for the local dP gauges. The adjustment of the values was made in a conservative manner to ensure the alarm set-point can be set or verified to protect the performance criteria value.

To address the vulnerabilities of the CMR loop instrumentation identified in the associated backfit analysis, a local Safety Significant gauge has been provided at the existing differential pressure transmitters supporting the HEPA filter units. This local gauge is used to support the operability determination for the various measured parameters because of the identified weaknesses in the CMR instrumented loop. The CMS/CMR loop alarm for the various differential pressure readings is, however, also credited with providing continuous monitoring of the parameter through an alarm as it provides a “backup” to the local indications. Because of the different instrument loop uncertainty values for the CMR alarm loop and the local gauge, the instrument tables may present different values for the same measured parameter. However, the adjusted values are based upon the same required value from the performance criteria. The review verified that the acceptable values and alarm setpoints listed were correct for the various dP instruments after the uncertainty was applied. As a result of the backfit analysis, the 308 bulkhead differential pressure loop has been replaced with an instrument that no longer sends signals through the CMS. A separate alarm panel is now available that meets all the requirements of a SS SSC. The table provides the LCO values for the 308 Bulkhead CMR alarm and local differential pressure instrument. A directed change (see SER section 5) addresses inconsistencies in the associated instrument uncertainties.

Annual calibration on the instrumentation for dP transmitter loop of DSA Table 5.5-4 is used to verify operability of the UVFS/IVS. This instrumentation includes the dP transmitters used for measurement of dP across each of the HEPA filter banks of the in-service HEPA filter units, and the dP transmitter used both for measurement of the dP at the 308 Bulkhead and for the local gauges. The loop elements that are calibrated include applicable pressure differential transmitters and pressure differential indicators as specified on the applicable calibration procedures. The calibration method described in the section is adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended standard calibration frequencies for this type of instrumentation.

To support the operability determination of the required instrumentation, the section describes calibrations and functional testing activities. An annual functional test on differential pressure alarm instrument loops of DSA Table 5.5-4 is used to confirm UVFS/IVS operability. A functional test is required to confirm that each of the dP transmitters and corresponding instrument loops provide accurate signal output to result in an audible CMR alarm for conditions outside the applicable alarm set points. The annual frequency is based upon industry recommended instrument loop functional test frequencies for this type of instrumentation.

An Annual functional test on differential pressure alarm instrument loops of DSA Table 5.5-1 is required to confirm that each of the differential pressure transmitters and corresponding instrument loops provide accurate signal output to the CMS and result in an audible CMR alarm and visual indication of the applicable alarm. The Functional Test consists of injection of a simulated or actual signal into the instrument loop, at the input of the differential pressure transmitter. The functional test method described in the section is adequate to maintain the operability of the instruments. The Annual Frequency is based upon industry recommended instrument loop Functional Test frequencies for this type of instrumentation.

3.6.3.5 309 Bulkhead Operability during Downloading of Waste Containers

DSA Chapter 3 and 4 identify the 309 Bulkhead pressure control as relied upon to mitigate the consequences of a release of radiological material at the Waste Shaft Station in the UG from ordinary combustible material fires to acceptable levels. Required 309 Bulkhead pressure draws air from this location to the Exhaust Shaft and filtering the air prior to its release to the environment. The 309 Bulkhead consists of two walls with a chamber in between. The differential pressure is measured from inside the chamber to the Waste Shaft Station side. A positive pressure indicates airflow is moving from the bulkhead chamber to the Waste Shaft Station side ensuring no air can pass from the Waste Shaft Station side to W-30. The 309 Bulkhead differential pressure control is an additional requirement for UVFS/IVS that is required to be available when Downloading is performed in the Waste Shaft Area. Therefore to support adequate control and mitigation of the potential for a release of radioactive material, the controls from section 5.5.5 and this section are required to be in place during Downloading also.

DSA section 5.5.6 describes the derivation of the operability attributes of the 309 bulkhead pressure control that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. The 309 Bulkhead dP control is an additional requirement for UVFS/IVS that is required to be available when waste handling activities are being performed in the waste shaft area. A separate control was established for the 309 Bulkhead pressure because of its conditional applicability, the dP requirements, and the requirement of three exhaust fans being in service to address the potential for an up-casting condition in the waste shaft.

The section details the performance criteria from DSA Chapter 4 concerning the 309 Bulkhead. Specifically, the section lists four operability requirements that must be in place in the UG to allow waste downloading operations. The operability requirements are associated with in-service fan alignments, dP at the 309 bulkhead, directional airflow in the Waste Shaft Station, and supporting dP instrumentation. The derivation of fan alignments for waste emplacement is based upon the ventilation study (DN-3590-29 Revision 4, *Modeling UVFS/IVS Fan Configurations with Various NVPs and Upset Conditions*, dated 3/18/2016). In this study, the potential for upcasting was evaluated in various exhaust fan alignments. The conclusion of the study was that when three exhaust fans are operating and exhausting the UG, the potential for upcasting is limited and a smoke test to verify flow toward the 308 barricade will suffice to preclude upcasting. The three fans to operate are the two 960 fans and one of the 860 fans. The SBRT did not review the underlying model in detail, but judged the control conclusions to be inherently robust and acceptable. To support the conditional application of this control, the verification of fan alignment (three exhaust fans in-service) is performed prior to each downloading activity. A verification of UVFS/IVS exhaust fan alignment of three exhaust fans, one UVFS (41-B-860A, 41-860-B, or 41-B-860C) and two IVS exhaust fans (41-B-960A and 41B-960B) are In Service is performed by visual observation of exhaust fan status as indicated in the CMR.

To support the conditional application of this control, the verification of adequate 309 bulkhead pressure is performed prior to each downloading activity. Bulkhead 309 pressure operability requires that a differential pressure is maintained of greater than or equal to +0.14 inches w.g.as indicated on the differential pressure local gauge, which also represents the flow direction from between the 309 Bulkhead walls to S-400. This value is based on a desired differential pressure of being greater than or equal to +0.05 inches w.g. and applying a calculated instrument loop uncertainty (CALC 16-010, *Loop Accuracy for a New Differential Pressure Indicator at Bulkhead 309*). Verification of dP at the 309 Bulkhead is performed by visual observation of the 309 Bulkhead pressure differential transmitter's local gauge as specified in DSA Table 5.5-7.

Operability of the UVFS/IVS also requires sufficient draw of air from the waste shaft station towards the 308 Bulkhead to ensure that the air is directed to the 308 Bulkhead. This operability requirement ensures that air from the waste shaft station is not being drawn up the unfiltered waste shaft instead of being directed towards the 308 Bulkhead, such as could occur during certain outside atmospheric conditions (i.e., upcasting). This potential of airflow directly up the waste shaft is prevented with sufficient UVFS/IVS exhaust fan draw of air from the waste shaft station towards the 308 Bulkhead. The use of airflow direction to support the verification was selected as suggested in the ventilation study. The check is a simple verification using smoke/aerosol to show movement of airflow towards Bulkhead 308 and not up the Waste Shaft. The selection of this method was based upon location of the verification and the limitations of instrumentation in the Waste shaft and Waste tower. Verification of airflow direction from the Waste Shaft Station towards the 308 Bulkhead is performed by a simple smoke test and observing that air from the Waste Shaft Station area is not being drawn up the Waste Shaft but towards the 308 Bulkhead. The smoke/aerosol test is taken at the Waste Shaft Station where the Waste Conveyance would rest to unload Waste Containers at the bottom of the Waste Shaft. Verification of each of this condition prior to each download activity is adequate to support the short duration activity of downloading waste containers.

To support the required differential pressure (dP) across the 309 Bulkhead, dP instrumentation is provided for local reading and remote indication in the CMR. The section discussion for the differential pressure instrument values for the 309 bulkhead lists DSA Chapter 4 related performance criteria as its basis. Additionally the required value has a discussion supporting the origination of the value (whether from engineering design documents or consensus standards) that was reviewed by the team and determined to be adequate. The dP value was adjusted to support the specific instrument uncertainty calculations for use in the LCO operability determination in accordance with the TSR guide. Each instrument was supported with an uncertainty calculation that was referenced in the section. These adjusted values are contained in DSA Table 5.5-6 for the CMR alarm loop and DSA Table 5.5-7 for the local dP gauges. The adjustment of the values was made in a conservative manner to ensure the alarm set-point can be set or verified to protect the performance criteria value.

To address the vulnerabilities of the CMR loop instrumentation identified in the associated backfit analysis, a local Safety Significant gauge has been provided at the existing differential pressure transmitter. This local gauge is used to support the operability determination for the various measured parameter because of the identified weaknesses in the CMR instrumented loop. The CMS/CMR loop alarm for the differential pressure reading is, however, also credited with providing continuous monitoring of the parameter through an alarm as it provides a “backup” to the local indication. Because of the different instrument loop uncertainty values for the CMR alarm loop and the local gauge, the instrument tables may present different values for the same measured parameter. However, the adjusted values are based upon the same required value from the performance criteria. The review verified that the acceptable values and alarm set points listed were correct for the various dP instruments after the uncertainty was applied. A directed change (see SER section 5) addresses inconsistencies in the associated instrument uncertainties.

To support the operability determination of the required instrumentation, the section describes calibrations and functional testing activities. Annual calibration of the instrumentation for the differential pressure instrument loop of DSA Table 5.5-6 and local gauge as specified in DSA Table 5.5-7. The loop elements that are calibrated include applicable pressure differential transmitter, CMR alarm and local pressure differential indicator as specified on the applicable calibration procedures. The calibration method described in the section is adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended standard calibration frequencies for this type of instrumentation.

An annual functional test on the differential pressure alarm instrument loop of DSA Table 5.5-6 is used to confirm that the differential pressure transmitter and corresponding instrument loop provide accurate signal and indication of conditions outside the applicable alarm set points via audible/visual CMR alarm. The functional test described in the section is adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended instrument loop functional test frequencies for this type of instrumentation.

3.6.3.6 Battery Exhaust Filtration System

DSA Chapter 3 and 4 identify the Battery Exhaust Filtration System as relied upon to mitigate the consequences of radiological material releases from non-NPH fire events to acceptable levels by filtering air from the CH Bay prior to its release to the environment. The Battery Exhaust Filtration System includes two HEPA filter units with two in series exhaust fans that exhaust air from the battery charging area and the TRUDOCK and TRUPACT-III unloading areas. The system’s exhaust enters the building exhaust duct downstream of that of the CH

WHB CVS and therefore provides a bypass to this credited system HEPA filter capability. The system is not a continuously-operated system. Each HEPA filter unit consists of one moderate efficiency filter bank and two in series HEPA filter banks. This system is configured to allow only one exhaust train to be in-service at a time. For each of the required operability parameters there is instrumentation that provides a local indication and a remote indication and alarm in the CMR.

DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, “lowest functional capability or performance level of SSCs required for safe operation.” DSA section 5.5.7 describes the derivation of the operability attributes of the system that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. Because the system is an active SS SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR.

Section 5.5.7.1 indicates that one operable HEPA unit is required to be in-service when a battery exhaust fan is in-service, to ensure that all of its airflow is HEPA filtered prior to leaving the building. Section 5.5.7.2 provided the surveillances that ensure the system can perform its safety function of providing adequate filtration and alarm capabilities. Surveillance requirements were provided for each of the operability parameters listed in the control derivation section. The associated values used to support the LCO values have been included along with performance methodology used during the test. These values were verified to agree with those listed in the section discussion. The surveillance requirements involve instrument calibrations, alarm functional testing for the CMR related equipment, verification of local DP readings, and HEPA filter testing in accordance with N510. The basis for the various SR frequencies is provided and was determined to be adequately defended in the section.

To ensure that the exhaust air is adequately filtered, an operability attribute of having one HEPA filter unit in-service is required. The operable HEPA unit is based upon the in-service filter having the required dP range (+0.28 inches w.g to +3.92 inches w.g.) and an efficiency of greater than or equal to 99%. The maximum pressure value is based on a desired differential pressure of less than or equal to +4.0 inches w.g. and applying an instrument uncertainty (CALC 16-007, *Room and HEPA Instrument Uncertainty*), The minimum value is based on a desired differential pressure of greater than +0.20 inches w.g. and applying calculated instrument loop uncertainty (CALC 16-007) which ensures that the HEPA filter banks are not being bypassed, Verification of dP across each in-service HEPA filter bank of the in-service HEPA filter unit is performed daily by visual observation of the HEPA filter bank pressure differential transmitters’ local gauges. Performance of an aerosol test of HEPA filter units is required annually in accordance with ASME N510, Testing of Nuclear Air Treatment Systems to demonstrate that each HEPA filter unit has an efficiency of greater than or equal to 99%. The basis for the HEPA filter unit filter efficiency of at least 99% is to satisfy the hazard analysis assumptions and the Chapter 4 performance criteria. The HEPA filter unit has two banks in series and each bank is required to have the required dP and efficiency for the unit to be declared operable. The in-place leak test uses a poly-dispersed aerosol test (0.3 - 0.7 micron aerodynamic equivalent diameter) to determine the system efficiency accounting for the system components (i.e., gaskets, frame, housing, etc.) that are typically challenged. The test is performed under actual conditions and at operational airflow by qualified/trained individuals. The annual frequency is based upon ASME N510 guidance.

To support the HEPA filter operability verification dP instrumentation is provided for local reading and remote indication in the CMR. The section discussion for each of the differential pressure instrument values across the in-service HEPA filters lists the DSA Chapter 4 related performance criteria as its basis. Additionally, each of the required values has a discussion supporting the origination of the value (whether from engineering design documents or consensus standards) that was reviewed by the SBRT and determined to be adequate. The dP value for each of the required parameters was adjusted to support the specific instrument uncertainty calculations for use in the LCO operability determination in accordance with the TSR guide. Each instrument was supported with an uncertainty calculation that was referenced in the section. These adjusted values are contained in DSA Table 5.5-8 for the CMR alarm loop and DSA Table 5.5-9 for the local dP gauges. The adjustment of the values was made in a conservative manner to ensure the alarm set point can be set or verified to protect the performance criteria value.

To address the vulnerabilities of the CMR loop instrumentation identified in the associated backfit analysis, a new local Safety Significant gauge has been provided near the existing local dP transmitters supporting the HEPA filters. This local gauge is independent from the dP transmitter and is credited to demonstrate operability for the various measured parameters because of the identified weaknesses in the CMR instrumented loop. The CMS/CMR loop alarm for the various dP readings is however, also credited with providing continuous monitoring of the parameter as it provides a “backup” to the local indications. Because of the different instrument loop uncertainty values for the CMR alarm loop and the local gauge, the instrument tables may present different values for the same measured parameter. However, the adjusted values are based upon the same required value from the performance criteria. The SBRT review verified that the acceptable values and alarm setpoints listed were correct for the various dP instruments after the uncertainty was applied. A directed change (see SER section 5) addresses inconsistencies in the associated instrument uncertainties.

To support the operability determination of the required instrumentation, the section describes calibrations and functional testing activities. An annual calibration on the instrumentation for each differential pressure transmitter loop of DSA Table 5.5-8 and the local gauges specified in DSA Table 5.5-9 is performed to verify operability of the battery exhaust system. The calibration method described in the section is adequate to maintain the operability of the instruments. The loop elements that are calibrated include applicable pressure differential transmitters and pressure differential indicators as specified on the applicable calibration procedures. The annual frequency is based upon industry recommended standard calibration frequencies for this type of instrumentation.

An annual functional test on differential pressure alarm instrument loops of DSA Table 5.5-8 is performed to confirm that each of the differential pressure transmitters and corresponding instrument loops provide accurate signal output to the CMS and result in an audible CMR alarm and visual indication of the applicable alarm. The functional test consists of injection of a simulated or actual signal into the instrument loop, at the input of the differential pressure transmitter, to verify operability of the differential pressure instrumentation and audible CMR alarm if outside the acceptable range. The functional test method described in the section is adequate to maintain the operability of the instruments. The annual frequency is based upon industry recommended instrument loop functional test frequencies for this type of instrumentation.

3.6.3.7 Waste Hoist Brakes

DSA Chapter 3 and 4 identify the Waste Hoist Brakes as relied upon to prevent damage to TRU Waste Containers by reducing the likelihood of an uncontrolled Waste Conveyance movement that results in a loss of confinement and the release of radiological materials. DSA Chapter 4 identifies specific performance criteria sufficient to ensure the required, "lowest functional capability or performance level of SSCs required for safe operation. DSA section 5.5.8 describes the derivation of the operability attributes of the Waste Hoist Brakes that are required to meet the performance criteria established in DSA Chapter 4 and thus to verify the system can adequately perform its credited safety function. Because the Waste hoist brakes are an active SS SSC with distinct operability parameters, an LCO was selected for implementation of the control in the TSR.

The Waste Hoist Brakes SS components consist of four brake units (two units each on the East and West hoist drum brake discs), a Lilly Controller with associated governors and contacts, and two emergency dump valves (i.e., valves SV-2 and SV-5). Each brake unit consists of 2 modules per unit, one module on each side of the disc and includes the spring, brake pads of a material and surface area as defined by the brake manufacturer, and the caliper housing.

The section provides a discussion of the attributes that are required to perform the safety function. The three attributes are the automatic capability of the Lilly controller to set the brakes in an over-speed condition, the ability of the emergency dump valves alone to set the brakes, and adequate brake pad thickness and caliper spring tension

To support the setting of the brakes in an over-speed condition, a Lilly controller is used. The Lilly Controller, a mechanical device monitors the hoist speed consists of a shaft with cams, two inertial (weight type) governors (so called fly-ball governors), a shaft that moves down as the ball spin speed increases, floating levers attached to the arm, and contact blocks. The fly-ball governors operate by centrifugal force, which causes the balls to spin around a shaft. As the speed of the hoist increases, the weighted balls spin faster and rise toward a horizontal plane resulting in the collar to which the balls are attached pushing down a center shaft. As the collar moves down, the center shaft moves floating levers. When the floating levers move an arm to a preset level, the arm motion removes the connection between two contacts. This opens the circuit supplying electric power to the hydraulic system. At a hoist conveyance over speed condition of approximately 550 fpm (maximum design speed of 500 fpm plus a 10% allowance), the Lilly Controller will automatically remove the electric power to the emergency dump valves. To support over-speed trips at different position in the shaft and at slower speeds retard cams are provided.

The emergency dump valves are used to ensure that the hydraulic pressure that holds the brakes open is released when the valves are de-energized. The emergency dump valves, SV-2 and SV-5, are closed electrically to hold the brakes open and are de-energized to relieve the pressure and allow the brakes to set. Upon a loss of electric power, the energized valves de-energize and return to either their normal open state.

The brake pad thickness and the spring tension are features that are required to ensure that brakes are capable of setting when required. The brake pads when received from the manufacturer are approximately 1 inch thick but must be greater than 0.5 inch thick to ensure proper adjustment of the pad to allow the required piston travel of 0.137 to 0.157 inch. The brake spring force of a minimum of 37,000 pounds is determined by the brake manufacturer based on the requirement to stop a maximally loaded conveyance within a travel distance of 30 feet when the brakes are applied.

DSA Section 5.5.8.2 indicates that a performance of the waste hoist braking capability is performed each shift prior to first use to verify the over-speed trip capability and the performance of the emergency dump valves. The Functional Test verifies that the brakes are automatically applied upon loss of electric power in an over speed condition. To support the testing, the hoist is positioned on a retard cam and an actual over-speed condition is initiated to verify the Lilly Controller fly-ball governor lifts the link between two contacts and the brakes set. The trip of the brakes at a lower speed is used to verify that in any position on the shaft, the brakes can be automatically set. This functional test is performed on one of the fly ball governors. Because each governor is configured to react in the exactly same manner to an over speed condition, the test on one governor indicates the trip capability for each. The weekly functional test actuates manually both governors. A successful over speed test is indicated by illumination of the Brake Set light and verified by the lack of Waste Hoist movement. The over speed test not only verifies the Operability of the Lilly Controller, but verifies that the brakes will set upon loss of electrical power as the Lilly Controller interrupts the electrical power supply to the control system.

The functional test also verifies the Operability of the emergency dump valves SV-2 and SV-5 by interrupting the electrical supply to the valves and demonstrating that these two dump valves alone open to relieve hydraulic pressure and set the brakes. This test verifies that the dump valves function as intended without any reliance upon the other four spool valves. The dump valves are verified to be open by visual indication that the Brake Set light illuminates in approximately 1 second and the Static Power Convertor Amp meter reaches 2,000 amps. To ensure the brakes are Operable and will stop a maximally loaded conveyance, during the tests, a 2000 amp current is applied to the Waste Hoist motor, which is more than 150% of the design load, while the brakes are set. The brakes are verified to prevent movement of the hoist against the torque supplied by the motors at this amperage loading and the Brake set light is verified to be lit.

A functional test of the Lilly Controller speed limiting unit is completed at least once per week to verify operability of the over speed control function. The functional test confirms that the Lilly Controller and the two fly-ball governors (fast and slow) and mechanical linkages are working correctly. Specifically it will verify that the mechanical linkages associated with the governors move freely and will lift the link between two contacts. The Lilly Controller and governor Operability is verified by manually lifting the fly-balls on the governors and verifying that the over speed contacts are opened (i.e., a connector bar is lifted from the contacts) while the brakes are set. The test is performed for each of the fly ball governors.

A surveillance is performed on the brake pad thickness and the spring tension to verify specified tolerances are present. The surveillance is completed on each of the four (4) brake units (eight modules) monthly. The current springs, supplied by the brake manufacturer, have a force of at least 37,000 pounds. The force is verified indirectly by a measurement of the caliper piston travel distance, which verifies the springs are in the normal force range. During the monthly test, the movement of each piston is verified, along with the brake pad thickness. The pad thickness is verified to be greater than 0.5 inches. If the piston movement measurement is 0.137 to 0.157 inch, the spring force is a minimum of 37,000 pounds and is sufficient to hold the brake pads against the disc and stop the conveyance upon demand. This monthly frequency is based on operational experience and the manufacturer's recommendations.

The SBRT concluded that the DSA provided an adequate description of the active SS SSCs that were selected as LCOs for control prevention and mitigation in DSA Chapters 3 and 4. The attributes for each of the active SSCs identified in Chapter 4 were appropriately included in the Chapter 5 derivation analysis. The discussion for each of the active SSCs contained sufficient information to determine the critical features of the identified attributes. In each discussion the attributes were evaluated and values were derived to support their inclusion into an LCO in the

TSR. The discussion for each of the active SSCs provided information necessary to derive the surveillance requirements for testing, calibration and inspection to assure that the necessary quality of systems is maintained and can be appropriately into the TSR. The surveillance discussion provided the basis for the frequency and the acceptable method to perform the surveillance.

3.6.4 LCO formatted SACs

The following discussion supports the SACs that are to be implemented in an LCO format. DOE-STD-1186 has provided guidance in the selection for LCO formatted SACs. Specifically, in Section 4.2 of the standard, it states LCO format should be used when the SAC is well defined, clear corrective actions are available, and conditions supporting the SAC can be easily surveilled. The application of this guidance resulted in four LCO formatted SACs. The LCOs are (1) Aboveground Liquid-fueled Vehicles/Equipment Control (2) UG Lube Truck Operational Control (3) Liquid-fueled Vehicles/Equipment Control and (4) WIPP WAC.

3.6.4.1 Aboveground Liquid-fueled Vehicles/Equipment Control

To address the hazard analysis conclusions for the mitigated risk evaluation for fires in the WHB, an Aboveground Liquid-fueled Vehicles/Equipment control has been established. DSA section 5.5.9 provides a description of the SAC, its applicability to the various process areas, and the associated surveillance requirements for SAC compliance. The LCO format is used for this SAC because the control is well defined with clear conditions and corrective actions to take if a condition is entered. Also, the conditions required to satisfy the SAC are readily surveyed and other controls (e.g., WHB FSS, WHB CVS, FPP) contribute to the reduction of risk if a noncompliance exists with the control.

CH Waste is brought into the CH Bay or Room 108 in a Closed Type B Shipping Package. The CH Waste is removed from the Closed Type B Shipping Packages in the CH Bay and/or Room 108. When no longer in a Closed Type B Shipping Package, the Waste Container may be impacted by a fire, and result in release of the radiological material. To address this potential fire event a SAC has been established as follows:

> *Aboveground Liquid-fueled Vehicles/Equipment shall not be present in the CH Bay, Room 108, or Waste Shaft Access Area when CH Waste is present*

The credited safety functions of the Aboveground Liquid-fueled Vehicle/Equipment Prohibition is to prevent fuel pool fires from affecting CH Waste in the CH Bay, and/or Room 108, and in the Waste Shaft Access Area,.

This control does not apply to electric vehicles/equipment that may contain hydraulic and lubrication fluids that could be involved in a pool fire since these are high temperature hydraulic fluids, which have a significantly higher flash point than diesel, and without an engine being present, the high temperature ignition source is removed from the event. This vulnerability is mitigated with the SS WHB FSS.

Section 5.5.9.2 describes the surveillance requirements for SAC compliance as being visual verification each shift that liquid-fueled vehicles/equipment are not present in the CH Bay, Room 108 or the Waste Shaft Access Area. The visual verification is not a complicated task that is performed by trained personnel. Based on operational experience and the operational use of electric powered vehicles in the CH Bay, a frequency of each shift is provided.

The review of the control discussion indicates that the operability parameters that are presented are consistent with the hazard analysis and the presentation in DSA Chapter 4 performance evaluation. The operability parameters are detailed appropriately to support implementation as an LCO and the corresponding parameters are supported by an associated surveillance requirement.

3.6.4.2 UG Lube Truck Operational Control

To address the hazard analysis conclusions for the mitigated risk evaluation for fires in the UG, a Lube Truck Operational control has been established. DSA section 5.5.12 provides a description of the control, the applicability to the various process areas, and the associated surveillance requirements for SAC compliance. The LCO format is used for this SAC because the control is well defined with clear conditions and corrective actions to take if a condition is entered. Also, the conditions required to satisfy the SAC are readily surveilled. And other controls (e.g., UG Vehicle FSS) contribute to the reduction of risk and if a noncompliance exists with the control.

The operation of vehicles and/or equipment at the WIPP UG is required for unloading, transporting, and emplacement of Waste Containers. Additionally, mining equipment and other support vehicles or equipment are used in the UG. These vehicles may require servicing (e.g., lubrication, hydraulic fluid, or diesel fuel) in various areas of the UG. The UG Lube Trucks can provide the services for the UG vehicles in areas away from the Maintenance Area or the UG Refueling Area. The safety function of the Lube Truck Operations control is to prevent a large fuel pool fire within 200 feet of the CH waste face in an Active Panel and to prevent a large pool fire within 200 feet of the Waste Shaft Station when CH Waste is present in the Waste Shaft Station. To address this potential fire event a SAC has been established.

An UG Lube Truck shall be prohibited within:

200 feet of the CH Waste Face in an Active Panel.

The Lube Truck Exclusion Zone when CH Waste is present.

The DSA section discussion provides an explanation of the various elements of the SAC control. The terms Active Panel, Lube Truck Exclusion Zone, and CH waste are appropriately defined to support the implementation into the TSR. The measurable distance of 200 feet from the waste face and even greater distance protected by the Lube Truck Exclusion Zone near the waste shaft station are supported by calculation WIPP-058.

To ensure these controls are maintained, surveillances of the Lube Truck operations are provided in Section 5.5.12.2. The section indicates that verification of the 200 foot separation will be performed prior to entry into the active panel by using visual indications. This SR is also completed once a shift when a Lube Truck is located in or remains in the Active Panel for more than one shift. Similarly, a surveillance will be performed to visually verify a Lube Truck is not present in the Lube Truck Exclusion Zone Prior to CH Waste entering the Lube Truck Exclusion Zone.

The review of the control discussion indicates that the operability parameters that are presented are consistent with the hazard analysis and the presentation in DSA Chapter 4 performance evaluation. The operability parameters are detailed appropriately to support implementation as an LCO and the corresponding parameters are supported by an associated surveillance requirement.

3.6.4.3 Vehicles/Equipment Control

To address the hazard analysis conclusions for the mitigated risk evaluation for fires in the UG and the CH Bay, a vehicle/equipment control has been established. DSA section 5.5.13 provides a description of the control attributes, its applicability to the various process areas, and the associated surveillance requirements for SAC compliance verification. The LCO format is applied to this SAC because the control is well defined with operability attributes, and clear conditions and corrective actions to take if a condition is entered. Also, the conditions required to satisfy the SAC are readily surveilled and other controls (e.g., UG Vehicle FSS and WHB FSS) contribute to the reduction of risk if a noncompliance exists with the control.. The required actions minimize the risk of a liquid-fuel pool fire during the time compliance with the LCO requirements is being restored. The SAC statement is:

Vehicles/equipment shall be controlled as follows:

Liquid-fueled vehicles/equipment:

- *Attended in the Waste Shaft Station when transporting CH Waste to or from the VEZ.*
- *Attended when transporting CH Waste between the VEZ and the CH Waste Face.*
- *Attended when less than 25 feet from the CH Waste Face.*
- *No more than two liquid-fueled vehicles/equipment within 25 feet of the CH Waste Face.*

Vehicles/equipment with liquid-combustible capacity greater than or equal to 25 gallons:

- *Attended in the RH Bay when CH waste is present in the CH Bay.*

The section provides a listing of the various locations that the Attendant must be while liquid fueled vehicles/equipment are near CH Waste. The various locations are clearly defined in the section discussion. The coverage area supports full coverage from when the CH waste enters the underground, to the VEZ and from the end of the VEZ, until it is emplaced. Another SAC addresses the Attendant control in the VEZ. The LCO also addresses a requirement for attendance of vehicles/equipment with greater than or equal to 25 gallons of liquid-combustible capacity in the RH Bay whenever waste is present in the CH Bay. In each case, the section provides the responsibilities of the Attendant in a clear and concise manner and provides guidance on the number required for each activity.

Specifically, the Attendant is responsible for recognizing potential collision risks and vehicle/equipment anomalies or malfunctions that could result in a fire and taking appropriate action, including alerting the vehicle/equipment operator and making appropriate notifications to the CMR. This description is adequate to support its use in the TSR.

The discussion also addresses the limitation of no more than two liquid-fueled vehicles/equipment being present within 25 feet of the CH Waste Face. Limiting the number of liquid-fueled vehicles/equipment within 25 feet of the CH Waste Face to no more than two prevents excessive vehicle/equipment congestion in this limited area, thus, reducing the probability of collisions that may result in a pool fire. The 25 foot criterion supports the assumptions related to radiant heat and fuel pool leaks involving the emplaced Waste.

The significant elements of this LCO SAC are the Attendance and control of liquid-fuel vehicles/equipment or vehicles/equipment with greater than or equal to 25 gallons of liquid-combustible capacity in the RH Bay, in the listed Process Areas while CH Waste is present. To ensure these controls are maintained, surveillances have been provided and are discussed in 5.5.12.2. Each of the five SAC elements has corresponding surveillance requirement. The requirement provides the frequency and the expected criteria that would prove the SR can be successfully met. The surveillance frequencies during transport of the Waste from the Waste

Shaft Station to the Waste Face include a requirement that the Attendant control be established prior to beginning the operation. For the SAC elements related to the number of vehicles near the Waste or when within 25 feet of Waste a once per shift frequency was established. This frequency was judged to be adequate because of the continual presence of personnel during activities near the Waste face. When CH Waste is in the CH Bay, this verification is also made prior to bringing any vehicles with $\geq$ 25 gallons of liquid combustible capacity into the RH bay. This surveillance is also performed at the beginning of every shift when waste is present in the CH Bay.

The review of the control discussion indicates that the operability parameters that are presented are consistent with the hazard analysis and the presentation in DSA Chapter 4 performance evaluation. The operability parameters are detailed appropriately to support implementation as an LCO and the corresponding parameters are supported by an associated surveillance requirement.

3.6.4.5 WIPP WAC Compliance SAC

To address the hazard analysis initial conditions for the content of the waste received at WIPP a Waste Acceptance Criteria control has been established. DSA section 5.5.20 provides a description of the control, the applicability to the various process areas, and the associated surveillance requirements for SAC compliance verification. Using the guidance of SAC standard 1186, a LCO format was selected for implementation of this SAC because the control is well defined with clear conditions and corrective actions to take if a condition is entered. Also, the conditions required to satisfy the SAC are readily surveyed.

The SAC statement described in the section is as follows:

> *TRU Waste Containers shall be compliant with the WIPP Waste Acceptance Criteria (WIPP WAC).*

The WIPP WAC was credited as an IC in the hazard analysis and is applicable to all Waste received at WIPP. WIPP WAC requirements include controls on content, form, and packaging of Waste to prevent internal fires, deflagrations/explosions, and chemical reactions that can breach the confinement of the Waste Container. The section discussion does not provide specific numerical limits on the package content. However, the section provides a summary of the types of waste allowed. The WIPP WAC excludes shipments of waste streams packaged in Pipe Overpack Containers that contain combustibles and of incompatible and reactive materials (e.g., pyrophorics, oxidizers, water reactive chemicals, exothermic chemical reactions). It also provides limits on flammable gas and volatile organic compound (VOC) concentrations in the innermost confinement layer and curie content. All packaging and receipt of waste is managed in accordance with the Chapter 18 safety management program.

Section 5.5.20.2 provides the discussion for the WIPP WAC surveillances to support the verification of the SAC. Surveillances are performed prior to acceptance of the waste package and once it is opened in the WHB. Visual and radiological surveys are performed once the package is opened. The internal waste containers are not opened at WIPP. The section provides a discussion on the SRs performed and provides a basis for the SR and its frequency.

An SR is established to verify that prior to acceptance of Waste at WIPP, a comparison of the shipping manifests and the WIPP WDS is performed. The WIPP facility does not accept Waste Container shipments for disposal if the Waste Container information has not been submitted into the WDS and approved by the WDS Data Administrator.

An SR is established to verify that there is no obvious damage or degradation to any of the Waste Container(s) resulting in its non-compliance with the WIPP WAC. This SR occurs after the package is opened in the WHB prior to being placed in the underground. The types of obvious damage are detailed in the section to provide guidance to the performer and are based upon WIPP WAC content. Examples of container conditions that are verified are the presence of rust or corrosion; obvious leaks, holes or openings, cracks, deep crevices, creases, tears, broken welds, sharp edges or pits; discoloration; and radiological contamination or direct radiation exposure.

An SR is established to determine if there is evidence that the Waste Container has been or is pressurized. The section describes pressurization as a fairly uniform expansion of the sidewalls, bottom, or top (bulging). Past pressurization can be indicated by a notable outward deflection of the bottom or top or material discharge from the lid. This inspection occurs at the same time as the previous container inspection.

An SR requires that for any Waste Container with an observable identification label, a visual observation is completed of the label and the identification number on the label compared to the WIPP WDS. This inspection is completed after removal of the waste containers from the shipping package.

The review of the control discussion indicates that the operability parameters that are presented are consistent with the hazard analysis and the presentation in DSA Chapter 4 performance evaluation. The operability parameters are detailed appropriately to support implementation as an LCO and the corresponding parameters are supported by an associated surveillance requirement.

3.6.5 Directive Action (DA) SACs

DSA section 5.6.2 contains a description of the direct action (DA) Specific Administrative Controls (SACs) that are credited in the hazard analysis in the prevention and/or mitigation of radioactive material releases. The guidance of DOE-STD-1186 was used in the presentation of the SACs, as either being Directive Action or LCO related SACs. The section indicates that there are seven DA SACs that are credited for safe operation of the facility. A Directive Action SAC provides a specific preventive or mitigative function for accident scenarios identified in the DSA, where the safety function has importance similar to, or the same as, the safety function of a safety SSC. The Directive Action SAC identifies the specific requirement/action and basis. This format is appropriate when it is essential that the SAC be performed when called upon every time and without any delay, or when a definitive program requirement(s) for specific activities is stated.

3.6.5.1 DA SAC Pre-Operational Checks of Vehicles/Equipment in Proximity to Contact-Handled Waste

Section 5.6.2.1 presents DA SAC 5.5.1 that states:

> *Prior to Use, Vehicle(s)/Equipment to be operated within 25 feet of the CH Waste Face, in the Vehicle Exclusion Zone, or in the Waste Shaft Station when CH Waste is present, shall be inspected for the following attributes: Brake operation, Steering, No excessive leaks, Operating lights and horn, Fluid levels are within operating range, and Cleanliness.*

The SAC provides the operability attributes of those vehicles that can come within 25 feet of CH Waste. These features are to be verified before the selected vehicle can enter the VEZ, Waste

Shaft Station or at the Waste Face. The 25-foot applicability protects the assumptions related to fires involving waste material from radiant fire or non-engulfing fires.

The section provided an expanded list of actions that could be taken to demonstrate the acceptable criteria for each of the attributes. The section also provides an explanation of the various criteria for judging compliance with the SAC. The description indicated that some of the attributes may not be applicable to the particular piece of equipment. That is, not all pieces may have a horn. However, the SAC indicates that for those attributes that apply a verification is required. This was evaluated as being acceptable as the various attributes do have overlap with respect to performing the credited safety function.

A pre-operational check of vehicles/equipment “Prior to Use” will provide assurance that the vehicle and/or equipment is operating properly and has no obvious signs of degradation that could lead to its malfunction before the equipment is declared ready for use. The Frequency of Prior to Use is based on operational experience, which has shown this is sufficient to ensure vehicle/equipment Operability near the CH Waste Containers. The “Prior to Use” term indicates that prior to use for the shift the equipment is to be used these verifications are made. This term allows the equipment to be started and stopped during the shift and not require the re-performance of this SAC. These attributes slowly degrade over time and the instantaneous failure of liquid fueled systems would be noted by leaks and level checks. As such, these attributes are not expected to fail during the shift without being noticed by the operators. In addition, vehicles/equipment being positioned within 25 of CH waste require an attendant to be present. The SBRT determined that the presentation of this control and its associated basis adequately provides the necessary safety function. It also specifies those attributes that are to be implemented to verify the credited control is in place.

3.6.5.2 DA SAC Transuranic Waste Outside the Waste Handling Building

Section 5.6.2.3 presents DA SAC 5.5.3 that states:

> *Waste, excluding site derived Waste, in the Outside Area shall be in Closed Type B Shipping Packages.*

The safety function of the TRU Waste Outside the WHB control is to prevent release of radiological material due to fires, explosions, collisions, and/or NPH events when TRU Waste (excluding site derived TRU Waste) is located outside of the WHB. Type B Shipping Packages are credited as an IC in the hazards analysis when TRU Waste is in a Closed Type B Shipping Package. The shipping package is also credited as a passive design feature in the safety analysis.

RH and CH Waste is received from generator sites in closed Type B Shipping Packages, which are not opened until positioned in the CH Bay, RH Bay, or Room 108, as applicable. In the event that TRU Waste needs to be placed outside of the WHB, the TRU Waste Container is placed into a Type B Shipping Package and closed prior to exiting the WHB. Site derived TRU Waste is excluded because it is directly loaded in a Type A container and stored inside the WHB until disposal in the UG. Also the radiological consequences of its release are not significant with respect to the DSA risk binning criteria to any receptor.

A Closed Shipping Package was described as having the following features: TRUPACT II or HalfPACT outer lid bolted in place with all bolts present for protection of CH Waste; TRUPACT-III Shipping Container with the outer cover in place with all bolts in place; RH-TRU 72-B Shipping Container with the impact limiters properly installed when on a trailer or on a Road Cask Transfer Car with no lid bolts loosened. These criteria have been determined to support the assumption in the analysis and are included in the TSR for a definition of a “Closed” container.

To support compliance with the SAC, monthly verifications are made of the containers outside the WHB. This verification is a visual check of the closed criteria. The periodicity is based upon the prohibition of opening containers outside along with the requirement for ensuring any containers moved from the WHB to outside are closed. The presentation of this control and its associated basis adequately provides the necessary safety function. It also specifies those attributes that are to be implemented to verify the credited control is in place.

3.6.5.3 DA SAC 5.5.4 Vehicle Exclusion Zone

Section 5.6.2.4 presents DA SAC 5.5.4 that states:

> *The VEZ shall be established, maintained and Attended for the transport of CH Waste in the UG along the Waste Transport Path. Additional vehicle(s) required to enter the VEZ to perform repair, replacement, or CH Waste transfer to another CH Waste Transfer vehicle shall be Attended.*

The safety function of the Vehicle Exclusion Zone (VEZ) control is to prevent collisions and pool fires by restricting the number and operation of UG vehicles during CH Waste transport,

The VEZ is defined in this control as the distance between the leading edge of the lead escort vehicle and the trailing edge of the lag escort vehicle, and the nominal width of drift. The VEZ is established around the CH Waste being transported to prevent other vehicles/equipment from entering the VEZ, and is maintained along the Transport path until situationally determined to be terminated. The VEZ consists of Electric Lead and Lag vehicles escorting the Waste transport, which ensures the VEZ only has one liquid-fueled vehicle. The VEZ provides a “moving buffer area” in the Transport Path from the S-400/E-140 intersection to the designated off -loading location and performed in the opposite direction when CH Waste is returned to surface. This configuration of vehicles is defined in the TSR to support implementation of this control. The section also provides a description of when and how the VEZ established. The limitations associated with space and the exceptions noted for repair and replacement of transport vehicles, and CH transfer of material in the VEZ to another vehicle were reviewed and determined to be acceptable.

While the Waste is in the VEZ it must be Attended. The Attendant is an individual in visual contact and in proximity to the vehicles and Waste who is able to control the item of interest. The Attendant will be trained and qualified to notify and take the proper actions when necessary. A detailed description of duties, training and qualifications of the Attendant is provided in the TSR. The presentation of this control and its associated basis adequately provides the necessary safety function. It also specifies those attributes that are to be implemented to verify the credited control is in place.

3.6.5.4 DA SAC 5.5.5 Fuel Tanker Prohibition

Section 5.6.2.5 presents DA SAC 5.5.5 that states:

> *Fuel Tankers delivering fuel to the Surface Fuel Station Storage Tanks are prohibited from entering the WHB Parking Area Unit.*

The safety function of the Fuel Tanker Prohibition control is to prevent tanker truck pool fires involving TRU Waste Containers by ensuring Fuel Tankers are precluded from the WHB Parking Area Unit. The WIPP safety analysis identified the potential for fuel delivery fire events in the WHB Parking Area Unit. These events could involve the WHB or could propagate to the WHB and involve radiological material contained in the WHB. For this SAC, fuel tankers are those that have large inventories of fuel and not those fuel containers and tanks that are used for moving fuel on site.

To support the area that is susceptible to the fire event, an area has been specifically identified where the tankers cannot go. The WHB Parking Area Unit is an area on the south side of the WHB that is depicted in DSA Figure 2.4-1. Fuel Tankers are defined as those allowed onsite to fill the Surface Fuel Station Storage tanks. The tankers are assumed to have large volumes of combustible material. The section noted that when a Fuel Tanker enters the facility its normal route is not to the south portion of the WHB. The WHB is south of this main access road and the WHB Parking Area Unit is south of the WHB, well away from the main access road. The presentation of this control and its associated basis adequately provides the necessary safety function. It also specifies those attributes that are to be implemented to verify the credited control is in place.

3.6.5.5 DA SAC 5.5.6 Waste Conveyance Operations

Section 5.6.2.6 presents DA SAC 5.5.6 that states:

The Waste Shaft Conveyance shall:

be present at the Waste Shaft Collar prior to moving Waste into or out of the Waste Shaft Collar Room,

move Waste between the Waste Shaft Collar and the Waste Shaft Station only when doors 155 or 156 are closed,

be present at the Waste Shaft Station prior to bringing Waste into the Waste Shaft Station, from the VEZ, and

remain at the Waste Shaft Station until Waste is loaded onto the Waste transporter and the transporter is moving away from the Waste Shaft.

The Waste Conveyance Operations control is to prevent vehicles, equipment, and/or loads from dropping down an open Waste Shaft and impacting Waste Containers. This is accomplished by requiring the presence of the conveyance when preparing to load or off-load, and requiring access to the shaft to be prohibited when Waste is being moved in the Waste Shaft. To support the completion of this SAC, the shaft tender is required to be present. The shaft tender position includes the top lander and the bottom lander since waste can be moving in either direction on the hoist.

Each of the four elements of the SAC presents a position that the waste and the conveyance can be in. The discussion provides the basis for each of the elements and the verifications that are to be made to support compliance with the SAC. In each case a shaft tender is required to perform the verification. The presentation of this control and its associated basis adequately provides the necessary safety function. It also specifies those attributes that are to be implemented to verify the credited control is in place.

3.6.5.6 DA SAC 5.5.7 CH Bay Alternative Vehicle Barrier Provision

Section 5.6.2.7 presents DA SAC 5.5.7 that states:

Liquid-fueled vehicles/equipment shall be prohibited within the WHB Parking Area Unit unless the following conditions are met:

Vehicle Barriers are installed as described in DF 6.12.

OR

Liquid-fueled vehicles/equipment shall be Attended when inside the exclusion zone footprint.

AND

Moving liquid-fueled vehicles/equipment in the WHB Parking Area Unit shall be Attended when the Vehicle Barriers are not fully installed.

The CH Bay Alternative Vehicle Barrier Provision control reduces the likelihood for release of radiological material from CH Waste in the WHB due to impacts by vehicles and/or fires adjacent to the southwest wall of the CH Bay. The Vehicle Barriers consist of two configured sections of Vehicle Barriers that protect the CH Bay southwest wall from vehicle impacts. Vehicle Barriers are a DF that is described in DSA section 4.4.14 and as shown in Figure 2.4-7. The referenced drawing provides a clear depiction of the area to be protected.

The discussion indicates that the barriers are allowed to be moved for certain operations to be performed in the protected area. If the Vehicle Barriers are moved to allow access to the exclusion zone, only the minimum number of individual barriers will be moved, such that only a limited size gap will be opened in the Vehicle Barrier. All the other barriers will remain in place and interconnected to continue to provide the exclusion zone and prevent vehicle impacts or pool fires that could impact the CH Waste inside the southwest corner of the CH Bay.

The SAC requires that any vehicles within the exclusion footprint must be attended. The attendant is in place to notify of any adverse conditions. Stationary vehicles in the WHB Parking Area Unit do not require an Attendant. A fire in this area is far enough away that the heat flux will not affect the Waste Containers inside the CH Bay.

The ISI Program along with normal Conduct of Operations and Maintenance and routine visual observation of the barriers is sufficient to ensure the barriers are not inadvertently moved or significantly damaged to the point that the safety function cannot be met. Additionally, Annually an inspection will be completed to verify the barriers were not subjected to significant damage or inadvertently moved. The presentation of this control and its associated basis adequately provides the necessary safety function.

3.6.5.7 DA SAC 5.5.8 Real Time Monitoring at Panel 6 and panel 7 Isolation Bulkheads

Section 5.6.2.8 presents DA SAC 5.5.8 that states:

Real-Time Monitoring for elevated airborne radioactive material levels in accordance with the WIPP Radiation Protection Program and provisions to alert workers shall be provided in the following areas when these applicable areas are occupied:

- *Drift S-2180 and all areas south of drift S-2180*
- *E-300 between S-2180 and the exhaust shaft*
- *Areas determined to be within the exhaust path of Panel 6 and/or Panel 7, Room 7 following changes in ventilation configuration*

The SAC has been changed to incorporate DOE directed changes (see SER section 5) explicitly adding the requirement to alert workers in the applicable areas. Panel 6 and Panel 7, Room 7, have non-compliant waste containers with the potential to result in an exothermic reaction similar to the one that occurred in February 2014. Real-time airborne monitoring for leakage from these areas is required as any radioactive material released in the closed panel or room may leak past the isolation bulkheads. Real-time airborne monitoring as required by the WIPP

Radiation Protection Program (RPP) must be ensured to protect workers in these applicable areas whenever they are occupied. This is accomplished by detecting and promptly alerting facility workers in these areas of elevated airborne radiological activity levels outside of the Isolation Bulkheads. The establishment of the monitoring is to be performed in accordance with the radiological protection program.

The areas included in this SAC are:

- Drift S-2180 and all areas south of drift S-2180
- E-300 between S-2180 and the exhaust shaft
- Areas determined to be within the exhaust path of Panel 6 and/or Panel 7, Room 7 following changes in ventilation configuration

The RPP is responsible for providing appropriate monitoring of these areas along with notification to workers in the applicable area(s). These functions must be provided regardless of UG ventilation configuration or if ventilation is lost when the applicable area(s) are occupied or access is needed. The Program is expected to evaluate and expand monitoring to other potentially affected areas to implement the SAC.

The Isolation Bulkheads and stagnant ventilation conditions significantly reduce any driving force for air change across the bulkhead, even in the event of a total ventilation system loss. Any release from the Panel 6 or Panel 7, Room 7, bulkheads due to an exothermic reaction is expected to be a slow process based on the low pressurization, the indirect flow path, and the closure bulkhead system which will only allow leakage around the bulkhead where the metal bulkhead construction and flashing contact the salt structure or through cracks in the salt structure. Although a specific type of monitoring and alerting is not specified in this control as the type and location of the Real-Time Monitoring is expected to change as conditions in the UNDERGROUND change, the preferred method is CAMs that provide an alarm to the CMR. Regardless of the monitoring used, the Real-Time Monitoring must provide detection and a prompt alert function for workers anywhere in the applicable areas. The Real-Time Monitoring will typically consist of, but is not limited to, any single method or a combination of the methods below as necessary to ensure the credited safety function of this Directive Action SAC throughout the occupied applicable areas:

- Continuous Air Monitors placed to monitor Panel 6 and Panel 7, Room 7 that alarm in the CMR and provide a local alarm.
- Temporary moveable Continuous Air Monitors that will provide a local alarm.
- Radiological Control Technician using a portable hand held monitor.
- Personal monitors with alarm function worn by workers in these areas as specified in the Radiological Work Permit. For groups of workers, at least one worker in visual contact of the others must wear a personal monitor with alarm function.

Because of the present limitations of the CAMs used to provide detection and notification in the underground, additional program elements are needed to support the complete SAC implementation. The SAC does not specify a set alarm value for the instruments but rather requires that the set-point be based upon the 10 CFR 835 requirements for facility workers. This value has been shown to be well below the significant criteria for the facility worker with respect to DSA control selection. The control discussion provides a clear and definitive area in which the control applies which should support appropriate implementation in the TSR. The SAC is applicable when facility workers are located in the applicable areas.

For those CAMs that provide an alarm to the CMR, when the alarm is received in the CMR, the CMR Operator will use the UG PA System or other available means of communication to alert workers to leave the areas. The use of the CMR operator to respond requires that he is positioned continuously in the CMR when personnel are in the underground. In addition, he is to be trained to know the credited safety function response to the alarm condition. The SSCs used to support the monitoring function are to be controlled, maintained, tested and set in accordance with the RPP requirements. That is there is no developed surveillance requirement for the equipment.

3.6.6 Design Features

The credited design features (DFs) from the hazard analysis are presented in DSA section 5.7. The DFs are characteristics of the facility, typically passive in nature and not subject to change by Operations personnel (e.g., configuration, physical arrangement, shielding, structural walls, relative locations of structures and components, or physical dimensions and interfaces). This section provided a description of the DF, its Safety Function, Performance Criteria that will be used to evaluate the DF for applicable ISIs. Additionally, derivation of the TSR DFs considered input from Chapter 4, which summarizes key features, that are necessary to ensure the safety function and performance criteria of the SSCs. Specificity was provided to clarify SSC key features relative to configuration, physical arrangement, shielding, structural walls, relative locations of structures and components, or physical dimensions and interfaces.

The individual ISI requirements and performance frequencies were not detailed in this section. This is an allowed presentation of the ISI development in the DOE Guide 423.1-1B. However, a reference was provided to indicate that information will be developed in the ISI program. WIPP has an established ISI Program as required by Chapter 10, which provides key elements of the ISI Program. The Cognizant System Engineers develop the ISI requirements for those items to be inspected based on the goal of early detection of precursors to degradation, damage, and other conditions that could result in a DF being unable to perform its credited function; and the salience of the attribute to the safety function of the DF. The frequencies are then selected to ensure early detection of precursors to degradation, damage, and other conditions that could impair the DF’s safety function. The appropriate ISI requirements and frequencies are identified in WIPP procedures and the ISIs will be completed by qualified personnel. Deviations or changes to the ISIs will be subject to the USQ process.

3.6.6.1 Waste Handling Building Structure and TRUDOCK Cranes

Section 5.7.1 presents the WHB description and its design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. Namely, that the building remains intact following design NPH events and various fire events to provide containment of radioactive material that may have been impacted by the events. The WHB structure protects various rooms, including the CH Bay, Room 108, RH Bay, CUR, Transfer Cell, and Waste Hoist Tower, that support the emplacement activities from externally induced building stresses. The TRUDOCK Cranes are designed to prevent their collapse and drop to the CH BAY floor during a design basis earthquake. Additionally, the WHB layout prevents a direct, unencumbered access to the Waste Shaft by vehicle/equipment for postulated drop down Waste Shaft scenarios. The section list the key features of the WHB structure to include the concrete and metal structure and curbing of the WHB (CH Bay, Room 108, RH Bay, CUR, Transfer Cell, and Waste Hoist Tower), which are of noncombustible construction and meet design basis requirements for NPH events. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.2 Facility Pallet

Section 5.7.3 presents the facility pallet description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. Facility Pallets (SDD WH00, Waste Handling System, System Design Description) are non-combustible, fabricated-steel units designed to transport CH Waste assemblies such as drums, Standard Waste Boxes (SWBs), shielded containers, Ten Drum Overpacks (TDOPs), and/or Standard Large Boxes 2 (SLB2s) to the UG. The section presents the key features of the Facility Pallet as being a stainless steel noncombustible surface excluding eight tie-down penetrations, that provides a contiguous flame barrier preventing direct flame impingement on the bottom of the Waste Containers, and has robust construction/strength that support the Waste loads during a pool fire. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.3 Waste Hoist Support Structure

Section 5.7.6 presents the Waste Hoist Support Structure description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. The Waste Hoist is used to lower and raise Waste packages from the UG. The Waste Hoist Support Structure is constructed of non-combustible steel components, and is designed to support the Waste Hoist Conveyance and a maximum load conveyance under all normal, upset and design basis NPH conditions. The section describes the key features of the Waste Hoist Support Structure to include structure location directly over the Waste Shaft; it being a robust non-combustible steel structure that consists of four steel I-beam columns mounted on a substantial concrete foundation; the wire ropes and load bearing components, counterweights, hoist brake system, and a maximally loaded conveyance (up to a 45 ton payload). The structure also has floor slabs and pads to which hoist equipment is bolted at various elevations to support the hoist system equipment. The Waste Hoist Support Structure is constructed of non-combustible materials and is not subject to failure from a fire related to combustible loads. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.4 Underground Fuel and Oil Storage Areas

Section 5.7.7 presents the Fuel and Oil Storage Areas location description as it relates to supporting the credited safety functions. To support operations, Fuel and Oil Storage Areas are provided in the UG, and both are located north of S-90. These areas allow for substantial quantities of liquid-combustibles to be stored and dispensed.

The performance criterion for the UG Fuel and Oil Storage Areas is that they shall be located at or north of the S-90 Drift. These physical locations/distances are far greater than those associated with the diameter of the worst case pool fires in these areas and where Waste may be present (i.e., Waste Shaft Station, Waste Transport Path, and Disposal Rooms). The section describes the key features of the UG Fuel and Oil Storage Areas control as being the location within the non-combustible salt structure of the underground and the 300 foot distance from any

Waste in the UG. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.5 Facility Casks

Section 5.7.8 presents the facility cask description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. There are two types of RH Facility Casks, the Facility Cask and the Light-Weight Facility Cask (LWFC), used to transfer the RH Waste Canister from the WHB FCLR to final emplacement in the UG boreholes. The robustness of the Facility Cask and LWFC serves to prevent any breach of the Facility Cask and LWFC and RH Waste Canister. An internal deflagration in a RH Waste canister within either cask is qualitatively judged to be insufficient to breach the cask. The confinement provided by the Facility Cask/LWFC mitigates the consequences of any release of the confined waste in any fire event. The section describes the key features of the Facility Casks as being shielding to limit the worker exposure to a high radiation source from the RH Waste, and protection provided during a fire or a drop or impact event. The closed Facility Cask and LWFC have no penetrations to allow direct flame impingement on the contained RH Waste canister. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.6 Type B Shipping Package

Section 5.7.9 presents the Type B Shipping Package description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. The Type B Shipping Package is used to transport all Waste to the WIPP facility. The Type B Shipping Package design is certified by the U.S. Nuclear Regulatory Commission (NRC) for transport of radiological waste on the nation’s highways.

The section indicates that the Type B Shipping Packages are designed and constructed to the requirements presented in 10 CFR 71 and are certified in accordance with the requirements of 49 CFR 173, “Shippers - General Requirements for Shipments and Packagings,” Subpart I, “Class 7 (Radioactive) Materials.” To meet the certification, the package design is required to successfully pass the criteria provided in 10 CFR 71.71, “Normal Conditions of Transport,” and 10 CFR 71.73, “Hypothetical Accident Conditions,” which include demonstration that no release of contents occurs after a 30-foot drop onto an unyielding surface or a thermal exposure of 800°C (1,475°F) for 30 minutes. The key feature of the Type B Shipping Packages are that the packages meet or exceed the minimum requirements of 10 CFR 71. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.7 Facility Cask Loading Room, Cask Unloading Room, and Transfer Cell Shielding

Section 5.7.10 presents the FCLR, CUR, and Transfer Cell description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. The FCLR, CUR, and Transfer Cell are an area in the WHB used to process the RH Waste. The FCLR, CUR, and Transfer Cell contain concrete walls, floors and ceilings, which provide permanent radiation shielding for personnel whenever RH Waste

Canisters are not in a Closed Type B Shipping Package, or Facility Cask/LWFC. The section describes the key features of the FCLR, CUR, and Transfer Cell Shielding as being robustly constructed of concrete and steel, steel and/or concrete doors and plugs that provide adequate shielding to ensure the external radiation dose outside the Hot Cell Complex is ≤ 200 mrem per hour when RH Waste is outside the Closed Type B Shipping Package. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.8 Panel 6 and Panel 7, Room 7 Bulkheads

Panel 6 and Panel 7, Room 7 & Bulkheads Section 5.7.11 presents the Panel 6 and Panel 7, Room 7 Bulkhead description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. The Bulkheads are a non-combustible barrier used in the UG to isolate closed disposal areas to reduce the quantity of material that could be released from an exothermal chemical reaction within a CH Waste Container located in Panel 6, or Panel 7, Room 7. The Panel 6 Bulkheads are constructed of steel and have a flashing (flexible rubber) that is bolted to the walls (ribs), and roof (back) of the entry. The steel bulkhead is about 22 feet from the Waste Face, based on a 2-foot gap between the Waste Face and chain link curtain, a 10-foot-long salt pile, and a 10 foot gap from the toe of the pile to the steel bulkhead (nominal dimensions). The Panel 7, Room 7, bulkheads are constructed of steel with flexible rubber flashing bolted to the walls (ribs) and roof (back) at the air intake and outlet side of the Room. The section describes the key features of the Panel 6 and Panel 7, Room 7 Bulkheads. The information provided is in agreement with the chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.6.9 Vehicle Barriers

Section 5.7.12 presents the WHB Vehicle barriers description and the design and performance criteria for the significant structural characteristics that are required to support the credited safety functions. Vehicle Barriers are placed along the southwest wall of the WHB reduce the likelihood for pool fires and/or vehicle impacts in this area. The Vehicle Barriers are a configured set of concrete barriers consisting of two continuous sections. A concrete Jersey type Vehicle Barrier is approximately 32 inches high, with a 24-inch base, in a variety of lengths, and weighs about 400 pounds or more per lineal foot. The barrier contains links (typically steel loops) at the end of each barrier that allow multiple barriers to be connected in series using connectors (e.g., steel J-J hooks or pin-and-loop) provided by the barrier manufacturer. Multiple individual barriers are connected in series using the manufacturer's recommended connectors to form a configured barrier of the desired length a nominal 25 feet from the exterior of the southwest wall of the CH Bay.

Key features of the Vehicle Barriers are that the barriers are structurally sound, robust, and have sufficient structural or material strength to withstand an impact or contain materials that will spread the load of an impact. The barriers are steel reinforced concrete barriers that have the capability to be interconnected with adjoining barriers using manufacturer supplied linking devices. The information provided is in agreement with the Chapter 4 performance evaluation results and also provides the necessary information that could be used to adequately evaluate the SSC for appropriate in-service inspections in accordance with DSA Chapter 10.

3.6.7 Derivation of the Minimum Staffing requirements

Section 5.6.1 provides a discussion on the derivation of the minimum staffing requirements for the WIPP facility. This section contains the individuals that are needed or credited in the safety analysis to perform a safety action or complete a required action from the TSR. The section indicates that the minimum operations shift complement per shift for WIPP shall be one FSM, one CMR Operator, and one Facility Operations Roving Watch. The safety function for the FSM is to provide facility command and control and take or direct actions in accordance with the TSR. The CMR Operator provides continuous monitoring of facility conditions in the CMR (i.e., monitoring and responding to alarms and indications, and communication with Attendants and personnel in the Underground). The Facility Operations Roving Watch provides the capability to meet, in a timely fashion, any action statement required by the TSR.

Shaft Tenders shall be present to support SAC 5.5.6, Waste Conveyance Operations, when moving Waste on the Waste Conveyance. This will include the top lander and the bottom lander. During the review it was noted that the Attendant is an individual that is also credited in the safety analysis as performing a safety function. His/her omission in this section was justified by requiring his/her attendance in the specific safety basis control statements. The SBRT determined that this listing was in agreement with the safety analysis assumptions.

3.6.8 SBRT Conclusions on Derivation of TSR Controls

DSA Chapter 5 supports and provides the information necessary for the separate technical safety requirement (TSR) document required by 10 CFR 830.205. The chapter provides sufficient basis to derive the TSR controls for credited SSCs (active and passive), SACs, and administrative programs from Chapter 4 necessary to perform the required safety functions. The SBRT determined that the control discussion was consistent with the accident analyses and supports the intent of the guidance in DOE-STD-3009 for this chapter content. The TSRs are identified that ensure adequate protection of workers, the public, and the environment and are available as detailed in the hazard analysis. The bases for deriving TSRs are identified and described in the hazard analysis and safety SSC chapters (which include SACs) and are consistent with the logic and assumptions presented in the analysis. The bases for deriving LCOs, surveillance requirements, and SACs are provided as appropriate. The facility modes are defined and those associated with TSRs are consistent with the hazard analysis and accident analysis.

3.7. SAFETY MANAGEMENT PROGRAMS

The SBRT technical review of the adequacy of Safety Management Programs (SMPs) focused on information presented in DSA Chapters 6, 7, 8, 9, 10, 11, 12, 14, 15, 17, and 18. Overall, the SBRT gave consideration to whether the following DOE-STD-1104-2014 and DOE-STD-3009-2014 criteria were met:

- The major programs needed to provide programmatic safety management are identified.
- Basic provisions of identified programs are noted, and references to facility or site program documentation are provided.
- Key characteristics (i.e., Key Elements) of programs that are identified in the hazard analysis or are recognized by facility management as an important capability warranting special emphasis are identified in safety management program descriptions. Such key characteristics are important to safe operation of the facility, but not at a level that requires safety significant classification.

Weakness in SMPs was identified as a significant factor contributing to the occurrence and progression of the February 2014 accidents. Compensatory measures were adopted early in the recovery process and significant effort focused on improving SMP performance. Each SMP has been subject to significant evaluation via a combination of Accident Investigation Boards, causal analysis required by the Occurrence Reporting and Processing System, line management reviews, and management self-assessments. Each SMP has undergone substantial change due to corrective actions associated with the aforementioned evaluations and related efforts focused on programmatic enhancement such as mentoring by SMEs brought in by both CBFO and the M&O contractor.

The SMP descriptions and Key Elements (KE) were reviewed by the SBRT. Per DOE-STD-3009-2014 and DOE Guide 423.1-1B, KEs: (1) are specifically assumed to function for mitigated scenarios in the hazard evaluation, but not designated a SAC; or, (2) are not specifically assumed to function for mitigated scenarios, but are recognized by facility management as an important capability warranting special emphasis. For this DSA revision, most of the KEs met criterion 2. KEs associated with the DSA's Hazard Analysis (WIPP-021) are noted as such in the following discussion.

3.7.1 DSA SMP, Chapter 6.0 –Prevention of Inadvertent Criticality

DSA Chapter 6, Prevention of Inadvertent Criticality, describes the Nuclear Criticality Safety Program as recently updated and submitted to CBFO for approval. WASTE accepted for disposal at the WIPP facility is required to be characterized and certified to meet the requirements of the WIPP WAC, including the requirements specific to fissile material content, prior to being approved for shipment to the WIPP. DSA Chapter 18 specifically addresses actions being taken to ensure future shipments of waste to WIPP comply with the WAC criticality requirements.

Nuclear Criticality Safety Evaluations analyze the activities involved in the handling and disposal of WASTE and demonstrate criticality incredibility. The Nuclear Criticality Safety Evaluations for CH and RH WASTE are documented in WIPP-016 Revision 5, *Nuclear Criticality Safety Evaluation for Contact-handled Transuranic Waste at the Waste Isolation Pilot Plant* and WIPP-020, Revision 2, *Nuclear Criticality Safety Evaluation for Remote-handled Waste at the Waste Isolation Pilot Plant*, respectively. The Nuclear Criticality Safety Program meets the requirements of DOE Order 420.1C, *Facility Safety*, Chapter III, "Nuclear Criticality Safety."

3.7.2 DSA SMP Chapter 7.0 –Radiation Protection

The WIPP Radiation Protection Program had never dealt with a significant spread of contamination prior to the accident in February 2014, but developed into a functioning program performing required entry monitoring and control, postings, routine dress-out, decontamination, and down-postings as the contamination boundary moved deeper into the mine (now limited to the areas of highest original contamination). The Radiation Protection Program (RPP), as thoroughly revised by the WIPP M&O contractor, is required to be approved by CBFO, and was demonstrated throughout recovery. DSA Chapter 7, Radiation Protection, describes the RPP organization and functional responsibilities, documents the RPP structure, and defines the radiological control management systems necessary to implement the program in accordance with the requirements of 10 CFR 835, and commits to comply with these requirements. The Chapter addresses important programmatic provisions such as ALARA (As Low As Reasonably Achievable) practices, training, radiation monitoring, radiation exposure control, radiation protection instrumentation, and record keeping. The Chapter identifies specific program documents and procedures developed and maintained to implement the RPP.

Chapter 7 KEs are written to address a few specific areas of program performance judged most important to limit the potential for significant worker radiological exposures. These KEs ensure that programs and equipment are maintained to protect facility personnel from radiation involved with both contamination and direct radiation streaming.

KE 7-1 *- Proper placement and operation of Continuous Air Monitors.* (Hazards analysis)

DSA sections 7.6 and 7.8 describe the program provisions for CAM placement and utilization to protect facility workers from airborne radioactivity. Specific CAM requirements are also established by SAC 5.5.8, Real-Time Monitoring at Panel 6 and Panel 7 Isolation Bulkheads. The KE ensures that the provisions for detection and response are implemented in a manner that protects facility workers from high radiological consequences.

KE 7-2 *- Control access and entrance to RH Hot Cells.* (Hazards analysis)

DSA section 7.6.2 describes program provisions for hot cell access control when RH waste is present in the hot cell. The KE ensures that these provisions are implemented in a manner that protects facility workers from high radiological consequences.

KE 7-3 – *Contamination control to address potential upcasting from the underground.*

DSA section 7.6 describes the program provisions for the radiological practices associated with controlling spread of contamination and inhalation or ingestion of radioactive materials. The KE ensures implementation of the provisions for detecting and responding to potential unfiltered radiological releases from the UG in order to protect personnel and the environment. Such action would be taken for example during an outage of the UVFS/IVS confinement ventilation system. In part, this KE addresses lessons learned from the less than adequate response to contamination spread following the February 2014 radiological release event.

3.7.3 DSA SMP, Chapter 8.0 –Hazardous Material Protection

As part of the aforementioned corrective actions, the Worker Safety and Health Program was revised by the WIPP M&O contractor and approved by CBFO. More recently, the program was further strengthened when unexpected high readings in the UG led to a thorough review of personnel protection practices and better understanding of the implications of limited airflow in the current facility ventilation configuration. A facility stand down drove increased program rigor to ensure that hazards including carbon monoxide, volatile organic compounds (VOCs), and nitrous oxides were being appropriately monitored and that effective actions were being taken when needed to protect personnel throughout the UG. DSA Chapter 8, Hazardous Material Protection, describes the Hazardous Material Protection Program that has been established to protect human health and the environment by controlling chemical hazards in accordance with 10 CFR 851, W*orker Health and Safety Program*, and 29 CFR 1910.1200, *Hazard Communication*. The Chapter addresses programmatic provisions such as hazard communications, hazardous material exposure control, hazardous material monitoring, instrumentation, training, and recordkeeping. Additionally, DSA Chapter 8 describes the processes and systems used for work performed by the WIPP M&O contractor and by subcontractors for their activities to control chemical hazards to protect personnel and the environment. The Chapter identifies specific program documents and procedures developed and maintained to implement the Hazardous Material Protection Program.

KE 11-13, addresses the need for measures to protect facility workers in the UG from VOCs. The required provisions include those necessary to protect workers in an active disposal room (some of which are specified by the Hazardous Waste Facility Permit) and those necessary to protect workers prior to or during entry into areas that have or recently had limited ventilation available. A directed change (see SER section 5) requires this KE to be moved to Chapter 8 as KE 8-1.

3.7.4 DSA SMP, Chapter 9.0 –Radioactive and Hazardous Waste Management

DSA Chapter 9, Radioactive and Hazardous Waste Management, sufficiently describes the Radioactive and Hazardous Waste Management Program which has been established to manage the radioactive, mixed, and hazardous wastes generated as a result of operations pertaining to the WIPP mission or from recovery actions. The Chapter addresses programmatic provisions such as waste management programs and organizations, site waste stream sources and characteristics, and the waste management process. Most wastes handled at WIPP are received in containers packaged offsite. Wastes with hazardous material generated during maintenance and operation of the WIPP facilities and equipment are managed in accordance with the Hazardous Waste Facility Permit for site-generated waste. Radiologically contaminated wastes, including waste from WIPP decontamination activities are managed as site-derived wastes; these provisions were, rarely used prior to the radiological release accident. The Chapter identifies specific program documents and procedures developed and maintained to implement the Radioactive and Hazardous Waste Management Program.

The DSA does not identify KEs for this chapter.

3.7.5 DSA SMP, Chapter 10.0 –Initial Testing, IN SERVICE Surveillance, and Maintenance

As part of the aforementioned corrective actions, the Nuclear Maintenance Management Program (NMMP) was revised by the WIPP M&O contractor and approved by CBFO. DSA Chapter 10, Initial Testing, In Service Surveillance, and Maintenance, commits to comply with applicable program requirements and describes the program provisions that ensure maintenance of SSCs that are part of the safety basis. These are the same SSCs subject to Chapter 17 configuration management requirements in accordance with DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*: safety significant SSCs and Design Features subject to degradation; other systems that perform important defense-in-depth functions; equipment relied on for the safe operation, safe shutdown of the nuclear facility, and for maintaining the facility in a safe shutdown condition as documented in the safety basis; and safety support systems. Maintenance of these SSCs ensures they are available and reliably provide their defined safety functions (i.e., each meets its functional requirements and performance criteria). Per the DOE O 433.1B definition, the defense-in-depth SSCs per DSA Chapter 3 section 3.3.2.4 that incorporate defense in depth controls from the WIPP-021 hazard evaluation tables and interfacing SSCs identified in DSA Chapter 4 Boundaries and Interfaces are included. While the improved SMP maintenance requirements apply to both credited safety and defense-in-depth SSCs, the improved maintenance of defense-in-depth SSCs addresses AIB findings related to less than adequate maintenance of the salt haul vehicle that contributed to the February 2014 fire. The Chapter identifies specific program implementing documents and procedures.

The following KEs apply to SSCs that are part of the safety basis in accordance with DOE O 433.1B. As stated above, these SSCs include defense-in-depth SSCs identified in DSA chapter 3, WIPP-021, and interfacing SSCs identified in DSA Chapter 4 Boundaries and Interfaces. The KEs of this SMP are implemented by the program to ensure appropriate initial and periodic verifications of the functionality of important SSCs, with long-term performance monitoring to assess the continuing functionality of the equipment.

KE 10-1 *– In Service Inspections of Design Features.*

DSA section 10.4 describes the program provisions for Design Feature inspection criteria and frequency. This KE ensures the implementation of provisions for early detection of degradation, damage, or other conditions which could challenge the ability of Design Features to provide their safety function. Implementation of this KE meets the requirement of DOE-STD-3009-2014 for specific design feature surveillances as needed to ensure their safety function.

KE 10-2 *- Testing, calibration, OPERABILITY, and preventive/corrective maintenance in accordance with applicable code requirements, manufacturer recommendations, established technical requirements, and engineering judgement consistent with tracking, trending, and failure history.*

DSA section 10.2 describes the program provisions for initial testing (i.e., startup, post modification) of SSCs which are part of the safety basis to ensure the SSCs meet established design criteria and functional requirements. DSA section 10.3 describes the program provisions for in-service testing and calibration of SSCs which are part of the safety basis to ensure safe and reliable operations of the SSCs. This includes the control of measurement and test equipment used during testing and calibration along with the training and qualifications of personnel performing testing and calibration activities. DSA section 10.5 describes the program provisions for the planning and conduct of maintenance activities which preserve and restore the availability, operability, and reliability of SSCs which are part of the safety basis (e.g., annual testing of water based fire suppression systems in accordance with NFPA 25 Section 8.3.3). This KE ensures the implementation of provisions for testing and maintaining of SSCs which are part of the safety basis in order to demonstrate the SSCs meet their safety function(s).

KE 10-3 *- Tracking and trending of the performance and deficiencies of the equipment covered by KE 10-2 above.*

DSA section 10.4 describes the program provisions for supervisory and cognizant system engineering personnel evaluation and trending of historical data obtained from operations, maintenance, and testing activities in order to determine if corrective actions are required. DSA section 10.5 describes the program provisions for maintenance history and trending activities performed to sustain SSC health and reliability. The KE ensures the implementation of provisions for trending the performance of SSCs which are part of the safety basis in order to identify degradation, damage, or other conditions which could challenge the ability the SSCs to provide their safety function(s).

3.7.6 DSA SMP Chapter 11.0 –Operational Safety Program

As part of the aforementioned corrective actions, the Conduct of Operations Matrix was revised by the WIPP M&O contractor and is required to be approved by CBFO. The WIPP M&O contractor has revised the Fire Hazards Analysis, which is also subject to CBFO review. DSA Chapter 11, Operational Safety, commits to comply with applicable requirements, and describes the Operational Safety Program as including the Conduct of Operations, Fire Protection, and Ground Control programs. The Chapter's Conduct of Operations section addresses applicable DOE O 422.1 requirements such as shift routines and operating practices, control area activities, control of equipment and system status, operations turnover, and operations procedures. The Chapter's Fire Protection section addresses DOE O 420.1 Fire Protection Program requirements, including the Fire Protection Program organization and provisions for fire prevention, fire suppression, fire hazards assessment, combustible loading control, hot work control, firefighting capabilities, and firefighting readiness assurance. The Chapter's Ground Control section addresses 30CFR Part 57 requirements such as periodic inspections, ground control remediation, and personnel training. The Chapter identifies specific program documents and procedures developed and maintained to implement the Conduct of Operations, Fire Protection, and Ground Control programs.

As part of the aforementioned corrective actions, Conduct of Operations has been a focus of attention by the M&O Contractor, resulting in progress being made forging the operating culture needed for reliable operation in compliance with requirements.

The fire protection program developed and demonstrated its ability to control combustibles in the underground, ensure equipment cleanliness and required maintenance, and provide the fire watch capabilities necessary to permit initial operation of needed diesel fueled equipment. A new FHA was prepared and implemented; necessary upgrade projects were chosen and are being implemented for equipment automatic fire suppression (for both waste handling and non-waste handling vehicles posing a significant fire risk), automatic fire suppression in specific underground areas, improved fire response capability, and a personnel notification system capable of both locating and communicating with individuals throughout the underground. The fire protection program further identified the need for both a Fire Protection exemption[5] on fire suppression throughout the UG and an equivalency on life safety requirements permitting the blending of those appropriate for surface structures and underground facilities. Additionally, one of the new Key Element s identified for the FPP addresses formal fire protection engineer combustible control inspections.

[5] Installation of water based fire suppression equipment supplied from the surface is impractical given the elevation difference and the difficulty in dealing with a large water inventory once introduced into the UG; moreover, fire suppression throughout the UG is unnecessary given the non-combustible salt construction.

While the ground control required to maintain underground habitability lapsed initially after the accidents, subsequent recovery efforts have restored most areas and demonstrated the M&O Contractor's capability to sustain UG habitability going forward.

The KEs of Operational Safety ensure the associated programs address significant Fire Safety considerations from the Fire Hazards Analysis, applicable Conduct of Operations requirements, and major aspects of mine safety assurance.

KE 11-1 *- Routine maintenance and inspection of non-waste handling vehicles in the UNDERGROUND for leaks and accumulation of combustible materials.*

DSA section 11.4.3 describes the program provisions for the control of combustible materials including vehicle restrictions, prompt removal and disposal of accumulated combustibles, and the proactive identification and mitigation of combustible hazards. The KE ensures that provisions to limit accumulation of combustible materials are implemented.

KE 11-2 *- Formal Fire Protection Engineer combustible control inspections to include inspection criteria, specified frequency of inspections, documentation of identified issues, issue disposition, tracking and trending of issues, and performance metrics.*

DSA section 11.4.3 describes the program provisions for combustible material loading inspections which are performed to identify potential fire hazards and/or non-compliances with combustible material storage, spacing, and handling requirements along with trending inspection results for continued improvement. The KE ensures the implementation combustible material inspections by a Fire Protection Engineer.

KE 11-3 *- OPERABILITY and testing of equipment (audible, visual) used for abnormal event communication/notification between workers (both aboveground and UNDERGROUND) and CMR.*

DSA sections 11.3 and 11.4.2 describe the program provisions for the use and testing of communication and notification systems which provide for normal and abnormal event communication between workers and the CMR. This includes the underground personnel notification and tracking system that was recently placed in service, affording a significant upgrade in communication capability responsive to AIB recommendations. The KE ensures the prior provisions for abnormal UG communications remain effectively implemented in addition to the new system both to notify personnel of hazards such as fire and of significant changes in facility status such as the need for alternate evacuation routes.

KE 11-4 *- Placement of fuel barrier of absorbent materials at the static WASTE FACE when waste emplacement or retrieval has not occurred for a period of 10 days*. (Hazards analysis)

This Key Element is developed from the DSA's hazard analysis and provides defense-in- depth protection for postulated liquid fueled vehicle fires (leak and collision initiated) which take place near a waste face. The KE ensures that barriers are in place for a static waste face (i.e., one with no waste emplacement for 10 days or more) providing added assurance that a fuel spill and fire will not impact the waste face. A directed change (see SER section 5) clarifies the KE as applicable only to a static waste face.

KE 11-5 *- Fire prevention/suppression controls include the following KEs:*

- UNDERGROUND diesel powered equipment is evaluated for fire risk in accordance with NFPA 122. All equipment determined to pose an unacceptable fire risk in the NFPA 122 analysis will be protected with an automatic fire suppression system prior to use.
- Areas in the UNDERGROUND where there is an increased combustible loading (e.g., refueling station, maintenance shop, combustible storage area, maintenance offices, lunch room, oil storage area) will be protected by automatic fire suppression systems.
- Ignition sources (e.g., hot work, designated smoking areas, portable heaters, electrical equipment) are controlled in accordance with the WIPP Fire Protection Program and Design Control Program.
- UNDERGROUND combustible materials are controlled in accordance with the WIPP Fire Protection Program (e.g., combustible control zone around personnel conveyances, combustible load permit process).

This KE is associated with the provision for hazard mitigative features identified in the WIPP M&O contractor's exemption from the DOE Order 420.1C requirements for a fire suppression system in the underground. The KE ensures the hazard mitigative features are implemented and maintained.

KE 11-6 - *Hoisting and Rigging Program which protects safety SSCs, waste packaging, and personnel from dropped loads.* (Hazards analysis)

This KE is developed from the DSA's hazard analysis and provides defense-in-depth protection for waste container drops, drops of material upon waste containers, drops of UGVS/IVS HEPA filters, and loss of power induced waste container drops. Additionally, the KE provides protection to workers and SSCs (e.g., above grade UVFS/IVS SSCs) from the risk of elevated loads. The KE ensures that the provisions for preventing the release of radiological materials associated with the aforementioned events are implemented in a manner that protects personnel from high radiological consequences and injury along with protecting against damaging SSCs.

KE 11-7 *- Mine entrance requirements impacting personnel safety (e.g., continuous air monitor operation, radiological conditions, ventilation capabilities, personnel training, personnel limits for IN SERVICE conveyances, back-up power).*

DSA section 11.3 describes the program provisions for adhering to safety requirements and maintaining proper configuration of the facility to safely support on-going operations. DSA section 11.4.2 describes the program provisions for underground occupant limitations. Radiological protection provisions are described in DSA Chapter 7, *Radiation Protection*, and Training provisions are described in DSA Chapter 12, *Procedures and Training*. The KE ensures entry requirements are implemented in a manner which protects personnel from the unique hazards associated with the underground.

KE 11-8 *- Mine evacuation requirements (e.g., unobstructed planned escape routes, mine exit markings, communications, Abnormal Operations Procedures).*

DSA section 11.3 describes the program provisions for promptly notifying personnel of changes in facility status and the development and use of abnormal operations procedures. DSA section 11.4.2 describes the program provisions for exit and evacuation plans, marking of egress and non-egress pathways, use of W65 self-rescuer respirator and self-contained self- respirators, and response to a fire in the underground. The KE ensures evacuation requirements are implemented in a manner which protects personnel from the unique hazards associated with the UG.

KE 11-9 *- Equipment deficiency tracking (including equipment in reduced status) that identifies, tracks, and evaluates safety impacts and implements compensatory measures until equipment is returned to service.*

DSA section 11.3 describes the program provisions for adherence to safety requirements, management of equipment deficiencies, maintaining proper configuration of the facility, authorizing changes to facility equipment, and returning equipment to service. DSA section 11.4.2 describes the program provisions for impaired fire protection equipment including identification of required controls pending return-to-service. The KE ensures the provisions for addressing equipment deficiencies are implemented in order to protect personnel, the facility, and the environment.

KE 11-10 *- Ground control inspections are conducted routinely, and remedial actions performed for unstable ground conditions by qualified personnel.*

DSA section 11.5 describes the program provisions for conducting underground visual inspections, monitoring installed geotechnical instrumentation, and conducting geotechnical field activities, comparing data and inspection results with design criteria, and identifying the need for and ensuring corrective action(s). The Section also addressed the training and qualification provisions for personnel conducting the aforementioned activities. The KE ensures the provisions for ground control are implemented in order to protect personnel and the facility.

KE 11-11 *- Maintenance and configuration management of ground control equipment.*

DSA section 11.5 identifies the types of equipment utilized for ground control and points to the Maintenance (DSA Chapter 10) and Configuration Management (DSA Chapter 17) programs. The KE ensures the provisions for ground control equipment maintenance and configuration management are implemented by the WIPP M&O contractor.

KE 11-12 *- Procedures address the actions to be performed by operators in response to CMR notifications, annunciators and other types of facility displays that indicate an abnormal condition.*

DSA section 11.3 describes the program provision for monitoring facility parameters, response to indications, and development and use of abnormal operating procedures. The KE ensures the Conduct of Operations provisions for addressing abnormal conditions are pre-planned and implemented.

KE 11-13 *- Establish provisions to monitor and control air quality to ensure underground workers are protected from volatile organic compounds; protective measures include posting hazardous areas, establishing monitoring requirements, ensuring local ventilation, and requiring personnel protective equipment such as respiratory protection as needed.*

DSA Chapter 11 does not address air quality further, but it is addressed in Chapter 8. A directed change (see SER section 5) requires this KE to be moved to Chapter 8 as KE 8-1. A corresponding change to the TSR is also directed.

3.7.7 DSA SMP, Chapter 12.0 – Procedures and Training

As part of the aforementioned corrective actions, the Conduct of Operations Matrix and Training Implementation Matrix were revised by the WIPP M&O contractor and approved by CBFO. DSA section 12.3 sufficiently describes the Procedures program which provides the processes used to develop, approve, issue, change, and use technical procedures in accordance with DOE O 422.1 requirements. DSA Chapter 12, section 12.4, commits to comply with applicable requirements and describes the Training program which provides the processes for training material development, maintenance, modification, and delivery in accordance with DOE O 426.2. The Chapter identifies specific program documents and procedures developed and maintained to implement the Procedure and Training Programs.

The Procedures and Training KEs ensure that the proven foundational aspects of high performing Procedures and Training organizations are explicitly institutionalized in the program. Additionally, KE 2 ensures that the unique aspects of WIPP as a DOE facility have comparably special treatment in the program.

KE 12-1 *- Preparation of procedures related to safe operation of the facility and/or safety SSCs with participation by end users and appropriate subject matter experts, verified to be technically correct, validated to be workable as written.*

DSA section 12.3.1 describes the program provisions for the development of procedures used during operations, maintenance activities, response to abnormal condition, and emergencies. These procedures are essential to safe and consistent performance of the aforementioned activities. DSA section 12.3.2 provides the program provisions for maintaining procedures including issuance, use, and change control. The KE ensures implementation of the provisions for providing technically correct and workable procedures consistent with its design basis.

KE 12-2 *- Worker training and qualifications on responding to incidents (e.g., use of rescue equipment, assembly areas).* (Hazards analysis)

DSA section 12.4.1 describes the program provisions for training and qualification requirements for personnel responding to abnormal and emergency conditions including alarms, fires, personal protective equipment use, and facility/Underground evacuation. The KE ensures provisions for incident response are implemented for abnormal and emergency conditions.

KE 12-3 *- Training and Qualification Programs are designed and developed to ensure personnel obtain initial requisite knowledge and skills resulting in abilities to effectively execute assigned duties during normal, abnormal, and emergency conditions. Continuing training is provided to maintain requisite knowledge and skill as warranted for changes such as emergent Evaluation of the Safety of the Situation documents. Personnel are not permitted to perform assigned duties independently until requisite training and qualification are complete.* (Hazards analysis)

DSA section 12.4 describes the program provisions for the training and qualification of WIPP personnel responsible for conducting normal activities as well as those responsible for identifying and responding to abnormal/emergency conditions. The KE ensures the implementation of training and qualification provisions for cognizant personnel to carry out assigned duties.

DSA SMP, Chapter 13.0 – Human Factors – Deleted

DSA Chapter 13 was determined not to be required based on DOE-STD-3009-2014 criteria and was deleted. The SBRT determined this deletion was appropriate since the Operational Safety (Conduct of Operations SMP) and Procedures and Training SMP adequately address human factors.

3.7.8 DSA SMP, Chapter 14.0 – Quality Assurance

As part of the aforementioned corrective actions, the Quality Assurance (QA) Plan was revised by the WIPP M&O contractor and approved by CBFO. DSA Chapter 14 commits to comply with applicable requirements and describes the QA Program organizational responsibilities and processes for quality improvement, document control, records management, and quality assurance performance (i.e., work processes, design, procurement, acceptance testing/inspection, and independent assessment). The Chapter identifies specific program documents and procedures developed and maintained to implement the QA Program.

The QA Key Element addresses the need for providing password protection for safety significant Programmable Logic Controllers.

KE 14-1 *- Password protection of safety significant Programmable Logic Controllers.*

DSA section 14.6.1 describes the program provisions for programmable logic controllers (PLC) including the PLC’s ability to provide defined safety function. The KE ensures the provisions for password protecting PLCs are implemented in order to prevent non-authorized personnel from operating or having access to safety significant SSCs utilizing PLCs.

3.7.9 DSA, SMP Chapter 15.0 – Emergency Preparedness Program

As part of the aforementioned corrective actions, the Emergency Preparedness Hazards Assessment was revised by the WIPP M&O contractor and approved by CBFO. DSA Chapter 15, Emergency Preparedness Program, commits to comply with applicable requirements and describes the Emergency Management Program organizational structure and processes for planning, assessment actions, notification, emergency facilities and equipment, protective actions, training, and recovery/re-entry per the requirements of DOE Order 151.1C.The Chapter identifies specific program documents and procedures developed and maintained to implement emergency management.

Emergency response has also made significant progress with training in the use of self-rescuers, improved planning, and regular drills.

Significant Emergency Preparedness and Management processes are embodied in the KEs below:

KE 15-1 *- Hazards are identified and analyzed through a technical planning basis process to provide pre-determined protective actions and protective action recommendations to protect workers and the public.*

DSA sections 15.3 and 15.4 describe the program provisions for event evaluation which includes hazard identification and analysis via the Emergency Planning Hazard Survey and Emergency Planning Hazard Assessment. This all-hazards approach includes surface and underground emergencies including those events which include CH or RH waste. DSA section 15.4.5 describes the program provisions for identifying protective actions during emergency planning for the associated emergency action level. The KE ensures provisions for hazard identification/analysis and protective actions are implemented in order to protect personnel.

KE 15-2 *- Emergency plans and procedures provide the framework for actions to be taken by workers and responders.*

DSA section 15.3 and 15.4.5 describe the program provisions for identifying Emergency Action Levels and associated protective actions for personnel to take in the event of an emergency. These actions are incorporated into categorization/classification procedures so the actions are automatically taken upon selection of an EAL. Thus, response to an extremely unlikely pool fire in the Waste Shaft Station that began lofting smoke and radiological material up the waste shaft is an example of a hazard event that would be addressed via emergency response plans. The KE ensures provisions for the identification of pre-planned response actions in order to protect personnel from the potential health and safety impacts of emergency conditions.

KE 15-3 *- Emergency response capabilities (e.g., OPERABLE equipment, minimum staffing, Incident Command System, Emergency Operations Center) are identified and maintained to respond and protect workers, public, property, and environment.*

DSA section 15.4.1.2 describes the program provisions for Field Response and Incident Command including Incident Commander and Command Post; off-site agencies; and the WIPP fire department, Employee Response Team, Mine Rescue Team, and Protective Force personnel. DSA section 15.4.1.3describes the program provisions for the Emergency Operations Center including its purpose and function. DSA section 15.4.4 describes the program provisions for Emergency Facilities and Equipment including a Baseline Needs Assessment which identifies the minimum resources necessary to respond to emergencies. DSA section 15.4.6 describes the program provisions for the initial and refresher training requirements for Emergency Response Organization (ERO) personnel and general employee emergency preparedness training. The KE ensure the provisions for emergency response capabilities are implemented in order for the ERO to effectively address emergency conditions.

KE 15-4 *- Emergency drills and exercises are planned and conducted to provide validation of plans, procedures, and response capabilities.*

Section 15.4.6.2 commits to a coordinated program of drills and exercises as an integral part of the WIPP Emergency Management Program. Validation of plans and procedures is specifically addressed. These provisions address specific AIB findings related to the lack of preparation at WIPP for the February 2014 accidents.

DSA SMP, Chapter 16.0 - Provisions for Decontamination and Decommissioning - Deleted

DSA Chapter 16 was determined not to be required based on DOE-STD-3009-2014 criteria and was deleted. The SBRT determined this deletion was appropriate given WIPP's life-cycle and on-going mission.

3.7.10 DSA SMP, Chapter 17.0 – Management, Organization, and Institutional Safety Provisions

DSA Chapter 17, Management, Organization, and Institutional Safety Provisions, commits to comply with applicable requirements and describes the Management, Organization, and Institutional Safety Provisions Program that establishes the organizational structure, responsibilities, interfaces, and staffing and qualifications for personnel involved in safety-related functions. The safety related functions include the Contractor Assurance System, Configuration Management, Occurrence Reporting and Processing System, and maintenance of the Safety Culture. As part of the aforementioned corrective actions, the Contractor Assurance System was revised by the WIPP M&O contractor. The Chapter identifies specific program documents and procedures developed and maintained to implement the Management, Organization, and Institutional Safety Provisions Programs.

The Chapter 17 Key Element restates the requirement for Configuration Management for the broad range of safety SSCs to emphasize its importance as part of the WIPP program.

KE 17-1 *- Configuration management of SSCs identified in accordance with DOE O 433.1B.*

DSA section 17.4.2 describes the program provisions for ensuring the configuration of SSCs that are part of the safety basis SSCs. These are the SSCs required per DOE O 433.1B: safety significant SSCs and Design Features subject to degradation; other systems that perform important defense-in-depth functions; equipment relied on for the safe operation, safe shutdown of the nuclear facility, and for maintaining the facility in a safe shutdown condition as documented in the safety basis; and safety support systems. For these SSC, configuration management is to be maintained, with confirmation that design changes do not impact the SSC's ability to provide its safety functions. The KE ensures provisions for the configuration management of safety SSCs that are part of the safety basis.

3.7.11 DSA SMP, Chapter 18.0 – Waste Acceptance Criteria Compliance

DSA Chapter 18, Waste Acceptance Criteria Compliance Program, is a new SMP chapter for Revision 5a. This reflects the importance placed on the WIPP Waste Acceptance Criteria (WAC) as several elements of the WAC are identified as initial conditions in the DSA's Hazards Analysis. These initial conditions are relied upon in establishing bounding unmitigated event frequency and radiological consequences to workers and the public. Chapter 18 describes the WAC Compliance program which includes cognizant organizational roles and responsibilities, clarifying the significant WAC-compliance role within the purview of the WIPP M&O contractor and the interface with DOE-managed programs, including the National TRU Program, that is necessary to preclude a repeat event like the radiological release accident of February 2014. The Chapter addresses the processes for WIPP Certified Program certification/recertification; waste certification; enhanced acceptable knowledge, chemical capability, and basis for knowledge determination; waste stream approval; waste confirmation; and generator site technical reviews. The Chapter also sufficiently describes the processes for authorizing shipment of the existing waste. The Chapter identifies specific program documents and procedures developed and maintained to implement an improved and effective WAC compliance assurance program.

The KEs of Chapter 18 are chosen to define WIPP M&O contractor actions judged sufficient to ensure that WIPP WAC requirements will be met for future waste receipts and emplacements:

KE 18-1*: The WIPP M&O Contractor verifies each container is part of an approved waste stream with the enhanced Acceptable Knowledge process prior to authorizing shipment in WDS.* (Hazards analysis)

This KE aids in ensuring TRU waste containers are compliant with the WIPP WAC prior to being authorized for shipment in order to implement the initial conditions and assumptions of the safety analysis as to the nature, quantity, and confinement of TRU Waste at WIPP.

KE 18-2*: The WIPP M&O Contractor reviews approved WSPFs to verify the information provided is complete and accurate, and that the waste stream complies with Hazardous Waste Facility Permit (HWFP) Waste Analysis Plan (WAP) and the WIPP Waste Acceptance Criteria (WAC) (DOE/WIPP 02-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant) prior to authorization for shipment.* (Hazards analysis)

This KE aids in ensuring individual waste containers are specified on a waste stream basis which has been verified to be complete, accurate, and compliant with WIPP WAC and the WAP prior to authorizing shipment.

KE 18-3*: The WIPP M&O Contractor verifies the HWFP requirement for confirmation of certified waste prior to shipment to the WIPP from the DOE Sites.* (Hazards analysis)

This KE aids in ensuring waste containers do not contain prohibited waste (e.g., ignitable, corrosive, reactive waste) and that the physical form of their waste is consistent with the waste stream description; the KE encompasses the review of radiography media and visual examination as applicable.

KE 18-4*: The WIPP M&O Contractor performs Generator Site Technical Reviews, which are reviews of DOE Sites' and Certified Programs' implementation of WIPP requirements (excluding DOE activities).*

This KE aids in ensuring WIPP WAC compliance by confirming the ability of the Certified Programs to ensure noncompliant materials are not present in waste containers, limit the quantity of individual waste container material at risk (MAR), and ensure individual waste container fissile material (i.e., FGE) is within mass limits. As a further measure, the WIPP contractor is cooperating with a pending report on the credible errors of the shippers non-destructive assay of the containers fissile mass.

KE 18-5: *The MAR statistics for waste certified for future shipment to WIPP are reviewed periodically by the WIPP M&O Contractor (no less frequently than annually) to ensure the values stated in Tables 3.4-1 and 3.4-2 (based on DOE-STD-5506 statistical analysis methodology) continue to provide conservative, unmitigated consequences in the Safety Analysis; further, each payload proposed for shipment to WIPP is additionally screened to ensure handling and emplacement of small groupings of containers will remain bounded by the Safety Analysis.* (Hazards analysis)

This KE ensures the multi-container statistical MAR in DSA Tables 3.4-1 and 3.4-2 bounds the population of waste containers accepted for emplacement at WIPP and includes a provision to monitor for and address the potential for unintentional concentration of MAR, not permitted by DOE-STD-5506-2007, during waste handling and emplacement.

Because of the situation of pre-certified waste in the complex, the following will occur to ensure all subsequent shipments of waste to WIPP will meet Chapter 18 requirements:

- Waste previously certified will be verified via the bullet points in section 18.8 of SMP Chapter 18. This verification will complete the same actions as done in KE 18-1.
- Waste previously certified will be verified against KE 18-2 and 18-3 prior to shipment.
- Waste certified after the implementation of DSA/TSR Revision 5 and WAC will be required to meet all KE's of SMP Chapter 18.
- The Generator Site Technical Review will be performed on all DOE Sites prior to initial shipment of new waste certified after DSA/TSR Revision 5 and WAC implementation.

3.7.12 Overall SBRT Conclusions on SMP Adequacy

The DSA SMP Chapters contain sufficient descriptions and requirements for the SBRT to conclude they provide for the safe operation of the facility as intended. The SMP Chapters meet expectations of DOE-STD-3009-2014, section 4, for the DSA sections [7.X], employing the allowance for use of the previous DOE-STD-3009-94 separate SMP chapter format and content. The basic provisions of the SMPs, along with their applicable Key Elements, are adequately addressed. The individual SMP Chapters identify the specific program documents and procedures developed and maintained to implement the SMP.

DOE-STD-3009-2014, section 4 states that other programs may be important for individual facilities, and should be addressed as a separate SMP. The WIPP DSA Revision 5a appropriately adds a new Chapter 18, Waste Acceptance Criteria Compliance Program, reflecting the importance placed on the WIPP WAC as an initial condition for the hazards analysis.

4.0 TECHNICAL SAFETY REQUIREMENTS

The purpose of the TSR is to ensure important operating parameters are maintained within acceptable limits and that safety SSCs and administrative controls are available and able to perform their intended safety function. To implement 10 CFR 830.205, Technical Safety Requirements, DOE Guide 423.1-1B has been prepared and approved. The TSR was reviewed against the acceptable practices as described in DOE G 423.1-1B. Review and approval of the TSR document is based upon the TSR provisions, which include limiting conditions for operation, surveillance requirements, administrative controls including SACs, and design features being traced from the hazard controls in the DSA to appropriate provisions that implement these controls in the TSR. The TSR provisions must be clear, implementable, and consistent with the DOE guide. The DOE review concentrated on the correct placement of the credited controls from DSA Chapter 5 into the TSR and the presentation of the controls themselves.

The DOE review of the TSR involves several sections within the document and will be described in the following order: Use and application, LCOs and Surveillance Requirements (including Bases), Administrative Controls, and Design Features. SACs are addressed as LCOs when that format is used and as administrative controls when they are written in the directive action format.

4.1 USE AND APPLICATION; SAFETY LIMITS

Section 1 of the TSR, Use and Application, is provided to support the presentation of definitions, process areas, modes, completion times, and defined surveillance frequencies that are used to implement the LCOs and ACs, including the SACs. The format and presentation of the section was compared to the DOE guide and determined to be consistent. The definitions were appropriately described in Section 1.1 and properly capitalized when used throughout the document. New definitions have been added and several have been expanded to support the hazard analysis. Specifically, the Attendant discussion has been expanded to address the duties performed as credited in the safety analysis. Other significant changes made to this section involve the addition of new defined terms for Active panel, Active room, Downloading, Functional testing, Response Plan, Shipping Package, WHB Parking Area Unit and the deletion of Designated Route.

To support the implementation of the LCOs, mode descriptions and defined process areas are described in DSA Tables 1.1.-1 and 1.2-1. The modes for the WIPP Facility are applicable to the above ground operations and the UG operations and are based on safety-significant SSC functions developed in the hazard and accident evaluations in Chapter 3.. For the above ground operations, Waste Handling, Waste Storage and Standby Modes are used to support the LCO applicability. For UG operations Waste Handling and Disposal are used. Each mode has adequate description and an explanation of the requirements which are consistent with the DSA derivation chapter. Mode designations and changes are an administrative declaration made by the Facility Manager of the Facility. Because the Facility consists of several areas that perform specific, independent functions, separate mode designations for each of the process areas are provided. The defined process areas are consistent with those listed in the DSA Chapter 5.

Other Use and Application content related to frequency, logical connectors, and completion times is also presented in accordance with DOE guide content and satisfies the expected Guide intent of the sections. The frequency values presented in Table 1.3-1 are of the standard definition and associated durations. The section provides an explanation of their use and an accompanying example. The frequency table also includes the additional 25% increase as detailed in the Guide. The only frequency content change that has been added is related to the term, “prior to use”. This expansion of the Each Shift definition is to allow performance at the first use for the shift and not re-performed again that shift unless required by changing conditions. The SBRT determined that this was acceptable and that the TSR explanation clarified its use. The logical connectors used in the TSR are “or” and “and”. The description of their use was provided in section 1.4. The completion time use and application was also provided in section 1.5 and was consistent with the Guide.

Section 1.6, Interim Safety Basis Changes, while not a section in the guide, was revised to address compliance with DOE G 424.1-1B when preparing safety basis information. Several comments were generated regarding the need for this section in the TSR. Discussions with CBFO and NWP resulted in the section remaining as long as the intent of the guide was maintained for PISAs, ESSs, JCOs, and other specified safety basis change package deliverables.

The TSR appropriately did not specify Safety Limits or Limiting Control Settings as there were none identified in the hazard evaluation, Chapter 4 or Chapter 5.

4.2 LIMITING CONDITIONS OF OPERATIONS (LCOS) AND SURVEILLANCE REQUIREMENTS (SRS)

Section 3.0 of the TSR describes LCOs 3.0/4.0 which are the generic rules for applying the LCOs and SRs. These LCO/SR rules were reviewed and determined to be consistent with the DOE guide and are therefore acceptable as presented. The following is a brief discussion of each of the LCOs.

LCO 3.1.1 WHB Fire Suppression System

LCO 3.1.1 describes the operability requirements for the Waste Handling Building Fire Suppression System. The LCO indicates that the system must be capable of serving the CH Bay and Room 108 when in the Waste Handling and Waste Storage Modes. During these modes, Waste is susceptible to a fire event. The LCO provides operability requirements that ensure the system can perform its credited safety function that are consistent with associated DSA TSR derivation section 5.5.1.1. To be operable per Revision 5a, the system must have one fire pump, sufficient water capacity, unobstructed flow in the delivery of water to the building sprinklers, and support instrumentation. In part, because the diesel fire pump has been out of service, DOE directed (see SER section 5) that the LCO be changed to require both fire pumps, with a new condition to address one being unavailable.

LCO actions are provided in the event the system or parts of the system become inoperable. For the conditions related to the CMR instrumentation for the fire water tank level, an increase in the surveillance of the local gauge level indication is required with restoration of operability within 92 days. This completion time is based upon the capability of reading the tank level from an operable gauge. The new condition for one fire pump being inoperable specifies LCO actions for implementation of a fire pump impairment plan and for restoration of operable pump status. The LCO actions taken in the event the system is not operable require the suspension of any new shipping packages from entering the applicable process area, stopping of all hot work, continuous fire watches on waste handling activities and roving fire patrols on stored waste. The system must either be restored to operable status, the process area placed into a non-applicable mode within 31 days, or the implementation of a response plan detailing an updated compliance strategy approved by CBFO. This completion time was determined to be acceptable based upon the potential time for major repairs of the system and the performance of the required actions. In addition, consideration was taken for the limited operations allowed, the lack of large combustible material in the process areas, and the availability of the CVS.

Surveillance requirements are provided for the verification of testing of the two fire pumps with respect to flow and pressure testing and auto-start capability; the available unobstructed flowpath provided by alignment checks, inspector test valve and main drain tests; and calibration of tank level instrumentation. These SR are consistent with the listed ones in DSA section 5.5.1.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards and NFPA standards. There are two parallel fire pumps each of which can provide water to the applicable sprinklers; both are required to be operable to satisfy LCO requirements. The operability requirements for each pump are provided along with the required frequency. If a pump does not satisfy the testing criteria consistent with the frequency, it cannot be considered operable to support the LCO.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

During the SBRT review, it was determined that a strategy of having two pumps available should be incorporated into the operability requirements of the LCO in order to support additional system redundancy and reliability. As such, directed page changes (See SER Section 5) require both pumps and separate LCO conditions for situations when either one or both are not available. Surveillance requirements, as well as bases for the system are also modified to reflect the new strategy.

LCO 3.1.2 Underground Vehicles and Equipment with a Fire Suppression System

LCO 3.1.2 describes the operability requirements for the Underground Vehicle/Equipment Fire Suppression System. This system is required for liquid fueled vehicles that satisfy the criteria of

NFPA 122. The LCO indicates that the system must be operable when CH Waste is being transported in the WSS, VEZ or to the waste face or when a vehicle is within 200 feet of the Waste Face. All of these activities occur in the Underground which is the identified Process Area. During these activities Waste is susceptible to a vehicle fire event. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.2.1. To be operable, the system must have a control panel, indicating lights, temperature elements, charged suppression system, distribution and engine cutoff capabilities. The LCO actions taken in the event the system or parts of the system are not operable require an attendant for the vehicle and actions to remove the vehicle from the area immediately. If this cannot happen in 4 hours, all waste movements in the underground are stopped to focus all attention on correcting the condition.

Surveillance requirements are provided for the verification of FSS prior to use and for functionally testing the unit. These SR are consistent with those listed in DSA section 5.5.2.2. The testing methodology and performance acceptance criteria are clearly presented and based upon NFPA standards.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.2.1 CH Waste Handling (WH) Confinement Ventilation System

LCO 3.2.1 describes the operability requirements for the CH Waste Handling Confinement Ventilation System. The LCO indicates that the system must be operable servicing the CH Bay, Room 108, and CLR (when door 140 is open) during the Waste Handling and Waste Storage Modes. During these modes, Waste is susceptible to a fire event. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.3.1. To be operable, the system must have one fan in-service, one operable HEPA filter unit in-service, adequate differential pressures in the CH Bay and Room 108, and associated CMR and local instrumentation. The operable HEPA is characterized by an efficiency of 99% and dP readings within the required readings.

LCO actions are provided in the event the system or parts of the system become inoperable. For the conditions related to the CMR instrumentation, an increase in the surveillance of the local gauge indications is required with restoration of the inoperability with 31 days. These completion times are based upon reading an operable gauge. The LCO actions taken in the event the system is not operable require the suspension of any new shipping packages from entering the applicable process area, stopping of all hot work, continuous fire watches on waste handling activities and roving fire patrols on stored waste. The system must either be restored to operable status or the process area placed into a non-applicable mode within 14 days. This completion time was determined to be acceptable based upon the potential time for major repairs of the system and the performance of the required actions. In addition, consideration was taken for the limited operations allowed, the lack of large combustible material in the process areas and the availability of the FSS.

Surveillance requirements are provided for the verification of an in-service fan and HEPA filter unit; the required differential pressures in CH Bay and Room 108; N510 testing for HEPA filter efficiency; and calibration of and functional testing of differential pressure instrumentation. These SRs are consistent with those listed in DSA section 5.5.3.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards and NFPA standards. The frequencies are also presented and supported by acceptable references. Tables are provided in the LCO that support a clear definitive listing of the instrumentation that is required to support the operability of the system. Specific instrument descriptions, Individual loop numbers, set points and surveillance ranges are provided.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.2.3 Underground Ventilation Filtration System/Interim Ventilation System

LCO 3.2.3 describes the operability requirements for the Underground Ventilation Filtration System/Interim Ventilation System. The LCO indicates that the system must be operable servicing the Underground during the Waste Handling and Disposal Modes. During these modes, Waste is susceptible to a fire event. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.5.1. To be operable, the system must have proper fan and HEPA filter unit alignment in-service, an operable HEPA unit in-service, adequate differential pressure at the 308 Bulkhead, directional airflow across the Active Waste Face when its manned, and associated CMR and local instrumentation. The operable HEPA is characterized by an efficiency of 99% and dP readings within the required readings.

LCO actions are provided in the event the system or parts of the system become inoperable. For the conditions related to the CMR instrumentation, an increase in the surveillances of the local gauge pressure indication is required with restoration of the inoperability with 31 days. These completion times are based upon reading an operable gauge. When the air flow is not confirmed into the active room, waste transfer to the underground is suspended, waste is placed in a safe configuration, and the active room is evacuated within 4 hours. When the system is determined to be inoperable, waste transfers to the Underground are suspended, containers and vehicles within 200 feet of waste face are placed into a safe configuration. The system is required to be restored to operable status or the implementation of a response plan detailing an updated compliance strategy approved by CBFO is completed within 31 days. This set of actions and completions times allow for the placement of waste into a safe configuration that is currently in transport or being emplaced. The placement of waste into a safe configuration is determined by the FM. This condition assumes that some exhaust fans are in operation. When no exhaust fans are in service, the actions are similar as when the system is inoperable except for the suspension of all liquid-fueled powered vehicle engines immediately. This action is taken to satisfy the MSHA requirements for the requirement of airflow when vehicles are operating. However, the actions do not require evacuation of the underground and personnel may remain with the waste not presently emplaced. In support of this potential condition, RPP elements will be consulted. With no air flow in the underground and all waste handling suspended the potential release events are located behind the panel bulkheads.

Surveillance requirements are provided for the verification of in-service fan and HEPA filter unit alignment and the HEPA unit differential pressures; the presence of directional waste face flow when the room is manned; annual N510 testing for HEPA filter efficiency and calibration of and functional testing of differential pressure instrumentation. These SRs are consistent with those listed in DSA section 5.5.5.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards. The frequencies are also presented and supported by acceptable references. Tables are provided to clearly indicate the proper fan and HEPA unit alignments and a clear definitive listing of the instrumentation that is required to support the operability of the system. Specific instrument descriptions, Individual loop numbers, set points and surveillance ranges are provided.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.2.4 309 Bulkhead Operability During Download of Waste Containers

LCO 3.2.4 describes the operability requirements for the Underground Ventilation Filtration System/Interim Ventilation System with respect to 309 Bulkhead during Download of Waste Containers. The LCO indicates that the system must be operable servicing the underground and the Waste Shaft Access Area during the Waste Handling Mode. During this mode, Waste is susceptible to a fire or drop event down the shaft. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.6.1. To be operable, the system must have three exhaust fans in-service, adequate differential pressure across bulkhead 309, airflow at the waste shaft station towards the 308 bulkhead, and associated CMR and local instrumentation. The exhaust and filtration of the underground air is performed by LCO 3.2.3.

LCO actions are provided in the event the system or parts of the system become inoperable. For the conditions related to the CMR instrumentation, an increase in the surveillance of the local gauge is required with restoration of the inoperability with 31 days. These completion times are based upon reading an operable gauge that is calibrated before each downloading operation. When the system is determined to be inoperable by non-compliance with the operability attributes, waste transfers to the Underground are suspended and any containers in the waste shaft collar room, waste shaft conveyance, or waste shaft station are removed from these areas within 4 hours.

Surveillance requirements are provided to ensure that prior to each downloading operation, three fans are in-service, the 309 bulkhead has adequate differential pressure and the airflow at the waste shaft station is towards bulkhead 308. SRs are also provided for annual calibration of and functional testing of differential pressure instrumentation. These SRs are consistent with those listed in DSA section 5.5.6.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards. The frequencies are also presented and supported by acceptable references. Tables are provided in the LCO that support a clear definitive listing of the instrumentation that is required to support the operability of the system. Specific instrument descriptions, Individual loop numbers, set points and surveillance ranges are provided.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.2.5 Battery Exhaust Filtration System

LCO 3.2.5 describes the operability requirements for the Battery Exhaust Filtration System. The LCO indicates that the system must be operable when a battery exhaust fan is in-service and the CH Bay or Room 108 are in the Waste Handling and Waste Storage Modes. This LCO applicability is conditional because the fans are placed into operation periodically to support battery charging operations and package opening activities. During these modes while the fan is in-service, Waste is susceptible to a release event that could be exhausted from the WHB through this system. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.7.1. To be operable, the system must have one operable HEPA filter unit in-service, and associated CMR and local instrumentation. The operable HEPA is characterized by an efficiency of 99% and dP readings within the required readings.

LCO actions are provided in the event the system or parts of the system become inoperable. For the conditions related to the CMR instrumentation, an increase in the surveillance of the local gauge indications is required with restoration of the inoperability with 31 days. These completion times are based upon reading an operable gauge. The LCO actions taken in the event the system is not operable require the suspension of the fan in operation. This action removes the potential for any releases and removes the system from LCO applicability. Of note, due to the significant length of time for hydrogen generation to build up to levels of concern (greater than 16 days), this LCO does not require actions associated with battery charging.

Surveillance requirements are provided for the verification of an HEPA filter unit dP readings; N510 testing for HEPA filter efficiency; and calibration of and functional testing of differential pressure instrumentation. These SRs are consistent with those listed in DSA section 5.5.7.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards. The frequencies are also presented and supported by acceptable references. Tables are provided in the LCO that support a clear definitive listing of the instrumentation that is required to support the operability of the system. Specific instrument descriptions, Individual loop numbers, set points and surveillance ranges are provided.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.3.2 Aboveground Liquid-fueled Vehicle/Equipment Prohibition

LCO 3.3.2 is a LCO-formatted SAC that describes the requirements for the prohibition of liquid fuel vehicles/equipment in the CH Bay during Waste Handling and Waste Storage modes. During these modes, waste is susceptible to a fire event because it can be present outside the protective shipping package. The LCO provides the requirements that ensure the waste operations can be performed within the credited safety analysis conclusions. The listing of the prohibition and process areas are consistent with associated TSR derivation section 5.5.9.1. To satisfy the LCO, no liquid fueled vehicles/equipment are allowed in the CH bay or Room 108 when waste is allowed to be outside the shipping package. An additional exception is made to this applicability in that the Waste Shaft Access Area is used for CH and RH activities and for downloading significant amounts of combustible fuel to support underground operations. This area can be accessed from the CH Bay. Therefore, the prohibition only applies to this area when CH waste is present because the RH waste DOE Type B shipping container prevents any impacts from fire events. The LCO actions taken in the event liquid fueled vehicle/equipment is present in one these areas is to suspend waste handling, attend the suspect vehicle and remove the vehicle from the area under the oversight of the Attendant. These actions support the safe recovery of the areas back into compliance with the LCO.

Surveillance requirements are provided for the verification that no liquid fueled vehicle/equipment are in these three process areas each shift. These SRs are consistent with those listed in DSA section 5.5.9.2. The frequency for the SRs are clearly presented and based upon operational experience and that the current operational practices of no vehicles needed for the support of waste handling activities in the CH bay.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.3.5 Underground Lube Trucks Operation

LCO 3.3.5 is a LCO-formatted SAC that describes the requirements for the distance that Lube trucks must maintain with CH Waste in the Underground during Waste Handling and Disposal modes. During these modes, waste is susceptible to a fire event because it can be present outside the protective shipping package. The LCO provides the requirements that ensure the waste operations can be performed within the credited safety analysis conclusions. The listing of the prohibitions and process areas are consistent with associated TSR derivation section 5.5.12.1. To satisfy the LCO, no lube truck is allowed within 200 foot of an active panel or within the Lube truck exclusion zone when CH waste is present. The lube truck exclusion zone is a defined term that includes a significant area near and around the Waste shaft station. These distances are provided to ensure the potential fire events from the lube truck do not impact the CH waste. The LCO actions taken in the event a lube truck is present in one these areas is to immediately Attend the lube truck and attempt to remove it or the CH waste from the affected area which would bring the facility back into LCO compliance. If this cannot be done within 4 hours, actions are then taken to continue the Attendant function, suspend downloading of any additional waste, place the lube truck in a safe configuration and within 14 days remove the lube truck from the affected area by whatever means necessary. These actions support the safe recovery of the area back into compliance with the LCO.

Surveillance requirements are provided for the verification that no lube truck will be in the exclusion area prior to CH waste being introduced and that prior to entry into an Active panel the 200-foot separation distance is evident and can be maintained. Some operations with the lube truck may extend longer than a shift, therefore a conditional frequency was established for per shift performance for this condition. These SRs are consistent with those listed in DSA section 5.5.12.2. The frequency for the SRs are clearly presented and based upon operational experience and that the current operational practices.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.3.8 Vehicle/Equipment Control

LCO 3.3.8 is a LCO-formatted SAC that describes the requirements for the Attendance of CH waste when liquid fueled vehicles or vehicles with liquid combustible capacity are being used that could impact the waste from a fire event. The process area applicability of the LCO is the CH Bay and the Underground during the modes of Waste Handling, Waste Storage, and Disposal. During these modes, waste is susceptible to a fire event because it can be present outside the protective shipping package. The LCO provides the requirements that ensure the waste operations can be performed within the credited safety analysis conclusions. To satisfy the LCO, liquid fueled vehicles shall be attended when waste is in the Waste Shaft station, between the VEZ termination point to the waste face, and when within 25 feet of the waste face. The LCO also requires attendance of vehicles/equipment with a liquid-combustible package greater than or equal to 25 gallons in the RH BAY when CH Waste is present in the CH Bay. An additional element of the LCO element is that no more than two liquid fueled vehicles can be within 25 feet of the waste face. The listing of the prohibitions and process areas are consistent with associated TSR derivation section 5.5.13.1. The LCO bases section describes in detail the rational for each of these controls. This discussion supports the DSA Chapter 5 and accident analysis conclusions.

The LCO actions are provided for each of the LCO elements. The Actions taken in the event of a noncompliance is to immediately place the vehicle/equipment in a safe configuration or remove it from the waste face. For those conditions that require an Attendant to be present, 1 hour is provided to ensure this action is completed. This action returns the facility back into compliance with the LCO. These actions support the safe recovery of the area back into compliance with the LCO.

Surveillance requirements are provided for the verification that each of the LCO elements. When CH waste is to be moved or transported by liquefied fuel vehicles in the Underground, this verification is made prior to bringing CH Waste near the vehicle. When CH Waste is in the CH Bay, this verification is also made prior to bringing any vehicles with ≥ 25 gallons of liquid combustible capacity into the RH bay. Some operations with the vehicle may extend longer than a shift in the RH bay, therefore an additional conditional frequency was established for per shift performance for this condition. For the verification of vehicles being within 25 feet of the waste face or no more than 2 near the waste face, a once per shift is required. These SRs are consistent with those listed in DSA section 5.5.13.2. The frequency for the SRs are clearly presented and based upon operational experience and that the current operational practices.

As stated previously, the bases sections for this LCO was prepared in accordance with the guide and provide the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.7.1 Waste Acceptance Control

LCO 3.7.1 is a LCO-formatted SAC that describes the requirements for compliance with the WIPP WAC for receipt and while any container is on the WIPP site. Therefore, this LCO applies to all process areas and at all times. The LCO provides the requirements that ensure the waste operations remain within the credited safety analysis conclusions. To satisfy the LCO, shipping package documentation, container integrity, potential pressurization conditions, noncompliance indicated by labeling, and allowed waste package contents in accordance with the WAC are required to be met. The listing of the LCO elements and process areas are consistent with associated TSR derivation section 5.5.20.1. The LCO bases section describes in detail the rational for each of these controls. This discussion supports the Chapter 5 and accident analysis conclusions.

The LCO actions are provided for LCO non-compliance. When documentation is not in compliance, actions are provided that prohibit the opening of the package and allow a limited time to obtain the necessary documentation. While the package is not open, the potential for release is eliminated. For the condition involving container integrity, actions are provided to overpack the noncompliant container within 48 hours. Completion of this action is analyzed in the safety analysis and is considered a low risk activity. For conditions involving waste container labeling issues (e.g., missing container labels, inconsistencies with WDS) in which the waste container is determined to not meet the WDS, actions require immediate placement of waste containers in a safe configuration and resolution of discrepancies within seven days. This is considered a low risk because issues are typically related to documentation (not content), and waste containers are not opened as part of the response actions. For the conditions involving pressurization or WIPP WAC container content noncompliance, actions are provided to place the package in a safe configuration and the implementation of a response plan detailing an updated compliance strategy approved by CBFO within 10 days.. The response plan provides specific actions for the unique situation and requires DOE approval. These actions support the safe recovery of the area back into compliance with the LCO. The LCO clearly states that entry into these conditions does not replace or circumvent the USQ process for determining if a PISA exists. A suspect noncompliant determination requires entry into the LCO. Independently the USQ process and PISA evaluation is determined.

Surveillance requirements are provided for the verification for each of the LCO elements. When Waste is to be received at the site, a verification is made of the WDS and the shipping manifest for consistency. Once packages are brought into the WHB and opened, verification is made of the container identification labels and the WDS, the container integrity, and for signs of pressurization. These SRs are consistent with those listed in DSA section 5.5.20.2. The frequency for the SRs are clearly presented and based upon operational experience and that the current operational practices.

As stated previously, the bases sections for this LCO was prepared in accordance with the guide and provide the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

LCO 3.8.1 Waist Hoist Brakes

LCO 3.8.1 describes the operability requirements for the Waste Hoist Brakes. The LCO indicates that the brakes must be operable when Waste is being downloaded. To support the LCO applicability, a definition of downloading was provided that specifically described the affected area and activity. Because this activity involves the waste hoist, the applicable Process areas are the Waste shaft access area and the Underground. The LCO provides the operability requirements that ensure the system can perform the credited safety function that are consistent with associated TSR derivation section 5.5.8.1. To be operable, the brakes must have four operable brake units, two operable emergency dump valves, and a Lilly controller that automatically sets the brakes in an over-speed condition.

The LCO actions taken in the event the system or parts of the system are not operable require the suspension of any new shipping packages into the Waste collar and placing the waste into a safe configuration. Surveillance requirements are provided for the verification of testing of the automatic over-speed and emergency dump valves, the manual operation of the Lilly controller and the verification of brake pad thickness and spring tension. These SR are consistent with the listed ones in DSA section 5.5.8.2. The testing methodology and performance acceptance criteria are clearly presented and based upon industry standards and manufacturer's guidance.

As stated previously, the bases section for this LCO was prepared in accordance with the guide and provides the required sections. The discussion is supportive of the area addressed and provides the operations staff with additional information to assist in the implementation of this control.

4.3 ADMINISTRATIVE CONTROLS

Section 5 of the TSR contains the administrative controls for the Facility. The administrative controls described in this section are consistent with DSA Chapter 5 and those provided in DOE guidance document.

Minimum Staffing

The section addresses the minimum staffing requirements for the WIPP facility. The section indicates that the minimum operations shift complement per shift for WIPP shall be one FSM, one CMR Operator, and one Facility Operations Roving Watch. Shaft Tenders shall be also present when moving Waste on the Waste Conveyance. The section appropriately provides control for the attendance of the Facility Manager at the certain operations and when continuous attendance is required in the Control Room. The attendance in the control room by a trained and qualified operations staff person is required to support the credited safety actions that are not automatically performed by the system software. These actions involve isolation of equipment and suspension of conveyance processing.

The SBRT determined that this listing was in agreement with the safety analysis assumptions and adequately detailed their safety functions. The failure to implement these positions will result in a TSR violation. However, as addressed in the section, there was an allowance for a temporary less than minimum shift compliment. This is a standard exception that supports times that the persons making up the shift compliment are unexpectantly absent. A two-hour period is allowed to restore the minimum compliment.

Training and Qualification Program

This section addresses the training and qualification requirements for those personnel that provide a credited safety function response. The applicable personnel are the FSM, CMR operator, Attendant, and Shaft tenders.

TSR Control and Response Plans

This section provides the instructions related to the control of revisions to the TSR, situations that result in a TSR violation, making decisions outside of the TSR and the programmatic content of a Response Plan. The instructions related to the TSR issues identified above were reviewed and determined to be compliance with DOE guidance.

The response plan is not a document that the Guide describes. At WIPP, this document is used to address those conditions where the facility cannot comply with a TSR requirement and there are no provided actions to restore compliance. The response plan provides additional analysis or administrative and management controls that are approved by DOE prior to implementation. While no guidance is provide in the guide, the use of this program element is acceptable when completed implementing the listed instructions governing content and approval.

SACs in Directive Action Format

This section addresses the seven Directive Action SACs that were identified in DSA Chapter 5. The wording on each of the SACs is consistent with the derivation chapter. See Section 3.6 of this SER for an assessment of the derivation of the Directive Action SACs. The TSRs were verified to include them appropriately. Each SAC presents a SAC statement, a basis for the SAC, and details related to its implementation. This presentation is consistent with the DOE TSR guide. In addition, those SACs that require a periodic verification, a basis for the frequency has been provided. The SACs are as follows:

- *5.5.1 Pre-Operational Checks of Vehicles/Equipment in Proximity to CH Waste*
- *5.5.3 TRU Waste Outside the WHB*
- *5.5.4 Vehicle Exclusion Zone*
- *5.5.5 Fuel Tanker Prohibition*
- *5.5.6 Waste Conveyance Operations*
- *5.5.7 CH Bay Alternative Vehicle Barrier Provision*
- *5.5.8 Real Time Monitoring at panel 6 and Panel 7 Isolation Bulkheads*

<u>A directed page change was identified by the SBRT (see SER Section 5) that requires a change to SAC 5.5.8 in order to clarify that the SAC statement includes notification requirements for workers.</u>

Programmatic Administrative Controls

Section 5.5.2 of the TSR contains the description of the administrative programs implemented at the facility.

In TSR, Revision 5a, the commitment to implement effective SMPs is included in a Programmatic Administrative Control, PAC 5.6.1, that specifically lists the applicable Key Elements. Including the Key Element in the TSR serves to emphasize their importance to the assurance of facility safety, raise the compliance expectation to the TSR level, and preclude changes to the requirements without DOE approval. A revised “Note:” in AC 5.4.2, *TSR Violations*, clarifies the conditions under which a TSR Violation would result from the programmatic breakdown of a PAC (or SMP by reference) and thus emphasizes DOE’s expectations for SMP compliance and KE implementation, stating:

> NOTE: Determination of a programmatic breakdown is determined by tracking and trending non-compliances and deviations, including KEs. A single non-compliance would not necessarily constitute a TSR violation. To qualify as a TSR violation, the failure to meet the intent of the referenced program is significant enough to render the DSA summary invalid.

Experience across the DOE Complex has shown the importance of effective processes to evaluate and demonstrate SMP health as implemented by the M&O contractor. The specified tracking and trending is a proven means to monitor, control, and demonstrate SMP health. It is a tool to aid SMP owners in ensuring the KEs and overall safety function of each SMP are implemented and maintained per TSR PAC 5.6.1.

See Section 3.7 of this SER for assessment of the individual safety management programs.

Reviews and Audits

Section 5.7 provides a discussion concerning the various reviews and audits that are required to be performed to evaluate facility's compliance with the TSR. The section provides the listing of those day-to-day activities that the operations manager should be cognizant of. In addition, the section provides a listing of the significant activities and programs that affect nuclear safety that should be reviewed. The section describes the methods used to conduct independent reviews as detailed in the guide and management responsibilities for establishing and overseeing these review and audit activities.

4.4 DESIGN FEATURES

The Design Features are addressed in Section 6 of the TSR. The listing and discussion of the design features are consistent with the DSA Chapter 5 listing. See section 3.6 of this SER for an assessment of the derivation of the design features. The design features appropriately include the information that is needed to support maintaining the credited safety function. See Section 3.6 for assessment of the derivation of Design Features.

5.0 CONDITONS OF APPROVAL

The SBRT identified conditions of approval that included directed page changes affecting various sections in the DSA and TSR. These directed page changes, as identified in Enclosure 1, shall be made to the WIPP DSA Revision 5a, WIPP TSR Revision 5a, and WIPP-021 hazard analysis, Revision 5, prior to issuance of the controlled documents. These changes address the few issues noted by the SBRT that must be corrected in the final submittal. In summary these issues include:

- Updates to references throughout the DSA and TSR to reflect the latest supporting documents;
- DOE decision to require both fire pumps for the WHB FSS rather than just one in LCO 3.1.1; correct Chapters 4 and 5 to be consistent; Add worker notification to the directed SAC scope in LCO 5.5.8 and clarify the basis; correct Chapter 4, including Table 4.5.1, and Chapter 5 to be consistent;
- Correction of inconsistencies in instrument uncertainties between the DSA (Chapters 4 and 5) and TSRs;
- Clarifying Key Element 11-4 as a defense in depth measure applicable to a static waste face (i.e., no waste emplacement for 10 days or more);
- Moving the Key Element 11-13 to become Key Element 8-1 in both the DSA and TSR;

- Clarification in Section 3.3.2.3 that VOCs were not screened out, but were an evaluated hazard;
- Correction in Section 3.3.2.3 regarding analyzed MAR in certain WHB pool fires;
- Correction in Section 3.3.2.3 and WIPP-021 to reflect the bounding risk outlier event involving ordinary combustible fire in the CLR with door 140 closed;
- Add loss of confinement events as protected by the UVFS/IVS in Table 3.3-10;
- Correction of the basis in Section 3.4.3.1.1 for judging certain Waste Shaft drop events to be extremely unlikely;
- Additional operational upgrades discussed in DSA Section 3.6 and 4.4.2.3 related to the fire suppression system;
- Clarification in Chapter 4 of the basis for NFPA-13-1983 compliance;
- Clarifications in Chapter 5 and the TSR related to conducting surveillances of airflow into an "active room" as described in SR 4.2.3.3; and
- Correction to WIPP-021 for the WAC Initial Condition for drum deflagrations.

Revision 5b of the DSA/TSR incorporating these changes and an updated version of WIPP-021 will be retransmitted to CBFO for information and are approved for implementation. Restart of waste receipt and emplacement is subject to the Authorization Agreement requirements for an Operational Readiness Review.

6.0 RECORDS

Review of the WIPP DSA/TSR is conducted in accordance with the general requirements in DOE-STD-1104-2014 and the provisions of CBFO Management Procedure (MP) 4.11, Revision 6, *Safety Basis Review Procedure*. Records generated by this procedure are maintained in compliance with current requirements identified in the CBFO records management procedure MP 4.9, Revision 6, *Quality Assurance Records*. The Safety Basis Document Review Plan was developed to aid in managing and conducting the DOE review. In accordance with MP 4.11, Revision 6, the records generated and maintained during the DOE review of the submitted DSA and TSR, Revision 5a, are identified below:

- DOE/CBFO-15-3551, Revision 1, "Safety Basis Document Review Plan";
- Completed CBFO Form 4.11-1, "Qualification of SB Review Team";
- Completed CBFO Form 4.11-2, "SB Document Review Record";
- DOE/WIPP 16-3565, Revision 0, "Safety Evaluation Report"; and
- The Safety Basis Documents being approved:
  - DOE/WIPP 07-3372, WIPP Documented Safety Analysis, Revision 5a
  - DOE/WIPP 07-3373, WIPP Technical Safety Requirements, Revision 5a

The SER is reviewed by management, in accordance with CBFO MP 4.2, Document Reviews, as the SER is a controlled CBFO document, identified with a standardized and unique number, and applies to WIPP nuclear processes. The purpose of the MP 4.2 review of the SER is to ensure the preparation of the document is consistent with the established processes for producing CBFO controlled documents and to consider aspects such as programmatic and strategic planning, regulatory compliance, cost, etc. impacts. References within the SER have been reviewed and determined to be complete and accurate enough to identify necessary information during future revision and review activities of the approved safety basis document(s) or of ancillary document(s), systems and/or activities/processes, as necessary.

7.0 PISA RESOLUTIONS

Six open Potential Inadequacies in the Safety Analysis (PISAs) against Revision 4 of the DSA/TSR are being closed by DSA/TSR Revision 5a. Of those six PISAs, three were declared for the UG vehicle fire (one) and the radiological event (two). USQ determinations associated with the PISAs were positive, in accordance with 10 CFR 830.203 and DOE Guide 424.1-1B. The other three PISAs involved issues with the design basis for the WHB Fire Suppression System (FSS), credit for floor slope in the WHB the RH Bay/CH Bay door that was found not to be provided, and a discovery that the TRUDOCK ventilation system was independent of the CH Bay ventilation system and therefore required its own filtration.

Evaluations of the Safety of the Situation (ESSs) were written as needed to address the three PISAs based on February 2014 events and to support site habitability, UG reentry, accident investigation, housekeeping and decontamination, diesel-fueled vehicle operation, closures of Panel 6 and of Panel 7, Room 7, HEPA filter replacement, electrical outages needed for maintenance, IVS installation, a consolidated ESS combining active portions of the prior ESSs, and an ESS for WHB Fire Suppression PISA deficiencies. These ESSs were submitted to DOE and approved during recovery and reflected the then current understanding of the situation and its impact on the safety basis; appropriate controls were included to address safety for the limited activities allowed during recovery. Only the WHB FSS PISA (P15-005) was judged to require a separate ESS for the limited scope of activities being performed during recovery (the other two, P15-006 and P15-008, were addressed in the interim with suitable long term timely orders). Each of those documents afforded controls conservatively selected to ensure safe performance of the necessary investigation and recovery activities until the cause investigations and corrective actions progressed to the point that a permanent safety basis change became practical. The ESSs including those still in effect were written and approved to supplement DSA and TSR, Revision 4. Those still in effect will be superseded upon implementation of Revision 5a.

The three open PISAs resulting from the February 2014 accidents, which are permanently corrected by DSA/TSR Revision 5a, are identified in items 1, 2 and 3 below:

1. Following the fire event, a PISA (PISA 14-0001, USQ D14-009) was identified for the following hazards as potentially not adequately addressed: a) the likelihood of UG liquid-fueled vehicle fires as evaluated in the WIPP DSA may not be conservative; and b) the performance of fire suppression systems on UG liquid-fueled vehicles may not be adequate.

    Resolution: DSA/TSR, Revision 5a, includes an updated hazard evaluation (WIPP-021) addressing a broad spectrum of vehicle fires including numerous fires that remain credible as mitigated events. New automatic fire suppression systems are being installed on vehicles with a significant fuel inventory in the UG. These systems are addressed by LCO 3.1.2 for vehicles involved in waste handling and by new KEs 11-1 *and 11-5 in the Fire Protection Program for other UG vehicles. LCO 3.3.8 also adds an attendant to further limit fire risk during waste handling and emplacement in the UG. In addition, other improvements include a new SAC (5.5.1) for pre-operational checks of vehicles/equipment in proximity to waste as well as operator response to fire events included as part of new KEs 11-3, 11-7, 11-8, 11-9, and 11-12.*

2. Following the radiological release, a PISA (PISA 14-0002, USQ D14-013) was identified for the following hazards as potentially not adequately addressed or controlled: a) the safety functions of the UG ventilation system, filtration and radiation monitoring systems, relied upon for protection of the facility worker (FW), co-located worker (CW), and maximally exposed offsite individual (MOI), are not adequately identified and protected in the WIPP DSA; and, b) performance of Ground Control inspections in accordance with 30 CFR Part 57, Subpart B, "Ground Control" were suspended following the events and were thus not being performed.

   Resolution: DSA/TSR, Revision 5a, requires HEPA filtration of the UG exhaust from the disposal and waste handling areas and upgrades those confinement ventilation systems to safety significant, subject to new TSR LCOs. CAMs needed for worker protection are addressed by a new KE 7-1 for the Radiation Protection Program and by a new directive action SAC 5.5.8 addressing the hazard posed by emplaced MIN-02 waste containers behind new closure barriers. The initial suspension of ground control has been addressed with an aggressive catch-up program to ensure habitability. New KEs 11-10 and 11-11 in the operational safety SMP ensure attention to ground control will be maintained.

3. Subsequently, based on new information on the radiological release, a PISA (PISA 14-0007, USQ D14-155) was identified for improper mitigation and packaging of untreated nitrate waste salts with the following hazards potentially not adequately addressed: a) drums from the LA-MIN02-V.001 waste stream could increase the probability of an accident (internal deflagration in contact-handled (CH) waste container in UG) previously evaluated in the existing safety analysis; and b) the existing safety analysis of an internal deflagration event (bounding non-explosion internal energetic event) assumes the material at risk (MAR) of a single waste container, but does not bound the actual release in the event.

   Resolution: DSA/TSR, Revision 5a, includes an updated hazard evaluation (WIPP-021) addressing such energetic chemical vents with a new model developed to bound the February 2014 accident. These hazards are addressed by the new safety significant closure barriers for Panel 6 and Panel 7, Room7 as well as the directive action SAC 5.5.8 discussed above that addresses the hazard posed by emplaced MIN-02 waste containers behind new closure barriers. The new Chapter 18 SMP (to include KE 18-1, 18-2, 18-3, 18-4) details the actions taken to ensure such a non-compliant container will not be received in the future – prevention is the first priority for an event of this severity. New beyond design basis evaluations address a future event in the WHB or during emplacement to ensure that the chosen control set and defense-in-depth planning are adequate to ensure worker protection should such an event occur.

Items 4, 5 and 6 below identify three additional open PISAs discovered since the February 2014 events that involved technical issues in the WHB.

4. PISA P15-005 (USQ D15-102) was declared upon discovery that the specified WHB fire suppression riser operability criteria (flow and pressure) may not suffice to ensure the described safety function for the actual supply piping configuration.

   Resolution: DSA/TSR, Revision 5a, Chapter 4 is supported by new calculations consistent with the existing facility and equipment that provide defensible criteria for WHB FSS operability.

5. A related PISA (P15-006, USQ D15-106) was subsequently issued to include a discovery that the design feature WHB floor slope was in fact not met.

   Resolution: DSA/TSR, Revision 5a, includes an updated hazard evaluation (WIPP-021) that does not credit the WHB floor slope and selects alternate controls, including the facility pallet design feature to mitigate the consequences of a fuel pool fire in the vicinity of the CH/RH Bay rollup door. The DSA acknowledges a vulnerability in the Chapter 4 performance evaluation of the WHB structure and credits an attendant SAC as a compensatory measure for unprotected structural steel columns near the rollup door. DSA section 3.6 commits to installation of a protective fire barrier for the structural steel columns.

6. Another PISA (P15-008, USQ D15-115) was declared for the WHB HEPA filter banks for the vent hoods used for the TRUDOCK and TRUPACT III exhaust system previously thought (in error) to have exhausted through the credited CH Bay HEPA filtration system.

   Resolution: DSA/TSR, Revision 5a, includes new LCO 3.2.5 to ensure that the battery exhaust/TRUDOCK ventilation is HEPA filtered.

In summary, significant design and operational safety improvements were implemented at WIPP in response to the UG fire and independent radiological release events that occurred in February 2014. These include measures addressing the three accident-based PISAs. DSA and TSR, Revision 5a affords a substantial revision, strengthening the WIPP safety basis in compliance with DOE-STD-3009-2014 requirements and guidance. These safety basis documents have undergone an appropriate review in accordance with DOE-STD-1104-2014. As summarized above, the new safety basis documents incorporate the necessary changes to ensure correction of the six PISAs identified.

8.0 CONCLUSIONS

This SER documents the required SBRT review of the complete Revision 5a submittal in accordance with the guidance provided in DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. The SBRT finds and concludes that the submitted safety basis documents were prepared in accordance with 10 CFR 830 Subpart B requirements, applying the safe harbor methodology specified in DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. Because WIPP handles TRU waste, the safety basis development was also governed by DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities,* developed to guide programs dealing with TRU waste within DOE-EM.

This SBRT concludes that the WIPP DSA, Revision 5a and the associated directed page changes:

- documents proposed activities, thoroughly described and analyzed, with the hazards appropriately identified;
- establishes the linkage between identified hazards and the final control set;
- documents the chosen controls, applying the specified hierarchy; and
- specifies control safety functions, and establishes clear operability criteria, appropriately captured in TSRs.

The SBRT further concludes the WIPP TSRs, Revision 5a and associated directed page changes:

- include a disciplined analysis and tracing of commitments to hazard controls in the DSA to appropriate provisions that implement these controls;
- specify TSR provisions that are appropriate and consistent with the DSA, and are clear and implementable;
- are adequately defined and supported by justifiable basis statements and surveillance requirements in accordance with the TSR guidance in DOE G 423.1-1B.

In addition, the SBRT concludes that SACs have been appropriately differentiated from PACs and have been established in a manner consistent with DOE-STD-1186-2004, and the requirements and guidance of DOE-STD-3009-2014.

As part of the comprehensive upgrade to the DSA/TSR, the SBRT finds the safety basis includes several key improvements (addressing significant deficiencies identified following the February 2014 events) as highlighted below:

- upgrading of the DSA, including specification of initial conditions determination of control effectiveness in accident prevention consistent with DOE guidance and
- significant improvements to the Safety Management Programs (SMPs), emphasizing maintenance, conduct of operations, fire protection, training, quality assurance and emergency response, while incorporating newly defined Key Elements (KEs) included in the TSR;
- the addition of a new SMP for the WIPP facility to ensure future compliance with the Waste Acceptance Criteria (WAC) in a manner coordinated with in-process National Transuranic (TRU) Program corrective actions related to the AIB reports;
- implementation of the recovery plan developed following the accidents (Waste Isolation Pilot Plant Recovery Plan, September 30, 2014, Revision 0), including the decision to utilize filtered ventilation for the underground (UG) waste handling and disposal areas to minimize the risk of future radiological release from the UG; and
- incorporation of other applicable Accident Investigation Board (AIB) lessons learned including fire protection upgrades and a recommendation to incorporate Continuous Air Monitors (CAMs) into the control strategy.

The SBRT concludes that the safety basis analyzed and documented in the WIPP DSA/TSR Revision 5 (to include all incorporated directed page changes) is comprehensive, correct, and commensurate with hazards associated with analyzed waste disposal operations, and that such operations will pose minimal risk to workers, the public, and the environment when conducted within the safety basis documented in the DSA. Thus, the SBRT recommends that the DOE

Safety Basis Approval Authority (SBAA) approve the submitted safety basis documents, subject to the specified condition of approval, to support the restart of waste receipt and emplacement at WIPP.

9.0 REFERENCES

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10 CFR Part 830, Nuclear Safety Management.

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