Summary of the Safety Impact Analysis for the Lead Shielded Container

Scope

This white paper summarizes the results of a safety impact analysis conducted on the lead shielded container (henceforth referred to as the shielded container). The purpose of this impact analysis is to identify any potential changes to the total effective (radiation) dose to on-site workers and the maximally exposed offsite-individual from previous analyses performed to support the WIPP Documented Safety Analysis. The WIPP Documented Safety Analysis currently considers a variety of waste containers for contact-handled transuranic (CH TRU) waste, including 55-gallon drums, 85-gallon drums, 100-gallon drums; standard waste boxes (SWB); ten drum overpacks; and pipe configurations overpacked in 55-gallon drums. The 85-gallon drum, 100-gallon drum, SWB and ten drum overpacks may also be used to overpack smaller waste containers, e.g., a 55-gallon drum may be overpacked in an 85-gallon drum. The process described in this white paper evaluates the potential impacts from shielded containers on total effective dose to on-site workers and to members of the public. This impact analysis has been performed as a step in the process of seeking EPA approval for the use of shielded containers at WIPP.

Description

The shielded container is proposed as an alternative to disposal of remote-handled (RH) transuranic (TRU) waste in canisters in the ribs (walls) of the disposal rooms. The shielded container will be used to emplace selected RH TRU waste streams in the WIPP repository. RH TRU waste that emits significant gamma radiation can be packaged within the shielded containers if the lead shielding reduces the surface dose rate to less than 200 mRem/hour, which is the level that is safe for handling as a contact-handled container. The shielded container can then be managed as a CH TRU waste container and emplaced on the floor, rather than in the walls of disposal rooms.

The shielded container has approximately the same exterior dimensions as a 55-gallon drum and holds a single 30-gallon drum that will contain the RH TRU waste (See Figure 1). The cylindrical sidewall of the shielded container has nominal 1-inch-thick lead shielding sandwiched within a double-walled steel shell. The external wall is 11 gauge (0.091 inch) steel and the internal wall is 7 gauge (0.144 inch) steel. The lid and the bottom of the container are made of carbon steel and are approximately 3 inches thick. The 30-gallon inner container has a gross internal volume of 4.0 ft^3 (0.11 m^3) and a maximum loaded weight of 2,260 pounds. The empty weight of the shielded container is 1,726 pounds.

The shielded container has been tested to Department of Transportation (DOT) Type 7A specifications and is certified by the U.S. Nuclear Regulatory Commission as an approved payload container for shipment within the Half-Package (HalfPACT) Transporter. This testing and certification ensure that the container will contain the waste under the most severe transportation accident conditions. The shielded containers will be configured as an assembly of three containers, i.e., a three-pack, for transport in the HalfPACT and for emplacement at WIPP.

Upon arrival at the WIPP facility, the shielded containers will be processed with a method similar to that for CH TRU waste. After receipt, the 3-pack assembly will be removed from the HalfPACT using existing lifting fixtures and equipment in the CH Bay portion of the Waste Handling Building. The 3-packs will be placed on a facility pallet (two 3-packs in a single layer) and downloaded to the underground repository along with other CH TRU waste containers. The 3-pack assembly of shielded containers will be emplaced randomly on the floor of the underground disposal rooms along with other CH TRU waste containers.

The emplacement configuration of the 3-pack has not been finalized. The most likely emplacement option is to place one 3-pack on top of another 3-pack, not to exceed two levels high. No other waste container assembly types will be placed on top of the shielded container 3-packs. In addition, the 3-pack assembly will not be placed at the bottom of a stack with other CH TRU waste assemblies on top due to the smaller footprint of the 3-pack assembly relative to a 7-pack of 55-gallon drums or other waste containers. Existing waste handling equipment and fixtures will be used for the emplacement of the 3-pack assembly of shielded containers. There are no plans to introduce new waste handling equipment and fixtures for the unloading, transporting and emplacement process.

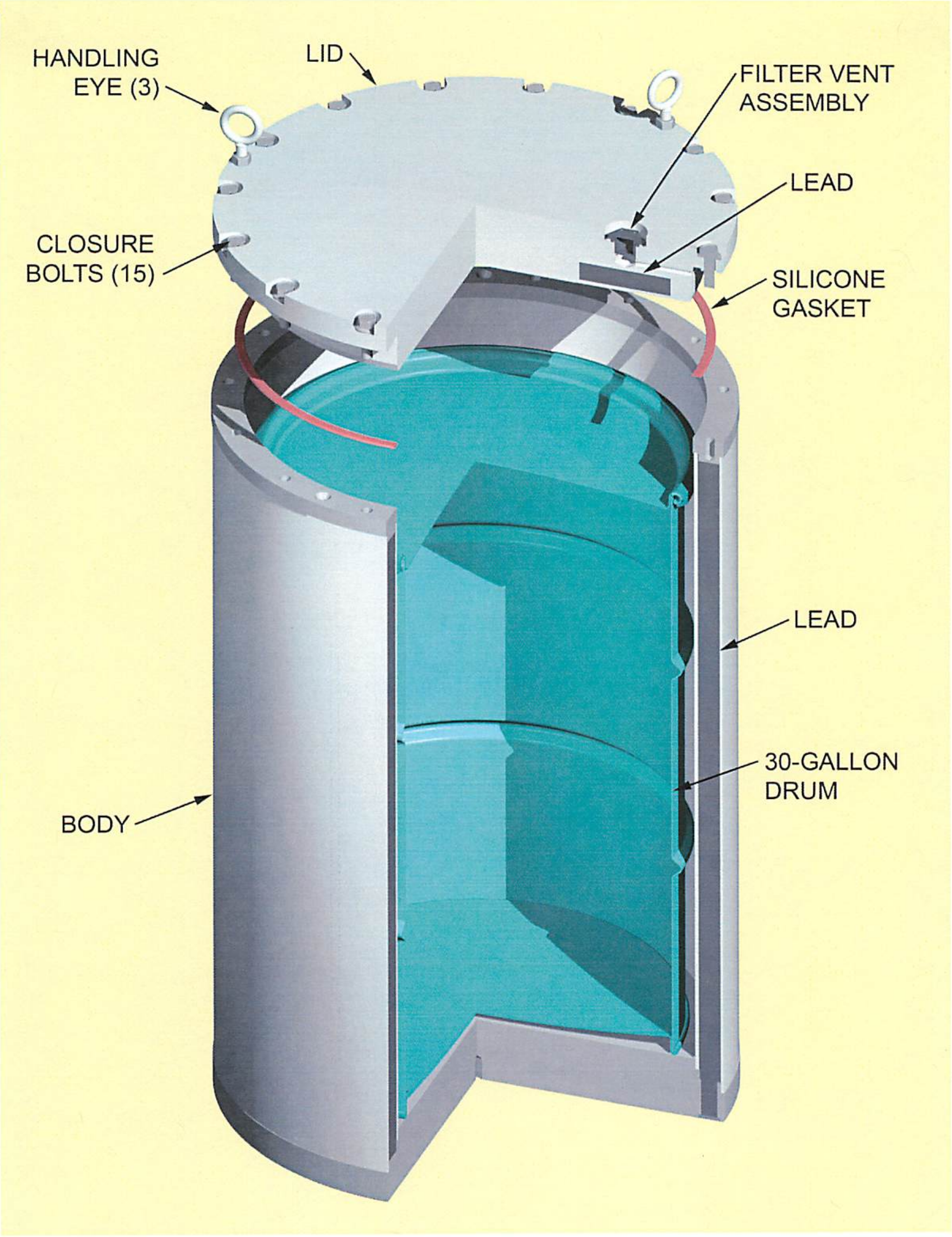

Figure 1. Isometric View of the Lead Shielded Container

Shielded Container's Impact on the Probability of Occurrence of an Accident

The use of shielded containers for emplacement of RH TRU waste at WIPP will not increase the probability of occurrence of an accident previously considered because they will be handled and emplaced in the disposal rooms in the same manner as what is currently used for CH waste. No new equipment will be required because the existing waste handling equipment can be used within the applicable design capacities. Few changes will be necessary to the waste handling procedures, except for those related to emplacement configuration.

The WIPP DSA is required to consider a minimum set of hazard event scenarios which includes fires, explosions, loss of confinement, direct radiation exposure, criticality, and externally initiated and natural phenomena. Site specific scenarios are developed for each of these categories. Each scenario evaluates a consequence for each authorized waste container configuration. Not all waste containers are damaged in every scenario. For example a 55-gal drum is assumed to be damaged for all drops above four feet; however, it is anticipated that the gamma shielded container will not be damaged from the same drop scenario because of its more robust design. Therefore, the four foot drop scenario would not be applicable for the gamma shielded container.

Table 1 summarizes all the scenarios that are applicable to the shielded container and that were considered in this safety impact analysis. The scenarios in Table 1 have been analyzed with a two-pronged approach: (1) worst case analyses for specific fire scenarios, and (2) a bounding approach for the remaining fire scenarios. A separate report, *Fire Analysis of the Shielded Container for the Waste Isolation Pilot Plant Carlsbad, New Mexico* (WTS2010b), evaluates the worst case fire scenarios which are applicable to a shielded container, and concludes that the worst case fire has no increase in consequence beyond the existing worst case scenario E-01G-CH/RH-UG. Based on this result, a judgment is made that there will be no increase in the consequence of the remaining applicable fire scenarios. This is an acceptable approach for DSA dose consequence calculation, where qualitative judgment is encouraged based on bounding analysis by DOE-Standard-3009-94, Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis and DOE-Standard-5506-2007, Preparation of Safety Basis Documents for Transuranic Waste Facilities. To summarize, Table 1 is a comprehensive list of all applicable fire scenarios and WIP-032 provides the detailed analysis of selected worst case fire scenarios that bound the scenarios in Table 1.

Table 1 also lists all the criticality scenarios that are applicable to the shielded container and that were considered in this safety impact analysis. Criticality consequences are not approached in the same manner as other scenarios. If a criticality event were to occur, the consequence to facility workers would be fatal. For this reason all possible scenarios involving criticality must be analyzed to ensure the events will not occur with any of the authorized waste container types. The criticality analyses were therefore updated to include the use of the shielded container. A separate report, *Summary of Nuclear Criticality Safety Evaluation for Shielded Containers at the Waste Isolation Pilot* (WTS 2009), *WIPP Safety Analysis Calculation* (WTS 2010a), evaluates the credibility of criticality scenarios which are applicable to a shielded container and concludes the possibility of criticality will still be incredible (less than 10^{-6} per year)(see 14A and14B events in Table 1) .

The shielded container is qualitatively judged to be at least as structurally robust as a overpack container for all hazard event scenarios except fires. In other words, the shielded container sustains less damage than the overpack container when subjected to the same hazardous events, except for fires (WTS 2010a, Section 3.3.1). For fires, events that directly involve CH waste containers were evaluated in (WTS 2010b). The analysis concludes that the design and construction of the shielded container is similar to certain physical attributes of other-TRU waste containers that have been exposed to fire testing (WTS 2010b, Section 5.0 and Table 5-1).

For direct radiation exposure events (see E-13A events in Table 1) there is no change in frequency from those previously evaluated in Chapter 3 of the existing Documented Safety Analysis. For criticality events, no credible criticality accident scenarios exist for the shielded container during storage, handling, and disposal processes at the WIPP (WTS 2009, Executive Summary). Therefore, the handling and emplacement of shielded containers does not increase the probability of any of the initiating hazardous events for any of the accident scenarios considered by the Documented Safety Analysis.

Shielded Container's Impact on the Consequences of an Accident

The shielded container will have the same limits on Plutonium-equivalent (PE) Curies and Fissile Gram Equivalent mass as a direct loaded CH TRU drum (WTS 2009, Section 2.1). More specifically, the fissile contents during transportation are limited by container and package limits defined in the *HalfPACT Safety Analysis Report* (DOE-CBFO 2009). With the same limits, there is no increase in the amount of TRU radionuclides available to be released by a given physical process. Stated differently, the total material-at-risk is unchanged for a CH TRU drum and a shielded container.

The bolted lid design of the outer assembly of the shielded container is qualitatively judged to be at least as structurally robust as an overpack container (WTS 2010a, Section 5.2) for all hazard event scenarios except fires. Therefore, the shielded container is given the same damage ratio as overpacked containers for all hazard event scenarios except fires. For fires, the shielded containers are damaged less than overpacked containers (WTS 2010b), and the total material released is less than that of TRU waste drums (previously identified) (WTS 2010a). For direct radiation exposure events (see E-13A events in Table 1) there is no change in the consequence to the on-site worker. The on-site worker consequences were qualitatively assessed to be low. These analyses assume the on-site worker has a reasonable opportunity to exit the scene of the event and take self-protective actions that will limit exposure. For criticality events, no credible criticality accident scenarios exist for the shielded container (WIPP 2009, Executive Summary). Therefore, there is no increase in the consequences for any of the accident scenarios considered by the Documented Safety Analysis.

Table 1. Applicable Accident Scenarios for the Shielded Container Safety Impact Analysis

Event Number	Event Description	Reference Document
E-01A-CH/RH-UG	Single liquid-fueled vehicle fire impacting CH and RH waste (pool fire)	WTS 2010b
E-01A-CH/RH-WHB	Fuel pool fire at the roll-up door affecting CH and RH waste	WTS 2010b
E-01A-CH-UG	Single liquid-fueled vehicle fire in the underground during transport (pool fire)	WTS 2010b
E-01A-CH-WHB	Single liquid-fueled vehicle fire in CH Bay in close proximity to staged waste (pool fire).	WTS 2010b
E-01B-CH/RH-OA	Large fueled vehicle impacts waste staged on trailers or waste trailer impacts fuel tanker (pool fire)	WTS 2010b
E-01B-CH/RH-UG	Collision of two liquid-fueled vehicles during transport involving CH and RH waste (pool fire)	WTS 2010b
E-01B-CH-UG	Collision of two liquid-fueled vehicles in the underground during transport (pool fire)	WTS 2010b
E-01C-CH-UG	Single liquid-fueled vehicle collision and fire at waste face (pool fire)	WTS 2010b
E-01D-CH/RH-UG	RH waste handling equipment collides into CH waste face involving CH and RH waste (pool fire)	WTS 2010b
E-01E-CH/RH-UG	Large pool fire in waste shaft	WTS 2010b
E-01G-CH/RH-UG	Lube truck collides into CH waste array with subsequent fuel pool fire	WTS 2010b
E-02A-CH/RH-OA	Small fire in waste container (internal waste container fire)	WTS 2010b
E-02A-CH/RH-UG	Small fire in waste container (internal waste container fire)	WTS 2010b

Event Number	Event Description	Reference Document
E-02A-CH/RH-WHB	Small fire in waste container (internal waste container fire)	WTS 2010b
E-02A-CH-WHB	Small fire following a collision involving electric forklift/Facility Transfer Vehicle	WTS 2010b
E-02B-CH/RH-OA	Small fire adjacent to waste containers	WTS 2010b
E-02B-CH/RH-UG	Small fire adjacent to waste container(s)	WTS 2010b
E-02B-CH/RH-WHB	Small fire adjacent to waste container(s)	WTS 2010b
E-02C-CH/RH-WHB	Fire in WHB/Hot Cell HEPA filters	WTS 2010b
E-03-CH-WHB	Waste container fire inside the shielded storage room	WTS 2010b
E-04A-CH/RH-WHB	Fire external to CH and RH Bays propagates to waste handling areas and impacts CH and RH waste	WTS 2010b
E-04A-CH-UG	Fire outside of the active disposal room (e.g., construction, mining, north ventilation circuit) propagates to active disposal room or disposal route	WTS 2010b
E-04A-CH-WHB	Large CH Bay fire involving ordinary combustibles	WTS 2010b
E-04B-CH/RH-WHB	Tanker truck fire in outside area propagates into waste handling areas and impacts CH and RH waste	WTS 2010b
E-04C-CH/RH-WHB	Large fire in Waste Hoist Tower results in waste conveyance drop	WTS 2010b
E-04C-CH/RH-WHB	Large fire in Waste Hoist Tower results in waste conveyance drop	WTS 2010b
E-04E-CH-WHB	Collision of two electric powered vehicles with subsequent fire	WTS 2010b
E-05A-CH/RH-OA	Boiling Liquid Expanding Vapor Explosion/Vapor Cloud Explosion (BLEVE/ VCE) of liquefied gas cylinder near WHB	WTS 2010a
E-05A-CH/RH-UG	BLEVE/ VCE of liquefied gas cylinder during transport in the underground	WTS 2010a
E-05A-CH/RH-WHB	BLEVE/ VCE of liquefied gas cylinder in WHB	WTS 2010a
E-05B-CH/RH-OA	Explosion of compressed gas cylinders near WHB	WTS 2010a
E-05B-CH/RH-UG	BLEVE/ VCE of liquefied gas cylinder in the UG at the waste face	WTS 2010a
E-05B-CH/RH-WHB	Explosion of compressed gas cylinder in CH or RH bay	WTS 2010a
E-05C-CH/RH-UG	Compressed gas cylinder explosion during waste transport or at the waste face	WTS 2010a
E-05C-CH/RH-WHB	Forklift battery explosion	WTS 2010a
E-05D-CH/RH-UG	Electric powered vehicle explosion during charging in the UG	WTS 2010a
E-05E-CH/RH-UG	Flammable gas explosion in filled panel	WTS 2010a
E09-B-CH/RH-UG	Underground vehicle collides with waste array	WIPP DSA Rev. 1, Chapter 3
E-09C-CH/RH-UG	Forklift tines puncture waste containers in UG	WTS 2010a
E-09C-CH-WHB	Waste container impacted by forklift tines	WTS 2010a
E-10A-CH/RH-WHB	Inadvertent fire arm discharge punctures waste container	WTS 2010a
E-10B-CH/RH-UG	Roof/Rib bolt punctures waste container	WTS 2010a
E-10C-CH-WHB	Elevated material falls or drops on waste containers	WIPP DSA Rev. 1, Chapter 3

Event Number	Event Description	Reference Document
E-10D-CH/RH-UG	Waste shaft conveyance failure leads to conveyance/ waste containers dropping down shaft.	WTS 2010a
E-13A-CH/RH-OA	Excess direct radiation exposure from waste containers	WIPP DSA Rev. 1, Chapter 3
E-13A-CH/RH-UG	Direct radiation exposure from waste containers	WIPP DSA Rev. 1, Chapter 3
E-13A-CH/RH-WHB	Direct radiation exposure from waste containers	WIPP DSA Rev. 1, Chapter 3
E-13B-CH/RH-UG	Direct contamination on waste containers	WIPP DSA, Rev. 1, Chapter 3
E-13B-CH/RH-WHB	Direct contamination on waste containers	WIPP DSA, Rev. 1, Chapter 3
E-14A-CH/RH-UG	Criticality in waste shaft sump following waste conveyance failure	WIPP DSA, Rev. 1, Chapter 3 and WIPP-025, Rev. 1
E-14B-CH/RH-OA	Criticality in closed shipping container	WIPP DSA, Rev. 1, Chapter 3 and WIPP-025, Rev. 1
E-14B-RH-WHB	Criticality in stored waste	WIPP DSA, Rev. 1, Chapter 3 and WIPP-025, Rev. 1
E-14B-CH/RH-UG	Criticality in disposed waste	WIPP DSA, Rev. 1, Chapter 3 and WIPP-025, Rev. 1
E-25-CH/RH-OA	Seismic event results in upending tractor/trailer resulting in pool fire involving CH or RH waste shipping containers	WIPP DSA, Rev. 1, Chapter 3
E-25-CH/RH-UG	Seismic event results in fire involving CH and RH waste	WIPP DSA, Rev. 1, Chapter 3
E-25-CH/RH-WHB	Seismic event damages WHB resulting in fire involving CH and RH waste	WIPP DSA, Rev. 1, Chapter 3
E-30-CH/RH-UG	Roof fall impacts waste containers	WIPP DSA, Rev. 1, Chapter 3

Shielded Container's Impact on the Probability of Occurrence of a Malfunction of Equipment

Existing CH waste handling equipment will be used to handle, process, and emplace the shielded containers. Handling and emplacement of shielded containers does not change the safety classification of the handling equipment. (Equipment important to safety (EIS) is credited with preventing or mitigating accidents.) Handling and emplacement of shielded containers also does not change the frequency of use of any EIS, or create a new failure mechanism for any EIS. Therefore, there is no increase in the probability of occurrence of a malfunction of any EIS.

Shielded Container's Impact on the Consequences of a Malfunction of Equipment

There is no increase in the material-at-risk in a shielded container versus a CH TRU 55-gallon container. The shielded container will have the same limits on Plutonium-equivalent (PE) Curies and Fissile Gram Equivalent mass as a direct loaded CH TRU drum (WTS 2009, Section 2.1). The shielded container is qualitatively judged to be at least as structurally robust as an overpacked container for all hazard events scenarios except fires. Therefore, when subjected to the DSA hazardous events, the shielded container is given the same damage ratio as an overpacked container for all events except fires. For fires, the shielded containers are damaged more than overpacked containers (WIPP-032), but the total material released is less than that of TRU waste drums (WIPP-031). Finally, if a piece of equipment important to safety were to fail, there would be no increase in consequence due to handling and emplacing shielded containers. It follows that there is no increase in the consequences for any of the accident scenarios considered in the Documented Safety Analysis.

Shielded Container's Impact on the Possibility of an Accident not Previously Included in the Documented Safety Analysis

The use of shielded containers at WIPP will not increase the probability of occurrence of an accident not previously included in the Documented Safety Analysis because the shielded containers will be handled and emplaced in the disposal rooms in the same manner as what is currently used for CH waste containers. No new initiating events result from the handling and emplacement of shielded containers.

Shielded Container's Impact on the Possibility of a Malfunction of Equipment

Existing CH waste handling equipment will be used to handle, process, and emplace the shielded containers. Handling and emplacement of shielded containers does not change the classification of equipment that prevents or mitigates accidents, the frequency of use of any EIS, or create a new failure mechanism for any EIS. Therefore, there is no increase in the probability of occurrence of a malfunction of any EIS previously evaluated.

Conclusion

The use of shielded containers at WIPP will be bound by the existing accident scenarios described in the WIPP Documented Safety Analysis. Consequences to the public (i.e., the maximally exposed offsite-individual) and to the on-site (facility) worker will not increase with the use of the shielded containers.

References

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