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POTENTIAL HEALTH AND SAFETY IMPACTS OF REMOVAL OF CONTAINERS FROM THE WASTE ISOLATION PILOT PLANT

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ACRONYMS

ACO	Administrative compliance orders
CCP	Central Characterization Project
CH	Contact-handled
CH-DSA	Contact Handled Documented Safety Analysis
DOE	Department of Energy
DVFR	Design Validation Final Report
EPA	Environmental Protection Agency
H&S	Health and safety
HERE	Horizontal emplacement and retrieval equipment
HWFP	Hazardous Waste Facility Permit
INL	Idaho National Laboratory
LANL	Los Alamos National Laboratory
MgO	Magnesium oxide
NMED	New Mexico Environment Department
PECOS	PECOS Management Services, Inc.
RH	Remote-handled
SWB	Standard waste box
TRU	Transuranic
VE	Visual examination
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WTS	Washington TRU Solutions

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I. PURPOSE AND SCOPE

The scope of this task covers all activities associated with operations of the Waste Isolation Pilot Plan (WIPP) related to the handling and disposal of both contact-handled (CH) and remote-handled (RH) transuranic (TRU) waste containers. These activities include those related to the removal of TRU waste containers from shipping casks, transfer of TRU waste containers to the disposal area, and disposal of TRU waste containers. This report provides an analysis of potential health and safety (H&S) impacts that could occur as a result of removing TRU waste containers from the WIPP or as a result of allowing non-compliant TRU waste containers (those that do not conform to the Waste Acceptance Criteria) to remain at the WIPP.

II. BACKGROUND

The WIPP, operated by the U.S. Department of Energy (DOE), is a geologic repository in southeastern New Mexico designated for the permanent disposal of TRU waste. It consists of surface facilities designed to receive, survey, and unload specially designed shipping casks that container TRU waste containers and transfer the TRU waste containers to the repository. Situated approximately 2,150 feet below ground in the middle of a vast salt formation (the Salado Formation), the design of this repository consists of a series of disposal panels to be mined from the salt. Each of these panels, which are positioned at right angles to the main access tunnels, is designed to contain seven rooms. As of November 2008, five panels have been mined, Panels 1, 2 and 3 have been filled with TRU waste, and Panel 4 is being filled. The CH TRU waste is packaged in a variety of container types and sizes for shipment to WIPP. The containers that are approved to be shipped are defined as payload containers and range from 55 gallon drums to 10 drum overpacks to standard waste boxes (SWB). The payload containers are emplaced in the rooms in rows, generally assembled into groups according to the size and type of container, and then stacked three-high. A woven polypropylene sack containing magnesium oxide (MgO) is then placed on top of the stacked containers. The RH TRU waste containers are packaged in specially designed canisters that are emplaced in boreholes that have been drilled horizontally into the walls of the rooms and into the access drifts on each side of the rooms.

There have been three recent instances in which containers of TRU waste containing prohibited items have been shipped to the WIPP in violation of the Hazardous Waste Facility Permit (HWFP). In the first instance, DOE notified the New Mexico Environment Department (NMED) on July 17, 2007, that a non-compliant container had been shipped in a SWB from Idaho National Laboratory (INL) on June 23, 2007; it was disposed at the WIPP on June 27, 2007. The container was non-compliant because there was more than one inch of liquid present in an internal container positioned within the payload container. On August 3, 2007, the NMED ordered DOE to remove the container from the underground repository, which DOE accomplished by August 17, 2007. The basis for the decision to order the removal of this container was that the history of the container contents indicated that this liquid was probably corrosive or reactive. There were no health and safety incidents during the retrieval or transportation of this container back to INL. An administrative compliance order (ACO)(1) for this incident was issued November 26, 2007.

The second instance of violation of HWFP at the WIPP involved the emplacement of 121 potentially non-compliant containers of TRU waste that may have contained HWFP-prohibited items (specifically, liquid in excess of one percent of the container volume). These containers originated at Los Alamos National Laboratory (LANL). The waste stream in question was dewatered sludge, which was generated at the Radioactive Liquid Waste Treatment Facility at LANL between November 1979 and December 1987. This sludge consisted of particulates that included heavy metals precipitated from radioactive liquid waste that originated at LANL, which were then dewatered by rotary drum vacuum filtration. The solid content of the final dewatered sludge was between 25 and 40 percent (by volume). This dewatered sludge was packaged inside lined 55-gallon containers as follows: approximately 10 pounds of dry Portland Cement were placed in the container first; the dewatered sludge was added; another 10 pounds of Portland Cement was added, and the liner and the container were then closed.

The Central Characterization Project (CCP) staff, using visual examination (VE), checked the containers in question for the presence of prohibited items from May 4, 2005, through June 23, 2005, and designated the containers as being free of prohibited items. The containers were then emplaced at the WIPP between August 14, 2005, and February 25, 2006. All 121 containers were emplaced in Panel 3, which was filled and closed in January 2007.

The fact that these containers may not have been properly characterized was discovered in May 2006 during a quality assurance audit of the CCP characterization activities at LANL. NMED had participated in that audit and had, at that time, become aware of the possibility the containers may not have been properly characterized. Following several rounds of information requests by NMED and ensuing responses from DOE and Washington TRU Solutions (WTS), the NMED issued another ACO(2), which ordered DOE and WTS to provide a plan for removal of the 121 containers. That ACO stated that DOE was to remove the containers by May 24, 2008 (180 calendar days from receipt of the ACO), unless it could provide a technical justification to NMED that the 121 containers would pose no elevated risk to human health and the environment if left in place at the WIPP. Subsequently, DOE entered into negotiations with NMED and reached a settlement in March of 2008, which did not require DOE to retrieve the containers due to the fact that the containers demonstrated no elevated environmental, health, or safety risk to either workers or the public. The NMED decision to not require removal of those drums was largely based on the fact that the liquid in the drums was water and that the waste materials in the drums were not reactive or corrosive.

The third instance occurred on June 6, 2008, when DOE notified the Environmental Protection Agency (EPA) and the NMED that a non-conforming drum of CH TRU waste from LANL had been erroneously emplaced at the WIPP.(3) The drum in question contained de-watered sludge, and CCP characterization activities had identified in excess of one percent by volume of free liquid, which is a violation of the HWFP prohibited items conditions. This drum was one of four in an SWB that had been shipped from LANL to WIPP on May 20, 2008, and emplaced on May 28, 2008. All emplacements in and shipments to the WIPP were stopped on June 6, 2008, and DOE initiated a drum retrieval action, which resulted in the retrieval of the drum in question on June 12, 2008. This drum was then returned to LANL, where it arrived on June 13, 2008. As with the retrieval of the INL drum discussed above, this retrieval was also completed with no health or safety incidents to either workers or the public.

III. SUMMARY OF FINDINGS

The technical background of the potential H&S impacts associated with removal of TRU waste containers from WIPP are discussed in the following two sections: *Health and Safety Issues Associated with Retrieval of TRU Waste Containers* and *Health and Safety Issues Associated with Leaving Non-Compliant Containers in Place*. Further, each section evaluates H&S issues for both the CH and RH TRU waste containers.

1. Health and safety issues associated with retrieval of TRU waste containers. The H&S issues associated with the proposed retrieval of non-compliant TRU containers from the WIPP included the following:

- Issues related to the deformation of the repository as a result of salt creep since closure

- Opening of closed panels
- Removal of waste containers and MgO
- Potential for release of radiation or other airborne contaminants
- Ventilation issues related to retrieval
- Storage of containers emplaced in front of non-compliant containers
- Reuse of panels after container removal
- Reloading of the containers into the shipping casks
- Transportation impacts
- Impacts on other generator sites

1.a. Issues related to the deformation of the repository as a result of salt creep since closure. This is the most important issue with respect to potential H&S impacts associated with retrieval of emplaced TRU waste containers, either CH or RH. The Salado Formation was chosen for WIPP in part because the salt beds that comprise the formation will deform or creep over time, thereby tightly encapsulating the waste containers.

The salt creep causes the ceiling, floor and walls of the repository to move inward over time. This results in a decrease of the horizontal and vertical clearance between the stack of CH TRU waste containers, topped with super sacks of MgO, and the ceiling and walls over time. Recognizing this natural phenomenon, in the 2004 Compliance Recertification Application (CRA)[4] , DOE indicated that the typical height of the rooms in the repository was four meters, which was selected so that there would be a nominal five-year life for operational purposes for mining, emplacement, and closure with no risk of CH TRU waste containers breaching. The CRA further states that at a room height of four meters, clearance between the CH TRU waste container stack and the ceiling is typically about 90 to 122 cm (36 - 48 inches), of which about 45 cm (18 inches) will contain MgO. Thus, the open space above the MgO will range from 18 to 30 inches at the time of emplacement. However, the text on page 2-13 of the WIPP Contact Handled Documented Safety Analysis (CH-DSA)[5] states that "the time expected for the roof beam to contact the waste stack in a panel will vary based on the height of a room, the closure rate, and the waste stack configuration . . ." The CH-DSA also indicates that the average room height in panel 3 is 13.5 ft (162 inches) and 16 ft (192 inches) in panel 4 and that the typical waste stack height for three seven packs of 55-gallon drums and a sack of MgO is approximately 130 inches. This information indicates that the clearance between the top of the supersack and the room ceiling would range from 32 inches to 62 inches. Since the CH-DSA is current through August, 2007 this is the clearance range used for the balance of this report. However, there may be some rooms and panels for which the clearance between the supersacks and the ceiling may be only 18 inches.

The WIPP Design Validation Final Report (DVFR)[6] indicates that a minimum clearance of 16 inches must be maintained between the top of the waste container stack (including the supersack) and the room ceiling to ensure proper operation of the ventilation system. This information correlates well with the 18 inch minimum clearance referenced in the CRA. Moreover, in order to safely retrieve a container, a certain clearance must be maintained between the top of the supersacks and the room ceiling to enable forklifts to lift and remove the supersacks without breaking them through contact with the room's ceiling. While this clearance could probably be as little as six inches, a reasonable assumption would be that at least 12 inches of clearance between the top of the supersack and the room ceiling would be required to safely retrieve a container. Using the clearance stated in the DSA, this assumption means that a vertical closure of from 20 to 50 inches would still allow supersacks to be removed safely with respect to clearance.

Based on the WIPP Geotechnical Analysis Report for 2006-2007,[7] the average reduction in vertical clearance (ceiling drop and floor rise combined) is about 6 inches per year, with measured rates having ranged from about 4 to 7.7 inches across the repository. (The DVFR assumed a one-foot vertical and 9-inch horizontal rate per year.) Using the highest rate of closure and the smallest excess clearance between the top of the supersacks and the panel ceilings, there would be a period of at least three years following emplacement during which the supersacks, which would have to be removed before any payload containers could be extracted, could be moved without increased risk of hitting the ceiling. However, using the average annual vertical closure rates, it is highly likely that after a period of 5⅓ years, there would be no clearance between some of the waste container stacks and the ceiling. In fact, the salt formation may actually be compressing the stacks by that time.

In determining whether a non-compliant container of CH TRU waste should be retrieved, the importance of salt creep is apparent when comparing the two most recent incidents involving the non conforming containers of CH TRU waste that were shipped to the WIPP. The non-compliant CH TRU container from the INL had only been emplaced in Panel 4 for about three weeks before DOE realized it was non-compliant. Panel 4 was still actively in use for TRU waste emplacement at the time the mistake was realized and reported to the NMED. Given the short time period between emplacement and discovery of non-conformance, there had been no significant salt creep in that panel; therefore, the stacks of TRU waste containers and the MgO supersacks positioned in front of the non-compliant CH TRU container could be removed without concern about clearance. Essentially, there was the same clearance above the stacks at the time of retrieval as there had been at the time of emplacement. Also, because Panel 4 was still open and active, an ongoing geotechnical stability inspection program ensured there would be minimal danger of part of the ceiling falling onto the workers.

In contrast, the WIPP Geotechnical Analysis Report indicates that the mining of Panel 3 started in May 2002 and was completed by March 2004. WTS began to emplace CH TRU waste in Panel 3 in May 2005. Based on data provided at the 92nd through the 97th quarterly information exchange meetings between DOE and NMED, it appears that the 121 CH TRU containers would have been placed in Rooms 5, 6 or 7 of Panel 3—since those were filled between May 2005 and March 2006. As shown in *Figure 1* below, these are the rooms of the panel that are furthest from the access drift and are the first rooms filled. .

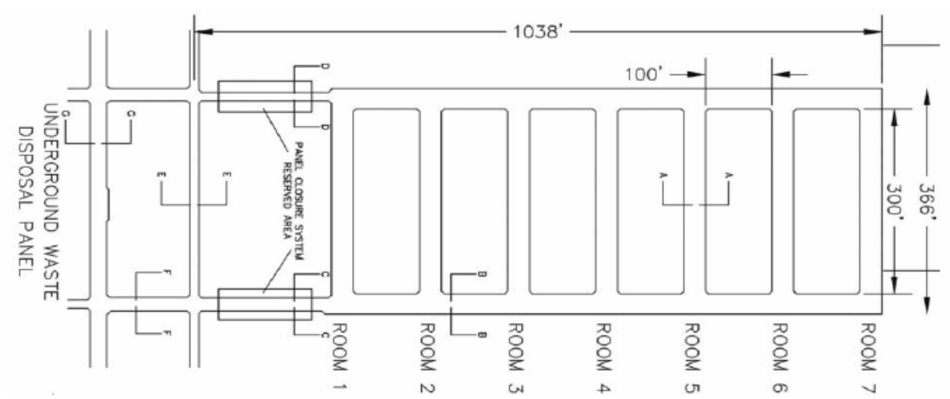

Figure 1. Typical Panel and Room Layout for WIPP (copied from HWFP).

Based upon these dates, it appears that between 19 and 27 months had elapsed between the time that the 121 CH TRU containers were emplaced in Panel 3 and the ACO was issued. Using the average annual reduction in vertical clearance of 6 inches per year and the average initial clearance of 32 inches (162 inches of room height minus 130 inches of height for waste container stack plus supersack) for Panel 3 as stated in the CH-DSA, this means the space between the top of the MgO sacks and the ceiling of Rooms 5, 6, and 7 had been reduced to between 22 inches and 18 inches by November, 2007. Beyond that, the salt creep would have decreased the height of the access ways (S2750 and S3080) by the same amount (if not more), since they were mined out by March 2004. While it would appear there should have been sufficient clearance to enable removal of the 121 CH TRU containers, the possibility of roof falls had to be considered. Per the CRA, ground control measures (roof bolts) installed in Panels 1 through 4 are effective, as there has been no roof fall in the active disposal panels; and to date, no known roof falls have occurred in closed panels. Roof bolts, however, do fail and are expected to fail. For Panels 3 and 4, it is expected that 50 percent of the installed bolts will have failed within 10 years. Since the ceiling of Panel 3 had not been inspected for approximately two years, there was a greater possibility for roof falls if it were reopened, which would have been a major health and safety risk to the workers and would have impeded progress toward removal of both the containers that were in front of the 121 CH TRU containers as well as the 121 CH TRU containers themselves. An extensive and continuous roof inspection would have been required to occur in concert with waste removal.

The impact of salt creep (deformation) on the potential to remove RH TRU waste containers is even greater, since there no more than two inches between the salt and the top of the RH TRU waste container once it is emplaced in the borehole. While the creep rate is expected to be less, based upon the configuration of the borehole, it is estimated it would close the boreholes to the point that retrieval would be physically impossible within no more than a year following emplacement of the RH TRU waste containers therein.

1.b. **Opening of closed panels.** Panels 1 and 2 have been closed by installation of a concrete block wall that serves as an explosion barrier; therefore, if any non-compliant containers were found to be present in either of those two panels, there would be ample protection in place to negate consideration of retrieval. Closure of the remaining panels is currently being completed through installation of a bulkhead pending a determination as to whether a more substantial closure system will be necessary. Because of salt creep, the bulkhead will be essentially embedded in the walls, ceilings, and floors within a few months following its installation. As a result, removal of that bulkhead would involve the initial removal of enough salt from around the periphery of the bulkhead to allow the bulkhead to be safely removed without causing a rock fall. Additionally, dismantlement of the bulkhead would introduce the possibility of worker injuries resulting from falling or dropped pieces of the bulkhead or from the use of required construction equipment, such as cutting torches. In addition, dismantling the bulkhead would oblige workers to receive additional training regarding dismantlement procedures.

1.c. **Removal of waste containers and magnesium oxide.** There is an increase in the risk of an accident or spill when CH TRU waste containers are "unstacked" as compared to when they are "stacked." First the MgO supersacks, which weigh about a ton, that have been placed on the top portion of the stack are pulled toward the forklift operator during unstacking (as opposed to being pushed away from the worker during stacking), and the operator's view of the top portion of the supersack during the unstacking operation is limited. This could easily result in a breach of the supersack through contact with the roof bolts in the ceiling. An additional concern is that when the supersack or containers are being pulled off the stack by the forklift operator, the entire column may topple since it is less stable than when the materials are pushed into the existing waste emplacement face. Also, the slip-sheets that have been placed under the supersacks were not designed for removal and may fail when those supersacks are removed. If this were to happen, the supersack would rupture and spill MgO, causing a consequent H&S concern regarding air contamination. (This concern was negated during retrieval of the INL container because the supersack and the top stack of payload containers were removed as a unit.) Another increased risk associated with the removal of waste container stacks is that they will be dropped or will topple over, which would damage and possibly breach those containers. Finally, removal of both the supersacks and the waste container stacks would require forklifts to drive in reverse while carrying bulky loads which would limit the operator's field of vision. H&S statistics[(8)] show that loaded forklifts have a high number of accidents, particularly when traveling in reverse, due to the reduced field of vision. DOE Operating Experience Summaries[(9)] also details numerous incidents of forklift accidents at DOE facilities including an incident at the INL Advanced Mixed Waste Treatment Facility in May 2004 when an operations technician accidentally punctured a waste drum with one of the tines of his forklift while maneuvering to pick up the drum. Further demonstrating the validity of this risk, in August 2008, an accident reported at the WIPP[(10)] involved forklifts that were being used to emplace TRU waste containers underground in a situation with better visibility than would be realized if containers were being removed.

The above risks were recognized and included in the retrieval plans for the SWB from INL, where 36 rows of supersacks and waste container stacks were removed without incident.[(11)] However, the magnitude of retrieval operations with respect to the 121 containers would be substantially greater due to the significantly increased number of rows that would have to be removed. If, as assumed, the 121 containers are located somewhere in Rooms 5, 6, and 7 of Panel 3, it would be necessary to first remove between 140 and 200 rows of triple-stacked containers as well as the MgO sacks from at least one access way and probably from an area partway into one or more of the rooms. Since, as discussed above, there would be reduced working space between the top of the MgO sacks and the ceiling in Panel 3, removal of those rows would require extreme caution, even more than was exercised when the errant INL container was retrieved from Panel 4, to prevent MgO sacks either bursting or slipping off of the forklifts and/or the waste stacks from toppling towards the forklifts. Further, if the ceiling did prove to be too close to or was actually found to be pressing onto the MgO sacks, it would probably be necessary to puncture the sacks and remove their contents. Depending upon methods employed, if the MgO sacks had to be punctured that would raise the likelihood of increased airborne dust levels in the mine, which could result in required respiratory protection devices for the workers. Such conditions would not only slow down the work pace; it would raise H&S concerns regarding vision restrictions that are attendant with wearing respiratory protection.

The original plans for emplacement of RH TRU waste at the WIPP included an option/ability to retrieve those containers; hence the name of the key equipment used at the WIPP, horizontal emplacement and retrieval equipment (HERE). However, once installation of a six-foot-long concrete plug in the boreholes was included in the operational process, DOE and the regulators essentially accepted the fact that no RH TRU waste containers will be retrieved. It appears that in addition to the difficulty of removing both the plug and the containers, they recognized that the potential H&S impact of any container breach resulting from the presence and consequent effects of prohibited items would be well contained by the plug.

1.d. Potential for release of radiation or other airborne contaminants. If more than three years pass from the time of a container's emplacement to the time of its retrieval, it is possible the salt creep by that time would have put enough pressure on the emplaced container to result in a loss of integrity—a rupture of the container. Also, when waste container stacks undergo a removal process, those stacks could be dropped and/or breached. Should containers lose integrity, there could be a release of radioactivity or other airborne contaminants. Therefore, the provision of real-time radiation monitoring comparable to that provided in the Waste Handling Building (WHB) would be necessary to protect workers from such a release. Radiation monitoring would have to be performed from the start of the removal operation (i.e. removal of the closure bulkhead) until the container(s) in question had been removed. Should any measurements of radiation indicate that a waste container had lost integrity, the entire removal process from that point forward would have to be accomplished while adhering to the radiation protection requirements for contaminated areas. In addition, this scenario would entail the need for special overpacks for the ruptured container(s), as well as additional training and monitoring related to re-packaging TRU waste.

In addition to the possible loss of integrity from salt creep, TRU waste containers might also undergo structural failure resulting from corrosion generated by their contents—particularly if the container's non-compliance issue involved the presence of free liquids measuring in excess of one percent by volume. In such a case, the free liquids could react with the contents of other waste containers in the same stack (payload position) or in nearby stacks that had also suffered a loss of integrity. This reaction could result in release of hazardous gases or liquids, which would be harmful to workers who are not properly protected. Consequently, additional monitoring precautions would have to be implemented and plans made to establish protective measures should any such releases be identified.

1.e. Ventilation issues. If the panel containing the non-compliant containers has been closed, retrieval operations will most probably entail opening only one of two access ways, an approach that would effectively eliminate the option of using cross-flow or circular ventilation as employed during waste emplacement. As a result, retrieval operations would require fans to provide air changes at the point of container removal and the possible addition of flow tubes or other directional devices to ensure the permit's ventilation requirements are met. While this would essentially be the same type of ventilation system used to mine the panel, the H&S risk would be greater during the retrieval process since the air would be directed at the relatively porous surface comprised of containers. As a result there would be the possibility that contaminants that had been released deeper in the panel might be transported to the front due to turbulent conditions among the containers. Therefore, it may be necessary for workers to wear respiratory protection devices. Further, if a retrieval operation involves re-activating a waste panel, the WIPP mine ventilation system may not be able to supply the additional volume of air necessary to maintain the required airflow for that panel without the shutdown of other underground operations.

1.f Storage of containers removed from in front of non-compliant container(s). When containers located in front of non-compliant containers are moved, H&S concerns associated with that removal vary from minimal if the panel is still open and partially empty to serious, if the panel has already been closed. Regardless of where these containers are moved, risks for accidents increase as forklifts retrieve and relocate them since forklift accidents are among the more frequent and serious types of accidents reported by the DOE. If a panel containing non-compliant containers is open, it should be possible to store the containers located in front of the non-compliant ones in empty rooms in the same panel. This activity would still require an adjustment of the ventilation system in order to maintain the required airflow in the active work areas, that is the room where the removed containers would be stored as well as the room from which the non-compliant container(s) would have to be retrieved. There would be increased risk of worker exposure if any of the containers were to vent airborne contaminants; because while normal operations isolate emplaced containers from the airflow, the ventilation air for removal and retrieval operations would flow past/through the stacks of TRU waste containers. If the panel containing non-compliant containers is closed, or if it is nearly filled, and the containers in question are located toward the back of that panel, there may be an H&S concern regarding where to temporarily store the containers that must be moved in order to access the non-compliant container(s). If there is insufficient room in the main drifts or in front of the closed panels to store the containers that have to be moved in order to retrieve non-compliant drum(s), it may be necessary to mine out a room in an active panel prematurely, with the attendant H&S risks associated with mining..

1.g **Reuse of panels after container retrieval.** Depending upon the amount of creep closure that has occurred in a panel, it may be necessary to excavate additional salt in order to restack containers and supersacks in the panel. Mining activities would introduce additional H&S risks, particularly since the panel would have been previously mined. A more significant H&S concern would involve a panel that had been emptied in order to retrieve non-compliant containers, which not be reused. This situation could have one of two results: 1) either a reduction in the amount of TRU waste that could be disposed at the WIPP, which would result in increased environmental H&S risks at the generator sites; or 2) expanded mining efforts to develop additional space to accommodate those containers that would have to be removed. Again, this would result in increased worker H&S risks associated with unplanned mining activities.

1.h **Reloading impacts.** H&S risks associated with repackaging non-conforming containers are greater than those associated with removal of TRU waste containers from shipping casks since loading non-compliant TRU waste containers back into shipping casks would require more precision and accuracy and, in fact, takes substantially more steps than does the process of removing them from shipping casks[(12)]. Additionally, since reloading is not a common practice for WIPP personnel, there would be a logical tendency to perform the operation more slowly than the unloading operation. Consequently, the reloading process would take more time, which naturally means that the risk of an accident during reloading is greater than during unloading.

1.i. **Transportation impacts.** Since the WIPP is not permitted to conduct any form of waste repackaging or treatment onsite other than that related to prevention or control of leaks or spills from damaged containers, any retrieved containers would have to be returned to the generator site. That return would have the same risk of accidents as the initial transport of the non-conforming container(s) to WIPP. Associated H&S risks would range from collision-caused injuries to the release of radionuclides. The frequency and magnitude of these risks are the same as those estimated in the WIPP Environmental Impact Statement for the transport of TRU waste from the generator sites to WIPP.

1.j. **Impacts on other generator sites.** The fundamental benefit of the WIPP is a reduction in the risk of a radioactive materials release to the uncontrolled environment. Essentially, it was recognized that storage of TRU waste in above-ground or near-surface facilities was not as safe as storage in a geologic repository such as the Salado Formation. Therefore, whenever there is a delay in the shipping schedule for TRU waste, there is increased potential for a release of radioactive materials at the generator sites. Though the risk is small, it must be factored into the decision regarding removal of non-compliant TRU waste containers from the WIPP. Essentially, the longer the WIPP must postpone TRU waste disposal in order to retrieve non-compliant containers, the greater the risk a natural disaster or man-caused accident will result in a release of radioactivity.

2. Health and safety impacts associated with leaving non-compliant containers in place: The H&S impacts associated with leaving non-compliant containers in place include those issues relating to the operating period as well as those relating to long-term post site closure.

- H&S issues related to leaving the containers in place during the operating period are almost entirely related to the potential for container failure, consequent reactions of free liquids with other wastes, and possible escape of volatile organic compounds or radioactive waste to an operating area
- H&S issues related to post site closure include any contribution to those factors evaluated by the performance assessments

Further, H&S issues associated with leaving non-compliant TRU waste containers in place primarily depend upon the reasons for non-compliance, which include:

- Presence of prohibited items
- Excess radioactivity
- Excess concentrations of radionuclides
- Other

Prohibited items include quantities of liquids in excess of the amounts allowed; pressurized containers; sealed containers greater than four liters in volume; certain forms or quantities of polychlorinated biphenyls, etc. Excess radioactivity equates to the amount of curies in a TRU waste container, while excess concentrations of radionuclides equates to the amount of plutonium in the container as well as selected other radionuclides and some associated elements or compounds such as beryllium or beryllium oxide.

The H&S concerns associated with non-compliant TRU waste containers are subdivided into two categories: pre-closure and post-closure. Pre-closure concerns are all essentially associated with CH TRU waste containers, since RH TRU waste containers are effectively isolated from the active workings by the six-foot concrete plug used to close the borehole after the RH TRU waste container is emplaced.

2.a. Pre-closure health and safety concerns: During the pre-closure (waste emplacement) stage of the WIPP, H&S concerns concerning non-compliant TRU waste containers are primarily associated with potential releases of hazardous or radioactive constituents and the resultant exposure to the underground workforce. The largest risk to the workforce would be caused by excessive (over one percent by volume) amounts of liquids in a TRU waste container, which would either evaporate into hazardous volatile organic gases (such as toluene or trichloroethane) or react with the container and/or contents, producing an explosive mixture or a release of radioactivity. This risk is discussed in detail in the DOE response to NMED regarding the non-compliant drum from INL.(13) A similar concern involves the presence of any pyrophoric materials in the TRU waste container, such as phosphorus, which would either ignite the waste or react with any water in the waste to produce a toxic gas that would vent to the underground atmosphere. The WIPP is equipped with monitoring stations that would detect a release of radioactivity or volatile organic gases or a buildup of flammable/explosive gases (such as methane); however, the location and response time of these devices would not prevent worker exposure to those releases. Therefore, if there is reason to suspect that liquid in a non-compliant TRU waste container is either toxic, ignitable, reactive or corrosive (by EPA definitions), there is definitely an increased risk to the workforce associated with leaving the container in the repository, which may offset risks associated with container retrieval, as discussed above.

Quantities (curies) of radioactive materials in excess of what is allowed would most likely not present any health or safety concerns to the underground workforce, since it is unlikely any CH TRU waste containers with higher-than-allowable surface dose rates would slip past the monitoring performed at the WIPP when shipping containers are opened. Similarly, there is an ample safety factor built into the operating procedures for WIPP that would circumvent any H&S concerns with respect to criticality or heat generation from non-compliant containers.

There is a risk that pressurized containers in the TRU waste container could explode due to changes in conditions after emplacement. Such explosions could cause TRU waste container failure and consequently release radionuclides into the underground atmosphere. However, this is a small risk since neither the temperature nor the pressure within the TRU waste container are expected to change significantly until after panel closure.

2.b. Post-closure health and safety concerns. With respect to post-closure, the only H&S concern would involve a non-compliant TRU waste container containing enough non-allowed materials to cause a greater release of radioactivity after closure. Given the conservatism of the performance assessment for WIPP, it would take a substantial number of non-compliant containers containing much greater-than-allowed quantities of liquids, chemicals, or radionuclides to cause a violation of the EPA long-term, post-closure standards. This is essentially confirmed by the technical justification DOE provided to the NMED in March 2008(14) that was related to the decision to leave the 121 potentially non-compliant TRU waste containers in place. In that justification, DOE made the point that even if all 121 drums were full of liquid, and if all of that liquid were to be released, there would still be less than the amount necessary to form a leachate which would transport contaminants. The DOE also made the point that even if the containers were full of liquid, that amount would still be less than one percent of the amount allowed by EPA and therefore, would have no effect on the performance assessment.

IV. CONCLUSION

It appears there would be no major H&S concerns related to waste container breach and release of radiation if waste containers from the WIPP are retrieved up to approximately three years following their emplacement. However, the sum of all increased H&S risks associated with a major retrieval action are probably greater than risks associated with leaving non-compliant TRU waste containers in place.

V. RECOMMENDATIONS

In order to minimize any H&S impacts associated with emplacement of non-compliant TRU waste containers (potential or actual), DOE should establish the procedures and systems necessary to allow the containers in question to be immediately isolated in the underground disposal system, enabling their safe removal, if necessary. In essence, DOE should cease the practice of emplacing additional TRU waste container stacks and supersacks in front of the TRU waste containers in question, and it should maintain an access way to the room/panel in which the containers in question are emplaced in order to facilitate retrieval if necessary.

In addition, DOE should establish a standard risk assessment process, acceptable to the regulatory agencies, to be used to expeditiously determine what, if any, elevated risk would be posed to the workers, public, and environment if non-compliant containers were left in place. DOE should then compare findings of any such elevated risk to any elevated risk presented by the retrieval and return of non-compliant containers to the generator sites.

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