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AN EVALUATION OF THE HEALTH AND SAFETY RISKS RESULTING FROM REPACKAGING TRU WASTE FOR DISPOSAL IN WIPP

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PECOS MANAGEMENT SERVICES, INC.

ISO-2 Project
Carlsbad, NM

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ACRONYMS

ACO	Administrative Consent Order
ALARA	As Low As Reasonably Achievable
ASER	Annual site environmental report
CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CH	Contact Handled
CO_2	Carbon Dioxide
DOE	Department of Energy
DOT	Department of Transportation
Dpm	disintegrations per minute
EHS	Environmental, health, and safety
EPA	Environmental Protection Agency
HLW	high level waste
HWFP	Hazardous Waste Facility Permit
INL	Idaho National Laboratory
LANL	Los Alamos National Laboratory
LWA	Land Withdrawal Act
NMED	New Mexico Environment Department
NRC	Nuclear Regulatory Commission
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated bi-phenols
PECOS	PECOS Management Services, Inc.
RCRA	Resource Conservation and Recovery Act
SAR	Safety Analysis Report
SARP	Safety Analysis Report for Packaging
SEIS-II	Final Supplemental Environmental Impact Statement
SRS	Savannah River Site
SWB	Standard Waste Box
TRU	Transuranic
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WTS	Washington TRU Solutions, LLC

AN EVALUATION OF THE HEALTH AND SAFETY RISKS RESULTING FROM REPACKAGING TRU WASTE FOR DISPOSAL AT WIPP

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I. PURPOSE AND SCOPE

The purpose of this report is to review of health and safety risks resulting from repackaging transuranic (TRU) waste to be disposed at the Waste Isolation Pilot Plant (WIPP) and to present the findings of PECOS Management Services, Inc. (PECOS). Additionally, this report offers a comparison of those risks to the environmental, health, and safety (EHS) risks associated with disposal of prohibited items in the WIPP.

The scope of the review included evaluation of the enabling legislation for the WIPP: the current Hazardous Waste Facility Permit (HWFP) issued by the New Mexico Environment Department (NMED); the earlier draft HWFP issued by the NMED for the WIPP test phase, regulations implementing the Resource Conservation and Recovery Act (RCRA); Nuclear Regulatory Commission (NRC) regulations; various versions of the waste acceptance criteria (WAC) for the WIPP; certification application to the Environmental Protection Agency (EPA) and associated approval documents, and documents related to transportation of TRU wastes. These documentation reviews were supplemented by several discussions concerning the history of prohibitions with WIPP personnel as well as a survey of the DOE Occurrence Reporting and Processing System (ORPS).

II. BACKGROUND

WIPP, located near Carlsbad, New Mexico, is a repository for the disposal of TRU radioactive waste resulting from the Department of Defense weapons production activities and associated research. Disposal facilities for WIPP are located 2,150 feet below the surface in the Salado Formation, a 250-million-year-old, geologically stable salt deposit. TRU waste is characterized

and containerized at several DOE facilities, shipped to WIPP, inspected, and transported underground for permanent emplacement.

A major concern associated with transportation and disposal of any hazardous or mixed waste container, including the TRU waste containers, is the potential risk to anyone who might be exposed to the contents of those containers in instances where contamination may be released; which could occur during routine handling of the containers for characterization, loading, unloading, and disposal activities, or during transportation, or as a result of an accident.

There is an essential concern that if waste contents from a TRU waste container were to cause a container to breach, a worker or a member of the public could be harmed, and/or contaminants would be released into the environment. Causation scenarios include reactions with the other waste contents or with container materials, as well as failure of a pressurized internal container, which could cause a pressure increase in the payload container, bursting the seals.

In response to these concerns, certain items and materials with the potential to cause such reactions have been identified and are prohibited from inclusion in TRU waste payload containers (containers placed in approved shipping casks for transport to WIPP and then emplaced at WIPP without change in configuration). Prohibited items include pressurized containers and sealed containers exceeding a certain volume. Prohibited materials include liquids of any kind as well as specific contaminants, such as liquid poly-chlorinated biphenyls (PCBs). Any TRU waste payload container found to contain prohibited items or materials must be remediated before it can be disposed in WIPP. Remediation involves opening the container, removing the contents from the container, removing or neutralizing prohibited items, and repackaging the waste in a container approved for disposal at WIPP. Inherent to these remediation activities is the risk to the workers who unpack, remediate, and repack the non-compliant waste containers. This report addresses only the health and safety issues associated with the presence of liquids above prescribed limits in the TRU waste containers.

There are two distinct considerations regarding EHS risks associated with prohibited items in TRU waste containers that are candidates for disposal at WIPP: 1) the risk of exposing workers and the public to hazardous substances during characterization, transportation and disposal of

TRU waste containers and 2) long-term risks associated with possible releases post-closure. Safeguarding workers and the public during the operational life of the WIPP is achieved through compliance with EPA certification requirements that address radioactivity and non-RCRA-regulated contaminants such as PCBs, and compliance with the HWFP requirements relating to the disposal of mixed waste, the NRC shipping container licenses, and Department of Transportation (DOT) rules regarding transportation of radioactive or mixed waste). Post-closure protection of the public and environment is also ensured through compliance with EPA certification requirements. DOE orders that incorporate health and safety requirements established by the EPA, the NRC, and the Occupational Safety and Health Administration (OSHA) directly address the protection of workers and the public during characterization and treatment of TRU waste as it is prepared for disposal at WIPP. The basic principle guiding worker protection standards maintains that exposure to ionizing radiation be kept as low as reasonably achievable (ALARA). In 10 CFR 835[1] Section 835.2, ALARA is defined as:

> ALARA means ``As Low As is Reasonably Achievable," which is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits of this part as is reasonably achievable.

Additionally, Section 835.101(c) requires the Radiation Protection Program for DOE activities to include formal plans and measures for applying the ALARA process to occupational exposure.

Potential environmental, health, and safety issues associated with liquids in TRU waste containers shipped to WIPP were publicly addressed in the *Final Environmental Impact Statement for the Waste Isolation Plant*, issued in 1980,[2] which indicated that free liquids were prohibited in waste containers. This position was clarified in the *Final Supplement Environmental Impact Statement (SEIS-II)*[3] *for the Waste Isolation Plant*, issued in 1997, which specified that the liquid content of waste was to be limited to one percent of the TRU waste container volume, and that minor liquid residues in drained containers located within the main TRU waste container were allowable. However, the SEIS-II did not include a risk analysis of the

possible exposure to workers during repackaging as an accident event for waste treatment at the generator sites. Basically, there was no discussion as to whether the application of the liquid limits and the resultant requirement to repackage or treat TRU waste containers already in storage was in conformance with the ALARA principle, which maintains there be no exposure to radiation (by workers or public) without commensurate benefit.

The Land Withdrawal Act (LWA)[4] was signed into law in 1992. This law provided a comprehensive environmental regulatory scheme for the operational and disposal phase of WIPP, and requires DOE to do the following:

1. Abide by the EPA compliance criteria for disposal of TRU waste at WIPP, and
2. Obtain a state permit under RCRA prior to management, storage, or disposal of radioactive mixed waste at WIPP.

The DOE submitted a compliance certification application (CCA)[5] to EPA in 1996 and received the certification that WIPP would meet EPA standards in May 1998. Part B of the HWFP permit application for disposal of mixed TRU waste was submitted to the NMED in 1997, and the HWFP[6] was issued October 1999.

Additional regulatory drivers for any restrictions on the contents of TRU waste containers include applicable NRC or DOT requirements. The NRC licenses shipping containers used to transport TRU waste to WIPP, and the DOT regulates transport of hazardous materials on public roads.

III. SUMMARY OF FINDINGS

The establishment of laws and regulations regarding transport, treatment, storage, and disposal of radioactive, hazardous, and mixed waste came about during the 1940s and continued through the 1970s; these laws and regulations evolved from the recognition that both immediate and long-term EHS problems associated with the disposal of hazardous and radioactive waste must be prevented. Major EHS problems were associated with the disposal of radioactive and hazardous waste in shallow landfills, tailings or waste piles, surface impoundments, and injection wells, resulting predominately in soil contamination, surface and groundwater contamination, and airborne transport of hazardous and radioactive constituents of the waste.

The NRC was given the responsibility to regulate disposal of radioactive waste as a part of its charter when it was formed in 1974. Similarly, regulation of the disposal of hazardous wastes became the responsibility of the EPA when RCRA was passed in 1976. Both agencies developed and implemented a set of regulations designed to prevent air, water, and/or soil pollution from the respective waste types, and they placed primary emphasis (with respect to disposal) on surface or near-surface disposal facilities. In fact, RCRA went so far as to prohibit the disposal of any hazardous waste in salt formations, such as the Salado Formation that houses the WIPP repository (RCRA was amended in 1984 to allow disposal in salt formations if EPA issued the appropriate permit).

The essence of the regulations that concentrated on allowable contents of radioactive or hazardous waste containers centered on the prevention of any type of physical, chemical, biological, or radiological reaction that would result in the breach of a waste container and the release of contaminants during any phases associated with waste: transportation, storage, treatment, or disposal. As a result, the regulating agencies, concerned both about reactions and transport of contaminants if a waste container were to be breached, focused on minimizing the quantity of free liquid in the waste containers. In addition, pressurized containers within waste containers were prohibited; such containers (aerosol cans) could hold enough liquid and could be under enough pressure to cause a waste container breach if that pressurized container failed. However, as with SEIS-II for WIPP, there was no indication that the ALARA principle or the

increased risk to exposure to radiation inherently associated with the waste treatment or repackaging efforts necessary to minimize/eliminate excess liquids from waste containers was considered in the development of these regulations.

The NRC established the limit placed on the volume of liquid in radioactive waste containers in 1982 as a federal regulation (10 CFR 61).[7] Part 61.56 of the regulation determined that this limit was not to exceed one percent of the volume of the container. Similarly, 10 CFR 60, Part135(a)(2)[8] established the following criteria for geologic repositories for high-level waste (HLW):

> *Free liquids.* The waste package shall not contain free liquids in an amount that could compromise the ability of the waste packages to achieve the performance objectives relating to containment of HLW (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure.

EPA promulgated a general prohibition on liquids in hazardous waste containers under RCRA in 40 CFR 264,[9] but did not provide a specific quantifiable measure. The EPA requirements instituted for WIPP in 40 CFR 194[10] specified that waste components that influence waste characteristics be identified and analyzed for impact on disposal system performance. It has been postulated that the presence of water and other liquids in the TRU waste could result in an increased concentration of radioactive elements in the liquid through either direct dissolution of the radioactive compounds or the production of gas (primarily, carbon dioxide, CO_2) from the waste, which would decrease the pH of the liquid and hence, increase the solubility of radioactive compounds. As a result, DOE was required to determine a limiting value for the amount of allowable liquid in waste stored at the WIPP as a part of the assessment of the long-term (10,000-year) performance of the WIPP relative to the EPA release standards that were established in 40 CFR 191[11] for the WIPP.

In Chapter 4 of the CCA, DOE stated that limits on the amount of liquid allowed in a TRU waste container were founded on the following: transportation requirements; the Safety Analysis Report for Packaging (SARP); disposal operations safety criteria as documented in the Safety Analysis Report (SAR) (DOE 1995d) for the repository; and regulatory compliance

requirements. Those requirements, included in the April 1996 version of the *Waste Acceptance Criteria (WAC) for WIPP*[12] stated that the total liquid volume (i.e., the sum of all internal or payload container volumes) could not exceed two liters in a 55-gallon drum or eight liters in a standard waste box (SWB), amounts that equaled approximately one percent of the volume of the containers, which was the NRC-established limit for radioactive waste shipments.

The CCA stated that those restrictions were not a result of the performance assessment. Further, the DOE assumed that the presence of Portland Cement and other sorbents, when intentionally added to the waste, would absorb any free-standing water. Therefore, the effect of water and other liquids in the waste itself were assumed to be negligible and were not considered an issue in repository performance.

For the performance assessment, DOE analyzed potential reactions of water and other liquids with the waste, the waste containers, and associated emplacement materials expected to be present in the WIPP. DOE then determined that hydrogen, methane, and carbon dioxide were the major gases of concern. Further analysis, as presented in the CCA, indicated that the only gas that would affect repository chemistry was the carbon dioxide, which would dissolve in brine and create an acidic condition, greatly increasing the solubility of actinides. Based on these concerns, and strictly for purposes of the performance assessment, DOE set the maximum restriction for "free water" emplaced with waste at 1,684 cubic meters, which is one percent of the contact-handled (CH) TRU design basis of the repository (168,485 cubic meters).

In its May 18, 1998, certification decision, the EPA found that WIPP was in compliance with the radioactive waste disposal regulations set forth in Subparts B and C of 40 CFR 191. While the certification decision did not specifically identify any liquid limits for WIPP, the one percent limit of liquids in the TRU payload containers proposed by DOE in its CCA submission became the rule; it was part of the whole CCA and thus part of the certification decision.

The one percent limit of liquid in payload containers was also carried over into the DOE's application for an HWFP. It was specifically mentioned in the *Draft No-Migration Variance Petition* dated May 31, 1995,[13] which stated that for TRU waste storage sites that cannot repackage waste, the DOE will allow shipment of residual liquids as long as such liquids did not

exceed one percent of the container volume. Further, the one percent liquid limit for a payload container was included in the August 1993 draft HWFP submittal by DOE[14] to the NMED. While evolution of the one percent limit of volume of liquids in waste containers appears to be primarily derived from NRC requirements and long-term performance of the WIPP after closure, the origin of the limitations on liquids in internal containers is not as clear. NRC regulations do not address the issue of liquid limits for internal containers; they simply limit liquid to one per cent of the volume of the waste container.

While RCRA regulations generally prohibit free liquids in waste containers, they allow liquids in internal containers under certain qualitative conditions. For example, 40 CFR 264.17 states that the owner or operator of a facility that treats, stores or disposes ignitable or reactive waste must take precautions to prevent reactions that produce uncontrolled flammable fumes or gases in sufficient quantities to pose a risk of fire or explosions. Further, 40 CFR 264.314 outlines requirements for the disposal of containerized liquids and specifically prohibits containers holding free liquids unless all free-standing liquid has been:

- Removed by decanting, or other methods
- Mixed with sorbent or solidified so free-standing liquid is no longer observed
- Otherwise eliminated

40 CFR 264.316 does allow the disposal of liquid in small containers in over-packed drums as long as there is a sufficient quantity of sorbent material to completely absorb all of the liquid contents of the inside container. Additional pertinent requirements related to transportation are stated in 49 CFR 173.12(b)[15] which states that any inner packages must be either glass (not exceeding 4-liter [1 gallon] rated capacity), or metal or plastic (not exceeding 20-liter [5.3 gallons] rated capacity). It also states that inner packages containing liquid must be surrounded by enough chemically compatible absorbent material to absorb the total liquid contents. Another pertinent requirement is contained in 40 CFR 261.7(b)(1), which limits the amount of wastes in empty containers to no more than 2.5 centimeters (1 inch) of material (in the bottom) or to no more than three percent of the weight of the container for containers with a capacity of 119 gallons or less. For a 55-gallon drum, which weighs 50-60 pounds, three percent equals 1.5 to 1.8 pounds. For water, that would be an equivalent volume of about 0.2 gallons—about 1.5 pints,

or three cups of liquid. Thus, three percent liquid residue in an empty 55-gallon drum equals about 0.36 percent by volume—much less than the one percent limit on liquids in containers allowed by the HWFP. For comparison, one inch of liquid in a 4-liter jug is about 1.5 cups of liquid; much less than allowed in an empty container under RCRA.

At the time NRC and the EPA issued their requirements to limit liquids in waste containers, the only waste disposal operations available for either radioactive or hazardous wastes were shallow, near-surface landfills; concern was primarily focused on groundwater pollution. The question as to whether there was a need for such a stringent limitation for the WIPP does not appear to have been considered throughout the research, planning, or approval process conducted for the WIPP. Also, it does not appear that risks associated with repackaging TRU wastes in order to remove excess liquids were evaluated during that time.

The restriction on limits of liquids in internal containers appears to have been discussed as early as 1989, when a revision of the WAC[16] indicated that "minor liquid residues remaining in well-drained bottles, cans, and other containers are acceptable." Attachment II-7 to the draft HWFP Part B application, dated August 1993, refers to the requirement that residual liquids in internal containers shall not exceed a one-volume percent of the internal container. This is the first mention of the liquid limit specifically aimed at internal containers. In contrast, the April 1996 version of the WAC only included a one-volume percent limit on residual liquid for the payload containers. The following was also noted: "It is not the intent of this WAC to require Sites to reject, repackage, or treat TRU waste solely because a small amount of liquid is detected in a payload container. At the same time, it is the Site's responsibility to restrict liquids to the extent possible as it generates new waste." This language infers that DOE did not expect small amounts of liquids in internal containers totaling less than one percent of the volume of the payload container to cause rejection of a payload container.

The first indication of a quantitative limit to liquids in internal containers was found in the draft HWFP[17] issued by the NMED in May, 1998. Module II.C.2.a of the draft permit stated: "Liquid waste is not acceptable at WIPP. Waste shall contain as little residual liquid as is reasonably achievable by pouring, pumping, and/or aspirating, and internal containers shall contain less than 1 inch or 2.5 centimeters of liquid in the bottom of the container. Total residual

liquid in any container may not exceed 1 percent volume of that container." It appears this language was derived from the EPA limit for materials in empty waste containers, though no explanation has been found in accessed documents thus far. The DOE suggested a change, a clarification of the draft HWFP language to make it more apparent that the one percent criterion applied to the payload container and not to the individual internal container. This change was accepted, and the HWFP issued by NMED states in several places that ". . . waste containers shall contain as little residual liquid as is reasonably achievable by pouring, pumping and/or aspirating, and internal containers shall contain less than 1 inch or 2.5 centimeters of liquid in the bottom of the internal container. Total residual liquid in any payload container (e.g., 55-gallon drum, standard waste box, etc.) may not exceed 1 percent volume of that container." This acceptance criterion was included in Revision 6.1 of the WAC[18 issued in 1999)] and remains in force today.

The liquid limits that have been established for both internal and payload containers certainly minimize the risk of exposure to radioactive or hazardous constituents during the transport or disposal of TRU waste. However, according to information received from DOE,[(19)] the liquid limits established for both internal containers and TRU waste payload containers in the HWFP have resulted in the rejection of an average of 30 percent of TRU waste payload containers throughout the DOE complex as candidates for disposal at WIPP. These limits have also resulted in a rejection rate of up to 69 percent for some waste streams, such as aqueous sludge waste. In some instances, rejection of a TRU waste payload container has been due to the presence of minute amounts of liquids in internal containers—amounts that were substantially less that one percent of the volume of the payload container. For example, in 2007, a TRU waste container (55-gallon drum) from the Idaho National Laboratory (INL) was identified for remediation because it contained small amounts of liquid in two internal containers. The volume of liquid in the internal containers totaled about 1/20 of a gallon (0.05 gal). (Note that the one percent liquid limit for a 55-gallon drum is 0.55 gallons). This volume was one-fourth of what would have been allowed in an empty 55-gallon waste drum, and this particular payload container was erroneously shipped to WIPP and emplaced, with no adverse effects (releases) noted during either shipment or emplacement. The NMED required DOE to remove that payload container and return it to INL for repackaging. Removal and return were also executed safely, with no releases of the liquids in question to either the container as a whole or to the environment.

In other instances, TRU waste such as dewatered waste treatment sludge, have failed the check for prohibited items due to the presence of free liquid. In these cases, even though absorbents, such as Portland Cement, have been added to the dewater sludge, unabsorbed water will often separate from the sludge as a result of moving the container or even because of changes in atmospheric pressure or temperature. This free liquid is water, usually at neutral to basic pH, and is minimally reactive with the waste container or the contents. Thus, this type of free liquid poses minimal risk of causing a release during either transportation or emplacement.

There are two relatively recent examples of containers holding waste streams with free liquids exceeding one percent that attest to their low risk factors related to transportation and/or disposal. Firstly, 121 containers of dewatered sludge classified as TRU waste were disposed of at WIPP between August 2005 and February 2006. An NMED review concluded that many of those drums probably contained more than one percent free liquid, which constituted a violation of the HWFP. In November 2007, after extensive discussions, NMED issued an administrative compliance order (ACO) that, in part, required DOE to provide a technical justification that proved leaving the containers in place posed no elevated risk to human health and the environment. The DOE response[(20)] to this part of the ACO consisted of arguments that maintained that excess liquids in the drums in question did not pose any elevated risk to the workers for two reasons: 1) the liquid was water (not a hazardous compound), and 2) any leakage would be absorbed by either the magnesium oxide backfill (assuming the bags had ruptured) or the salt formation itself. Further, DOE argued that the total potential volume of water that might be in the 121 drums, even under worst-case conditions, was still much less than the regulatory limit of liquid that could be contained in waste as established by the EPA with respect to long-term performance standards. The NMED accepted these arguments, and the drums were left in place. (Interestingly, no mention was made of the fact that the panel in which the 121 drums were deposited [Panel 3] had been closed for over a year; and that repository monitoring systems had not found any indication of increase in radiation or hazardous chemical levels.)

In the second instance, a 55-gallon drum of dewatered TRU waste sludge from Los Alamos National Laboratory (LANL) containing approximately one gallon of water was erroneously

placed in an SWB and disposed at the WIPP. Even though the amount of liquid in the drum amounted to less than one percent of the volume of the payload container (the SWB), once the error was discovered, DOE[21] decided to retrieve the SWB and return it to the generator not due to health or safety concerns regarding the drum; but rather, due to the seriousness of the violation of procedure. As with the INL TRU waste container, the LANL container was shipped to WIPP, emplaced, recovered, and shipped back to LANL with no releases.

While the transportation and emplacement of waste containers with liquid volumes in excess of the regulatory limits has not resulted in any releases, it is a fact that the enforcement of the liquid limit for internal containers has resulted in several health and safety incidents. As TRU waste containers are repackaged for purposes of remediating internal containers that contain liquids over the one-inch limit, related incidents have included both injuries and radioactive contamination to workers. For example, at the Savannah River Site (SRS) in 2006, it was reported in the ORPS[22] that an operator received a puncture wound on his left thumb and clothing/skin contamination while repackaging TRU waste. Radiological personnel found 30,000 disintegrations per minute (dpm) of alpha clothing contamination on the operator's surgical gloves, and skin contamination of 10,000 dpm beta-gamma and 6,000 dpm alpha on the operator's punctured left thumb.

In light of the concern for worker exposure, PECOS reviewed a number of the annual site environmental reports (ASER) for those DOE sites generating TRU waste to assess potential worker exposure to radiation. The 2005 ASER[23] for LANL states the following: “The only location with a measurable contribution from LANL operations is near TA-54, Area G.” The document further asserts that “TA-54, Area G, which is a temporary storage area for transuranic waste awaiting shipment to the Waste Isolation Pilot Plant . . . is a controlled-access area, so Area G data are not representative of a potential public dose.” Data associated with Area G, Station #623, east of Building 49 in the first quarter sampling for 2005, revealed a recorded dosage of 365 mR of gamma. A location north of Building 373, Station # 606 was found to consistently have a neutron dosage in excess of 290 mR for 2005 (as well as for previous years. These dosage rates are in sharp contrast to the dose history for workers at WIPP, which are less than 0.1 mrem per year for every year WIPP has been disposing TRU waste.[24] The WIPP dose history was derived from doses received by radiological control technicians and waste handlers,

two positions that typically incur the most interaction with waste during the disposal process. Only about one-third of these personnel received a measurable dose, the majority of which were only slightly above the limit of detection.

Although the WIPP dose history and the LANL report do not have any correlation, they demonstrate the differing risk of worker exposure between handling waste containers that are properly packaged for disposal (WIPP dose history) and operations that involve repackaging and daily management of waste (LANL).

Similarly, A study by Sandia regarding risks associated with remediating TRU waste containers to remove liquid PCBs[(25)] indicated that the risk of exposure to harmful levels of radionuclides in the TRU waste was four to five orders of magnitude greater than the risk of exposure to harmful levels of PCBs in the container.

IV. CONCLUSIONS

Exposure to radiation during remediation of excess liquids in a waste container poses a much greater risk to the workers than simply leaving the liquid in the waste containers. In addition to difficulty of performing the remediation in glove boxes during remediation work, there is added risk to workers involving accidental contamination due to the presence of sharp objects in the TRU waste containers. These risks do not appear to have been fully considered when establishing either the payload or the internal container liquid limits.

The basis for the development of the one percent liquid limit for payload containers destined for disposal in WIPP was concerns about 1) transportation, 2) worker health and safety at WIPP, and 3) potential for releases of radioactivity post closure. However, that limit appears to be overly conservative for the following reasons.

Transportation. It appears that liquid limits for TRU waste containers were derived from requirements established for the transportation of unprotected payload containers and disposal in near-surface landfills. Establishment of the one percent liquid limit in waste containers by the NRC appears to precede the establishment of requirements for separate shipping containers for TRU waste. Hence, the concern during transportation was primarily related to the possibility of the liquids in the waste containers causing a breach of the waste container and the consequent

uncontrolled release to the environment. However, the design of the shipping containers for TRU waste payload containers effectively ensures that should a TRU waste container leak or vent during transportation, there would be no release to the environment and no risk of exposure to workers or the public. Consider the incident in 2005 when a TRU waste payload container that was shipped from INL had a radiation release resulting from improper sealing during transportation to WIPP. The radiation release was contained by the shipping container, and it was detected by standard sampling procedures applied prior to opening the shipping container. Thus, from a health and safety perspective, the addition of the requirement to ship TRU waste payload containers inside separate shipping containers negates the need to limit the amount of liquid in TRU waste containers to no more than one percent of the volume.

Disposal. It is estimated that over 100 TRU waste payload containers containing over one percent free liquid by volume have been disposed of safely at WIPP with no container breaches, spills or leaks. Therefore, it appears that from the perspective of protecting the health and safety of the workers during disposal, the one percent liquid limit is overly conservative. The fact that the NMED did not require that the suspect drums from LANL be removed also indicates that they recognize the EHS risk of leaving the drums in place was less than the risks of accidents or releases if they were to be removed.

Long-term Performance. DOE emphasized in the compliance certification application to EPA that the liquid limit restrictions were not a result of the performance assessment. They have also inferred in their justification for not retrieving the 121 drums that substantially more than one percent liquid in the waste containers would not cause any releases of radiation greater than the EPA standards. The fact that EPA did not act to cause the 121 drums to be removed indicates that agency is not concerned with more than one percent liquid in the payload containers

The limitation on the quantity of liquid in internal containers for TRU waste disposal in WIPP appears to have stemmed from a concern for possible reactions between such liquids and the other contents of the TRU waste payload containers. Probably, the limitation criterion is a consequence of a belief that liquid in internal containers would most likely not be water and could in fact, be a concentrated acid or base. This appears to have been the basis driving the NMED decision to retrieve the drum containing less than a cupful of liquid in an internal

container and return it to the generator site. However, the one-inch limit for liquid in internal containers is inconsistent with the one percent limit by volume for the payload container. In fact, TRU waste containers with more than 0.5 gallons of liquid in the container have been allowed to remain in WIPP—the foremost example being the 121 drums of dewatered sludge from LANL, many of which were believed to contain greater than 0.5 gallons of free liquid (water).

Therefore, it is concluded that liquid limits established for both TRU waste payload containers and internal containers in TRU waste payload containers are inconsistent, overly conservative, and do not appear to have been developed following ALARA guidelines. As a result, establishment of this liquid limit has caused and will probably continue to cause more contamination incidents resulting from the repackaging of TRU waste in an effort to eliminate these minimal amounts of liquids found in internal containers. Further, the application of these overly conservative liquid limits has resulted in inordinate delays in the disposal of TRU waste in WIPP with the resulting increased risk of contamination release as a result of accidents or major weather events at the generating sites.

VI. RECOMMENDATION

The one percent liquid limit appears to have been based upon concerns related to reactions during the handling of TRU waste containers (primarily mixed TRU waste) prior to the advent of shipping casks; it is therefore recommended that DOE conduct an ALARA-based risk evaluation focused on the potential for releases from shipping casks with liquid volumes at higher percentages in the payload containers—consider up to five percent. This risk evaluation should be coupled with a comparable risk evaluation of potential releases of payload containers with greater volumes of liquids at WIPP—during unloading, movement, and emplacement operations. If the risk evaluation reveals that greater volumes of liquid do *not* result in elevated risks of release during transport or disposal operations, an appropriate change to the NRC regulation and HWFP should be pursued. Additionally, the performance assessment should be recalculated using higher container liquid contents; if it is confirmed that EPA standards established in 40 CFR 191 will continue to be met, an appropriate change to the EPA certification should also be pursued.

If such a universal change to requirements is not considered feasible, then DOE should pursue modifying existing restrictions to allow greater than one percent of liquid to be present in TRU waste containers if through acceptable knowledge it can be demonstrated that: 1) the liquid is water, and 2) waste materials will not react with the liquid in such a way as to cause pressure increase or other adverse conditions within the container. For example, if the basic waste form in a container is sludge from a process water treatment facility, any liquid present would most probably be water. In this case, the only risk would be to container integrity, which would be offset by existing standards for the waste containers.

With respect to the liquid limit for internal containers, it is recommended that the HWFP be changed to allow liquids in internal containers for legacy containers (those packaged before the opening of WIPP) as long as the sum total of the volume of liquids in the TRU waste payload container does not exceed the liquid limit applied to the whole payload container. The revised HWFP and associated WAC should also specify that any smaller containers destined to be disposed in newly packaged TRU waste containers are to be completely emptied—with no visible sign of liquid—before being placed in a TRU waste container.

These changes will still require TRU waste containers to be characterized by acceptable knowledge and then visual examination or real-time-radiography for those containers thought to contain excessive volumes of liquids, but such modifications will substantially reduce the number of TRU waste containers requiring repackaging, which in turn, will substantially reduce the risk for worker exposure and release into the environment, as well as for public exposure from TRU waste operations at generator sites.

Finally, in addition to the reduced risk for workers at generator sites, the above-recommended changes to liquid limits will also reduce the probability that a TRU waste container be mistakenly emplaced at WIPP. The health and safety benefits associated with reducing the probability of retrieving containers from the WIPP translate to a decrease in the potential for accidents during the retrieval of a non-compliant container and/or its transportation back to the responsible generator site.

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