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UPDATE TO THE RH/CH DISPOSAL OPERATIONS EVALUATION

September 2010

PECOS MANAGEMENT SERVICES, INC.

ISO-2 Project
Carlsbad, NM

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ACRONYMS

ARRA	American Recovery and Reinvestment Act of 2009
ATWIR	Annual Transuranic Waste Inventory Report
CAST	CAST Transportation
C&C	consultation and cooperation
CCA	Compliance Certification Application
CCP	Central Characterization Project
CH	contact-handled
CRA	Compliance Recertification Application
DOE	Department of Energy
EEG	Environmental Evaluation Group
FY	fiscal year
H&S	health and safety
HWFP	Hazardous Waste Facility Permit
NMED	New Mexico Environment Department
PABC	performance assessment baseline calculation
PECOS	PECOS Management Services, Inc.
Q	quarter
RH	remote-handled
SNL	Sandia National Laboratories
SQS	small-quantity sites
SRS	Savannah River Site
TRU	transuranic
WDS	Waste Database System
WIPP	Waste Isolation Pilot Plant
WMS	Waste Management Symposia
WTS	Washington TRU Solutions
WWIS	WIPP Waste Information System

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I. PURPOSE AND SCOPE

In March 2009, the Department of Energy (DOE) began disposing transuranic (TRU) waste in Panel 5 of the Waste Isolation Pilot Plant (WIPP). The following month, the American Recovery and Reinvestment Act of 2009 (ARRA) increased WIPP funding in order to accelerate TRU waste characterization, certification, shipment, and emplacement. Despite this increase in funding and resources, DOE continues to bypass some horizontal boreholes that were drilled and designated for remote-handled (RH) TRU waste disposal.

The purpose of this task is to determine how the continued bypassing of RH TRU waste disposal boreholes that previously occurred in Panel 4 and is presently occurring in Panel 5 will ultimately impact DOE's ability to effectively and efficiently use WIPP to emplace the contact-handled (CH) and RH TRU waste volume presented in the 2009 Annual Transuranic Waste Inventory Report (ATWIR). In completing this task, PECOS reviewed all current and planned activities associated with WIPP operations pertaining to CH and RH TRU waste handling and disposal. Changes to disposal operations that could help improve RH TRU waste disposal efficiency and the potential health and safety (H&S) impacts of such measures were also considered and actions recommended alleviating the issue.

II. BACKGROUND

Repository limits for disposing TRU waste were first defined in the 1980s when DOE announced its decision to proceed with the phased development of WIPP and subsequently produced the Consultation and Cooperation (C&C) Agreement with the state of New Mexico.[1] At that time, WIPP was expected to accommodate 6,200,000 ft^3 (175,564 m^3) of CH TRU waste plus 250,000 ft^3 (about 7,080 m^3) of RH TRU waste for a total of 6,450,000 ft^3 (182,643 m^3) of TRU waste. But in 1992, the Land Withdrawal Act (LWA) established that the combined volume of CH and RH TRU waste allowed at WIPP must be less than or equal to 6,200,000 ft^3 (175,564 m^3) with a disposal limit for RH TRU waste of 7,080 m^3 and no more than 168,484 m^3 of CH TRU waste.[2,3] Accordingly, if DOE fails to dispose 7,080 m^3 of RH TRU waste in the WIPP, the acceptable CH TRU waste volume allowed at WIPP will scale up. While the LWA established volumetric limits for TRU waste for WIPP, the basis for measurement of the volumes of TRU waste disposed in WIPP was not defined, which has led to some confusion.

Potential RH TRU waste disposal issues were identified by several agencies well before WIPP began receiving waste in 1999. As early as 1994, Sandia National Laboratories (SNL), at the direction of DOE,

authored an update to a 1991 report entitled "*Recommended Strategy for the Remote-Handled Transuranic Waste Program, DOE/WIPP 90-058, Revision 1,*" in which SNL stated the following:

> "The most serious obstacle to having RH TRU waste ready to go to WIPP is the lack of the major facilities needed to prepare the waste for shipment and emplacement . . . In order to place the full, currently allocated 7,080 m^3 of RH TRU waste in WIPP, it appears some deviation from the current emplacement plan needs to be developed. Placing canisters at closer-than-8-foot centers, making emplacement holes deep enough for two canisters, and emplacing waste in cross-drift walls are three alternatives to be considered." [4]

Later that year, an independent oversight group, the Environmental Evaluation Group (EEG), evaluated DOE's preparedness to package and ship RH TRU waste. EEG opined that while failure to ensure timely RH TRU waste emplacement would pose problems, DOE had already identified this issue in the aforementioned 1991 document.[5]

Nonetheless, the DOE proceeded with a TRU waste disposal plan for WIPP that consists of underground disposal panels mined perpendicularly to the main access drifts. Each disposal panel contains 7 rooms, which are approximately 300 feet long by 33 feet wide by 13 feet high. One hundred foot thick salt pillars separate each room. The TRU waste disposal process in each room is to first drill horizontal boreholes in each wall for disposal of RH TRU waste. Then, RH TRU waste canisters are inserted in the boreholes, which are then closed with a shield plug. The RH TRU waste emplacement equipment must then be removed from the room before the CH TRU waste can be deposited on the floor of the room. The major reason for this approach is the difficulty of moving the borehole drilling equipment and the RH TRU waste emplacement equipment in and out of a room to accommodate disposal of both TRU waste types in a room sequentially. As a result, if the deliveries of RH TRU waste to WIPP are not sufficient to fill all the boreholes in a room before the room is needed for CH TRU waste, then any unfilled boreholes in that room are bypassed.

While DOE had initially requested a modification of the Hazardous Waste Facility Permit (HWFP) in 2002 to allow the disposal of RH TRU waste, the HWFP was not amended to allow the RH TRU waste emplacement until 2006 and the first shipment arrived at WIPP in 2007. Meanwhile, it does not appear that DOE had implemented many initiatives to mitigate the issues described in the 1991 document, which indeed became full-fledged problems upon initiation of RH TRU waste disposal. The issue of an imbalance in the receipt and disposal of CH and RH TRU waste was then addressed in some detail in a fiscal year (FY) 2008 report by PECOS.[6]

In spite of ARRA funding, the RH TRU waste handling inefficiencies evident in FY2007 and FY2008 do not appear to have been changed enough to positively impact the RH TRU waste disposal goals as of the FY2010 midpoint. In attempting to isolate the source of slippage, PECOS focused its investigations on three areas: waste preparation (waste characterization and certification [with or without repackaging, if required]), transportation, and repository utilization.

III. SUMMARY OF FINDINGS

In reviewing the currently available information related to disposal operations at WIPP, PECOS has assimilated the following data concerning planned versus actual TRU waste preparation, transportation, and emplacement.

Repository-Related Factors

In the 1979 conceptualization of WIPP, scientists at SNL presented a likely scenario where RH TRU waste was slated for disposal in boreholes drilled into the floor of the lower portion of a two-level design. The dual level layout would facilitate efficient emplacement because CH and RH TRU waste disposal would occur independently of each other.[7]

However, the WIPP design developed in the early 1980s only consisted of a single level with eight mined panels.[8] This layout dictates that CH and RH TRU waste emplacement rates must be highly coordinated in order to maintain efficient operations. The seven rooms comprising a panel must be filled from the back, room-by-room, first with RH TRU waste and then with CH TRU waste. In earlier plans, the allowed volume of RH TRU was only to be disposed in horizontal boreholes in these eight panels. Once completed, the main access drifts, commonly referred to as Panels 9 and 10, would be filled with the remaining CH TRU waste and the repository closed.

Westinghouse Electric Corporation conducted studies during the 1980s to determine the spacing of RH TRU waste boreholes in the repository walls.[9] According to criticality models, a minimum center-to-center spacing of 5.63 feet could be used, assuming the boreholes were left unplugged and CH TRU waste was stacked adjacent to the openings. A subsequent criticality analysis performed by Westinghouse Safety Management Solutions in 2001 stated that RH canisters could be as close as 30 inches on center while maintaining a k_{eff} of less than 0.947 (the limit at which it becomes credible that a criticality accident can occur).[10] Moreover, that same report and its 2006 revision concluded that boreholes could be double-loaded, or arrayed in two rows and single-loaded, as long as RH TRU waste canisters held to the fissile material requirements in the WIPP Waste Acceptance Criteria and the Certificate of Compliance for RH TRU waste transportation containers.[11]

In addition to this conclusion, SNL conducted heat generation studies for RH TRU waste.[12] EEG reviewed these results and concluded that the calculated wall stability was sensitive to borehole spacing, but only at higher thermal loadings.[13] However, wall stability was not shown to be sensitive to deeper borehole length, although reviewers did not consider criticality in that scenario. These geotechnical perspectives were verified in a PECOS FY2008 review.[14]

Despite data supporting closer borehole placement, DOE stated in a 2005 response to the New Mexico Environment Department (NMED) during the process of modifying the HWFP to include RH TRU waste that, “The eight foot center-to-center spacing was selected based on the operational characteristics of the emplacement machinery as configured at the time.”

Changing TRU Waste Inventory

While scientists were determining exactly how the salt would respond to TRU waste, and as regulators attempted to secure permits for WIPP, the amount of inventoried TRU waste was changing; the method used to calculate RH TRU waste volumes was being altered, and WIPP's capacity to effectively dispose of RH TRU waste was diminishing.

In 1994, EEG noted there had been a great disparity in RH TRU waste inventory volumes reported by DOE from 1980 to 1994, and that there was not enough room in WIPP to accommodate the anticipated RH TRU inventory reported in 1994.[16] A review of the CH and RH TRU waste inventory data changes over time as presented in *Figures 1 and 2*, indicates that there is more CH TRU waste and less total RH TRU waste now forecast than there was when the Compliance Recertification Application (CRA) inventory was compiled in 2005. (The total amount of TRU waste, whether CH or RH, is the anticipated volume [waste in WIPP, waste at the generator sites, and projected waste generation through 2033] plus potential waste. This "potential" waste is classified as TRU, but a final determination has not yet been determined.)

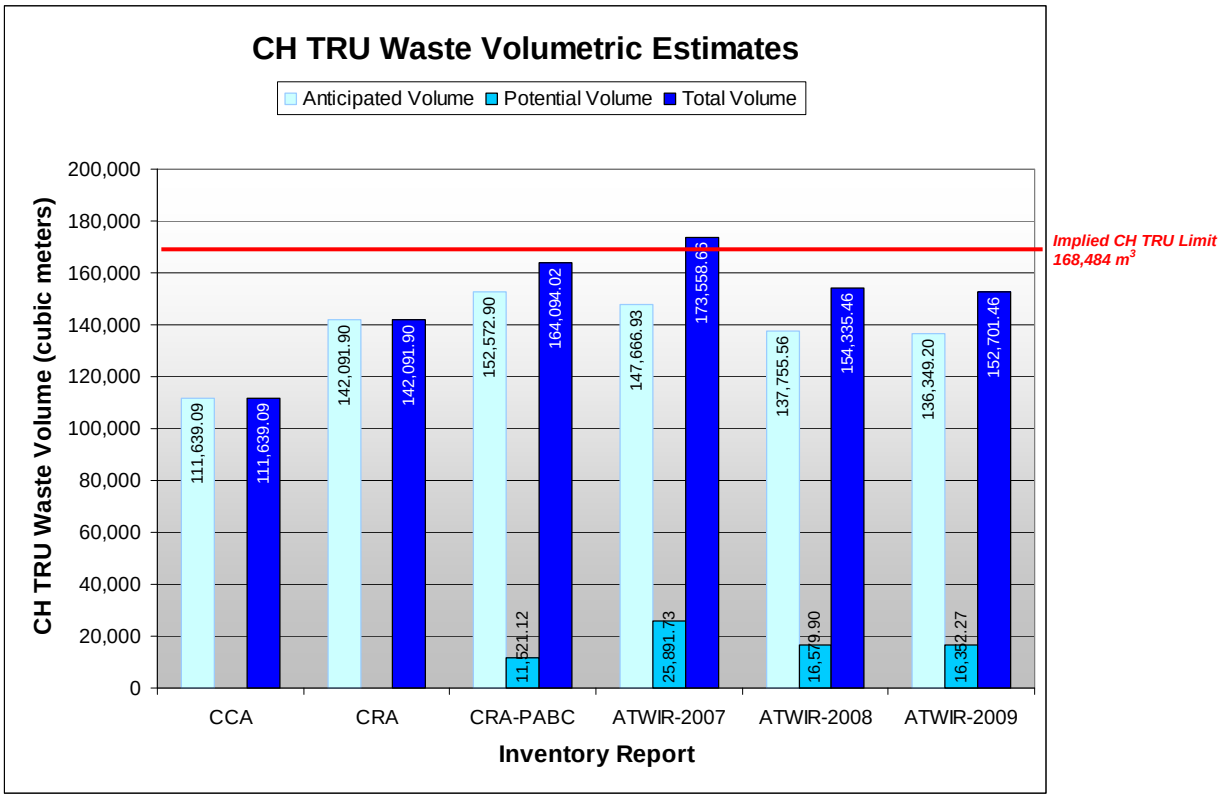

Figure 1. Trends in the CH TRU waste inventory from 1996 through 2008, as compiled by PECOS from original inventory source documents (PECOS).

As seen in *Figure 2*, the amount of potential RH TRU waste has increased since the inventory was released for the CRA-Performance Assessment Baseline Calculation (PABC) in 2004. Moreover, the most recent inventory (the ATWIR-2009 with data current to December 31, 2008) reveals the following:

- There is roughly a 20 percent increase over the total RH TRU waste volume from just a year before.
- There is approximately a 40 percent increase in anticipated RH TRU waste.
- The total volume of RH TRU waste in the DOE complex than can legally be disposed of in WIPP has been reported to be greater than the permitted volume (7,080 m^3) in every inventory report issued since the mid 1990's.

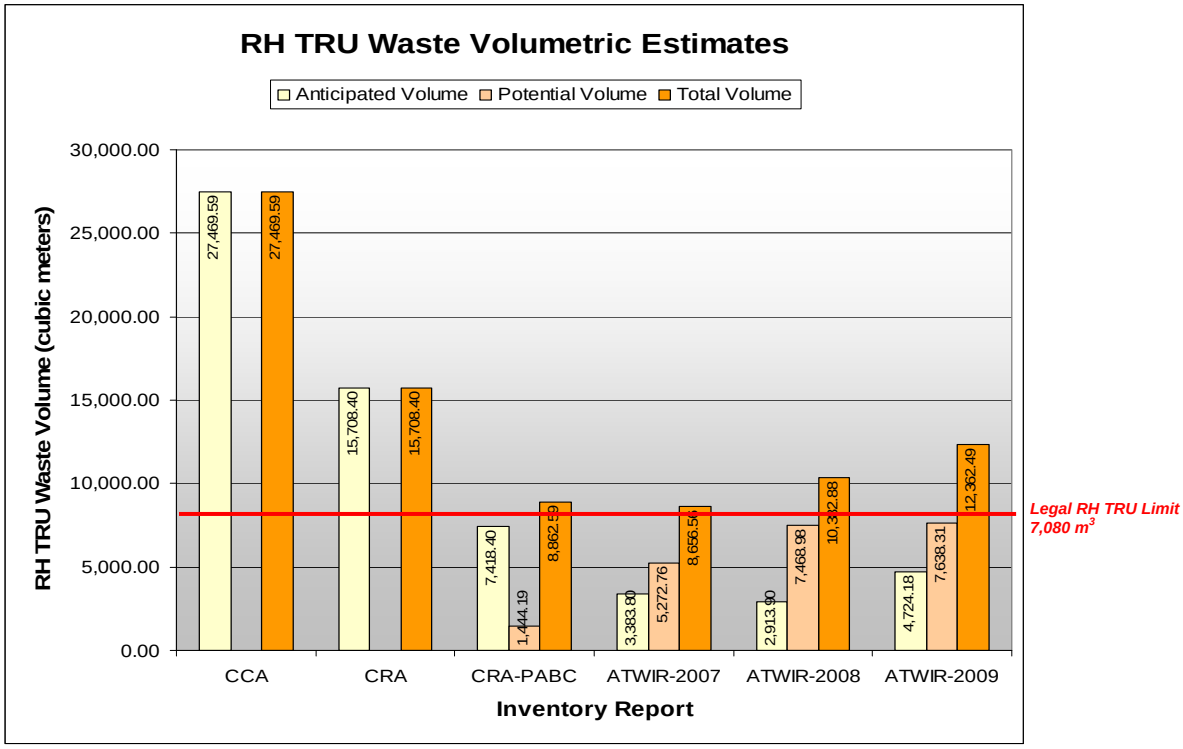

Figure 2. Trends in the RH TRU waste inventory from 1996 through 2008, as compiled by PECOS from original inventory source documents (PECOS).

Calculating the Volume of Emplaced RH TRU Waste

Early in the WIPP planning and design process, it was determined that each RH TRU waste canister would have an inner volume of 0.89 m^3, which was used to calculate the number of boreholes needed.[8] Because RH TRU waste could be loaded directly into the canister, or drums containing the waste could be put into the canister, the "disposed" volume of a canister was considered to be 0.89 m^3 in all WIPP RH TRU waste documents. Similarly, the disposal volume of 55-gallon drums containing CH TRU waste was 0.21 m^3 of CH TRU waste. It is immaterial that the drum might only be 30 percent full.

Now it appears that while the HWFP and other WIPP-related documents are still using 0.89 m^3 as the disposal volume for RH TRU waste, the WIPP waste data systems have been calculating volume on a canister-by-canister basis according to the internal volume of drums loaded into the canisters. Thus, the volume is reported to be the combination of 55-gallon drums (0.21 m^3 each) and 30-gallon drums (0.11 m^3 each), with up to three drums of either type accommodated by each canister, resulting in the fact that RH TRU waste emplacement volumes have been reported differently in various WIPP documents. For example, the volume of RH TRU waste emplaced in Panel 4 is reported as 83 m^3 in the Waste Database System and as 176 m^3 per the HWFP. Regardless, both sources will present the same number of canisters in their totals. In this report, canister-volume equivalents are calculated using 0.89 m^3.

The Capacity to Dispose of RH TRU Waste in WIPP

In 1986, only 1,000 canisters (890 m^3) of RH TRU waste were scheduled to be emplaced in WIPP.[18] Two years later, in 1988, DOE determined that WIPP could accommodate 6,566 canisters (about 5,844 m^3) using the eight-foot spacing if waste was only placed into the walls of the eight panels in the repository.[19] Then in 1991, DOE revised that estimate and stated that WIPP had room for approximately 7,900 RH TRU waste canisters (7,031 m^3) assuming the north-south drifts (Panels 9 and 10) were used in addition to Panels 1 through 8.[20] This was slightly less than the permitted amount (7,080 m^3).

This expected RH TRU waste capacity was revised by DOE in a 1995 report that stated that due to "facility layout and emplacement equipment selected," WIPP could only dispose about 5,370 RH TRU waste canisters (4,780 m^3). The report went on to state that if RH TRU waste disposal could not be approved shortly after WIPP was opened, and if waste emplacement bypassed Panel 1 entirely, an estimated 562 boreholes (500 m^3) would be lost, bringing the RH TRU waste useful capacity down to 4,808 boreholes (4,280 m^3).[21]

In 1999, DOE calculated it could drill 731 boreholes per panel (equivalent to about 6,580 boreholes) in Panels 2 though 10, accommodating nearly 5,856 m^3 of RH TRU waste.[22] DOE submitted an HWFP modification request to NMED in 2002 to allow RH TRU waste disposal in WIPP, proposing 731 boreholes (650 m^3) per panel.[23] That same year, the National TRU Waste Management Plan generated by DOE speculated that over 2,400 RH boreholes (2,136 m^3) would be bypassed during the operational life of WIPP.[24]

Approval of the HWFP modification to allow RH TRU waste disposal was initially rejected by the NMED, which resulted in changing the starting panel for RH TRU waste emplacement from Panel 2 to Panel 4. When the Class 3 HWFP modification request was resubmitted, DOE responded by attempting to increase the number of boreholes allowed per panel, arguing that the WIPP design criterion assumed RH TRU waste canisters would collectively emit no more heat than 10 kilowatts per acre. Therefore, because no more than 60 watts was produced by each canister, up to 2,230 canisters (1,985 m^3) could be disposed of in each panel, assuming the volumetric limit of 7,080 m^3 was not exceeded.[25] This would have required

a major operational change for RH TRU waste disposal in WIPP including disposing of two RH TRU waste canisters in each borehole and other undefined disposal techniques.

The HWFP modification that was ultimately approved in 2006 allowed RH TRU waste emplacement to start in Panel 4, but at a reduced volume of 400 canisters (256 m^3). Reduced RH TRU waste disposal values were also applied to Panel 5 (500 canisters, or 445 m^3) and Panel 6 (600 canisters, or 534 m^3), though NMED had included a stipulation that DOE could propose an HWFP modification to increase these numbers to the full volume of 730 canisters (650 m^3). As a result of the delay in the HWFP modification that approved RH TRU waste disposal, Panels 1, 2 and 3 were bypassed. This meant that the opportunity to dispose over 2,500 RH TRU waste canisters was lost before RH TRU waste emplacement had even begun assuming Panels 1-3 would have each been permitted for 730 canisters of RH TRU waste and including the loss of 330 boreholes were approved for Panel 4.

Assuming that Panels 7 and 8 would be permitted to dispose of 730 canisters each and that DOE could, in fact, achieve the RH TRU waste disposal limits set for Panels 5 and 6, no more than 2,960 canisters (2,634 m^3) of RH TRU waste will be disposed in the disposal panels of WIPP, which was the original design. This shortfall would enable DOE to increase the volume of CH TRU waste to 167,130 m^3. However, the actual amount of CH TRU waste deposited into the repository panels has fallen short of the permitted amount (only 81% of available CH TRU waste capacity was used in Panels 1-4). *Table 1* summarizes the efficiency of waste emplacement for both CH TRU and RH TRU waste.

Table 1. Data for CH and RH TRU waste emplacement in Panel 4 (Rooms 7 through 1) and Panel 5 (Rooms 7 through 4), as compiled from NMED and DOE information. [26]

VOLUME	Panel 4 (complete)	Panel 5 (planned, through Room 1)	Panel 5 (actual, data through Room 4)
CH volume limit	18,750 m^3	18,750 m^3	10,714 m^3
CH actual volume	14,258 m^3	***unknown***	6,248 m^3
CH percent filled	***76.0%***		***58.3%***
RH volume limit	356 m^3	445 m^3	254 m^3
RH actual volume	176 m^3	***unknown***	120 m^3
RH percent filled	***49.4%***		***47.2%***
RH borehole limit	400	500	285
RH boreholes drilled	297	***unknown***	162
RH boreholes used	198	***unknown***	125
Percent permitted boreholes used	***49.5%***		***43.9%***
Percent drilled boreholes used	***66.7%***		***77.2%***

With the advent of ARRA funding in April 2009, DOE expected to emplace an additional 14 percent CH TRU waste and 10 percent RH TRU waste during FY2009 though FY2011, as reported on www.recovery.gov.[27] This means that 35,126 m^3 of CH TRU waste would be emplaced (as opposed to 30,601 m^3) over the course of three years, or about 11,709 m^3 of CH TRU waste per FY. Likewise, 971 m^3 of RH TRU waste was originally slated to be emplaced during this time frame, but the ARRA funding goal is to bring the total to 1,071 m^3, or 357 m^3 per FY. In FY2009, however, the amount of TRU waste disposed was only a combined total of 6,175 m^3—roughly 51 percent of the goal. By mid FY2010, the rate appears relatively unchanged, as evidenced by the combined CH and RH TRU waste emplaced volume of 3,283.1 m^3 mentioned in the WTS key performance data for the end of March 2010.[28]

As illustrated in *Table 1*, it seems RH TRU waste boreholes are being bypassed in Panel 5 at approximately the same rate as they are bypassed in Panel 4. This could be occurring for one of two reasons: either there is not enough RH TRU waste ready to be emplaced at WIPP or CH TRU waste arrives at a rate that outstrips that of RH TRU. The latter appears to be the case even though the amount of CH TRU in Panel 5 is also falling below permitted levels. Thus, the point of slippage is most likely tied to transportation or waste preparation (characterization, repackaging and certification), not to operations at the repository.

Waste Transportation Factors

The February 2009 Carlsbad Field Office Environmental Management Project(s) Baseline Summary states, "The Carlsbad Field Office has the capability and physical resources to ship 40 shipments per week; however actual shipments are funding dependent."[29] In other words, DOE states that if requisite funding is provided, they have ample tractors, tractor teams, and Type B packages (shipping containers) to complete 40 shipments per week. The practicality of this statement is evaluated below.

DOE has the services of two companies to ship TRU waste from generator sites to WIPP: CAST Transportation (CAST) and Visionary Solutions. The continued use by DOE of two companies ensures there are always resources available to ship TRU waste. Between CAST and Visionary Solutions, there are a combined fleet of 40 tractors available to transport TRU waste.

In late FY2007, CAST increased its number of WIPP tractor teams from 11 to 15. In early 2009, Visionary Solutions had 11 tractor teams, which was increased to 15 with ARRA funding in mid 2009.[30] From this information, PECOS estimates there are at least 26 teams currently available to haul CH and RH TRU waste to WIPP, and up to 30 available when inter-site shipments are not needed.

With respect to the number of Type B packages for those weekly shipments to WIPP, DOE has 112 transportation containers: 84 TRUPACT-IIs, 15 HalfPACTs, 12 RH-72Bs, and a single CNS-160B. (This last package can only be used for inter-site shipments because it exceeds highway weight limits.)[31] ARRA funding was allocated in 2009 to begin constructing five additional HalfPACTs (though they are not considered for the purposes of this report). If three TRUPACT-IIs or HalfPACTs are used per CH TRU

shipment, and one RH-72B is used per RH TRU shipment, there are enough Type-B packages to substantiate DOE's capability claim of 40 shipments per week.

It was known as far back as 1994 that if DOE did not meet its shipment goals, the inventory of RH TRU waste would not be efficiently emplaced in the underground. Specifically, DOE and SNL both concluded that transporting fewer than six RH TRU waste canisters to WIPP per week would result in forfeited RH TRU waste capacity.[32,33] Transporting more than six, they claimed, would impact mining operations, mine ventilation, and worker H&S. Thus, the actual transportation goal for WIPP is not 40 shipments per week as stated in the introduction to this section, but 17 CH TRU waste and six RH TRU waste shipments, for a total of 23 shipments each week, well within the transportation capability currently available to WIPP.

While six shipments of RH TRU waste correspond to six RH canisters, the goal of 17 CH TRU shipments translates to a maximum weekly goal of 51 Type-B packages (TRUPACT-IIs and HalfPACTs). However, no goal has ever been explicitly stated for the number of CH TRU waste drums shipped to WIPP each week inside those Type-B packages. Assuming each team uses one tractor and makes one round trip per week, the goal of 23 total shipments seems achievable. There are also enough Type-B packages to meet shipping goals of 51 CH TRU packages and six RH TRU packages. The claim by DOE of having the capacity to make 40 shipments per week, however, is only possible if some teams make more than one roundtrip per week. As illustrated in *Figure 3*, the reality is that the shipments-per-week goal has been demonstratively achievable for CH TRU waste, but not for RH TRU waste.

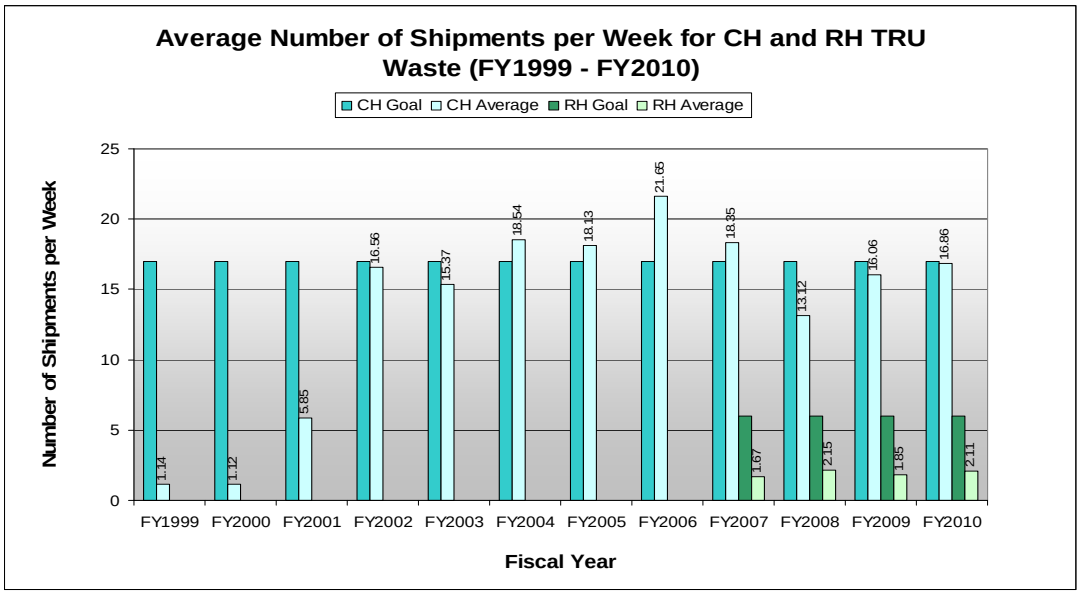

Figure 3. Trends in average weekly shipments for FY1999 through present, as compiled from WTS documents.[28]

Moreover, upon examination of the data available since RH TRU waste emplacement was initiated in FY2007, PECOS noted the emergence of a couple of trends. First of all, the rate at which RH TRU waste arrives at WIPP hovers around two canisters per week. Although there have been weeks during FY2009 and FY2010 where four or more RH canisters were shipped to WIPP as a result of ARRA funding, the

average number of RH TRU shipments received per week remains low because there are times when no RH TRU waste is received and times when WIPP is down for maintenance (*Figure 4*).

Additionally, the number of CH TRU waste Type-B packages shipped to WIPP has increased to the point of once again meeting the weekly goal, but the amount of CH TRU waste disposed in WIPP has not increased accordingly (seen previously in *Table 1*). This indicates that the TRUPACT-IIs and HalfPACTs might not contain the maximum possible number of CH TRU waste containers.

Waste Preparation Factors

If bypassed boreholes cannot be attributed to poorly coordinated TRU waste emplacement operations or inefficient shipping methods, the most like source of the problem is waste preparation at the generator sites. This involves TRU waste characterization, possible treatment/repackaging, and certification.

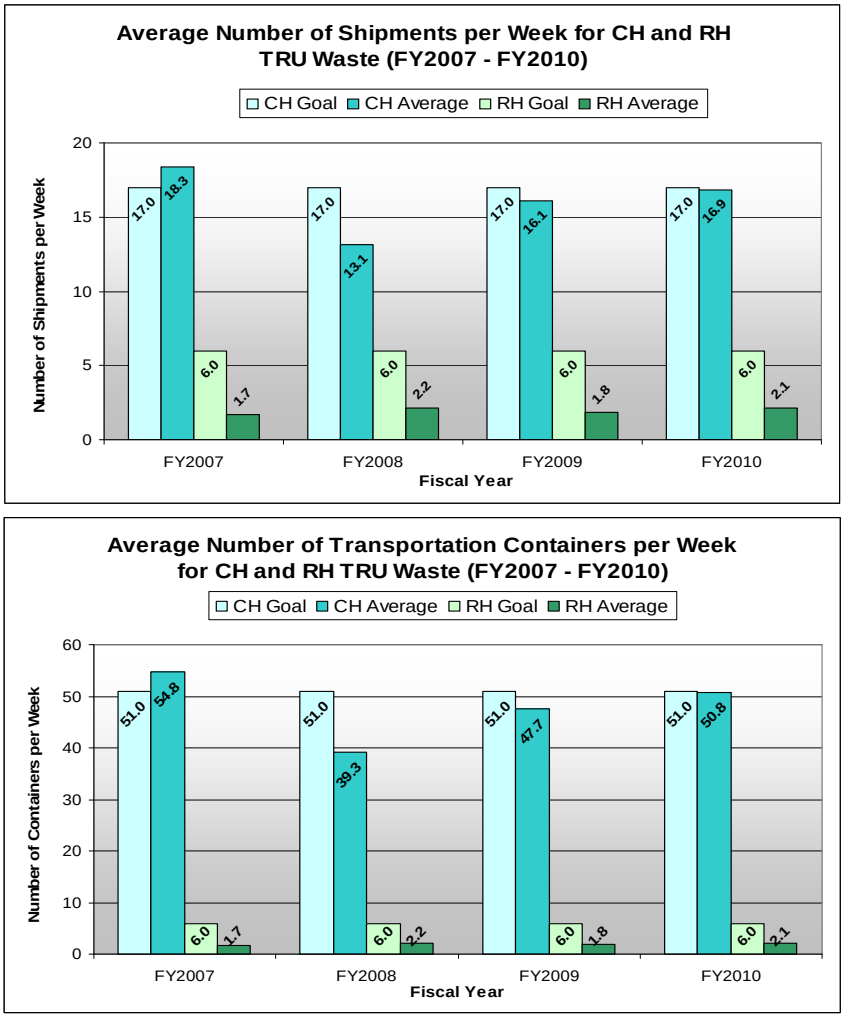

Figure 4: DOE goals versus the average number of shipments (top chart) and shipping packages (bottom chart) received per week, as compiled from WTS documents.[28]

In order for TRU waste to be accepted by WIPP (or an interim TRU waste storage/reprocessing site), the waste container must pass a certification process to ensure it complies with the waste acceptance criteria for that site. These criteria encompass both transportation requirements set forth by the Department of Transportation and the Nuclear Regulatory Commission and the disposal requirements of agencies regulating the receiving site. To facilitate waste characterization and certification, the Central Characterization Project (CCP) was initiated in 2002 to characterize and certify TRU waste, beginning with the small sites then expanding to essentially all sites. The goal of the CCP was to alleviate the financial burden on the small sites and to apply the waste characterization procedures consistently and efficiently at all sites.

A review of the DOE draft operating plan for use of ARRA funding indicates characterization and certification do indeed comprise the primary system limitation.[34] In that document, DOE identified areas where existing preparation activities are insufficient, including the following:

- Most TRU waste remaining at generator sites will require repackaging and/or remediation because issues were identified during initial characterization or existing knowledge showed that it could not be certified to ship to WIPP as packaged. In other words, the easily characterized and certified waste (both CH and RH) is already in or on its way to WIPP.
- Some generator sites had problematic TRU waste streams. DOE decided to redirect resources to these sites in order to assist them in resolving this issue, which may increase the chance of transporting these waste streams to WIPP.
- The Savannah River Site (SRS) lacked the ability to characterize and certify large TRU waste containers and had insufficient resources to perform ARRA-required 24/7 characterization and certification actions.

WTS publishes a weekly "key performance data," report which includes the number of shipments completed, number of containers certified, and volume of TRU waste placed in the repository.[28] Certification values in these reports do not differentiate between inter-site shipments and shipments to WIPP, and the amounts of TRU waste characterized by CCP personnel across the DOE complex are not reported. Trends in containers certified by CCP and containers emplaced in WIPP are shown in *Figure 5*.

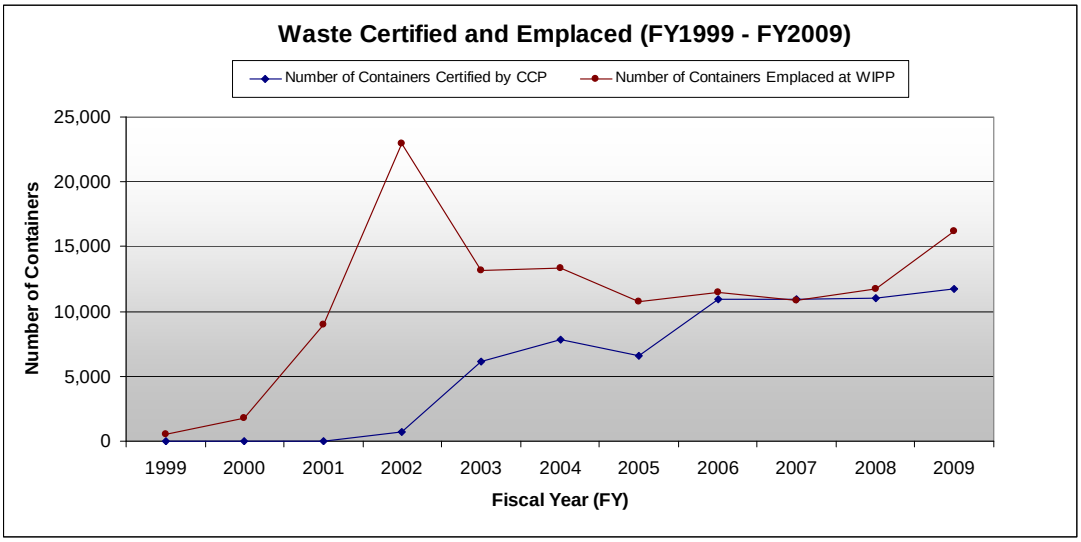

Figure 5. Waste emplacement and certification since CCP took over in FY2002, as compiled from WTS documents.[28]

RH TRU waste emplacement started in FY2007. In *Figure 5*, the spike in emplacement in FY2002 is due to the disposition of TRU waste from Rocky Flats and Idaho National Laboratory. ARRA funding was applied in FY 2009.

The rate of TRU waste characterization performed by CCP and the generator sites has exceeded the rate of waste containers certified for disposal, which indicates that a critical path involves repackaging this waste in order to remove prohibited items so containers can attain final certification. With the addition of ARRA funding, certification rates appear to be improving. Namely, there were 11,765 containers certified in FY2009 and 7,774 containers certified as of the half-way point for FY2010.[28] Unfortunately, the certification numbers available do not differentiate between CH and RH TRU waste containers.

DOE asserts that after more than 10 years of disposal at WIPP, there is very little easily characterized TRU waste left at the generator sites. DOE also states that the changes in TRU waste inventory, as shown previously in *Figures 1* and *2*, and will continue to change as more details regarding the remaining legacy waste are identified. This variability could make it increasingly difficult for DOE and WTS to plan RH TRU waste characterization, transportation, and disposal operations with any amount of certainty, especially when combined with preparing a much larger CH TRU waste volume for disposal.

Currently Proposed Solutions

In addition to DOE's receipt of ARRA funding to accelerate certification, shipping, and emplacement, DOE and SNL have considered several other options as possible solutions for disposal of RH TRU waste other than the current approach:

- As far back as 1995, shielded containers were considered to be a viable disposal alternative for RH TRU waste. Shielded containers are 30-gallon drums over-packed into lead-lined containers

that reduce the surface dose rate to or below the levels established for CH TRU waste containers and can be transported to WIPP in HalfPACTs. This decreases the number of shipments and reduces H&S risks to the public along the transportation routes as well as to workers who handle the containers. At the 2008 Waste Management Symposia (WMS), DOE said that based on inventory estimates, only about 30 percent of RH TRU waste is a candidate for this option.[35] Specifically, using the inventory for the PABC (cut-off date of December 31, 2002), Los Alamos National Laboratory estimated that the entire DOE complex had 1,921.64 m^3 of RH TRU waste that would be a candidate for disposal via shielded containers.[36] Operational and regulatory modifications to accept this disposal strategy as well as the production of more HalfPACTs via ARRA funding are already under way according to DOE's reports at www.recovery.gov and its draft ARRA operational plan.

- ARRA funding has also been appropriated for construction of a new lightweight facility cask and horizontal emplacement machine for RH TRU waste disposal. Due to a dearth of available information, PECOS cannot confirm that this new equipment is capable of loading RH TRU waste canisters into boreholes at a faster pace than the existing equipment, nor can PECOS determine whether it can place two canisters into a single borehole, a possibility SNL explored as long ago as 1987.[37] Judging from the information that was available for review, it appears that double-loading boreholes (placing two RH TRU waste canisters into a single borehole) would require a change to the borehole drilling equipment. However, studies have already been conducted to confirm that heat generation would not be an issue and that criticality limits would not be exceeded. (A review of this topic is contained in a companion FY2010 PECOS minor action report entitled, "Assessment of an Alternate Approach for RH TRU Waste Disposal.")
- At the 2010 WMS, DOE mentioned it was investigating the possibility of extending the disposal area beyond Panels 4 and 5 or Panels 7 and 8, though there are no citations in its resulting paper, nor are there any known published papers regarding such studies.[38]

No solutions have been proposed at this time to alleviate the RH TRU waste characterization and repackaging bottleneck.

IV. CONCLUSIONS

After reviewing publically available information for all current and planned RH TRU waste activities associated with WIPP operations, PECOS has drawn the following conclusions:

Based on present configuration of WIPP and existing disposal plans, it will not be possible for DOE to dispose the known (currently identified/acceptable) ATWIR-2009 RH TRU waste inventory into the WIPP; despite the fact that DOE has known from the day WIPP opened that failure to accurately meet and balance CH and RH TRU waste shipping goals would indeed produce this end result.

Only 2,920 boreholes are currently planned for WIPP although it will require approximately 5,304 boreholes to accommodate the known RH TRU waste volume,. Data reviewed for this report reveal DOE

has routinely failed to meet the shipping goal established for RH TRU waste, resulting in utilization of less than 50 percent of boreholes allowed by the HWFP for Panel 4 (or 67 percent of boreholes actually drilled). As noted previously, a similar trend is emerging for Panel 5. An FY2009 PECOS report discusses ramifications of this situation, also presented herein (*Table 2*) and based on ATWIR-2009 data.

In summary, even if all planned and expected HWFP-allowed boreholes are filled, the ATWIR-2009 inventory of currently acceptable RH TRU waste will simply not fit in WIPP, assuming the existing HWFP limits are applied to Panel 8 and without considering either the use of the main drifts (Panels 9 and 10) or the use of shielded containers. Moreover, using the present configuration, the forecasted future acceptable RH TRU waste is greater than the current volume permitted for disposal in WIPP. Thus, while WIPP can legally accommodate 7,080 m^3 of RH TRU waste, delayed RH TRU waste disposal and HWFP-imposed per-panel limits for RH TRU waste virtually ensure this amount will never be placed in WIPP as it is currently configured and operated.

Table 2: Implications of missing RH TRU waste boreholes in Panels 5 through 10.

	Panels 5 - 8	Panels 9 - 10*	Total Panels 5 - 10*	Remaining ATWIR-2009 RH Waste
HWFP Limit	2,278 m^3	1,299 m^3	3,577 m^3	973 m^3
50% Borehole Utilization	1,139 m^3	650 m^3	1,789 m^3	2,762 m^3
75% Borehole Utilization	1,709 m^3	974 m^3	2,683 m^3	1,868 m^3
90% Borehole Utilization	2,050 m^3	1,169 m^3	3,219 m^3	1,331 m^3
100% Borehole Utilization	2,278 m^3	1,299 m^3	3,577 m^3	973 m^3

** Based on assumption that the same number of boreholes will be allowed in Panels 9 and 10 as in Panels 7 and 8.*

There is no correlation between the volume of RH TRU waste reported in the inventory and the expected number of RH TRU waste canisters to be shipped to WIPP.

As stated above, the actual volume of RH TRU waste disposed in WIPP is now calculated based on the size of the waste container in each canister and can range from 0.33m^3 (3 30-gallon waste containers) to 0.63m^3 (3 55-gallon waste container to 0.89 m^3 (separately loaded canister). Thus, the actual number of RH TRU waste canisters and boreholes needed to dispose of the C&C Agreement limit is, at a minimum, 7955 and is probably closer to double that. Similarly, to dispose of the current maximum forecast of RH TRU waste (12,362.49 m^3) would require an excess of between 14,000 and 30,000 canisters and boreholes under the current operating conditions depending on the fill efficiency of each canister.

Even if the application of ARRA funds continues to improve the efficiency of RH TRU waste preparation and transportation, the ARRA emplacement goals established by DOE cannot possibly be met; therefore, the potential for bypassing more boreholes remains.

DOE stated that the ARRA funding it received for WIPP-related operations would enable it to dispose of

about 14 percent more CH TRU waste while concurrently increasing RH TRU waste emplacement by ten percent. This means about 11,709 m^3 of CH TRU waste and 357 m^3 of RH TRU waste must be disposed of per FY for 2009, 2010, and 2011. A combined total of 6,175 m^3 TRU waste (only about 52 m^3 of which was RH TRU waste according to WDS) was emplaced in FY2009, and as of the midpoint of FY2010, the rate appears relatively unchanged, as evidenced by the combined CH and RH TRU waste emplaced volume of 3,283.1 m^3 (about 32 m^3 of which is RH TRU waste).

While extended maintenance outages at WIPP during the FY2009 and FY2010 winter breaks would naturally have an adverse impact on emplacement, DOE compounded the problem by failing to use these two periods to queue as many RH TRU waste containers as allowed by the HWFP. According to that document, once TRU waste arrives at WIPP, it can remain there in a sealed Type-B container for as long as 59 days after the inner containment vessel is closed at the generator site. This can assist in providing a steady source of disposal-ready TRU waste containers when characterization and certification are lagging at the generator sites (as in the case of RH TRU waste canisters). To this end, the HWFP also says that as many as 50 Type-B packages containing CH TRU waste can be in the WIPP Parking Area Unit (comprised of the Parking Area and the Parking Area Surge Storage). The limit for RH TRU waste shipping containers in the Parking Area Unit is 12 RH-72Bs.

PECOS has reviewed many sources of data in an attempt to pinpoint where DOE could make operational changes that would result in fewer bypassed RH TRU waste boreholes. Based on this review of disposal performance through March 31, 2010, WIPP has only met or surpassed their stated goal of receiving 17 CH TRU waste and six RH TRU waste shipments with a single week one time since RH TRU waste emplacement operations began in 2006. Therefore, it is unclear whether WIPP can continuously achieve receipt and disposal of 23 TRU waste shipments on a week-to-week basis. Moreover, DOE's stated capability of transporting 40 shipments to WIPP per week does not appear to be substantiated.

In addition to this, the date in *Table 1* indicates that CH TRU waste is being sent to WIPP in partially filled TRUPACT-IIs, although this has not yet been absolutely confirmed by PECOS. While this should slightly mitigate the need to bypass RH TRU waste boreholes in favor of CH TRU waste emplacement on the repository floor, there is no benefit as of yet when examining the totals presented by WTS in their weekly updates. In fact, if true, the shipment of partially filled shipping containers increases the risk for an accident since it increases the number of trips required to dispose of the TRU waste inventory in WIPP.

Therefore, assuming emplacement and transportation are not points of slippage in this system, PECOS can only conclude that CCP either cannot characterize RH TRU waste quickly enough due to lack of resources or readily available RH TRU waste, or it prioritizes CH TRU waste certification and characterization.

V. RECOMMENDATIONS

In light of the conclusions drawn in this Major Action Report, the following action is recommended:

DOE should identify the reason(s) for inefficient waste emplacement, especially in light of apparent increasingly effective transportation modes and methods. In order to arrive at a solution to the current failure of the RH TRU waste disposal portion of WIPP, which cannot be quantified nor proven without further investigation and additional research and data—DOE is encouraged to examine the following information:

- Total number of CH and RH TRU waste disposal containers and volume of waste characterized each FY from 1999 to present.
- Total number of CH and RH TRU waste disposal containers and corresponding volume of waste certified for transportation to WIPP each FY from 1999 to present.
- Total number of CH and RH TRU waste disposal containers (and corresponding volume of waste) received at WIPP each FY from 1999 to present.
- Total number of CH and RH TRU waste disposal containers (and volume of waste) emplaced each FY from 1999 to present.

It is also recommended that DOE only use the inner volume of the RH TRU waste canister to report the volume of RH TRU waste disposed since that volume has been the basis of the original planning and design documents as well as the TRU waste inventories and is the volume used to establish the RH TRU waste disposal limits in the permit. If, for planning purposes, DOE needs to track the number of RH TRU waste containers in each canister, then that number should either not be reported in the WDS as the RH TRU waste volume disposed or caveated accordingly as a management tool not a regulatory statistic.

To prompt this action, PECOS should provide formal correspondence to DOE stating the following:

> The reason inefficient RH TRU waste emplacement is occurring cannot be discerned easily from the available data. It appears that the problem is RH TRU waste preparation/characterization at the generator sites, but without data regarding the number of drums shipped to WIPP, PECOS cannot say this definitively. Moreover, it is not understood why a larger number of both CH and RH TRU waste containers were not queued for emplacement during the five-week FY2010 maintenance outage, especially in light of accelerated certification and shipping stimulated by ARRA funds. DOE should identify the point of slippage and institute corrective measures immediately in order to achieve the goals outlined in ARRA documents.

Because it does not appear that the potential RH TRU waste will fit in the current repository design, DOE should move quickly to openly consider alternatives for RH TRU waste disposal. In particular, DOE should develop alternative plans to enable the disposal of RH TRU waste up to the regulatory limit and initiate the required National Environmental Policy Act evaluation. This evaluation would provide comprehensive information to the public as to relevant environmental and health and safety issues, and it would address concerns associated with any required modifications to WIPP which would qualify it to meet the criteria necessary to accommodate as much of the RH TRU waste inventory as possible.

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