

Getting West Valley Demonstration Project Wastes on the Right Path to Disposal - 11140

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ABSTRACT

In terms of waste, the West Valley Demonstration Project (WVDP) has almost every radioactive waste generated in the nuclear and defense industries: liquid, solid, particulate, remote handled and contact handled Low Level Waste (LLW), solidified High Level Waste (HLW), transuranic (TRU) waste, greater than Class C (GTCC), mixed LLW (MLLW), wastes subject to the Waste Incidental to Reprocessing requirements of Department of Energy (DOE) Order 435.1, “Radioactive Waste Management” [1] and spent nuclear fuel-like debris. Evolving packaging criteria and lack of final disposal options have added to the challenges associated with managing these wastes and the longer that waste disposal decisions are deferred for these wastes, the more likely it is that these wastes could be handled multiple times.

West Valley remains the only licensed US facility to have reprocessed commercial spent nuclear fuel. While that is unique in and of itself, another complicating factor is its complex stakeholder relationships. New York State (NYS) owns the site while the clean-up effort is being led by the DOE. Over the past four years, positive advancements have been made between NYS and the DOE, including the issuance of the Phase 1 Final Environmental Impact Statement (EIS) Record of Decision (ROD) [2] and settlement of a cost sharing agreement between NYS and DOE (Consent Decree) [3].

However, several outstanding waste issues remain that are impacting the ability of the Project to complete its mission. There are at least nine types of problematic wastes in storage that do not have defined disposal options. While DOE is moving forward with the next phase of the Project to reduce site infrastructure and related facilities, lack of defined disposal options for these problematic wastes will require continued on-site storage and may require future processing to meet final transportation and disposal requirements.

This paper will provide the history behind the more complicated wastes, the challenges with processing the waste, and associated lessons learned that might be pertinent to other DOE sites. This paper will also discuss some of the longer-term potential impacts related to disposal uncertainty and the future decision-making that has the potential to create a path forward for this waste.

INTRODUCTION

The WVDP is located about 30 miles south of Buffalo, New York, on the site of a former commercial spent nuclear fuel reprocessing facility which operated from 1966 to 1972. Approximately 640 metric tons of commercial and defense fuels were reprocessed at the site using the Plutonium Uranium Reduction by Extraction (PUREX) and Thorium Reduction by Extraction (THOREX) chemical processes. A commercial operator, Nuclear Fuel Services (NFS) under contract by NYS, ceased reprocessing operations in 1972 for plant modification and

capacity enlargement which required a construction permit and relicensing by the Atomic Energy Commission (AEC). As a result of regulatory issues and other considerations, NFS abandoned its plans to upgrade and reopen the West Valley plant. In 1976, the commercial operator notified NYS of its intent to exercise its rights under the waste storage agreement and to surrender the responsibility for all wastes to NYS.

In 1980, Congress passed and the President signed the West Valley Demonstration Project Act (WVDP Act) [4], directing the DOE to:

- 1) Solidify the HLW remaining from reprocessing operations;
- 2) Develop containers for the permanent disposal of the solidified high level waste (HLW);
- 3) Transport the HLW to a federal repository;
- 4) Dispose of LLW and TRU waste resulting from HLW solidification; and
- 5) Decontaminate and decommission the HLW storage tanks, solidification facilities, and any materials/hardware used during the Project.

Although the DOE is responsible for this cleanup project, NYS owns the site property and funds a portion of Project costs.

At the start of the Project, approximately 2.3 million liters of neutralized PUREX high-level radioactive waste remained on the site in an underground, carbon steel tank designated Tank 8D-2. This waste consisted of insoluble hydroxides and other salts that precipitated out of the highly concentrated waste solution to form a bottom sludge layer, and a liquid (supernatant) upper layer rich in sodium nitrate. In addition, approximately 31,000 liters of acidic THOREX waste from the reprocessing of a single campaign of thorium based fuel, remained in a smaller, underground, stainless steel storage tank designated Tank 8D-4. By license requirement, each waste storage tank had a spare identical tank.

West Valley Nuclear Services Company (WVNSCO), the original prime contractor to the DOE, pretreated the HLW and solidified approximately 99.7% of this material in a borosilicate glass waste form. Approximately 90% of the remaining liquids left in the tanks following HLW vitrification were retrieved, treated and stabilized into a solid waste form that was subsequently shipped for off-site disposal as sodium bearing low level waste. This left a total of 76,000 liters of residual liquid remaining in one 2.9 M-liter carbon steel tank and one 54,000-liter stainless steel tank.

BACKGROUND

WVNSCO achieved the first two requirements of the WVDP for DOE, completing the vitrification campaign in 2002, and placing the 275 HLW canisters into safe storage on site in canisters designed for permanent disposal. Since that time, the Project focus has shifted to deactivation and decontamination (D&D) of Project facilities, waste management and disposal, and management of the underground HLW tanks and an on-site waste disposal area.

In order to complete the last three requirements of the Act [4], the Project stakeholders must come to agreement regarding the final state of the Project premises and determine a safe and sensible solution for managing the Project's more complicated waste streams. West Valley

remains the only US facility to have processed commercial spent nuclear fuel. The fact that New York State (NYS) owns the site while the clean-up effort is being led by the DOE has complicated the disposal options for some of the waste generated during the clean-up initiatives. Over the past four years, positive advancements have been made between NYS and the DOE, including the issuance of the Phase 1 Final EIS ROD [2] and settlement of a cost sharing agreement between NYS and DOE [3]. However, there still remain several outstanding waste issues that impact the ability of the Project to complete its mission. While DOE is moving forward with the next phase of the Project to reduce site infrastructure and related facilities, lack of defined disposal options for at least nine problematic wastes will require continued on-site storage and may require future processing to meet final transportation and disposal requirements.

HISTORICAL PLANT OPERATIONS

Spent Nuclear Fuel (SNF) reprocessing operations occurred at the West Valley facility over a span of six years (1966 – 1972). The SNF was received by both rail and truck using transport casks. After receipt on-site, the cask was prepared for and placed underwater in a deep cask unloading pool. With water providing both shielding and contamination control, the SNF was removed from the transport cask, loaded into storage cans and transferred to a storage pool awaiting the next step in the fuel reprocessing operation.

The SNF assemblies were transferred one at a time from the storage pool to the Process Mechanical Cell (PMC) for shearing. This shearing operation started with a preliminary fuel inspection followed by fuel marking for sawing. In the PMC, the fuel assembly was moved by crane to the saw table where the end fittings and other extraneous metal, such as tube sheets were removed. A saw was used to slit open fuel assembly casings or to reduce the cross-sectional dimensions of the fuel to be sheared, as necessary. Large pieces of hardware were removed and sawed into smaller sections if necessary. All removed hardware was placed in 132-liter drums, transferred through a hatch to the underlying General Purpose Cell (GPC) and subsequently removed for disposal at the on-site burial area. This mechanical disassembly was a first of a kind operation at the West Valley facility.

The fuel assembly was pushed out of its casing into a shear feed magazine. The fuel assembly was sheared into pieces nominally 2.5 to 4.0 cm long which dropped 3 meters through a discharge chute into baskets positioned in the underlying GPC. When the basket was filled, it was removed from the chute and transferred to a storage rack in the GPC until six baskets, a full dissolver load, had been prepared.

In support of the dissolution process, six fuel baskets containing chopped fuel were transferred one at a time from storage in the GPC to the dissolvers in the Chemical Process Cell (CPC) through a hatch between the GPC and CPC. The dissolvers were filled with nitric acid which leached the uranium, plutonium and fission products from the chopped fuel casings leaving behind the metal hulls as residue in the baskets. The baskets containing leached hulls were then returned to the GPC. In the GPC, the baskets were dumped onto a leached hull sampling and inspection table where the hulls were visually inspected and sampled for analysis to ensure dissolution and support accountability records. The scrap hulls were collected into 132-liter drums and removed from the GPC through a hatch into the scrap removal room where the containers were placed in casks positioned on a shielded truck. The truck then transported the scrap materials to an on-site burial area for disposal.

Meanwhile, the dissolved SNF was processed through a series of chemical extraction columns where the uranium and plutonium were separated from the waste fission products. The fission products were sent to the HLW Tank Farm and the recovered uranium and plutonium were packaged as the product of this plant.

Following shut down for upgrades, NFS extensively flushed the plant vessels and piping with a variety of chemicals to remove the contamination to the greatest extent possible to allow for the hands-on upgrades that NFS was anticipating on making. The flush solutions were transferred to the HLW Tank Farm following sampling and analysis.

Since DOE's arrival on-site in 1982, emphasis has been put into the D&D of the facilities used for the SNF reprocessing operations. The focus was first on preparation of space to support the HLW vitrification operations and then later on cleaning the facilities used during vitrification of the HLW, as well as preparing the project facilities for eventual closure. Wastes generated during early D&D efforts were disposed of on-site in the disposal facility mentioned above. In 1986, on-site waste disposal operations ceased and all subsequent Project wastes were placed into on-site storage for eventual off-site disposal. At its peak, the Project had nearly 28,300 m³ of legacy waste in storage (Fig. 1). After vitrification operations were concluded in 2002, the Project was able to focus attention and resources on waste management.



Fig. 1. At its peak, the Project had nearly 28,300 m³ of legacy waste in storage in tent-like structures and hardstands awaiting off-site disposal.

D&D activities resulted in removal of vessels, piping, equipment, debris, including SNF hulls, hardware, metal fines and dust, from SNF reprocessing and vitrification of the HLW. In

addition, wastes generated in the HLW Tank Farm included expended pumps, and other HLW contaminated equipment and debris. Over the past 8 years, waste shipping has become a priority for the Project and, as of December 2010, 36,790 m³ of LLW/MLLW has been shipped off-site for disposal. Based on the Phase 1 EIS ROD [2], it is estimated another 213,736 m³ of LLW/MLLW will be shipped in support of this portion of the project. Approximately 2,535 m³ of that waste falls into one of the problem areas identified in Table I.

Table I. WVDP Waste with No Current Path for Disposition	
DESCRIPTION	VOLUME
Waste Requiring a WIR Determination	381 m ³ (note 1)
TRU/GTCC Waste	1,950 m ³ (note 1)
SNF	0.3 m ³ (note 1)
Melter Evacuation Canisters	1.8 m ³ (2 canisters)
TRU Liquids	2.8 m ³
TRU Waste with Dose > 450 R/hr	2.3 m ³ (17 132-Liter drums)
TRU Waste with Dose >1000 R/hr	1.4 m ³ (10 132-Liter drums)
Vitrification Canister Samples	0.3 m ³ (2 132-Liter drums)
HLW Canisters	195 m ³ ft ³ (note 1)
TOTAL	2,535 m³

Note 1: Volumes are based on information contained in the West Valley Demonstration Project Phase 1 Decommissioning – Facility Disposition Request for Proposal [5]

Each of these problematic waste streams will be described in detail below.

WASTE REQUIRING A WASTE INCIDENTAL TO REPROCESSING DETERMINATION

Waste incidental to reprocessing (WIR) determination is a deliberate decision making process for declaring that certain wastes that may have been derived from or contacted by HLW can be managed as something other than HLW using either a citation or evaluation process. The citation process is specific to a list of wastes that are excluded from the HLW definition. The evaluation process requires that the generator demonstrate that specific criteria have been met per DOE Order 435.1 [1].

In 2000, the Project developed a site-specific procedure to complete WIR determinations per DOE O 435.1 [1] requirements as part of the waste characterization program. An independent review team, including the Nuclear Regulatory Commission (NRC), DOE and NYS representatives reviewed the procedure which was subsequently approved and implemented.

As part of the WVDP Act-required oversight, NRC issued site-specific License Termination Rule [6] criteria including WIR criteria applicable to on-site closure activities at the WVDP. DOE continues to apply the DOE O 435.1 [1] criteria to waste being shipped off-site for disposal.

In 2004, while planning for the disposition of three large vitrification processing components - the Slurry Fed Ceramic Melter (Melter), the Concentrator Feed Makeup Tank and the Melter Feed Hold Tank (Fig. 2) for disposal at Nevada National Security Site, actions were halted due to a WIR lawsuit in Idaho.

As a result of the lawsuit, DOE worked with Congress to develop criteria for making WIR determinations by the evaluation process. The legislation is contained in the Ronald Reagan National Defense Authorization Act, Section 3116 [7] which, although written specifically for the Idaho and South Carolina sites, is being applied equally across all DOE sites for consistency. This process establishes a specific NRC and public review of the draft WIR evaluation, which can last 90 days or more. A WIR evaluation for the melter has been drafted and is currently awaiting issuance to NRC and publication in the Federal Register upon approval from DOE.



Fig. 2. Three large vessels removed from the Vitrification Facility in 2004 await shipment off-site following a WIR determination.

TRU/GTCC WASTE DISPOSAL OPTIONS

The TRU waste inventory at West Valley is comprised of debris generated during D&D of site facilities throughout the Project's duration. Most wastes generated prior to 2001, some as early as 1986, were typically placed in the largest containers possible and placed into storage without consideration of long-term disposition. In large part, this was due to the Project's focus on HLW vitrification, the primary and most immediate project mission. However, at the same time there was also the lack of a decision regarding how TRU waste was to be defined at the Project. An earlier court case required that the Project clarify the TRU waste definition with the NRC.

As the TRU waste inventory at the Project grew, it became apparent in 2000 that a decision related to the disposition of the Project's TRU waste inventory was needed.

The only available facility for TRU waste disposal in the United States is the Waste Isolation Pilot Project (WIPP). However, per the WIPP Land Withdrawal Act (LWA) [8], WIPP can only accept defense-related TRU waste. At present, there is no pathway for West Valley TRU waste disposal.

The lack of a clear disposal pathway has resulted in multiple handling of the Project's TRU waste. Over the past 8 – 10 years, West Valley has been processing and/or repackaging TRU waste inventory (Fig. 3) per the evolving WIPP Waste Acceptance Criteria (WAC) [9]. In 2009, the Contact Handled (CH) Transuranic Packaging Instructions [10] were issued and WVDP has implemented this guidance. This required the Project to process waste that had been already been packaged to the new set of criteria adding both cost and risk.



Fig. 3. RH and CH TRU waste processing (right) ramped up over the past four years. Once processed per the WIPP waste acceptance criteria, the TRU waste is placed in on-site storage for eventual disposition (left).

At present there are two options for TRU waste at West Valley: (1) Pursue disposition at WIPP either through a Defense Determination or a change to the LWA [8]; or (2) Disposal as Greater-than-Class-C (GTCC) in a federal repository.

The first option, to pursue disposition at WIPP, is consistent with the current management philosophy of the Project. CH and RH TRU are being packaged in accordance with the WIPP WAC [9] for CH TRU and RH TRU waste for potential future transportation and disposal at WIPP. This is being done in compliance with existing requirements. If it is subsequently determined that WIPP is available for the disposal of the Project's TRU wastes, these wastes will be in a compliant and ready-to-ship condition. An alternative would be to gain WIPP acceptance through an act of Congress, such as an amendment to the WIPP LWA [8], but there are no efforts to pursue this option at this time.

The second option is to characterize and manage the WVDP TRU waste as GTCC per 10 CFR Part 61 [11]. By law, disposal of such waste material is the responsibility of the DOE. DOE is currently pursuing a GTCC EIS and has included the Project's TRU waste inventory in this evaluation. One option being considered for disposal of GTCC is ultimately WIPP. However, the completion of an EIS, selection of the GTCC disposal site and the issuance of a ROD will have to be completed before this alternative could be fully implemented.

In either option, DOE is facing challenges to develop a timely decision with regards to the path forward for Project TRU or GTCC wastes.

SPENT NUCLEAR FUEL

There are two 132-liter drums that DOE has identified as SNF. These two containers were generated during the clean-up of the Head End Cells (HECs) between 2002 – 2004. Due to high dose rates, the containers are currently stored in the canister racks in the HLW Interim Storage Facility (HLWISF) in the Main Plant Process Building (MPPB). With the implementation of the next contract cycle, these containers will have to be removed from the MPPB and stored in another location, such as with the HLW canisters in the Canister Interim Storage Casks. Ultimately, these two drums contain materials similar in nature to other drums of waste removed during the HEC decontamination effort, but have been differentiated due to operations documentation suggesting that recognizable pieces of fuel were packaged in them. These drums may require future processing to remove and package their contents in accordance with a yet-to-be-defined set of transportation and disposal criteria.

There are a number of existing regulatory definitions for SNF, all having very similar meanings including DOE Manual 435.1 [12], Nuclear Waste Policy Act (NWPA) of 1982 [13], Atomic Energy Act of 1954 [14], 40 CFR Part 91 [15], 10 CFR Part 61[11] and 10 CFR Part 72 [16]. These comparable definitions have essentially two requirements to be SNF:

- 1) Fuel that has been withdrawn from a nuclear reactor following irradiation,
- 2) The constituent elements of which have not been separated by reprocessing.

Application of this SNF definition was limited to two drums and not the remaining population of HEC drums. The balance of HEC containers consists of debris, tooling and equipment generated during the mechanical size reduction of SNF prior to chemical reprocessing. The hulls, fines and other related fuel hardware and tooling were packaged during Project decontamination operations. Unlike the two drums labeled SNF, the balance of the HEC containers do not contain recognizable pieces of fuel based on operational documentation. The contaminants commingled in this waste material include SNF radioisotopes such as uranium and plutonium.

Dose rates on the HEC containers range from <100 mR/hr to 4,100 R/hr. The two drums that contain the documented spent fuel have dose rates of 256 and 881 R/hr. All of the HEC waste was packaged as TRU waste in accordance with the then applicable WIPP WAC [9].

Repackaging, if necessary for the SNF drums, will require a robust facility and repackaging criteria. With Yucca Mountain unavailable for HLW disposal, near-term decision making is unlikely. In addition, if extrapolation of the SNF definition is made to the remaining HEC drums other issues are likely, including exclusion to WIPP per the LWA [8]. SNF is prohibited for disposal at WIPP per the WIPP LWA [8], which states “The Public Law 102-579, Waste Isolation Pilot Plant LWA [8], bans the disposal of spent nuclear fuel and high-level waste, as defined by the Nuclear Waste Policy Act of 1982 (NWPA) [13], at WIPP.”

TRU LIQUIDS

There are 28 m³ of packaged liquids in storage that are currently classified as TRU waste. Due to the nature of these liquids, consultation with WIPP (if selected as the final disposal location) would be necessary to ensure that they are solidified and/or treated to meet acceptance criteria. Similar to other site TRU wastes, a disposal path has not been selected and therefore these

wastes are in an indeterminate state. Since solidification would be necessary for transportation at an alternate location, site infrastructure to support such solidification may be required.

TRU WASTE WITH DOSE RATES ABOVE 450 R/HR AND 1,000 R/HR

There are a number of TRU waste containers currently in storage at West Valley that have dose rates that are either above 450 R/hr or 1,000 R/hr. These drums are, for the most part, coincidental to those that were removed from the HECs and contain SNF debris materials. Containers greater than 450 R/hr are of concern from a transportation perspective. The standard transportation cask for RH-TRU waste going to WIPP has licensing limits that West Valley waste would exceed, based on its radioisotope distribution. There are three options for these waste containers:

- 1) Either ship the waste in a different cask that has higher limits and modify procedures at WIPP to allow acceptance,
- 2) Repackage the waste such that the licensing criteria of the standard RH TRU shipping cask can be met, or
- 3) Wait until dose rates naturally decay to accepted limits.

There are also seven containers of waste that have dose rates above 1,000 R/hr. These containers are problematic from both a transportation perspective as described above and from a disposal perspective, particularly if these wastes are going to WIPP. The LWA [8] for WIPP limits the dose rate on the waste being received to less than 1,000 R/hr. Although there is some ability to shield these containers down to less than 1,000 R/hr and still ship them in a configuration that can go in a standard shipping cask, this is not possible for all of the containers, one of which is as high as 4,100 R/hr. Ultimately, a portion of these containers will require repackaging depending on the disposal option pursued, which is currently TRU or GTCC disposal.

HLW CANISTERS AND EVACUATED CANISTERS

During vitrification of the 2.6 million liters of HLW generated during historical SNF reprocessing operations, 275 canisters of glass were produced. As part of controlled shut down of the Vitrification system to the maximum extent technically and economically practical, two canisters of glass were also generated while flushing the melter with clean glass. These two canisters are commonly referred to as evacuated canisters (Fig. 4).

The 275 HLW canisters and 2 canisters of flushing glass are stored in racks in the High Level Waste Interim Storage Facility (HLWISF) in the MPPB. The plan was to dispose of the HLW canisters at the Federal Repository at Yucca Mountain. However, with the continuing controversy regarding whether Yucca Mountain is the appropriate repository for SNF and HLW, the long term plans for the glass canisters remains unclear. The evacuated canisters are considered TRU waste using the WIR process based on its incidental nature as decontamination solutions. To move forward at the Project, DOE has decided to construct an alternate storage facility on site so that all of the glass canisters can be readied for ultimate shipment and allow the MPPB to be removed. The current path forward is to design an above-ground storage facility, and to develop a method to package and move the canisters from their current location to the new above-ground interim storage area to await long-term decision-making.

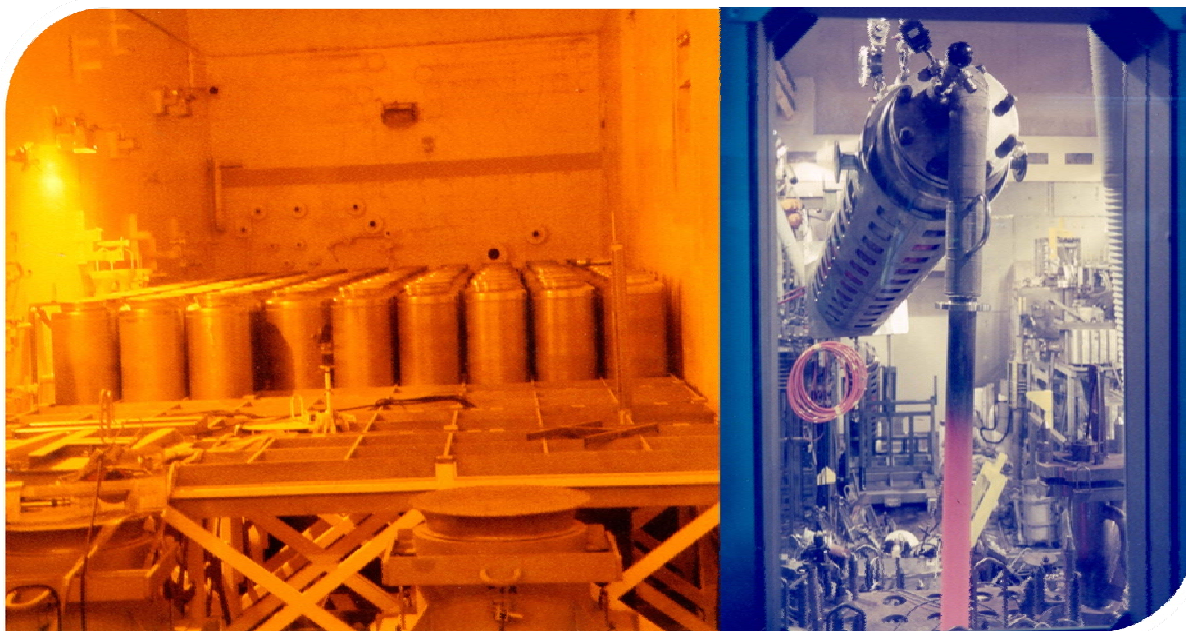


Fig. 4. Over six years, 275 HLW canisters were generated and placed in storage in the MPPB (left). During controlled shut down, two canisters (evacuated canisters) were used to empty the melter of the flushing glass (right).

There is an issue associated with the glass canisters and their potential acceptability at whatever repository is ultimately determined to be appropriate. The glass canisters have already been made to the specifications of the assumed Yucca Mountain Repository. If another alternative is decided and the specifications of the waste stream are changed then these canisters are potentially at risk. In addition, the two evacuated canisters do not have a disposal option and due to their association with the melter may not be acceptable at WIPP or a GTCC repository. Due to dose rates, these evacuated canisters would have the same issues as discussed above regarding transportation and disposal at WIPP. If they were required to be managed as HLW, they would need to be considered off-specification, because they do not meet the criteria for HLW glass canisters.

CONCLUSION

West Valley has a long history of working within existing guidance and various regulatory issues to develop programs to keep waste processing and waste packaging constantly moving forward, even with the issues that have been discussed. However, experience has shown that processing waste without a defined path for disposal creates risks and may result in more costly rework in the future.

The lack of a final decision for these WVDP issues creates the possibility of someday re-handling high activity, high dose, radioactive waste, once a final disposition is established without the site infrastructure to accommodate such processing.

In summary, West Valley's "problematic" wastes require near-term decisions to allow DOE to move forward on the next phase at West Valley. While creative solutions and assumptions have helped to keep WVDP progressing forward to date, key decisions that consider the life cycle

management of these wastes is critical. These decisions should consider long-term storage, transportation, reprocessing, and disposition options in light of completing the mission objectives at West Valley in a timely and cost-effective manner.

REFERENCES

1. DOE Order 435.1, Radioactive Waste Management.
2. Phase 1 Final Environmental Impact Statement Record of Decision, EIS/ROD-0226 (April 14, 2010).
3. Consent Decree between DOE and NYSERDA, No. 06-CV-810 (August 2010).
4. West Valley Demonstration Project Act, PL 96-368 (October 1, 1980).
5. West Valley Demonstration Project Phase 1 Decommissioning – Facility Disposition Request for Proposal, DE-SOL-0002084 (October 13, 2010).
6. NRC Final Policy Statement on Decommissioning Criteria for the WVDP (License Termination Rule), 67 FR 5003 (February 1, 2002).
7. Ronald Reagan National Defense Authorization Act, PL 108-375, Section 3116 (October 28, 2004).
8. WIPP Land Withdrawal Act, PL 102-579 (November 19, 1990).
9. Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, DOE/WIPP-02-3122 (December 29, 2010).
10. Contact-handled Transuranic Waste Packaging Instructions, Revision 1.
11. 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste.
12. DOE Manual 435.1, Radioactive Waste Management Manual.
13. Nuclear Waste Policy Act of 1982, PL 97-425 (January 7, 1983).
14. Atomic Energy Act of 1954, PL 83-703 (August 30, 1954).
15. 40 CFR Part 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes.
16. 10 CFR Part 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.