Innovative Disposal Practices at the Nevada Test Site to Meet Its Low-Level Waste Generators' Future Disposal Needs

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ABSTRACT

Low-level radioactive waste (LLW) streams which have a clear, defined pathway to disposal are becoming less common as U.S. Department of Energy accelerated cleanup sites enters their closure phase. These commonly disposed LLW waste streams are rapidly being disposed and the LLW inventory awaiting disposal is dwindling. However, more complex waste streams that have no path for disposal are now requiring attention.

The U.S. Department of Energy (DOE) National Nuclear Security Administration Nevada Site Office (NSO) Environmental Management Program is charged with the responsibility of carrying out the disposal of onsite and off-site defense-generated and research-related LLW at the Nevada Test Site (NTS). The NSO and its generator community are constantly pursuing new LLW disposal techniques while meeting the core mission of safe and cost-effective disposal that protects the worker, the public and the environment.

From trenches to present-day super-cells, the NTS disposal techniques must change to meet the LLW generator's disposal needs. One of the many ways the NTS is addressing complex waste streams is by designing waste specific pits and trenches. This ensures unusual waste streams with high-activity or large packaging have a disposal path.

Another option the NTS offers is disposal of classified low-level radioactive-contaminated material. In order to perform this function, the NTS has a safety plan in place as well as a secure facility. By doing this, the NTS can accept DOE generated classified low-level radioactive-contaminated material that would be equivalent to  . Nuclear Regulatory Commission Class B, C, and Greater than Class C waste.

In fiscal year 2006, the NTS will be the only federal disposal facility that will be able to dispose mixed low-level radioactive waste (MLLW) streams. This is an activity that is highly anticipated by waste generators. In order for the NTS to accept MLLW, generators will have to meet the stringent requirements of the NTS Waste Acceptance Criteria.

The disposal operations previously mentioned take place at the NTS in two disposal facilities. The isolation protection and overall performance of the two LLW disposal facilities at the NTS transcend those of any federal radioactive waste disposal site in the United States. The first of the two disposal sites is the Area 5 Radioactive Waste Management Site (RWMS) which is situated

on alluvial fan deposits in the Frenchman Flat basin, approximately 770 feet (235 meters) above the water table. The Area 5 RWMS utilizes a combination of engineered shallow land disposal cells and deep augured shafts for the disposal of a variety of waste streams.

Fifteen miles (24 kilometers) north of the Area 5 RWMS is the Area 3 RWMS located approximately 1,600 feet (488 meters) above the water table in Yucca Flat. Disposal activities at the Area 3 RWMS center around the placement of bulk LLW in subsidence craters formed from underground testing of nuclear weapons. Native alluvium soil is used to cover waste placed in the disposal cells at both facilities.

In addition, information on the technical attributes, facility performance, updates on waste disposal volumes and capabilities, and current and future disposal site requirements will also be described.

INTRODUCTION

The NTS is a federal facility that is approximately 1,375 square mile ,561 square kilometers) situated 65 miles (104 kilometers) northwest of Las Vegas, Nevada. Access to the remotely-located NTS is restricted with additional protection provided by the buffer of U.S. Air Force and Bureau of d Management property which surrounds it. In fact, the nearest population center to the Area 5 RWMS is a rural community 24 miles (39 kilometers) to the southeast (Fig. 1). The remoteness and the security of the radioactive waste management facilities provide protection to distant population centers and against unwanted intruders.

On January 27, 1951, the first nuclear device was tested at the NTS. This test effectively started the need for an onsite low-level radioactive waste disposal site. The same conditions that made the NTS an ideal location for the testing of nuclear weapons also made it suitable for the management of radioactive waste.

Historical records indicate that as early as 1953, LLW generated by weapons testing activities was collected at a site in Area 5 of the Nevada Test Site. The first disposal trench, Sugar Bunker, was cut into the alluvium at Area 5 RWMS in January 1961.

In July 1968, following the success of the a 5 RWMS, the U.S. Department of Energy Nevada Operations Office (now the NSO) located its second LLW disposal site 13 miles (21 meters) north in Area 3 o e NTS. This new site, called the Area 3 RW , used subsidence craters formed by past nuclear tests as radioactive waste disposal cells.

In addition to the favorable physical attributes, various environmental conditions add to the technical basis for the operation of disposal facilities. Both the Area 5 and Area 3 RWMSs are located in closed basins that are well above the water table at approximately 770 feet (235 meters) and 1,600 feet (488 meters), respectively. In fact, the average annual rainfall at the sites is four to six inches (10 to 15 centimeters), while evaporation exceeds rainfall by 14 times. This combination of extremely dry climate, deep groundwater, and "sponge-like" alluvial soil severely limit the likelihood of any water migrating into the disposal cells, surface water, or subsurface water.

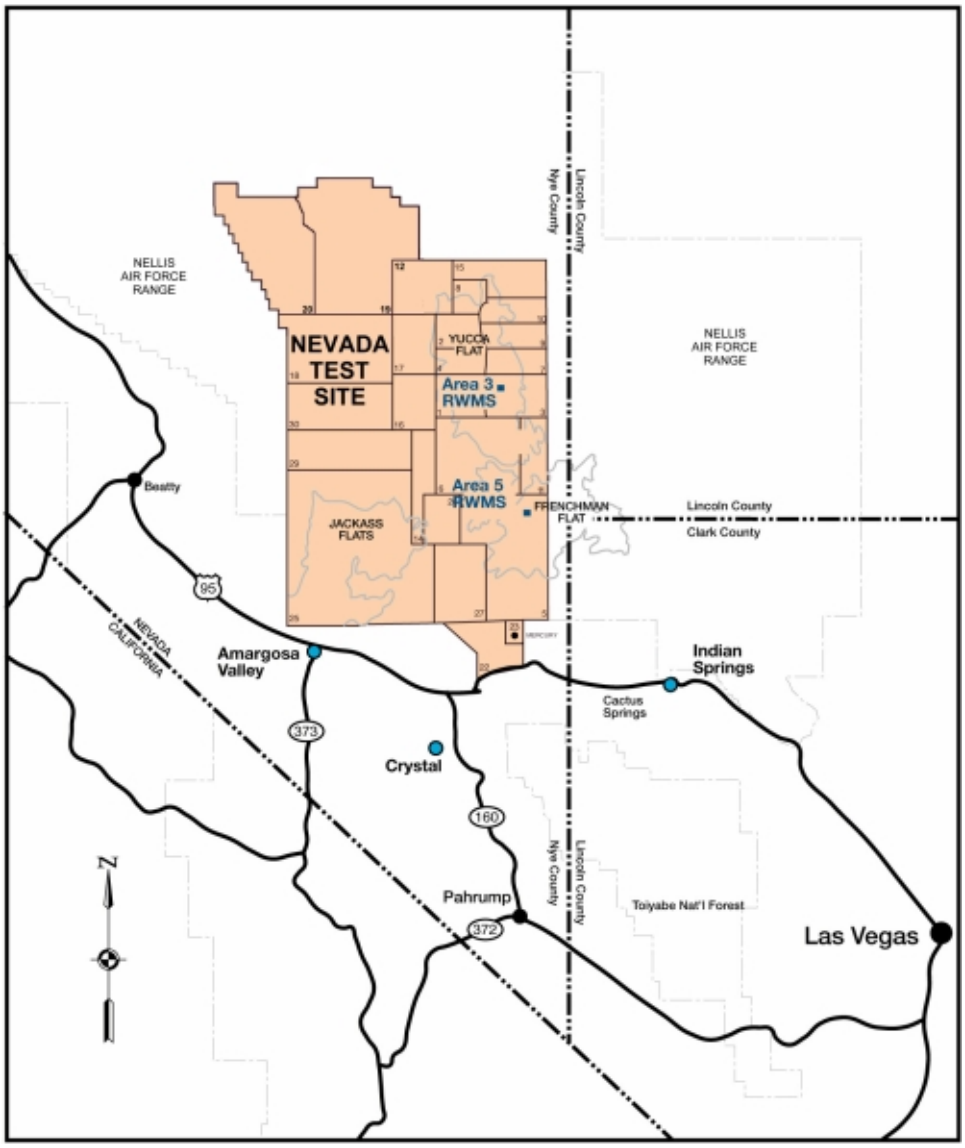

Fig. 1. Regional location of the Nevada Test Site and its disposal facilities

Because the NTS is regulated by DOE Order 435.1, Radioactive Waste Management, the NTS developed site-specific LLW performance assessments and composite analyses. The DOE Order (via its DOE 435.1-1 Manual) establishes Performance Objectives the RWMSs must meet in order to protect human health and the environment. These objectives are:

1. The air pathway dose must not exceed 10 mrem
2. The all pathways dose must not exceed 25 mrem
3. Radon flux must be less then 20 pCi/m^2/sec
4. The proposed site must be protective of groundwater resources
5. The site must protect the inadvertent human intruder

The NTS analyzes each proposed LLW stream against these Performance Objectives before it is accepted for disposal at the RWMSs. As a DOE Order 435.1 disposal site, the NTS has more

flexibility to accept LLW. Generators can dispose of higher activity LLW (e.g., LLW that would be Class B, C, or Greater than Class C waste if such wastes were regulated by the U.S. Nuclear Regulatory Commission) at the NTS because the NTS can bury LLW deeper to meet DOE Order 435.1 disposal requirements.

Often, as an approved LLW generator approaches its final stages of closure, the LLW generator will start proposing more complex LLW streams for disposal. As the NTS analyzes these waste streams against the Performance Objectives of DOE Order 435.1, there is a need to become more creative in engineering LLW disposal cells to meet the generator's needs. Fortunately, NTS performance assessment modeling tools provide quick evaluations of the proposed LLW waste streams to help the engineers design such disposal cells.

NTS LLW DISPOSAL CAPABILITIES

There are 732 acres (296 hectares) available for LLW disposal in Area 5, of which approximately 160 acres (56 hectares) are currently used by Disposal Operations (Fig. 2). The Area 3 RWMS covers 120 acres (49 hectares). Currently, the remaining LLW capacity in the developed subsidence craters at the Area 3 RWMS is approximately 1,000,000 cubic feet (approximately 37,000 cubic meters). The remaining LLW/MLLW capacity of the engineered disposal cells at the Area 5 RWMS is approximately 4 million cubic feet (approximately 148,000 cubic meters).

Fig. 2. Area 5 Radioactive Waste Management Complex at the Nevada Test Site.

Although the Area 3 RWMS has an additional 10 million cubic feet (approximately 370,000 cubic meters) of LLW disposal capacity in its two undeveloped subsidence craters, the forecasted LLW volumes for the next 5-years are not compelling to require the development of these

subsidence craters for disposal. Therefore, in the 2nd quarter of fiscal year 2006, the NTS will place the Area 3 RWMS on stand-by, meaning it will not be used for radioactive waste disposal unless a future need demands its use. In the near future, the NTS will be developing a closure performance assessment for the Area 3 RWMS facility.

Current plans for radioactive waste management at the NTS after 2nd Quarter 2006 is to dispose all LLW/MLLW at the Area 5 RWMS. Once the remaining 4 million cubic feet (approximately 148,000 cubic meters) are used, the additional disposal cells will be engineered in the unused portions of the 732 acre RWMS (approximately 590 acres). The NTS estimates that once the 4 million cubic feet (approximately 148,000 cubic meters) of current capacity is consumed in the existing LLW disposal cells, 116 million cubic feet (3.3 million cubic meters) more LLW can be accommodated by developing the unused portions of the Area 5 RWMS.

Although the Area 5 RWMS typically receives conventionally packaged LLW in containers such as steel drums and 4 x 4 x 7 feet (1.2 x 1.2 x 2.1 meters) or 2 x 4 x 7 feet (0.6 x 0.6 x 2.1 meters) wooden and steel boxes, lesser known, but still U.S. Department of Transportation compliant, packaging techniques have been used for more challenging LLW streams accepted at the NTS from approved DOE and U.S. Department of Defense generators. Specialized disposal cells have been constructed at the Area 5 RWMS to address generator needs to dispose more complex LLW streams. Examples of specialized disposal cells and innovative disposal techniques used at the NTS follows.

Classified Low-Level Contaminated Material

The NTS is the only facility in the nation that can take classified low-level contaminated material. These materials are not considered waste because the materials still contain useful information to the DOE, and as such, the materials must be retrievable. The classified low-level contaminated materials must conform to NTS security plans before disposition inside the Area 5 RWMS. Although classified low-level contaminated materials have been accepted at the Area 5 RWMS almost from its creation, these materials often do not fit into conventional disposal packages and may require specialized storage configurations. Disposal Operations at the Area 5 RWMS position large items, small items, and odd-shaped items all in the same cell. Once placed in the cell, Disposal Operations personnel cover the material with soil to conceal the classified packages from view.

Foster-Wheeler LLW Disposal Cell

In fiscal year 2004, Foster-Wheeler approached the NSO with a need to dispose of high-activity LLW. The waste form would be approximately 100 monoliths that required remote handling (see Fig. 3). The NTS RWMS performance assessments team analyzed the proposed waste stream and concluded the LLW stream would meet the Performance Objectives of DOE Manual 435.1-1. NTS Disposal Operations engineered a single trench that measured 23 feet wide x 15 feet deep x 900 feet long (7 x 4.5 x 274 meters). Operations then nested the monoliths among cargo containers (20 feet [6 meters] long) and buried the LLW immediately to inhibit radiation exposure. Foster-Wheeler completed its campaign of these LLW monoliths in June of 2005.

Fig. 3. A Foster-Wheeler high-activity LLW monolith being disposed at the Area 5 RWMS

Fernald 11e(2) Materials

Beginning in 2000, the NSO worked with the Fernald Closure Project regarding the disposal of approximately 160,000 cubic feet (4,600 cubic meters) of 11e(2) material. The radionuclide of concern was radon gas produced by the decay of the thorium contained in the material. The performance assessments team calculated that if the Fernald packaged material was buried in a single layer cell in a 25 feet (7.6 meters) deep disposal cell and then covered the material with approximately 27 feet (8 meters) of soil, the disposed 11e(2) material would meet DOE Manual 435.1-1 performance objectives. Thus NTS Disposal Operations engineered such cells (see Fig. 4).

Defense Logistics Agency Thorium LLW

Around the time that NTS Disposal Operations engineered the Fernald disposal cells, the Defense Logistics Agency approached the NSO regarding Thorium LLW it needed to dispose. Since Fernald waste stream acceptance at the NTS encountered legal challenges, the Defense Logistics Agency Thorium LLW was disposed in a cell originally engineered for Fernald. The Defense Logistics Agency's shipping campaign was a completely flawless success and ended in August 2005.

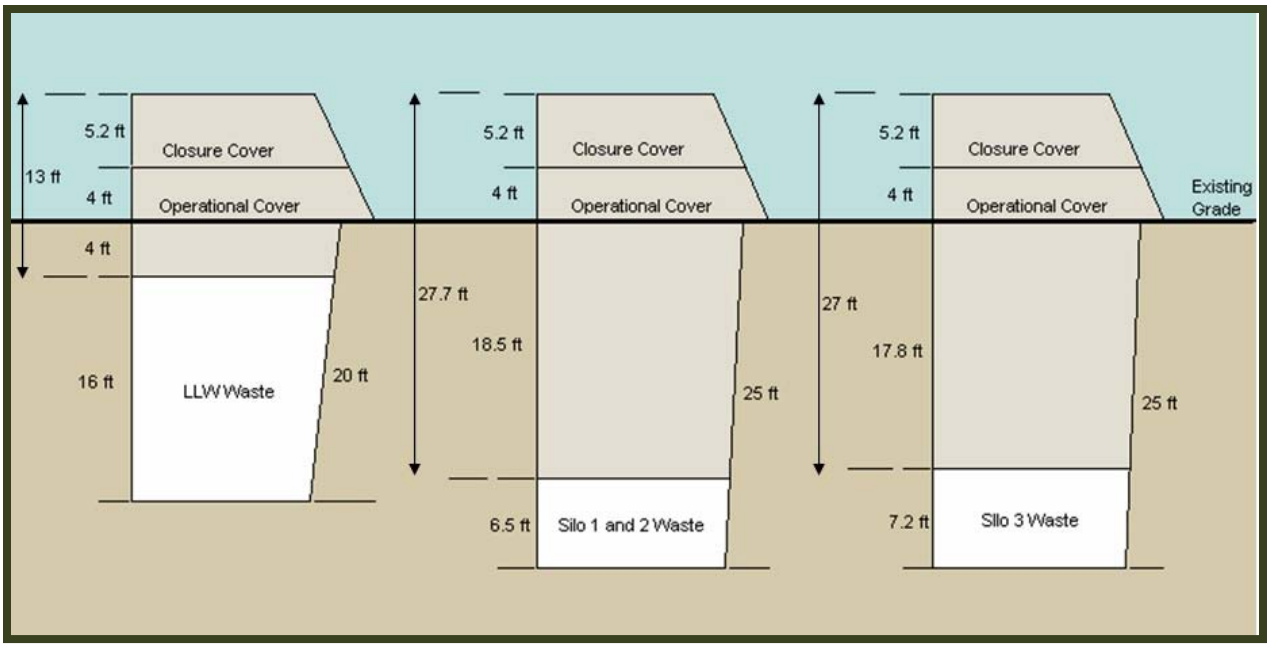

Fig. Schematic of proposed Fernald 11e(2) material disposal in cells at the Area 5 RWMS

West Valley Large LLW Items (the LLW Super Cell)

In 2005, West Valley (an approved LLW generator) approached the NSO to discuss the disposal of very large LLW packages at the NTS. The packages of LLW would be so large that the truck used for transporting them would be unable to turn-around in existing disposal cells. As a result, Disposal Operations constructed a cell that allows trucks transporting LLW to enter the disposal cell, drop-off its cargo, and exit the cell (via a back door). To date, the West Valley LLW packages have not yet been delivered to the NTS.

Piggy-Backing LLW Stream

"Piggy-backing" is an action where a potential, uncertified NTS Waste Acceptance Criteria (NTSWAC) LLW generator uses a certified NTSWAC generator's program to ship LLW to the NTS. The NTS allows generators to "piggy-back", because there are LLW streams and/or generators that are relatively small in size and/or volume. In these situations, it is simply too expensive for the potential LLW generator to fund an NTSWAC certified program. Thus, the small uncertified LLW generator will contact a large generator and use the larger generator's certified LLW program to dispose of its LLW.

Although "piggy-backing" has been around for some time, it is not been used very often by the LLW generator community. However, the Berkley National Laboratory successfully used Lawrence Livermore's NTSWAC certified program to ship LLW to the NTS in order to meet clean-up program goals.

Since the NSO allows "piggy-backing," two commercial LLW generators, Duratek and Perma-Fix, developed NTSWAC certification programs in fiscal years 2005 and 2006. Duratek

successfully achieved its certification in the 2nd Quarter of fiscal year 2005 and completed its first LLW shipment to the NTS in the summer of 2005. Perma-Fix also succeeded in obtaining their NTSWAC certification for LLW as well as MLLW early this calendar year.

MIXED LOW-LEVEL RADIOACTIVE WASTE

On December 1, 2005, the State of Nevada reissued the NTS its Resource Conservation and Recovery Act Part B Permit. The signing of the permit opened the door to off-site disposal of MLLW from approved NTS generators for the first time since 1985. The NTS is the only federal facility that can dispose DOE-generated MLLW in the nation. However, conditions set forth in the Part B Permit limit MLLW acceptance to a maximum of 706,000 cubic feet (20,000 cubic meters) for a period of five years (through November 2010), whichever comes first.

Because higher-activity LLW (e.g., Class B, C, or Greater than Class C waste if regulated by the NRC), can be disposed at the NTS, the NSO recommends the approved generator community prioritize MLLW streams and submit (for review and approval) profiles for the higher-activity MLLW first. The NSO is aware that this advice is opposite of current generator practices since the higher activity MLLW is more difficult to characterize and send to the NTS. However, such prioritization will allow MLLW streams that formerly had no disposal path forward, to be disposed at the NTS in the time allowed (i.e., before the five-year window of opportunity closes). In addition, the simpler and lower-activity MLLW streams (e.g., Class A waste streams if regulated by the NRC) currently have a disposal path forward at a commercial facility.

CONCLUSION

Radioactive waste disposal has been occurring at the NTS for more than 40 years. The experience and knowledge acquired during this time has provided an edge for developing flexible and safe solutions for approved DOE and U.S. Department of Defense generator needs. Today, performance assessment tools (the NTS modeling platform) developed and used at the NTS are instrumental to designing cells (trenches and super cells) which maintain radioactive waste disposal flexibility. This flexibility combined with the dedicated area available for expansion and the required disposal permits (the NTS Part B Permit) makes the NTS a premier facility capable of meeting the future LLW disposal needs of the DOE complex.

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