WASTE MANAGEMENT AT THE NEVADA TEST SITE YEAR 2003 CURRENT STATUS

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ABSTRACT

The performance objectives of the U. S. Department of Energy's Nevada Site Office Low-level Radioactive Waste (LLW) disposal facilities located at the Nevada Test Site transcend those of any other radioactive waste disposal site in the United States. Situated at the southern end of the Great Basin, 244 meters (800 feet) above the water table, the Area 5 Radioactive Waste Management Site (RWMS) has utilized a combination of engineered shallow land disposal cells and deep augured shafts to dispose a variety of waste streams. These include high volume low-activity waste, classified material, and high-specific-activity special case waste. Fifteen miles north of Area 5 is the Area 3 RWMS. Here bulk LLW disposal takes place in subsidence craters formed from underground testing of nuclear weapons. Earliest records indicate that documented LLW disposal activities have occurred at the Area 5 and Area 3 RWMSs since 1961 and 1968, respectively. However, these activities have only been managed under a formal program since 1978. During fiscal year 2003 the Nevada Test Site (NTS) Low-level Waste Operations is expected to dispose over 3 million cubic feet of LLW, the largest waste volumes ever disposed at these facilities. Preliminary waste forecasts for fiscal year 2004 indicate a continuance of these high volumes as the complex continues its cleanup and closure efforts. This paper describes the technical attributes of the facilities, present and future.

INTRODUCTION

In 1978, what is now known as the Nevada Site Office (NSO) established a managed LLW disposal project at the Nevada Test Site (NTS). Two sites, that were already accepting limited amounts of on-site generated waste for disposal and off-site generated Transuranic Waste for interim storage, were selected to house the disposal facilities. In those early days, the sites, located about 24 kilometers (15 miles) apart, afforded the NSO the opportunity to use at least two alternative technologies to effectively manage its disposal cost. The Area 5 RWMS uses engineered shallow-land burial cells to dispose packaged waste while the Area 3 RWMS uses subsidence craters formed from underground testing of nuclear weapons for the disposal of packaged and unpackaged bulk waste.

Authorization Basis

The Areas 3 and 5 RWMSs are classified as Category II Non-reactor Nuclear Facilities. The authorization to operate the RWMSs is based on a variety of documents which may include, but are not limited to, Integrated Safety Management System Description, Activity Agreements, Real Estate and Operating Permit, appropriate Safety Analysis documentation, Execution Plans, Environmental Impact Statement, Health and Safety Plan, and procedures. A Disposal Authorization Statement (DAS) was received in October 1999 for Area 3. In October 2000, the NSO Manager approved the NTS Integrated Closure and Monitoring Plan as well as the Performance Assessment and Composite Analysis Maintenance Plan as required by the Area 3 DAS. A DAS for Area 5 was received in December 2000. The Area 3 and 5 RWMSs received initial determination of acceptability from U.S. Environmental Protection Agency (EPA) pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Off-Site Rule, in July 1998. The determination of continued acceptability is evaluated annually.

Physical/Technical Attributes

The NTS is a federally owned restricted-access facility located on the southern end of the Great Basin in south central Nevada. It consists of approximately 3,561 square kilometers (1,375 square miles) and is surrounded by the Nellis Air Force Range and areas controlled by the Bureau of Land Management. The two disposal facilities are inside the boundaries of the NTS and are located 24 kilometers (15 miles) (Area 5) and 48 kilometers (30 miles) (Area 3) north of the main access gate. Remoteness to populated areas is a key feature that enhances the site characteristics. The closest populated area to either disposal facility is the small town of Indian Springs, Nevada located 55 kilometers (34 miles) to the southeast. Las Vegas, the closest major population, is approximately 105 kilometers (65 miles) southeast.

The Area 5 RWMS is located in the southeastern section of the NTS in Frenchman Flat, within a to pographically closed basin where all surface water drains into a playa. The facility is sited on a coalesced alluvial fan, south of the Massachusetts Mountains. The water table is 244 meters (800 feet) beneath the facility. Site characterization studies show that there is no aerially distributed recharge to the aquifer in the vicinity of the RWMS. In fact, hydrogeologic testing in boreholes show that in approximately the upper 46 meters (150 feet) of the vadose zone, the movement of moisture is upward (negative water potentials).

The Area 3 RWMS is located approximately 24 kilometers (15 miles) north of the Area 5 RWMS in the Yucca Flat basin, another closed basin where all surface drainage terminates in a playa at the south end of the basin. The water table is 488 meters (1,600 feet) beneath this facility. Both facilities receive on average 10-15 centimeters (4-6 inches) of precipitation annually.

Measurements at meteorological stations show that annual potential evaporation exceeds precipitation by greater than a factor of 14, and a moisture deficient state is maintained in the surface soils. The combination of the arid desert setting, the high evapotransporation potential, the generally homogeneous properties of the alluvium (matrix-dominated flow), the very slow rates of upward moisture movement, and the absence of a ground water pathway provide an ideal setting disposal and long-term isolation of radioactive waste.

The Nevada Test Site Waste Acceptance Criteria (NTSWAC) limits the amount of free liquids the waste can contain to one percent of the volume of the waste in a container. This equates to approximately 2 liters (one-half gallon) in a 208 liters (55 gallon) drum or 32 liters (eight gallons) in a 1.2x1.2x2.1 meter (4'x4'x7') box. The adequacy of these limits was verified in the Area 5 RWMS Performance Assessment (PA). In the PA, no credit was given for the packaging of the waste. All waste and radionuclide inventories were assumed to be available to the transport process immediately upon final closure of each cell. A bounding scenario in the PA model assumed uniform closure cap subsidence to a depth of 1.8 meters (six feet) below grade, three

successive 200 year flood events which filled the 1.8 meters (six foot) subsidence depression and then infiltrated the ponded water into the waste. Even under these extreme conditions, the disposal site did not exceed the regulated performance objectives.

To optimize utilization of the full disposal capacity of the disposal site, the NSO is in the process of refining and updating the PAs for both the Area 5 and Area 3 RWMSs. The DAS for these sites was based on conservative performance assessments that used bounding assumptions and parameter values in analytical and numerical models. The net result of this approach is an underestimation of the true disposal capability of the sites. This approach was suitable for establishing compliance of the facilities under the performance objective of U.S. Department of Energy Order 435.1. With issuance of the DAS, the facilities are now under a formal maintenance program that seeks to continue to test and verify PA models through site monitoring, and reduce uncertainty. To achieve these goals, the NSO is transitioning the existing deterministic PAs to probabilistic assessments and implementing these revised PAs through a simulation-based computer software program (GoldSim). There are multiple advantages to the transition. First, the probabilistic PAs will define the expected behavior and the uncertainty performance of the disposal sites, not bounding values for site performance. This will provide increased information to manage the facilities (quantification of uncertainty) and will likely result in less restrictive waste concentration limits. Both factors lead to increased potential for the NSO facilities to serve the needs of the U.S. Department of Energy complex. Second, implementation of the PAs in the GoldSim software decreases the time required to assess new waste streams and perform required yearly updates of the disposal sites. Revisions of the existing PAs using the GoldSim software require only updating the parameter values in the models and overnight computer runs. More importantly, assessment of problematic waste streams that normally require lengthy and costly performance assessments can now be conducted through the routine maintenance program with no additional costs for the waste generators.

Full benchmarking of a deterministic version of the GoldSim PA model for the Area 5 RWMS was completed in fiscal year 2002. The first fully probabilistic GoldSim version of the Area 5 PA was completed in late fiscal year 2002. It is now being evaluated with enhanced sensitivity and uncertainty analyses and will be used for initial assessments of new waste streams in fiscal year 2003. A probabilistic PA model for Area 3 is also scheduled for completion in fiscal year 2004.

Acceptance Process

The NTSWAC establishes the standard and requirements that generator sites must meet in order to receive approval to ship radioactive waste to the NTS. The NTSWAC covers the generator waste certification program, characterization of the waste, traceability, waste forms, and packaging and transfer of the material. Radioactive Waste Acceptance Program (RWAP) personnel maintain the NTSWAC. The RWAP personnel review the generator's program and documentation to verify the generator sites capability to develop and maintain a NTSWAC compliant program. Waste profiles are reviewed and biennial program audits, annual assessments and periodic surveillances are conducted to verify and validate the generators' waste management programs. RWAP personnel can recommend the suspension of a generator program and/or waste stream that was found to be noncompliant or falls below standards described in the NTSWAC. In addition to the reviews by RWAP staff, the actual waste shipment and containers are inspected upon arrival at the RWMS facilities to verify items such as placards, manifests, marking and labeling, and container integrity. During fiscal year 2003 a joint effort by the NTS and Hanford Site resulted in the creation and implementation of a standardized LLW profile. This single profile form will enable waste streams to be reviewed for acceptability by either or both disposal facilities.

Disposal Process

Both RWMSs are shallow-land disposal facilities, but there are differences between the sites. Area 5 has 296 hectares (732 acres) available for disposal of LLW. Disposal Operations finally had to expand beyond the original 37 hectares (92 acres) compound. One new cell was opened in fiscal year 2003 in the new expansion area and 2 new cells are projected for construction in fiscal year 2004. At Area 5, LLW, NSO mixed low-level waste (MLLW) generated within the state of Nevada, radioactively contaminated regulated asbestos, and classified material are disposed. High specific activity LLW was disposed in Greater Confinement Disposal (GCD) boreholes; however, this disposal option is not currently being used. Additionally, there are facilities for the storage, characterization, and certification of Transuranic Waste.

Engineered disposal cells are used for disposition of waste at the Area 5 RWMS. The disposal cells are excavated and, consequently, are more expensive to develop than the subsidence craters used at Area 3. The Area 5 disposal space has historically been reserved for conventionally packaged waste in containers such as steel drums and 1.2 x 1.2 x 2.1 meters (4 x 4 x 7 feet) or 0.6 x 0.6 x 2.1 meters (2 x 4 x 7 feet) wooden and steel boxes. On occasion, other container sizes are accepted on a case-by-case basis, such as the regulated asbestos cell that accepts 2.4 x 2.4 x 6.1 meters (8 x 8 x 20 feet) cargo containers.

All packages accepted for disposal are required to meet the rigid U. S. Department of Transportation performance based packaging requirements. With the exception of cargo containers, the NTSWAC requires all boxes to meet a 1,500-kilograms/square meter (3,300-pound/square foot) compressive strength test. This provides a factor of safety for the workers. The waste packages disposed at Area 5 are stacked one upon the other in a stair step configuration, until the stack is four feet below the top of the cell walls. Because these packages can weigh as much as 4,090 kilograms (9,000 pounds) each, there is the potential for the bottom box in the stack having to support in excess of 27,000 kilograms (60,000 pounds) of loading. Thus, the strength criterion in conjunction with the stacking configuration ensures a secure work platform for the waste handling crew. Process safety is taken seriously, as the disposal operations have experienced only 2 lost-time accidents in more than seven years.

The Area 3 RWMS covers 49 hectares (120 acres). Area 3 disposes waste in subsidence craters formed from underground testing of nuclear weapons instead of conventional engineered cells. The criterion used for choosing these craters was that the emplacement of the nuclear device had to have been above the water table. This criterion was chosen to ensure that no preferential pathway would be available to the underlying aquifers. These disposal cells are considerably less expensive to develop than the Area 5 cells because the waste is disposed in existing subsidence craters. The disposal process also differs significantly here. Smaller packages are replaced with larger bulk-sized packages such as the previously mentioned cargo containers, large pieces of equipment, super sacks or soils in lined dump trailers, referred to as "burrito wraps." Instead of stacking the waste in a single monolith configuration, waste is disposed in layer-cake geometry with each layer of waste covered by a layer of compacted soil ranging from 0.3 to 0.9 meters (1 to 3 feet) in depth.

Disposal Access

The NTS RWMSs can receive LLW from 26 generators including: Aberdeen Proving Grounds; Argonne National Laboratory, East; Bechtel BWXT Idaho; Bechtel BWXT-Y12; Bechtel Jacobs, Oak Ridge Reservation; Bechtel Nevada; Boeing North American-Rocketdyne; British Nuclear Fuels Limited, Inc., Oak Ridge; Earthline Technologies; Fernald Environmental Management Project; Foster Wheeler, Oak Ridge; General Atomics; Honeywell, Kansas City; International Technology Corporation, Las Vegas; Lawrence Livermore National Laboratory; Lovelace Respiratory Research Institute; Mound Plant; Paducah Gaseous Diffusion Plant; Pantex Plant; Portsmouth Gaseous Diffusion Plant; Princeton Plasma Physics Laboratory; Rocky Flats Plant; Sandia National Laboratories/California; and Sandia National Laboratories/New Mexico;

Savannah River Site; and the West Valley Demonstration Project. U. C. Berkeley is currently shipping waste utilizing the Livermore Certification Program. Only NSO MLLW generated within the state of Nevada is currently accepted. However, NSO anticipates being operationally permitted to accept MLLW from off-site generators in calendar year 2004.

The Waste Management Programmatic Environmental Impact Statement Record of Decision for disposal of LLW and MLLW, issued on February 25, 2000, identified NTS as one of two regional disposal sites. It is anticipated during fiscal year 2004 that at least two new generators will receive approval to ship LLW to NTS. Los Alamos National Laboratory, U. C. Berkeley, Nuclear Fuel Services, the Defense National Stockpile Agency, and U. T. Battelle, are either considering or actively pursuing NTS Approved Generator status.

Present and Future Capabilities for Waste Disposal

The current Area 5 RWMS inventory of disposal cells is 25; not including the GCD boreholes. These range in size from 25 to 345 meters (83 to 1,133 feet) long, 9 to 102 meters (30 to 336 feet) wide, and 4 to 15 meters (12 to 48 feet) deep. The total disposed volume of waste in these cells is over 301,600 cubic meters (10.6 million cubic feet). Available open capacity at Area 5, in existing cells, is approximately 160,049 cubic meters (5.6 million cubic feet). This includes the 20,000 cubic meters (706,000 cubic feet) being proposed for MLLW disposal. Two new cells with a capacity of 62,300 cubic meters (2.2 million cubic feet) will be constructed in fiscal year 2004. No master plan currently exists for the layout of future cells across the total 296 hectares (732 acres). However simple calculations based upon existing inventory for the 37 hectares (92 acres) show that the current capacity averages 4,572 cubic meters per 0.4 hectares (161,000 cubic feet of waste per acre) of available ground. Extrapolation of this calculation for the total 296 hectares (732 acres), taking no credit for future technology such as deeper cells, shows the total capacity of Area 5 RWMS is about 3.3 million cubic meters (118 million cubic feet).

The Area 3 RWMS includes a total of seven craters, representing five cells, designated for disposal operations. The current inventory of disposed waste at the Area 3 RWMS is approximately 480,000 cubic meters (16.9 million cubic feet). Open capacity available in the two developed cells is estimated to be approximately 132,580 cubic meters (4.7 million cubic feet). The two remaining craters, which at the present time are assumed to be individual cells, represent an estimated combined available future capacity of 204,000 cubic meters (7.2 million cubic feet).

In the five year period covering fiscal years 1999 through 2003, the NTS has received on average 1,243 shipments of LLW representing 45,514 cubic meters (1,607,110 cubic feet) of waste annually from as many as 23 waste generators. This volume of waste has been transported, received, and disposed safely with minimal risk to the general public, the workers at the disposal facility or the environment. A conservative calculation of total remaining disposal capacity at the NTS is about 3.6 million cubic meters (128 million cubic feet). This does not consider expansion into undesignated land surrounding the Area 5 RWMS or the inclusion of additional subsidence craters adjacent to the Area 3 RWMS.

The question of when NTS may reach its disposal capacity is dependent on the volume of waste received. Using 45,514 cubic meters (1,607,110 cubic feet) of waste received per year it will take approximately 79 years for the NTS RWMSs to reach capacity. Knowing that the waste volumes in the future will diminish as DOE completes the cleanup of the weapons complex and that the 79-year estimate does not include expanding into undesignated areas or future technology, NTS capacity is virtually unlimited.

CONCLUSION

The years of experience in waste management programmatic assessments and disposal operations, in conjunction with remoteness of the location, superior physical attributes (depth to groundwater, arid environment) establish NTS as one of the nation's premier LLW disposal facilities. The issuance of the Waste Management Programmatic Environmental Impact Statement for LLW, and an available capacity of over 3.6 million cubic meters (128 million cubic feet), make the NTS LLW disposal facilities a keystone in the efforts to clean up and close DOE sites across the complex. This is especially critical for those sites that are unable to dispose of LLW at onsite facilities or unable to access a commercial facility. The continuing refinements and development of probabilistic PA models for the facilities will further enhance the ability of the sites to provide the disposal needs of accelerated cleanup across the complex.

FOOTNOTE

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