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## **LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT AT THE NEVADA TEST SITE - YEAR 2000 CURRENT STATUS**

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### **ABSTRACT**

The performance objectives of the U. S. Department of Energy's 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 RWMS's since 1961 and 1968, respectively. However, these activities have only been managed under a formal program since 1978. This paper describes the technical attributes of the facilities, present and future capacities and capabilities, and provides a description of the process from waste approval to final disposition. The paper also summarizes the current status of the waste disposal operations.

### **INTRODUCTION**

In 1978, the U. S. Department of Energy, Nevada Operations Office (DOE/NV), 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 DOE/NV the opportunity to use at least two alternative technologies to effectively manage its disposal cost. The Area 5 Radioactive Waste Management Site (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.

### **TECHNICAL ATTRIBUTES**

The NTS is a federally owned facility located on the southern end of the Great Basin in south central Nevada. It consists of 3,497 square kilometers (1,350 square miles) and is surrounded by the Nellis Air Force Range and areas controlled by the Bureau of Land Management. Access to the NTS is controlled by manned guard gates. 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 which enhances the site characteristics. The closest populated area to either disposal facility is the small town of Indian Springs, NV 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 topographically closed basin where all surface water drains into a playa lake. The facility is sited on a coalesced alluvial fan, south of the Massachusetts Mountains. The water table is 244 meters (800 feet)

## **WM'00 Conference, February 27 – March 2, 2000, Tucson, AZ**

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 lake at the south end of the basin. The water table is 488 meters (1,600 feet) beneath this facility.

Both facilities receive on average 10.2-15.2 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 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 1.9 liters (one-half gallon) in a 208 liters (55 gallon) drum or 3.8 liters (one gallon) in a 1.2x 1.2x2.1 meter (4'x4'x7') box. The adequacy of these limits were 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.

### **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. The NTSWAC is maintained by the Radioactive Waste Acceptance Program (RWAP) personnel. 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, triennial 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.

The NTSWAC can be accessed electronically at <http://www.nv.doe.gov>.

### **DISPOSAL PROCESS**

Both RWMS's are shallow-land disposal facilities, but there are differences between the sites. Area 5 has 296 hectares (732 acres) available for disposal of LLW. Current operations uses 37.2 hectares (92 acres) of this total acreage. Here, engineered disposal cells are used for disposition of waste. These cells are planned, designed and constructed to fit within the existing fenced area. At Area 5, LLW, DOE/NV in-state generated mixed waste (MW), radioactively contaminated regulated asbestos, and classified LLW 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.

## **WM'00 Conference, February 27 – March 2, 2000, Tucson, AZ**

The disposal cells at Area 5 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 1.2x1.2x2.1 meter (4'x4'x7') or 0.6x0.6x2.1 meter (2'x4'x7') wooden and steel boxes. On occasion, other container sizes are accepted on a case-by-case basis, such as the regulated asbestos cell which accepts 2.4x2.4x6.1 meter (8'x8'x20') cargo containers.

All packages accepted for disposal at Area 5 are required to meet the rigid U. S. Department of Transportation performance based packaging requirements. With the exception of cargo containers and drums, the NTSWAC requires all boxes to meet a 16,113 kilograms/square meter (3,300 pound/square foot) compressive strength test. This provides a factor of safety for the workers. The waste packages 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 19,800 kilograms (9,000 pounds) each, there is the potential for the bottom box in the stack having to support in excess of 132,000 kilograms (60,000 pounds) of loading. Thus, strength criteria 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 has been accident free for more than five years.

The Area 3 RWMS covers 296 hectares (120 acres). Area 3 disposes waste in subsidence craters formed from underground testing of nuclear weapons instead of conventional engineered cells. The criteria used for choosing these craters was that the emplacement of the nuclear device had to have been above the water table. This criteria 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. Small packages such as boxes and drums 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 a layer-cake geometry with each layer of waste covered by a layer of compacted soil ranging from 0.3-0.9 meters (1-3 feet) in depth.

### **DISPOSAL ACCESS**

The NTS RWMS currently receives LLW from 15 generators including: Aberdeen Proving Grounds; AlliedSignal; Bechtel Nevada; Boeing North American-Rocketdyne; Fernald Environmental Management Project; General Atomics; International Technology Corporation, Las Vegas; Lovelace Respiratory Research Institute; Mound Plant; Pantex Plant; RMI Environmental Services; Rocky Flats Plant; Sandia National Laboratories/California; and Sandia National Laboratories/New Mexico. Only DOE/NV in-state generated MW is currently accepted.

### **PRESENT AND FUTURE CAPACITIES**

The current Area 5 RWMS inventory of disposal cells is 22, not including the GCD boreholes. These range in size from 25.3-345.5 meters (83 to 1,133 feet) long, 9.2-102.4 meters (30 to 336 feet) wide, and 3.7-14.6 meters (12 to 48 feet) deep. The total disposed volume of waste in these cells is over 245,866 cubic meters (9 million cubic feet). Available open capacity in the fenced 37.2 hectares (92 acre) compound at Area 5, in existing cells, is approximately 141,593 cubic meters (5 million cubic feet). 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 37.2 hectares (92 acres) show that the current capacity averages 4,304 cubic meters per 0.4 hectares (152,000 cubic feet of waste per acre) of

## **WM'00 Conference, February 27 – March 2, 2000, Tucson, AZ**

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 3,143,355 cubic meters (111 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 283,185 cubic meters (10 million cubic feet). Open capacity available in the two developed cells is estimated to be between 283,185 and 339,822 cubic meters (10 and 12 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 226,548 cubic meters (8 million cubic feet).

In the five year period covering fiscal years 1993 through 1997, the NTS has received on average 709 shipments of LLW representing 20,333 cubic meters (718,000 cubic feet) of waste annually from as many as 15 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. Once the DOE Programmatic Environmental Impact Statement Record of Decision for LLW is issued, the number of off-site generators that have access to the NTS is expected to increase. However, the overall volume received from off-site is anticipated to remain relatively unchanged.

Conservative calculations of total disposal capacity at the NTS is about 3,964,593 cubic meters (140 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 22,655 cubic meters (800,000 cubic feet) of waste received per year it will take approximately 175 years for the NTS RWMSs to reach capacity. Knowing that the waste volumes in the future are diminishing and that the 175 year estimate does not include expanding into undesignated areas or future technology, NTS capacity is virtually unlimited.