Electroshock Fishing for Background Samples with the New York State Department of Environmental Conservation

Environmental Monitoring Program Information

Introduction

The high-level waste (HLW) presently stored at the West Valley Demonstration Project is the by-product of the reprocessing of spent nuclear fuel conducted during the late 1960s and early 1970s by Nuclear Fuel Services, Inc. (NFS).

Since the Western New York Nuclear Service Center is no longer an active nuclear fuel reprocessing facility, the environmental monitoring program focuses on measuring radioactivity associated with the Project's high-level waste treatment operations and the residual effects of NFS, Inc. operations. The following information about the operations at the Project and about radiation and radioactivity may be useful in understanding the activities of the Project and the terms used in reporting the results of environmental testing measurements.

High-level Waste Treatment

Most of the waste from NFS operations had been stored in one of four underground tanks (tank 8D-2). Within the tank the waste had settled into two layers: a liquid — the supernatant — and a precipitate layer on the tank bottom — the sludge.

To solidify the high-level waste, WVDP engineers designed and developed a two-stage process of pretreatment and vitrification.

Pretreatment

During pretreatment, sodium salts and sulfates were separated from the radioactive constituents in both the liquid portion of the high-level waste and the sludge layer in the bottom of the tank.

The supernatant was composed mostly of sodium and potassium salts dissolved in water. Radioactive cesium in solution accounted for more than 99% of the total fission products in the supernatant.

Pretreatment of the supernatant began in 1988. A four-part process, the integrated radwaste treatment system (IRTS), reduced the volume of the high-level waste that needed pretreatment by producing low-level waste stabilized in cement.

- The supernatant was passed through zeolite-filled ion exchange columns in the supernatant treatment system (STS) to remove more than 99.9% of the radioactive constituents.
- The resulting liquid, containing sodium and sulfur compounds, was then concentrated by evaporation in the liquid waste treatment system (LWTS).
- This low-level radioactive concentrate was blended with cement in the cement solidification system (CSS) and placed in 271-liter (71-gal) steel drums.
- Finally, the steel drums were stored in an on-site aboveground vault, the drum cell.

Processing of the supernatant was completed in 1990. Eighty percent of the radioactivity in the liquid was removed and 10,393 drums of cemented waste produced.

The sludge that remains is composed mostly of iron hydroxide. Strontium-90 accounts for most of the radioactivity in the sludge.

Pretreatment of the sludge began in 1991. (See **1991 Activities at the West Valley Demonstration Project** below.)

Vitrification

The second stage of the high-level waste treatment process, solidification into glass (vitrification), is scheduled to begin in 1996. The high-level waste mixture of sludge and zeolite from the ion-exchange process will be combined with glass-forming chemicals, fed to a ceramic melter, heated to approximately 2,000°F, and poured into stainless steel canisters. Approximately 300 stainless steel canisters 10 ft by 2 ft (diameter) will be filled with a uniform high-level waste glass that will be suitable for eventual shipment to a federal repository. Vitrification is scheduled to be completed in 1998.

Radiation and Radioactivity

Radioactivity is a process in which unstable atomic nuclei spontaneously disintegrate or change into atomic nuclei of another isotope or element (see Glossary). The nuclei decay until only a stable, nonradioactive isotope remains. Depending on the isotope, this process can take anywhere from less than a second to hundreds of thousands of years.

Radiation is the energy released as atomic nuclei decay. By emitting energy the nucleus moves toward a less energetic, more stable state. The energy that is released takes three main forms: alpha or beta particles, and gamma rays.

■ *Alpha Particles*

An alpha particle is a fragment of a much larger nucleus. It consists of two protons and two neutrons and is positively charged. Alpha particles are relatively large and heavy and do not travel very far when ejected by a decaying nucleus. Alpha radiation thus is easily stopped by a thin layer of material such as paper or skin. However, if radioactive material is ingested or inhaled, the alpha particles released inside the body can damage soft internal tissues because all of their energy is absorbed by a small amount of tissue.

■ *Beta Particles*

A beta particle is an electron that results from the breakdown of a neutron in a radioactive nucleus. Beta particles are small compared to alpha particles, travel at a higher speed (close to the speed of light), and can be stopped by a material such as wood or aluminum an inch or so thick. If beta particles are released inside the body they do much less damage than alpha particles because they are smaller and faster and have less of a charge.

■ *Gamma Rays*

Gamma rays are high-energy "packets" of electromagnetic radiation called photons. They are similar to x-rays but generally have a shorter wavelength and therefore are more energetic than x-rays. If the alpha or beta particle released by the decaying nucleus does not carry off all the energy available, the excess energy may be emitted as gamma rays. If the released energy is high a very penetrating gamma ray is produced that can only be effectively reduced by several inches of a heavy element such as lead. Although large amounts of gamma

IONIZING RADIATION

Radiation can be damaging if, in colliding with other matter, the alpha or beta particles or gamma rays knock loose electrons from the absorber atoms. This process is called ionization, and the radiation that produces it is referred to as ionizing radiation because it changes a previously electrically neutral atom, in which the positively charged protons and the negatively charged electrons balance each other, into a charged atom called an ion. An ion can be either positively or negatively charged. Various kinds of ionizing radiation produce different degrees of damage.

radiation are dangerous, gamma rays are also used in many lifesaving medical procedures.

Measurement of Radioactivity

The rate at which radiation is emitted from a decaying nucleus can be described by the number of nuclear transformations that occur in a radioactive material over a fixed period of time. This process of emitting energy, or radioactivity, is measured in curies (Ci) or becquerels (Bq). One becquerel equals one decay per second. One curie equals 37 billion nuclear disintegrations per second (3.7×10^{10} d/s). Very small amounts of radioactivity are sometimes measured in picocuries. A picocurie is one-trillionth (10^{-12}) of a curie.

Measurement of Dose

The amount of energy absorbed by the receiving material is measured in rads (radiation absorbed dose). A rad is 100 ergs of radiation energy absorbed per gram of material.

Alpha, beta, and gamma radiation affect the body to different degrees. Dose equivalent, or dose, is a unit of measurement used to compare the effects of different kinds of radiation. Each type of radiation is given a quality factor that indicates the extent of cell damage it can cause compared with equal amounts of other ionizing radiation energy. Alpha particles cause twenty times as much damage to internal tissues as x-rays, and so alpha radiation has a quality factor of 20 compared to gamma rays, x-rays, or beta particles, which have a quality factor of one.

The unit of dose measurement is the rem. Rems are equal to the number of rads multiplied by the quality factor of the kind of radiation. Dose can also be measured in sieverts. One sievert equals 100 rem.

Environmental Monitoring Program Overview

Human beings may be exposed to radioactivity primarily through air, water, and food. At the West Valley Demonstration Project all three pathways are monitored, but air and surface water pathways are the two major means by which radioactive material can move off-site.

The geology of the site (kinds and structures of rock and soil), the hydrogeology (location and flow of surface and underground water), and meteorological characteristics of the site (wind speed, patterns, and direction) are all considered in evaluating potential exposure through the major pathways.

The on-site and off-site monitoring program at the West Valley Demonstration Project includes measuring the concentration of total alpha and beta radioactivity, conventionally referred to as "gross alpha" and "gross beta," in air and water effluents. Measuring the total alpha and beta radioactivity in several samples, which can be done within a matter of hours, produces a comprehensive picture of current on-site and off-site radiation levels from all sources. In a facility such as the West Valley Demonstration Project, frequent updating and tracking of the overall levels of radioactivity in effluents is an important tool in maintaining acceptable operations.

More detailed measurements are also made for specific radionuclides. Strontium-90 and cesium-137 are measured because they are normally detected in WVDP waste streams. Radiation from other important radionuclides such as tritium or iodine-129 are not sufficiently energetic to be detected by gross measurement methods, so these must be analyzed separately with instruments having greater sensitivity. Heavy elements such as uranium require special analysis to be detected because in comparison to background they exist at such low levels at the WVDP.

The radionuclides monitored at the Project are those that might produce relatively higher doses or that are most abundant in the air and water effluents. Because sources of radiation at the Project have been decaying for more than twenty years, the monitoring program does not routinely include short-lived radionuclides, i.e., isotopes with a half-life of less than two years, which would have only 1/1000 of the original radioactivity remaining. (See *Appendix A* for a schedule of samples and radionuclides measured and *Appendix B* for related Department of Energy protection standards.)

Data Reporting

Because any two samples are never exactly the same, statistical methods are used to decide how a particular measurement compares with other measurements of similar samples. The term *confidence level* is used to describe how certain a measurement is of being a "true"

Potential Effects of Radiation

The biological effects of radiation can be either somatic or genetic. Somatic effects are restricted to the person exposed to radiation. For example, sufficiently high exposure to radiation can cause clouding of the lens of the eye or loss of white blood cells.

Radiation also can cause chromosomes to break or rearrange themselves or to join incorrectly with others. These changes may produce genetic effects and may show up in future generations. Radiation-produced genetic defects and mutations in offspring of an exposed parent, while not positively identified in humans, have been observed in some animal studies.

The effect of radiation depends on the amount absorbed. An instantaneous dose of 100-200 rem (1-2 Sv) might cause temporary effects such as vomiting, but usually would have no long-lasting side effects. At 50 rem (0.5 Sv) a single instantaneous dose might cause a reduction in white blood cell count.

Assessing biological damage from low-level radiation is difficult because other factors can cause the same symptoms as radiation exposure. Moreover, the body apparently is able to repair damage caused by low-level radiation.

The effect most often associated with exposure to relatively high levels of radiation appears to be an increased risk of cancer. However, scientists have not been able to demonstrate with certainty that exposure to low-level radiation causes an increase in injurious biological effects, nor have they been able to determine if there is a level of radiation exposure below which there are no biological effects.

The West Valley Demonstration Project work force is limited to 0.1 rem (1 mSv) for individual daily work exposures, and to 1 rem (10 mSv) per calendar quarter. At such low exposures no clinically observable effects have ever been seen. The calculated doses from Project operations during 1991 for the maximally exposed off-site individual are about 0.23 mrem (2.3×10^{-3} mSv) for all of 1991.

Background Radiation

Background radiation is always present and everyone is constantly exposed to low levels of such radiation from both naturally occurring and manmade sources. In the United States the average total annual exposure to this low-level background radiation is estimated to be about 360 millirem (mrem) or 3.6 millisieverts (mSv). Most of this radiation, approximately 300 mrem (3 mSv), comes from natural sources. The rest comes from medical procedures and from consumer products.

Background radiation includes cosmic rays, the decay of natural elements such as potassium, uranium, thorium, and radon, and radiation from sources such as chemical fertilizers, smoke detectors, and televisions. Actual doses vary depending on such factors as geographic location, building ventilation, and personal health and habits.

value. The WVDP environmental monitoring program uses the 95% confidence level, which means that 95% of the measurements (19 out of 20) are within the statistical "uncertainty" range.

The uncertainty range is the expected range of values that account for random nuclear decay and small measurement process variations. The uncertainty range of a measurement is the plus-or-minus (±) value following the measurement (e.g., 5.30 ± 3.6E-09 µCi/mL). Within this range a measurement will be "true" 95% of the time. For example, a value that falls within 5.30 ± 3.6E-09 means that 95% of the time the "true" value will be found between 1.7 µCi/mL to 8.9E-09 µCi/mL. If the uncertainty range is greater than the value itself, the measurement is below the detection limit, which means that at least 95% of the time the "true" value is somewhere below the detection limit value. (In general, the detection limit is the minimum amount of constituent that can be picked up by an instrument or method and distinguished from background and intrument noise. Thus, the detection limit is the lowest value at which a sample measurement shows a statistically positive difference from a measurement in which no constituent is present.)

1991 Activities at the West Valley Demonstration Project

High-level Waste Processing

Sludge Pretreatment

Pretreatment of the sludge layer in the high-level waste tank 8D-2 began in 1991. Five specially designed 50-ft long pumps were installed in the tank to mix the sludge layer with water in order to produce a uniform sludge blend and to dissolve sodium salts and sulfates. After mixing, the sludge will be allowed to settle. The water used to wash the sludge will be processed through the integrated radwaste treatment system. Radioactive constituents removed from the washwater will be solidified in glass later on. The remaining washwater will be stablized in cement.

The sludge is scheduled to be washed three more times during the next two years. Following sludge pretreatment, the ion-exchange zeolite used in the liquid processing to trap radioactivity will be blended with the sludge in the glass-forming feed mixture.

Low-level Waste Processing

Aqueous Waste

Water containing added radioactive material from site cleanup operations is collected and treated in the low-level liquid waste treatment facility. (Sanitary water, which does not contain added radioactive material, is managed in a separate system.)

The treated process water is held, sampled, and analyzed before it is released through a State Pollutant Discharge Elimination System (SPDES)-permitted outfall. In 1991 33.5 million liters (8.85 million gal.) of water were treated in the low-level waste treatment system and released.

The discharge waters contained an estimated 39 millicuries (mCi) of gross alpha plus gross beta radioactivity. Comparable releases during the previous six years averaged about 44 millicuries per year. The 1991 release was about 11% below this average.

The 1.09 curies of tritium also released in 1991 was about half of the previous five-year average.

Solid Waste

Low-level waste at the WVDP consists of various materials generated through site maintenance and cleanup activities. It is stored in aboveground facilities. Metal piping and tanks are cut up and packaged in a special size-reduction facility and dry compressible materials such as paper and plastic are compacted to reduce waste volume. In 1991 waste volume was reduced from 1990 levels by about 717 m^3 (25,300 ft^3).

Two weatherproof storage structures, completed in 1991, provide an additional 300,000 ft^3 of controlled storage space for low-level waste.

Hazardous Wastes

(See *Environmental Compliance Summary: Calendar Year 1991.*)

Waste Minimization Program

A waste minimization plan that includes long-range planning for waste storage and processing facilities, manpower, funding, and waste minimization at the Project was approved and issued in 1991.

A major goal of the plan was achieved in 1991 when the amount of hazardous, radioactive, and mixed waste generated by Project activities was reduced by 5% from anticipated levels. The WVDP's goal is to reduce waste generation by 25% over the next five years.

Pollution Prevention Awareness Program

The WVDP's pollution prevention awareness program is a significant part of the Project's overall waste minimization program. The program includes the right-to-know communications program and new employee orientation that provides information about the WVDP's INDUSTRIAL HYGIENCE AND SAFETY MANUAL, environmental pollution control procedures, and the HAZARDOUS WASTE MANAGEMENT PLAN.

In 1991 hazardous waste operations training programs and radiation worker/hazardous waste requalification programs were modified to include information regarding pollution prevention goals and progress. In addition, three articles on pollution prevention topics were carried in the WVDP's monthly employee newsletter.

The WVDP's goal is to make all employees aware of the importance of pollution prevention both at work and at home.

1991 NEPA Activities

As a federal agency the Department of Energy is required to consider the environmental effects of its proposed actions. The President's Council on Environmental Quality established a screening system of analyses and documentation that requires each proposed action to be categorized according to the extent of its environmental effect. The levels of documentation include categorical exclusions (CXs), environmental assessments (EAs), and environmental impact statements (EISs).

Categorical exclusions evaluate and document actions that will not have an effect on the environment. Environmental assessments evaluate whether the proposed action will significantly affect the environment. If a proposed action has the potential for significant effects, an environmental impact statement is prepared that describes proposed alternatives to an action and explains the effects.

Phase I NEPA Activities

Phase I NEPA activities at the WVDP generally involve facility maintenance and minor projects that support high-level waste vitrification. Most of these projects are documented and submitted for approval as categorical exclusions.

Fifteen proposed activities were submitted in 1991 as having been previously approved within existing NEPA documents or as categorically excluded from further NEPA review.

In addition, a draft environmental assessment for a proposed expansion to the WVDP sewage treatment plant continued in the DOE review and approval process during 1991. This assessment will conclude in either a finding of no significant impact (FONSI) and approval to proceed or in the preparation of an environmental impact statement if the potential for significant effects is established.

Phase II NEPA Activities

In December 1988 the DOE published a Notice of Intent to prepare an environmental impact statement for the completion of the West Valley Demonstration Project and closure of the WNYNSC. The EIS will describe the potential environmental effects associated with various site closure alternatives. Completion and closure are Phase II activities.

In order to assess potential effects associated with alternative closure actions, an extensive multidisciplinary characterization of the site was necessary. Characterization activities began in 1989, but require data collection for several years. Site characterization studies include investigations in geomorphology, soils, geohydrology, surface water hydrology, geochemistry, water quality, air quality, seismology, demography, cultural resources, botany, and terrestrial and aquatic ecology.

1991 Changes in the Environmental Monitoring Program

Minor updates in the 1991 monitoring program met several regulatory additions and supported current site characterization activities.

The changes were limited to adding specific points where isotopic or chemical species had not been well-defined previously. Three stormwater locations also were defined although they had been included in the routine monitoring program.

A number of redundant or supporting sample locations were cut back or eliminated after extensive evaluation of historical data and a review of the current rationale for sampling: Water or media from standing bodies of waters (ponds or pools) were reduced by half, and one redundant soil sample location was eliminated. One water sampling location was reduced from weekly to monthly sampling.

The most significant effect on the 1991 monitoring program was the gradual initiation of the full sampling regimen for the 109 groundwater sampling locations. Although all the wells were initially sampled in 1990, the full set of analyses and replicates in 1991 increased the sample work load and data evaluation by an order of magnitude beyond the 1989 program.

Appendix A summarizes the program changes and lists the sample points and parameters measured in 1991.

RCRA Reports

WVNS has developed a hazardous waste management plan that ensures proper management of all hazardous waste from the point of generation to final disposition. The plan's basic requisites include properly designating and packaging all hazardous waste generated at the facility; obtaining appropriate samples and characterizing wastes according to hazardous wastes regulations; maintaining required records and reports; stocking and maintaining spill control materials and equipment and ensuring that the appropriate employees are trained in emergency response; and determining nonradioactive hazardous waste release reporting and notification requirements and, when required, making appropriate notifications.

Toxic Chemical Inventory

Under the Superfund Amendments and Reauthorization Act (SARA) Title III requirements, also known as the Emergency Preparedness and Community Right-to-Know Act (EPCRA), hazardous chemical inventories on-site must be reported to the EPA. During the 1991 reporting period the WVDP produced quarterly updates of the inventory of hazardous chemicals used on-site and sent them to local and state emergency management agencies. The chemicals, quantities stored on-site, and on-site use in 1991 included:

ammonia (380 lbs), used in the laboratories and for sewage treatment

cement (70,000 lbs), used in the solidification of low-level radioactive waste

chlorine (600 lbs), used to disinfect potable water

diesel fuel #2 (7000 lbs), used for back-up power for generators

ferrous sulfate (32,000 lbs), used in wastewater treatment

gasoline (16,500 lbs), used for on-site vehicles

fuel oil # 2 (7,000 lbs), used for back-up power for boilers and other equipment

hydrogen peroxide (1,100 lbs), used in the nitrous oxides off-gas system

lithium hydroxide (2,600 lbs), used in vitrification

nitric acid (1,200 lbs), used in vitrification testing and for pH control

oil (9,000 lbs), used to lubricate various equipment

propane (500 lbs), used for fuel

silicon dioxide (17,100 lbs), used in vitrification

sodium hydroxide (12,400 lbs), used in water treatment and high-level waste sludge washing

sulfuric acid (33,000 lbs), used in water treatment

zinc bromide (13,500 lbs), used for radiation shielding in viewing windows.

On-site Environmental Training

The safety of personnel who are involved in hazardous waste operations falls under the Occupational Safety and Health Act (OSHA). This act is a comprehensive law governing diverse occupational hazards such as protection from fire and electrical safety as well as the handling of hazardous materials. The purpose of OSHA is to maintain a safe and healthy working environment for employees.

Training for hazardous waste operations at the West Valley Demonstration Project is job-specific and takes the mixed waste characteristics of the Project into consideration.

OSHA 29 CFR 1910.120 (hazardous waste operations) requires that employees at treatment, storage, and disposal facilities, which are regulated by the Resource Conservation and Recovery Act, who may be exposed to health and safety hazards during hazardous waste operations, receive twenty-four hours of initial training and eight hours of annual refresher training.

The Project's training program identifies employees who are eligible for OSHA instruction and provides an initial twenty-four hour training program and an eight-hour refresher course and documents the instruction.

Initially offered in 1990, the program provides detailed information on hazardous materials management procedures, focusing on lessons learned in the field. A total of 987 employees have participated in this program.

OSHA 29 CFR 1910.120 also requires training in proper response to on-site spills of hazardous materials or wastes. To date, sixty-five employees have been fully trained as a hazardous materials response team.

An eight-hour course for supervisors covers how to determine site hazards, how to assess risk, on-the-job training, and incident command. Sixty-three employees have completed this course.

In addition, each visitor or nonworker at the site must receive a site-specific briefing on safety and emergency procedures before being admitted to the site. Currently, each visitor views an information tape that explains site safety policies and emergency evacuation procedures.

Self-assessment

Assessments concerning environmental compliance and regulations are summarized in the *Environmental Compliance Summary: Calendar Year 1991*. See also Chapter 5, *Quality Assurance*, for additional information.