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

1.0 Environmental Program Information Summary

Radiation and Radioactivity

As the Western New York Nuclear Service Center is no longer an active nuclear fuel reprocessing facility, the major interest of the environmental monitoring program is in the radiation and radioactivity levels associated with the cleanup activities. The following information 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.

Radioactivity is a property of unstable atomic nuclei that spontaneously disintegrate or change into atomic nuclei of another isotope or element (see Glossary). As the nuclei decay, total radioactivity is reduced 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 a general term used to describe several forms of energy, including the energy that accompanies decay of atomic nuclei. Radiation from radioactive materials that are of primary interest take three forms: alpha or beta particles, and gamma rays.

- Alpha Particles

An alpha particle may be emitted as a fragment from a much larger nucleus. It consists of two protons and two neutrons, just like a helium nucleus, 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.

- 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, assuming that equal amounts of energy are absorbed by the tissue.

- 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 nucleus rids itself of the excess energy by emitting 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 radiation are dangerous, gamma rays are also used in many lifesaving medical procedures.

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 neutral atom into a charged atom called an ion (see Glossary).

Various kinds of ionizing radiation produce different degrees of damage. The **relative biological effectiveness** (RBE) or **quality factor** (QF) of a particular kind of radiation indicates the extent of cell damage it can cause compared with equal amounts of other ionizing radiations. 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.

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.

Units of Measurement

Radiation is described in three ways: The rate of emission, the amount of energy absorbed, or the biological effect.

Nuclear disintegrations:

The rate at which radiation is emitted can be described by the number of nuclear transformations that occur in a radioactive material over a fixed period of time. This process, 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.

Energy absorbed:

Radiation effects can be predicted based on the amount of energy absorbed by the receiving material, measured in rads (radiation absorbed dose) or grays. A rad is defined as a dose of 100 ergs of radiation energy absorbed per gram of material while a gray is one joule of energy absorbed per kilogram of material. Energy can also be expressed in terms of electron volts (eV). However, as an electron volt is such a small amount of energy the preferred unit is a million electron volts (MeV). Thus, a gamma ray photon from barium-137m (from cesium-137) would have an energy of 662,000 eV or 0.662 MeV. (One rad equals 62.4×10^{6} MeV of energy per gram of material).

Biological effect:

A third measure of radiation is the rem, the unit of "dose equivalent" that is proportional to the biological damage to tissue produced by different kinds of ionizing radiation. Rems are equal to the number of rads multiplied by a quality factor that is related to the relative biological effectiveness of the radiation involved. Dose equivalents can also be measured in sieverts. One sievert equals 100 rem. (See Chapter 4, "Radiological Dose Assessment," for more information.)

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, clouding of the lens of the eye or loss of white blood cells can be caused by sufficiently high exposure to radiation.

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. Temporary effects such as vomiting might be caused by an instantaneous dose of 100-200 rem (1-2 Sv), but with no long-lasting side effects. At 50 rem (0.5 Sv) a single instantaneous dose might cause a reduction in white blood cell count.The West Valley Demonstration Project work force is limited to 0.1 rem (1 mSv) for individual daily work exposures, not to exceed 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 for the maximally exposed off-site individual is about 0.23 mrem (2.3E-03 mSv).

The difficulty in assessing biological damage from radiation is that 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 is an increased risk of cancer. However, scientists have not been able to demonstrate that exposure to low-level radiation causes an increase in deleterious biological effects, nor have they been able to determine if there is a level of radiation exposure below which there are no biological effects.

Measuring Radiation at the West Valley Demonstration Project

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 (water presence and flow), and meteorological characteristics of the site (wind speed, patterns, and direction) are all considered in evaluating potential exposure through the major pathways.

The West Valley Demonstration Project Monitoring Program

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, tracking the overall levels of radioactivity in effluents is an important tool in maintaining acceptable operations.

Other radioactive parameters are measured as well. Strontium-90 and cesium-137 are measured because of their relative abundance in WVDP waste streams. Radiation from certain important radionuclides such as tritium or iodine-129 are not sufficiently energetic to be detected with the gross beta measurements, so these must be analyzed separately with instruments having greater sensitivity. Heavy elements such as uranium require special analysis to be detected because 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 fifteen years, the monitoring program does not routinely include short-lived radionuclides, i.e., isotopes with a half-life of less than two years. (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" 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 calculated uncertainty range.

The *uncertainty range*, related to the confidence level, is the expected range of values that account for background nuclear decay and small measurement process variations for which a measurement will be "true" 95% of the time. The uncertainty range, expressed as a "+/-" followed by a value (e.g., 5.30 +/- 3.6E-09 μCi/mL) means that the "true" value will be found 95% of the time within the uncertainty range (e.g., from 1.7 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.

1990 Activities at the West Valley Demonstration Project

High-level Waste Processing

- The Integrated Radwaste Treatment System (IRTS)

The high-level radioactive waste (HLW), a by-product of the spent nuclear fuel reprocessing conducted at the site during the late 1960s and early 1970s by Nuclear Fuel Services, Inc., is currently isolated underground in two steel tanks that are contained within concrete vaults.

Approximately 98% of the waste is in one of the tanks (tank 8D-2). The waste has settled into two layers: a liquid phase, the supernatant, and a precipitate layer on the bottom of the tank, the sludge. The total radioactivity in the tank is about equally divided between the supernatant and the sludge.

The supernatant is composed mostly of sodium and potassium salts dissolved in water; the sludge is composed mostly of iron hydroxide. Radioactive cesium in solution accounts for more than 99% of the total fission products in the supernatant and strontium-90 accounts for most of the radioactivity in the sludge.

The integrated radioactive waste treatment system (IRTS), which began operating in 1988, is a four-step process that reduces the volume of the high-level waste fluids by producing low-level waste stabilized in cement. The IRTS removes more than 99.9% of the radioactivity from the high-level waste fluid, concentrates the resulting low-level liquid waste, blends it with cement, and stores it in 71-gallon square steel drums in an above-ground, shielded vault. More than 272,000 gallons of liquid high-level waste were processed in 1990, and approximately 3800 drums were produced, bringing the total number to about 10,300 drums.

THE SUPERNATANT TREATMENT SYSTEM (STS), housed in a spare storage tank (tank 8D-1) identical to the tank that stores most of the high-level waste, passes the supernatant through four ion-exchange columns filled with zeolite, a synthetic, granular clay material that removes most of the radioactive cesium from the supernatant. The low-level salt solution that remains is sent to the liquid waste treatment system (LWTS) through triple-walled piping. The cesium-loaded zeolite is being stored in tank 8D-1 until the high-level waste vitrification process begins.

THE LIQUID WASTE TREATMENT SYSTEM (LWTS) concentrates the low-level liquid salt solution through evaporation. The liquid is heated and the resulting steam is collected, condensed, and processed before being released as liquid effluent. The radioactive concentrates are then sent to the cement solidification system (CSS).

THE CEMENT SOLIDIFICATION SYSTEM (CSS) blends the radioactive concentrates with cement. This cement/waste mixture is placed in 270-liter (71-gallon) lined, square steel drums that are then stored in a specially designed above-ground shielded vault, the drum cell.

THE DRUM CELL, designed to store Class B and Class C low-level waste, was completed in 1987. It is located southwest of the main plant near the NRC-licensed disposal area (NDA). The drum cell can store approximately twenty thousand 270-liter drums of cement-stabilized low-level waste.

Low-level Waste Processing

- Aqueous Waste

Throughout 1990 the low-level waste treatment facility (LLWTF) processed aqueous wastes before discharge. In 1990 the Project released 42 million liters (11.1 million gallons) to the environment. The discharge waters contained an estimated 46 millicuries (mCi) of radioactivity (gross alpha plus gross beta). Comparable releases during the previous five years, 1985 through 1989, averaged about 44 mCi per year. The 1990 release was roughly 5% above this level.

The 4.42 curies of tritium released in 1990 was a factor of 2.3 above the previous five-year average, primarily as a result of the liquid waste treatment system operation.

- Solid Waste

Contaminated equipment and hardware from NFS operations, as well as contaminated wastes generated by current Project operations, are collected, analyzed, packaged, and stored on-site. When appropriate, metal objects such as piping and tanks are cut up and compressible wastes are compacted to reduce the waste volume. Approximately 37,000 cubic feet of low-level waste was processed in 1990 using compaction and cutting to achieve a 75% reduction in volume. About 53,500 cubic feet of low-level waste in addition to the IRTS drums was collected and placed in storage during 1990. All Project low-level waste is being stored in above-ground facilities. Two additional temporary weatherproof structures were erected in 1990 and will provide more than 50,000 square feet of storage space for packaged low-level waste.

Hazardous Wastes

Nonradioactive hazardous materials used in various site maintenance, cleanup, and testing activities also are subject to safety and regulatory requirements. Hazardous waste management activities in 1990 included building a new storage facility to segregate hazardous materials, installing a new computer program to track on-site hazardous materials, and adding National Fire Protection Association labels to all hazardous material containers.

The Project's hazardous waste management also included new warehouse facilities used to prepare hazardous wastes for off-site transportation; installing four specially engineered steel storage lockers meeting all state and EPA requirements for storage of containerized hazardous waste; establishing a hazardous materials transportation group to manage all hazardous materials shipments; and conducting approximately 4,000 hours of training in hazardous waste operations for 370 employees.

Waste Minimization Program

The draft waste minimization plan for the West Valley Demonstration Project, prepared in accordance with DOE Order 5400.1, provides a basis for long-range planning for waste storage and processing facilities, manpower, funding, and waste minimization activities at the WVDP.

Objectives of the plan include careful segregation of clean materials from contamination zones and reuse of contaminated tools whenever practicable. Waste minimization policy also includes supercompaction of waste, size-reduction, and pretreatment of high-level waste fluids to reduce the volume of material requiring vitrification.

The Project's waste minimization program calls for reducing sources of waste by requiring justification for purchase and use of industrial chemicals and by providing active recycling and treatment of hazardous wastes to make them nonhazardous, where possible. Industrial nonhazardous waste is minimized by recycling certain waste streams and by placing surplus material at auction or into Government Services Administration surplus.

Pollution Prevention Awareness Program

The West Valley Demonstration Project pollution prevention awareness program includes the right-to-know communications program and new employee orientation that provides information about the WVDP's Industrial Hygiene and Safety Manual, the Environmental Pollution and Control Procedure, and the Hazardous Waste Management Plan.

The pollution prevention awareness program is an integral part of the overall waste minimization program. However, it is a discrete program implemented by all operational groups in the WVDP and is supported by the Training and Development department.

The full pollution prevention awareness program eventually will include all-employee meetings, video screenings, posters, contests and awards, and a Pollution Prevention Awareness Day.

National Environmental Policy Act (NEPA) Activities

The eventual goal of the West Valley Demonstration Project is not only to convert high-level waste into stabilized waste forms (Phase I) but to also decontaminate and decommission the facilities used in the Project in a manner that will ensure the safety of the environment and the public (Phase II). Phase I activities generally concern the day-to-day operations that support solidifying the high-level waste.

Phase I NEPA Activities

During 1990 thirty-nine Environmental Checklists documenting proposed WVDP actions were submitted as categorical exclusions for Department of Energy review and approval. (A categorical exclusion is defined as a category of action that normally does not individually or cumulatively have a significant effect on the quality of the human environment and that requires neither an environmental impact statement nor an environmental assessment). Before memoranda-to-file were discontinued in September 1990, the WVDP received approvals for three on-site activities that had been submitted for approval as memoranda-to-file.

Phase II NEPA Activities: Site Characterization

Before the Department of Energy can move from Phase I activities to Phase II closure activities another environmental impact assessment must be produced. Initial steps toward this goal include intensive characterization of the site in order to provide an estimate of the environmental effects of closure activities.

Existing site and waste data were collected and reviewed, and more than one thousand historical documents were indexed. Field activities included an overland gamma survey, surface soil sampling at selected solid waste management units (SWMUs), preliminary sediment sampling of Lagoons 2 and 3, and data collection and analysis of the geohydrology of the site, geochemistry and water quality, air quality, and the distribution of radiological and hazardous contaminants. Contaminant transport modeling also was evaluated as well as the cultural and ecological resources of the site and its environs.

Although a signficant portion of the preliminary work for the Phase II site characterization had been completed in 1989 and 1990, budgetary cutbacks necessitated a change in the pace of work on the environmental impact statement (EIS) site characterization. However, compliance monitoring under the Resource Conservation and Recovery Act (RCRA) continues to retain its high priority.

The WVDP is currently negotiating a 3008(h) Order on Consent and a Federal and State Facilities Compliance Agreement (FSFCA) with the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation with respect to Resource Conservation and Recovery Act (RCRA) guidelines and their implementation at the WVDP.

The Consent Order and the Federal and State Facilities Compliance Agreement requires that the site conduct investigations and develop plans and schedules that comply with RCRA guidelines. Since these negotiations and compliance agreements had been anticipated, much of the 1990 site characterization work also satisfied these future needs.

In order to satisfy RCRA guidelines and decelerate the environmental impact statement program, work during 1990 and 1991 has focused on the solid waste management units.

1990 Changes in the Environmental Monitoring Program

Several changes were made in the routine environmental monitoring program in 1990 as part of a continuing effort to improve existing monitoring points and in response to regulatory changes.

- SPDES Permits and DOE Order 5400.5

The Project's modified SPDES permit expanded monitoring of location WNSP001, the primary point of liquid effluent batch release from the site, to include analyses for several additional chemical parameters. To demonstrate compliance with DOE Order 5400.5, which was effective May 1990, monitoring of sanitary waste sludge from the sewage treatment plant for radiological parameters was added to the program.

- Expanded Monitoring Program

The existing monitoring program was expanded by adding several sampling locations: a new fallout collection point on-site, new locations for collection of site drinking water, and an underdrain collection point to better monitor subsurface drainage in the high-level waste storage and processing area. Additional analyses of samples from existing locations – tritium analysis of beef and deer samples and uranium analysis of selected soil samples – were added in the 1990 program. And rather than sampling half of the private residental drinking water wells every year, all are now sampled annually.

One on-site surface water monitoring point was upgraded for automated sample collection. This point monitors surface waters draining from the lag storage area, where additional waste storage buildings have been added and elevated monitoring needs are anticipated. (See Appendix A for details of the above changes. Although not noted in Appendix A, new on-site groundwater monitoring wells installed in 1990 were sampled during the year during the well development phase. Results are not included in this report because the sampling was only preliminary.)

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 1990 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 1990 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 waste water 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
- sulfuric acid (33,000 lbs), used in water treatment
- zinc bromide (13,500 lbs), used for radiation shielding in viewing windows

Seven chemicals (12,300 lbs) were deleted from the 1989 list because vitirification testing had been completed and the chemicals had been disposed of, returned to the vendor, or used in various processes.

On-site Environmental Training

The West Valley Nuclear Services Co., Inc. (WVNS) provides a comprehensive program that identifies eligible employees and trains, retrains, and documents their Occupational Safety and Health Act (OSHA) instruction as required by 29 CFR 1910.120. The WVNS program focuses on the company's responsibility for providing adequate environmental, health, and safety training for all identified employees of the West Valley Demonstration Project.

To date, more than 300 employees have been trained in a site-specific twenty-four hour hazardous waste operations course that was developed in 1990. WVNS also has trained 198 employees to properly respond to spills on-site. In addition, supervisors are briefed on the legal aspects of environmental compliance through an additional eight hours of skills training for supervisors of hazardous waste operations. Specific RCRA-awareness training also was conducted throughout 1990 for the WVDP management.

In October 1990 an eight-hour hazardous waste operations training program was initially offered. This program provides detailed information on hazardous materials management procedures.

To provide pollution prevention awareness for employees, the goals of the waste minimization program have been included in the radiation worker program and the hazardous waste operations courses. Specific employee incentive programs that recognize improvements in waste minimization and pollution prevention will begin in 1991.

Self - Assessment

Assessments concerning environmental compliance and regulations are summarized in the Environmental Compliance Summary above.