ENVIRONMENTAL PROGRAM INFORMATION

Introduction

The high-level radioactive waste (HLW) presently stored at the Western New York Nuclear Service Center (WNYNSC) on the West Valley Demonstration Project (WVDP) premises is the byproduct of the reprocessing of spent nuclear fuel during the late 1960s and early 1970s, when the WNYNSC was leased by Nuclear Fuel Services, Inc. (NFS) for a commercial nuclear fuel reprocessing facility.

As the WNYNSC is no longer an active nuclear fuel reprocessing facility, the environmental monitoring program focuses on measuring radioactivity and chemicals associated with the residual by-products of NFS operations and the Project's high-level waste treatment and low-level waste management operations. The following information about the operations at the WVDP and about radiation and radioactivity will be useful in understanding the activities of the Project and the terms used in reporting the results of environmental testing measurements.

Radiation and Radioactivity. Radioactivity is a characteristic of some elements that have unstable atomic nuclei which spontaneously disintegrate or "decay" into atomic nuclei of another isotope or element. (See *isotope* [p. GLO-5] in the 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 billions of years.

As atomic nuclei decay, radiation is released in three main forms: alpha particles, beta particles, and gamma rays. By emitting energy or particles, the nucleus moves toward a less energetic, more stable state.

Alpha Particles. An alpha particle, released by decay, is a fragment of a much larger nucleus. It consists of two protons and two neutrons (similar to the nucleus of a helium atom) and is positively charged. Compared to beta particles, alpha particles are relatively large and heavy and do not travel very far when ejected by a decaying nucleus. Alpha radiation, therefore, 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 tissue cells in the immediate vicinity of the decay. An example of an alpha-emitting radionuclide is the uranium isotope with an atomic weight of 232 (uranium-232). Uranium-232 is in the high-level waste mixture at the WVDP as a result of a thorium-based nuclear fuel reprocessing campaign conducted by NFS and has been previously detected in liquid waste streams.

Radioactivity

Atoms that emit radiation are called radionuclides. Radionuclides are unstable isotopes that have the same number of protons as any other isotope of the element but different numbers of neutrons, resulting in different atomic masses. For example, the element hydrogen has two stable isotopes, H-1 and H-2 (deuterium), and one radioactive isotope, H-3 (tritium). The numbers following the element's symbol identify the atomic mass, which is the number of protons plus neutrons in the nucleus. Thus, H-1 has one proton and no neutrons, H-2 has one proton and one neutron, and H-3 has one proton and two neutrons.

When radioactive atoms decay by emitting radiation, the daughter products that result may be either radioactive or stable. Generally, radionuclides with high atomic numbers, such as uranium-238 and plutonium-239, have many generations of radioactive progeny. For example, the radioactive decay of plutonium-239 creates uranium-235, thorium-231, protactinium-231, and so on through eleven progeny until only the stable isotope lead-207 remains.

Radionuclides with lower atomic numbers often have no more than one daughter. For example, strontium-90 has one radioactive daughter, yttrium-90, which finally decays into stable zirconium; cobalt-60 decays directly to stable nickel with no intermediate nuclide.

The time required for half of the radioactivity of a radionuclide to decay is referred to as the radionuclide's half-life. Each radionuclide has a unique half-life; both strontium-90 and cesium-137 have half-lives of approximately 30 years while plutonium-239 has a half-life of 24,400 years. Knowledge of radionuclide half-lives is often used to estimate past and future inventories of radioactive material. For example, a 1.0-millicurie source of cesium-137 in 2000 would have measured 2.0 millicuries in 1970 and will be 0.5 millicuries in 2030.

Radiation emitted by radionuclides may consist of electromagnetic rays such as x-rays and gamma rays or charged particles such as alpha and beta particles. A radionuclide may emit one or more of these radiations at characteristic energies that can be used to identify them.

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 low-level background radiation is estimated to be about 360 millirem (mrem) or 3.6 millisieverts (mSv). Most of this radiation, approximately 295 mrem (2.95 mSv), comes from natural sources. The rest comes from medical procedures, consumer products, and other manmade sources. *(See Figure 4-1 [p. 4-2] in Chapter 4, Radiological Dose Assessment.)*

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.

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 with 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 less than an inch thick. If beta particles are released inside the body they do much less damage than an equal number of alpha particles. Because they are smaller and faster and have less of a charge, beta particles deposit energy in tissue cells over a larger volume than alpha particles. Strontium-90, a fission product, is an example of a beta-emitting radionuclide. (See *fission* [p. GLO-4] in the Glossary.) Strontium-90 is found in the stabilized supernatant.

Gamma Rays. Gamma rays are high-energy "packets" of electromagnetic radiation, called photons, that are emitted from the nucleus. 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 generated by the nuclear disintegration, the excess energy may be emitted as gamma rays. If the released energy is high, a very penetrating gamma ray is produced that can be effectively reduced only by shielding consisting of several inches of a heavy element, such as lead, or of water or concrete several feet thick. Although large amounts of gamma radiation are dangerous, gamma rays are also used in many lifesaving medical procedures. An example of a gamma-emitting radionuclide is barium-137m, a short-lived daughter product of cesium-137. Both barium-137m and cesium-137 are major constituents of the WVDP high-level radioactive waste.

Measurement of Radioactivity. The rate at which radiation is emitted from a disintegrating nucleus can be described by the number of decay events or 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).

The curie is based on the decay rate of the radionuclide radium-226 (Ra-226). One gram of radium-226 decays at the rate of 37 billion nuclear disintegrations per second (3.7E+10 d/s), so one curie equals 37 billion nuclear disintegrations per second. One becquerel equals one decay, or disintegration, per second. (See the Scientific Notation section at the back of this report [UOM-2] or p. 1-5 of this chapter for information on exponentiation [i.e., the use of "E" to mean the power of 10].)

Very small amounts of radioactivity are sometimes measured in picocuries. A picocurie is one-trillionth (1E-12) of a curie, equal to 3.7E-02 disintegrations per second, or 2.22 disintegrations per minute.

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. (An erg is the approximate amount of energy necessary to lift a mosquito one-sixteenth of an inch.) "Dose" is a means of expressing the amount of energy absorbed, taking into account the effects of different kinds of radiation.

Alpha, beta, and gamma radiation affect the body to different degrees. Each type of radiation is given a quality factor that indicates the extent of human 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, so alpha radiation has a quality factor of 20, compared to gamma rays, x-rays, or beta particles, all of which have a quality factor of 1.

The unit of dose measurement to humans is the rem (roentgen-equivalent-man). The number of rem are equal to the number of rad multiplied by the quality factor for each type of radiation. Dose can also be expressed in sieverts. One sievert equals 100 rem.

Environmental Monitoring Program Overview

Exposure of human beings to radioactivity would be primarily through air, water, and food. At the WVDP all three pathways are monitored, but air and surface water pathways are the two primary means by which radioactive material can move off-site.

The geology of the site (types of soil and bedrock), the hydrology (location and flow of surface water and groundwater), 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 WVDP includes measuring the concentration of 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 from key locations, which can be done within a matter of hours, produces a comprehensive picture of on-site and off-site levels of radioactivity from all sources. For a DOE site such as the WVDP, 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 have been previously detected in WVDP waste materials. Radiation from other important radionuclides such as tritium or iodine-129 is not sufficiently energetic to be detected by gross measurement techniques, so these must be analyzed separately using methods with greater sensitivity. Heavy elements such as uranium, plutonium, and americium require special analysis to be measured because they exist in such small concentrations in the WVDP environs.

The radionuclides monitored at the Project are those that might produce relatively higher doses or that are most abundant in air and water effluents. Because manmade sources of radiation at the Project have been decaying for more than thirty years, the monitoring program does not routinely include short-lived radionuclides, that is, isotopes with a half-life of less than two years, which would have less than 1/1,000 of the original radioactivity remaining. (See Appendix B [pp. B-1 through B-44] for the schedule of samples and radionuclides measured and Appendix K, Table K-1 [p. K-3] for a listing of the half-lives of radionuclides measured in WVDP samples and related Department of Energy [DOE] protection standards, such as the derived concentration guides [DCGs]. See also the discussion of DCGs [*facing page*].)

Data Reporting. Because the decay of radioactive atoms is a random process, there is an inherent uncertainty associated with all measurements of environmental radioactivity. This can be demonstrated by repeatedly measuring the number of atoms that decay in a radioactive sample over some fixed period of time. The result of such an experiment would be a range of values for which the average value would provide the best indication of how many radioactive atoms were present in the sample.

However, in actual practice an environmental sample usually is measured for radioactivity only once. The inherent uncertainty of the measurement, then, stems from the fact that it cannot be known whether the result that was obtained from

Derived Concentration Guides

A derived concentration guide (DCG) is defined by the DOE in DOE Order 5400.5 as the concentration of a radionuclide in air or water that, under conditions of continuous exposure by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation) for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to a "reference man." These concentrations – DCGs – are used as reference screening levels to enable WVDP personnel reviewing effluent and environmental data to decide if further investigation is needed. (See Table K-1, Appendix K [p. K-3] for a list of DCGs.)

For liquid effluent screening purposes, the percentages of the DCGs for all radionuclides present are summed. If the total is less than 100%, then the effluent released complies with the DOE guideline. DCGs are also compared with radionuclide concentrations from these sources to verify that Best Available Technology standards for treatment of water are being met.

The DOE provides DCGs for airborne radionuclides in locations where members of the public could, over an extended period of time, breathe air containing contaminants. DCGs are only applicable to radionuclides in air breathed by members of the public. DCGs may be used as a basis for screening concentrations from air emission points.

DOE Orders require that the hypothetical dose to the public from facility effluents be estimated using specific computer codes. (See Dose Assessment Methodology [p. 4-3] in Chapter 4, Radiological Dose Assessment.) Doses estimated for WVDP activities are calculated using actual site data and are not related directly to summed DCG values. Dose estimates for liquid effluents are based on the product of radionuclide quantities released and the site-specific dose equivalent effects for that radionuclide. Although airborne DCGs are used for comparison purposes, the more stringent U.S. Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulate Project airborne effluents at the point of release. For a consistent guide to relative concentrations, both air and water sampling results are compared with DCGs throughout this report.

one measurement is higher or lower than the "true" value.

The term *confidence interval* is used to describe the range of measurement values above and below the test result within which the "true" value is expected to lie. This interval is derived statistically. The width of the interval is based primarily on a predetermined confidence level, that is, the probability that the confidence interval actually encompasses the "true" value. The WVDP environmental monitoring program uses a 95% confidence level for all radioactivity measurements and calculates confidence intervals accordingly.

The confidence interval around a measured value is indicated by the plus-or-minus (±) value following the result (e.g., 5.30 ± 3.6E-09 µCi/mL), with the exponent of 10^{-9} expressed as "E-09." Expressed in decimal form, the number 5.30±3.6E-09 would be 0.00000000530 ± 0.0000000036 µCi/mL. A sample measurement expressed this way is correctly interpreted to mean "there is a 95% probability that the concentration of radioactivity in this sample is between 1.7E-09 µCi/mL and 8.9E-09 µCi/mL." (See also Scientific Notation [p. UOM-2] at the end of this report.) If the confidence interval for the measured value includes zero (e.g., 5.30 ± 6.5E-09 µCi/mL), the value is considered to be below the detection limit. The values listed in tables of radioactivity measurements in the appendices include the confidence interval regardless of the detection limit value.

In general, the detection limit is the minimum amount of constituent or material of interest detected by an instrument or method that can be distinguished from background and instrument noise. Thus, the detection limit is the lowest value at which a sample result shows a statistically positive difference from a sample in which no constituent is present. (Maximum and minimum values in data sets showing positive results have been set in boldface type in the data appendices at the back of this report; the key to this convention is described at the beginning of each appropriate appendix.)

Nonradiological data conventionally are presented without an associated uncertainty and are expressed by the detection limit prefaced by a "less-than" symbol (<) if that analyte was not measurable. (See also Data Assessment and Reporting [p. 5-7] in Chapter 5, Quality Assurance.)

Changes in the 2001 Environmental Monitoring Program. Several modifications to the environmental sampling and surveillance network were made in 2001 to better reflect current facility status.

• Work is no longer being done in the former low-level waste treatment building. The building ventilation system and its air sampler (ANLLWTVH) have been shut down. Therefore no air samples were collected at this location during 2001.

• Water sampling at the waste tank farm underdrain (WN8D1DR) was discontinued in December 2001 at the direction of DOE. The location is not considered representative of the underground drainage system.

• The french drain water sampling point (WNSP008) was capped off in May 2001 to prevent the discharge of elevated levels of lead detected at this location. (See SPDES Permit Limit Exceptions [p. 1-18].)

• Due to a pending property sale, the community air sampler in West Valley (AFWEVAL) was relocated from a private residence to property of the West Valley Fire Department in November 2001.

• Monthly milk sampling was discontinued at location BFMCOBO in August 2001 when the local farmer stopped selling milk to commercial dairies and withdrew from the program.

See Appendix B for a summary of the program changes (p. B-iv) and the sample points and parameters measured in 2001 (pp. B-1 through B-44).

Vitrification Overview

High-level radioactive waste from NFS operations was originally stored in two of four underground tanks (tanks 8D-2 and 8D-4). The waste in 8D-2, the larger of the active tanks, 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 process of pretreatment and vitrification.

Pretreatment Accomplishments. The supernatant (in tank 8D-2) was composed mostly of sodium and potassium salts dissolved in water. Radioactive cesium in solution accounted for more than 99% of the total radioactivity in the supernatant. 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.

Pretreatment of the supernatant began in 1988. The integrated radwaste treatment system (IRTS) reduced the volume of the high-level waste needing vitrification 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 cesium. The resulting liquid 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 71-gallon (269-liter) steel drums. The cement-stabilized waste form has been accepted by the U.S. Nuclear Regulatory Commission (NRC).

The steel drums were stored in an on-site aboveground vault, the drum cell. (See Fig. A-1 [p. A-3].) Processing of the supernatant was completed in 1990, with more than 10,000 drums of cemented waste produced.

The sludge that remained was composed mostly of iron hydroxide. Strontium-90 accounted for most of the radioactivity in the sludge. Pretreatment of the sludge layer in high-level waste tank 8D-2 began in 1991. Five specially designed 50-foot-long pumps were installed in the tank to mix the sludge layer with water to produce a uniform sludge blend and to dissolve the sodium salts and sulfates that would interfere with vitrification. After mixing and allowing the sludge to settle, processing of the wash water through the IRTS began. Processing removed radioactive constituents for later solidification into glass, and the wash water containing salt was then stabilized in cement.

Sludge washing was completed in 1994 after approximately 765,000 gallons (2.9 million liters) of wash water had been processed. About 8,000 drums of cement-stabilized wash water were produced. In January 1995, high-level waste liquid stored in tank 8D-4 was transferred to tank 8D-2. (Tank 8D-4 contained THOREX high-level radioactive waste, which had been produced by a single reprocessing campaign of a special fuel containing thorium that had been conducted from November 1968 to January 1969 by the previous facility operators.) The resulting mixture was washed and the wash water was processed. The IRTS processing of the combined wash waters was completed in May 1995.

In all, through the supernatant treatment process and the sludge wash process, more than 1.7 million gallons (6.4 million liters) of liquid had been processed by the end of 1995, producing a total of 19,877 drums of cemented low-level waste. These drums are stored in the drum cell.

As one of the final steps, the ion-exchange material (zeolite) used in the IRTS to remove radioactivity was blended with the washed sludge before being transferred to the vitrification facility for blending with the glass-formers. In 1995 and early 1996 final waste transfers to high-level waste tank 8D-2 were completed in preparation for vitrification.

Preparation for Vitrification. Nonradioactive testing of a full-scale vitrification system was conducted from 1984 to 1989. In 1990 all vitrification test equipment was removed to allow installation of shield walls for remote radioactive operations. The walls and shielded tunnel connecting the vitrification facility to the former reprocessing plant were completed in 1991. The slurry-fed ceramic melter was assembled, bricked, and installed in 1993, and the cold chemical building was completed, as was the sludge mobilization system that transfers high-level waste to the melter. This system was tested in 1994. Several additional major systems components also were installed in 1994: the canister turntable, which positions the stainless steel canisters as they are filled with molten glass; the submerged bed scrubber, which cleans gases produced by the vitrification process; and the transfer cart, which moves filled canisters to the storage area.

Nonradiological testing ("cold" operations) of the vitrification facility began in 1995, and the first canister of nonradiological glass was produced. The WVDP declared its readiness to proceed with the necessary equipment tie-ins of the ventilation and utility systems to the vitrification facility building and tie-ins of the transfer lines to and from the high-level waste tank farm and the vitrification facility. In this closed-loop system, the transfer lines connect to multiple common lines so that material can be moved among all the points in the system.

High-level waste vitrification began in 1996. Phase I, which saw the majority of the high-level liquid waste vitrified, was completed in mid-1998. Phase II, removing and vitrifying residual radioactivity, continued throughout 2001. (See Vitrification [*below*].)

2001 Activities at the WVDP

The WVDP's environmental management system is an important factor in the environmental monitoring program and the accomplishment of its mission. Significant components, initiatives, and pertinent information about the work accomplished at the WVDP in 2001 are summarized below.

Vitrification. Solidification of the high-level waste in glass continued in 2001. The high-level waste mixture of washed sludge and spent zeolite from the ion-exchange process is combined in batches with glass-forming chemicals and then fed to a ceramic melter. The waste mixture is heated to approximately 2,000^{o}F and poured into stainless steel canisters. Approximately 300 stainless steel canisters eventually will be needed to hold all of the vitrified waste. Each canister, 10 feet long by 2 feet in diameter, is filled with a uniform, high-level waste glass that will be suitable for eventual shipment to a federal repository. During Phase I (June 1996 to June 1998) 210 canisters were filled. In 2001 more than 0.15 million curies of radioactivity were transferred to the vitrification facility and ten high-level waste canisters were produced. Since the beginning of vitrification in 1996 through calendar year 2001, 264 high-level waste canisters have been filled and more than 11 million cesium/strontium curies have been transferred to the vitrification facility and vitrified.

Tank Cleaning and Characterization. The recovery of the remaining waste has been challenging primarily due to the complex internal structural support system within the tanks. In 2001, two remotely operable tool deployment systems were installed in the main tank – tank 8D-2. From these two access points, remotely operated sluicers guided by video cameras were used to wash more than 80 percent of the tank's interior surfaces.

Several innovative characterization technologies deployed in tank 8D-2 include a burnishing sampler, a gamma camera, and a beta/gamma detection system. The burnishing sampler scours material from the tank surfaces and draws this residual material into a sample collection device for laboratory analysis. The gamma camera was used to map the tank interior for areas of cesium-137 accumulation. The beta/gamma detector system was used to scan the vertical tank walls to determine levels of fixed surface contamination.

Decontamination and Decommissioning. Initial decontamination efforts in the main plant are focusing on the process mechanical cell and the general purpose cell to place the cells in a safer configuration for future facility decommissioning. After a readiness assessment was completed, decontamination and decommissioning (D&D) work began in the process mechanical cell during September 2001. Additional D&D projects completed during 2001 included decontamination of the acid recovery pump room and the decontamination, dismantlement, and packaging of a large glove box that was used during Nuclear Fuel Services reprocessing operations.

Preparation for Spent Fuel Shipping. A significant achievement during 2001 was the loading of 125 spent nuclear fuel assemblies remaining from former fuel reprocessing operations into two specially designed casks for rail shipment to Idaho. The WVDP worked with the NRC to allow full-load shipments, resulting in one shipment instead of two. The casks are currently staged on-site, awaiting shipment to the Idaho National Engineering and Environmental Laboratory.

Remote-Handled Waste Facility Construction. As part of project operations, various contaminated materials/components have been removed from the former Process Building and are in storage awaiting disposal. In addition, as efforts increase toward eventual decommissioning, additional materials and components will be removed from the Waste Tank Farm and the former Process Building. Before these waste materials can be shipped for disposal, they have to be characterized, sorted, processed as necessary, and packaged to meet regulatory requirements for transportation. The Remote-Handled Waste Facility (RHWF) is a new facility which will be used to process and package these highly contaminated, high-activity, solid radioactive wastes. Construction of the Remote-Handled Waste Facility started in September 2000 and continued throughout 2001. The facility is currently scheduled to begin operations sometime in calendar year 2004.

Environmental Management of Aqueous Radioactive Waste. Water containing radioactive material from site process operations is collected and treated in the low-level waste treatment facility (LLWTF). (Water from the sanitary system, 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 New York State Pollutant Discharge Elimination System (SPDES)-permitted outfall. In 2001, 8.4 million gallons (31.9 million liters) of water were treated in the LLWTF system, which includes the low-level waste treatment building (LLW2) and associated holding lagoons, and discharged through outfall 001, the lagoon 3 weir. The discharge waters contained an estimated 13.2 millicuries of gross alpha plus gross beta radioactivity. Comparable releases during the previous sixteen years averaged about 37 millicuries per year. The 2001 release was about 36% of this average. (See Radiological Monitoring: Surface Water, Low-level Waste Treatment Facility Sampling Location [p. 2-3] in Chapter 2.)

Approximately 0.11 curies of tritium were released in WVDP liquid effluents in 2001 – about 9% of the sixteen-year average of 1.30 curies.

Environmental Management of Airborne Radioactive Emissions. Ventilated air from the various points in the IRTS process (high-level waste sludge treatment, main plant and liquid waste treatment system, and the cement solidification system) and from other waste management activities is sampled continuously during operation for both particulate matter and for gaseous radioactivity. In addition to monitors that alarm if particulate matter radioactivity increases above pre-set levels, the sample media are analyzed in the laboratory for the specific radionuclides that are present in the radioactive materials being handled.

Air used to ventilate the facilities where radioactive material cleanup processes are operated is passed through filtration devices before being emitted to the atmosphere. These filtration devices are generally more effective for particulate matter than for gaseous radioactivity. For this reason, facility air emissions tend to contain a greater amount of gaseous radioactivity (e.g., tritium and iodine-129) than radioactivity associated with particulate matter (e.g., strontium-90 and cesium-137). However, gaseous radionuclide emissions still remain so far be-

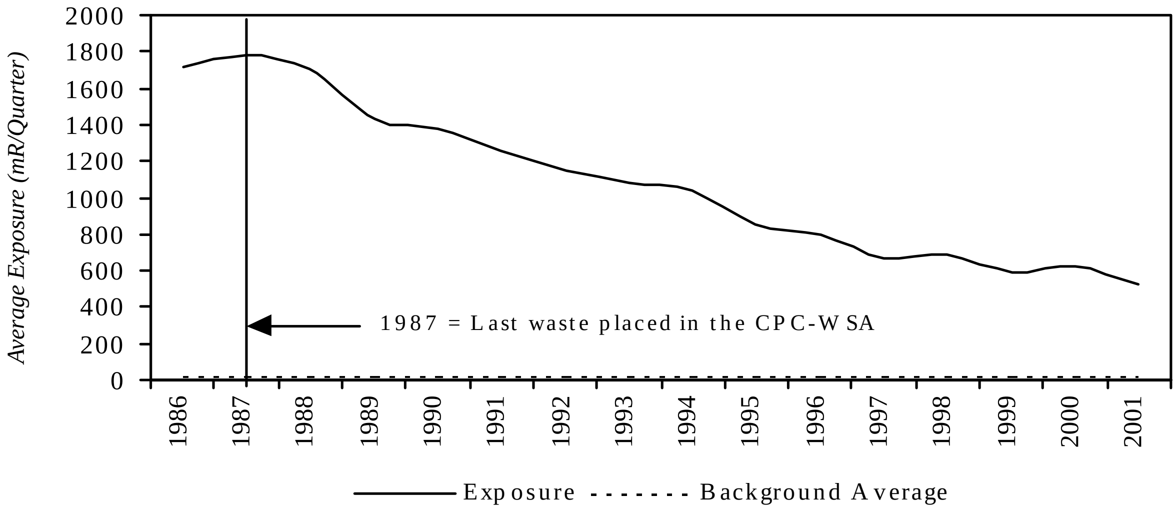

Figure 1-1. Annual Average Exposure at the CPC-WSA (DNTLD24)

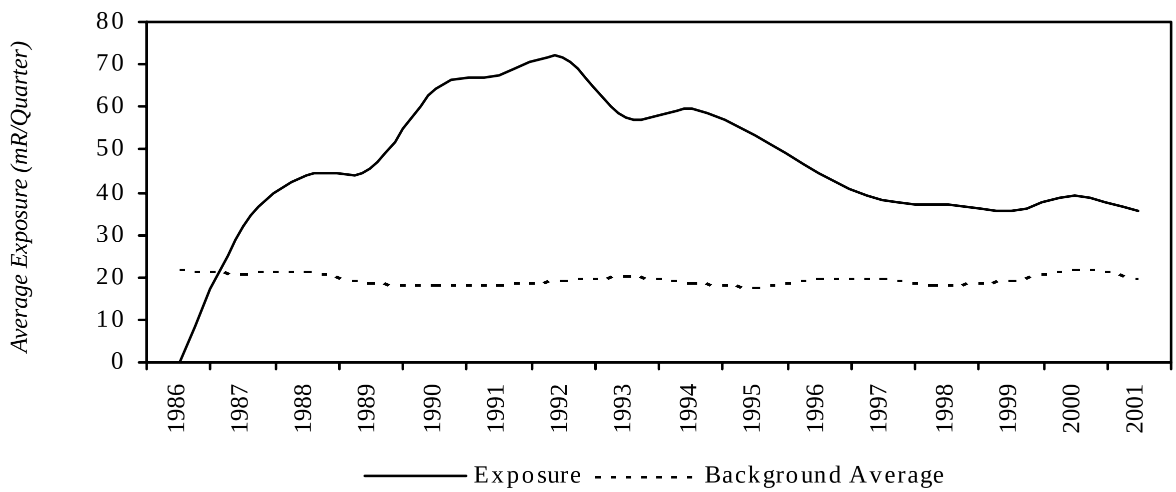

Figure 1-2. Annual Average Exposure at the Drum Cell (DNTLD36)

low the most restrictive regulatory limit for public safety that additional treatment technologies beyond that already provided by, for example, the vitrification off-gas treatment system, are not necessary.

Gaseous radioactivity emissions from the main plant in 2001 included approximately 26.5 millicuries of tritium (as hydrogen tritium oxide [HTO]) and 0.52 millicuries of iodine-129. (See Chapter 2 [p. 2-27] for a discussion of iodine-129 emissions from the main plant stack.) As expected, these 2001 values are quite low in comparison to values from 1997, a year in which the vitrification system was in operation for the entire year at a relatively high rate of production and tritium and iodine-129 emissions were 140 millicuries and 7.43 millicuries respectively.

Particulate matter radioactivity emissions from the main plant in 2001 – conservatively determined –

included approximately 1.2 millicuries of gross beta-emitting radioactivity and 0.004 millicuries of gross alpha-emitting radioactivity. In 1997, beta-emitting and alpha-emitting radioactivity emissions were 0.4 millicuries and 0.001 millicuries, respectively. The increase is suspected to be attributable to the changing character of the waste being vitrified (residuals in Phase II versus the bulk wastes of Phase I), increasing contributions to air emissions from D&D activities, and a release from the main plant stack in the fall of 2001. (See Unplanned Radiological Releases [*this page*].)

Environmental Management of Radiological Exposure. Radiological exposures measured at on-site monitoring locations DNTLD24, located near the chemical process cell waste storage area (CPC-WSA), and DNTLD36, located near the drum cell, have shown steady decreases for several years. (See Fig. A-10 [p. A-12] for the locations of these two monitoring points.) Exposure data for these two monitoring locations are shown in Figures 1-1 and 1-2 (*facing page*).

The beginning of the long-term steady decrease in exposure at DNTLD24 correlates well with the cessation of placement of waste containers in the CPC-WSA in 1987 and with the decay of the mix of isotopes in the stored waste. The decreases noted at DNTLD36 can be attributed to the cessation of the placement of waste drums in the drum cell as well as the decay of the mix of isotopes in the stored waste over time and to the revised stacking plan initiated in 1990, which changed the arrangement of waste and shield drums in the drum cell.

Unplanned Radiological Releases. There were no unplanned liquid radiological releases on-site or to the off-site environment from the Project in 2001.

During routine radiation work surveys conducted during mid-November 2001, fixed radioactivity was found on-site in unexpected locations close to the main process building. The small spots of contamination were limited to an area immediately north, and to a lesser extent southeast, of the main plant stack. Upon discovery, the area involved was promptly isolated and decontaminated or stabilized. On-site personnel were surveyed and no personnel contamination was found. Additionally, environmental monitoring data were checked and the data indicated that contamination did not spread off-site.

An extensive investigation was carried out to determine the origin of the contamination. Careful evaluation of radiological monitoring data, operations records, and meteorological (weather) information helped to confirm that the contamination was the result of the release of small amounts of cesium-137 from the waste tank farm ventilation system dissolved in condensed water vapor being released from the main plant stack during late September and early October 2001. The radioactivity release rate was too low to result in any stack monitoring alarms and the total amount of radioactivity released was well within regulatory limits. An unusual combination of ventilation process and weather conditions resulted in an unexpected local deposition of radioactivity. To help prevent recurrence of such an event in the future, operational procedures and system designs are being reviewed and modified to preclude condensation of water vapor in process ventilation systems.

NRC-Licensed Disposal Area (NDA) Interceptor Trench and Pretreatment System. Radioactively contaminated n-dodecane in combination with tributyl phosphate (TBP) was discovered at the northern boundary of the NDA in 1983, shortly after the DOE assumed control of the WVDP site. Extensive sampling and monitoring through 1989 revealed the possibility that the n-dodecane/TBP could migrate. To contain migration of this subsurface radioactive organic contaminant, an interceptor trench and liquid pretreatment system (LPS) were built.

The trench was designed to intercept and collect subsurface water, which could be carrying n-dodecane/TBP, to prevent the material from entering the surface water drainage ditch leading into Erdman Brook. The LPS was installed to decant the n-dodecane/TBP from the water and to remove iodine-129 from the collected water before its transfer to the low-level waste treatment facility. The separated n-dodecane/TBP would be stored for subsequent treatment and disposal.

As in previous years, no water containing n-dodecane/TBP was encountered in the trench and no water or n-dodecane/TBP was treated by the LPS in 2001. Approximately 147,000 gallons (556,000 liters) of radiologically contaminated water were collected from the interceptor trench and transferred to the LLWTF for treatment during the year. Results of surface and groundwater monitoring in the vicinity of the trench are discussed in Chapter 2 under South Plateau Sampling Locations (p. 2-7) and in Chapter 3 under Results of Monitoring at the NDA (p. 3-13).

Waste Minimization Program. The WVDP formalized a waste minimization program in 1991 to reduce the generation of low-level waste, mixed waste, and hazardous waste. This program is a comprehensive and continual effort to prevent or minimize pollution, with the overall goal of reducing health and safety risks, protecting the environment, and complying with all federal and state regulations. (See also the Environmental Compliance Summary, Waste Minimization and Pollution Prevention [p. ECS-5] and p. 1-18 of this chapter.)

Pollution Prevention Awareness Program. The WVDP's Pollution Prevention (P2) Awareness Program is a significant part of the Project's waste minimization program. The goal of the program is to make all employees aware of the importance of pollution prevention both at work and at home.

A crucial component of the P2 Awareness Program at the WVDP is the Pollution Prevention Coordinators group. This group communicates, shares, and publicizes prevention, reduction, reuse, and recycling information to all departments at the WVDP. The P2 coordinators identify and facilitate the implementation of effective source-reduction, reuse, recycling, and procurement of recycled products. During 2001, an incentive program was developed and implemented to encourage employees to align their waste minimization and pollution prevention activities with the Department of Energy's P2 goals. This resulted in waste stream reduction/elimination, energy savings, and affirmative procurement with total cost savings and avoidances of more than $1,400,000 with implementation costs of about $45,000.

Waste Management. The WVDP continued reducing and eliminating waste generated by site activities. Reductions in the generation of low-level radioactive waste, mixed waste, hazardous waste, industrial wastes, and sanitary waste such as paper, plastic, wood, and scrap metal were targeted. Specific waste minimization achievements included the following items.

- Ninety-five percent of unused software stored in the warehouse was sent to a recycling vendor, with the remaining 5% donated to local schools.

- A portable steam cleaner was purchased to clean sewage grinder pumps. Use of this cleaner has reduced personnel exposure to chemicals, protected the environment, and avoided future costs of approximately $40,000 for shipping 571,000 gallons of sewage off-site.

- Minimum/maximum inventory limits were changed, reducing the quantity of laboratory materials on hand.

- More than 703 cubic feet of unused radiological supplies were transferred to other DOE facilities for use.

- More than nine metric tons of plastic and metal drums were emptied, cleaned, and either returned to the vendor for deposit or sold for recycling.

- More than 100 metric tons of scrap carbon and stainless steel were collected and sold to a metal recycling vendor.

- Activities associated with the vitrification expended materials program reduced waste material by more than 344 metric tons.

Low-Level Waste Shipping Program. Activities were initiated in 1997 to reduce the inventory of legacy low-level waste on-site. More than 125,000 cubic feet of waste have been safely shipped off-site since the program was instituted. The WVDP received approval to ship waste to the Nevada Test Site in July 2001, the only new generator to receive this certification.

A truck shipment of low-level radioactive waste from the WVDP was delayed on Monday, July 30, 2001 during a refueling stop in West Wendover, Nevada, when the driver noticed that some absorbent material appeared to have been released from a metal waste box. The shipment, consisting of two metal boxes and five high-integrity containers holding solid, low-level radioactive debris, was en route to the DOE's Nevada Test Site for disposal. The WVDP and local authorities were notified as were representatives from the DOE's Radiological Assistance Program. Radiological surveys of the materials and containers indicated that no radiologically contaminated materials were released. Uncontaminated, non-hazardous absorbent packing material had fallen through a small (one-inch) crack in the container. The damaged waste box and its contents were returned to the WVDP and the remaining containers continued on to the Nevada Test Site. This event resulted in no environmental release and no safety and health consequences. An investigation was carried out and corrective actions were put in place to prevent a recurrence.

National Environmental Policy Act Activities. Under the National Environmental Policy Act (NEPA), the Department of Energy is required to consider the overall environmental effects of its proposed actions or federal projects. 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 potential 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 a significant effect on the environment. Environmental assessments evaluate the extent to which the proposed action will 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.

Facility maintenance, decontamination and decommissioning activities, and minor projects that support high-level waste vitrification are documented and submitted for approval as categorical exclusions, although environmental assessments occasionally are necessary for larger-scale activities.

West Valley Citizen Task Force

In addition to the public comment process required by the National Environmental Policy Act, the New York State Energy Research and Development Authority (NYSERDA), with participation from the DOE, formed the West Valley Citizen Task Force in January 1997. The mission of the Task Force is to provide advice on the completion of the West Valley Demonstration Project and cleanup, closure, and/or long-term management of the facilities at the site. The Task Force process has helped illuminate the various interests and concerns of the community, increased the two-way flow of information between the site managers and the community, and provided an effective way for the Task Force members to establish mutually agreed upon recommendations for the site managers to consider in their decision-making process.

In December 1988 the DOE published a Notice of Intent to prepare an environmental impact statement for the completion of the WVDP and closure of the facilities at the WNYNSC.

The draft environmental impact statement, which describes the potential environmental effects associated with Project completion and various site closure alternatives, was completed in 1996 and released without a preferred alternative for a six-month public review and comment period. Having met throughout 1997 and 1998 to review alternatives presented in the draft environmental impact statement, the Task Force (see inset [*above*]) issued the West Valley Citizen Task Force Final Report (July 29, 1998). This report provided recommendations and advice on the development of a preferred alternative. The Task Force continues to meet and discuss issues related to Project completion and site closure decision making.

Because the Nuclear Regulatory Commission (NRC) is authorized by the West Valley Demonstration Project Act to prescribe decommissioning criteria for the WVDP, from 1998 until early 2002 the NRC worked to develop those decommissioning criteria through a series of draft policy papers and public meetings.

In January 2002 the NRC announced that it was issuing its final policy statement establishing the criteria of its existing license termination rule as the decommissioning criteria for the WVDP. The final policy statement was issued February 1, 2002 (67 FR 5003).

After the federal administration change in 2001, the DOE and NYSERDA continued efforts to reach agreement on a preferred alternative and agency responsibilities for completion of the WVDP and closure and/or long-term management of the WNYNSC. Also in 2001, DOE formally initiated its plan to revise the scope of the existing EIS by splitting that scope into two separate documents. The decision-making process has been separated into two phases by revising the scope of the 1996 draft environmental impact statement. Re-scoping will allow two separate environmental impact statements – one EIS for near-term waste management decision making and one EIS for final decommissioning and/or long-term stewardship decision making.

DOE published a Federal Register Notice of Intent (NOI) March 26, 2001 (66 FR 16447) formally announcing its rescoping plan and preparation of the waste management EIS. A draft EIS for waste management is being prepared for public review and comment.

DOE also published an Advance NOI on November 6, 2001 (66 FR 56090) announcing its commitment to begin work on the decommissioning and/or long-term stewardship EIS.

National Environmental Performance Track
U.S. Environmental Protection Agency

The National Environmental Performance Track is designed to recognize and encourage top environmental performers – those who go beyond compliance with regulatory requirements to attain levels of environmental performance and management that benefit people, communities, and the environment.

The logo identifies those facilities that qualify for Achievement Track membership. Achievement Track facilities can participate in a peer exchange network to share experience, benchmark each other's performance, share information on successful practices and strategies, and receive recognition for their work at state and local levels. The WVDP was awarded charter membership in this program.

Self-Assessments. Self-assessments continued to be conducted in 2001 to review the management and effectiveness of the WVDP environmental protection and monitoring programs. Results of these self-assessments are evaluated and corrective actions are tracked through to completion. Overall results of these self-assessments found that the WVDP continued to implement quality requirements and in some cases improve the quality of the environmental protection and monitoring program. (See the Environmental Compliance Summary [p. ECS-18] and Chapter 5, Quality Assurance [p. 5-6].)

Occupational Safety and Environmental Training. The safety of personnel who are involved in industrial operations under DOE cognizance is protected by standards mandated by DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards, which directs compliance with specific Occupational Safety and Health Act (OSHA) requirements. This act governs diverse occupational hazards ranging from electrical safety and protection from fire to the handling of hazardous materials. The purpose of OSHA is to maintain a safe and healthy working environment for employees.

Hazardous waste operations and emergency response regulations require that employees at treatment, storage, and disposal facilities, who may be exposed to health and safety hazards during hazardous waste operations, receive training appropriate to their job function and responsibilities. The WVDP environmental, health, and safety training matrix identifies the specific training requirements for such employees.

The WVDP provides the standard twenty-four-hour hazardous waste operations and emergency response training. (Emergency response training includes spill response measures and controlling contamination of groundwater.) In 2001, the WVDP implemented a 40-hour training program for hazardous waste operations and emergency response to meet the additional OSHA training requirements of a cleanup site. The additional training will provide workers with information and techniques for working on decontamination and decommissioning.

Training programs also contain information on waste minimization, pollution prevention, and the WVDP environmental management program. Besides this standard training, employees working in radiological areas receive additional training on subjects such as understanding radiation and radiation warning signs, dosimetry, and respiratory protection. In addition, qualification standards for specific job functions at the site are required and maintained. These programs have evolved into a comprehensive curriculum of knowledge and skills necessary to maintain the health and safety of employees and ensure the continued compliance of the WVDP.

In 2001 the WVDP maintained a hazardous materials response team trained to respond to spills of hazardous materials. This team maintained its proficiency through classroom instruction and scheduled training drills.

Medical emergencies on-site are handled by the WVDP Emergency Medical Response Team. This team consists of on-site professional medical staff, volunteer New York State-certified emergency medical technicians, and main plant operators who are First Responders.

Any person working at the WVDP who has a personal photo badge receives general employee training that covers health and safety, emergency response, and environmental compliance issues. All visitors to the WVDP receive a site-specific briefing on safety and emergency procedures before being admitted to the site.

Voluntary Protection Program STAR Status. On May 5, 2000 the WVDP received Voluntary Protection Program (VPP) STAR status, the highest safety award given within OSHA or the DOE. This prestigious award was granted in recognition of the WVDP's excellent worker safety and health programs. (See also the Environmental Compliance Summary [p. ECS-16].)

During 2001, the WVDP reaffirmed its commitment to DOE's VPP. During this reporting period, the annual VPP site evaluation was completed and submitted to DOE. WVDP representatives presented a workshop at the VPP Participants Association National Conference on the Interstate Zero Program (a program promoting zero on-the-job injuries). In addition, the WVDP was awarded DOE's Star of Excellence Award at this conference, which is given to sites with outstanding safety records.

Environmental Management System (EMS) Implementation. The project's environmental management system provides the basic policy and direction for work at the WVDP through procedures that support proactive management, environmental stewardship, and the integration of appropriate technologies throughout all aspects of the work at the WVDP.

The Project's environmental management system satisfies the requirements of the Code of Environmental Management Principles (CEMP) for federal agencies and International Organization for Standardization (ISO) 14001, Environmental Management Systems: Specification for Guidance and Use, which is being implemented worldwide. The CEMP was developed by the EPA in response to Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, in order to serve as the basis for responsible environmental management. Following the principles and performance objectives of the CEMP helps to ensure that a federal facility's environmental performance is proactive, flexible, cost-effective, and sustainable. The WVDP was awarded charter membership in the EPA's National Performance Track program for implementation of this EMS. (See inset on p. 1-15.)

Integrated Safety Management System (ISMS) Implementation. A plan to integrate environmental, safety, and health (ES&H) management programs at the WVDP was developed and initiated at the WVDP during 1998. During development of the ISMS, the enhanced work planning program (EWP) was identified as an integral part of the ISMS and a site-wide work review group was established to review work plans, identify ES&H concerns, and specify practices that ensure that work is performed safely.

Implementation of an ISMS at the WVDP, including the EWP, was verified by the DOE Ohio Field Office in November 1998. The most recent self-assessment by WVNSCO, performed in August 2001, verified that the ISMS continues to be effectively implemented at the WVDP. An annual ISMS review by the DOE occurred in October 2001 and confirmed the results of the WVNSCO self-assessment.

Performance Measures

Performance measures can be used to evaluate effectiveness, efficiency, quality, timeliness, productivity, safety, or other areas that reflect achievements related to organization or process goals and can be used as a tool to identify the need to institute changes.

The performance measures applicable to operations conducted at the WVDP, discussed here, reflect process performance related to wastewater treatment in the low-level waste treatment facility, the identification of spills and releases, the reduction in the generation of wastes, the potential radiological dose received by the maximally exposed off-site individual, and the transfer of high-level waste to the vitrification system.

Radiation Doses to the Maximally Exposed Off-Site Individual. One of the most important pieces of information derived from environmental monitoring program data is the potential radiological dose to an off-site individual from on-site activities. As an overall assessment of Project activities and the effectiveness of the as-low-as-reasonably achievable (ALARA) concept, the effective radiological dose to the maximally exposed off-site individual is an indicator of well-managed radiological operations. The effective dose equivalents for air effluent emissions, liquid effluent discharges, and other liquid releases (such as swamp drainage) from 1993 through 2001 are graphed in Figure 1-3 (*below*). Note

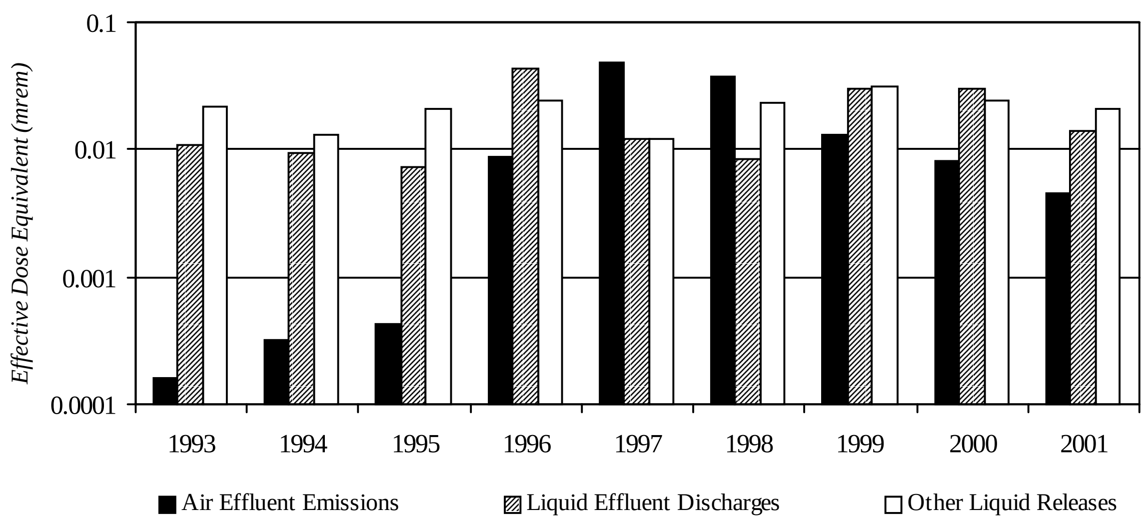

Figure 1-3. Annual Effective Dose Equivalent to the Maximally Exposed Off-Site Individual

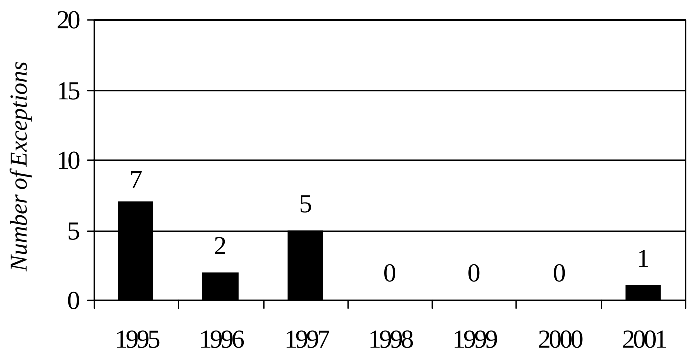

Figure 1-4. Yearly SPDES Permit Exceptions

that the sum of these values is well below the DOE standard of 100 mrem per year. These consistently low results indicate that radiological activities at the site are well-controlled. (See also Table 4-2 [p. 4-6] in Chapter 4, Radiological Dose Assessment.)

SPDES Permit Limit Exceptions. Effective operation of the site wastewater treatment facilities is indicated by compliance with the applicable discharge permit limitations. Approximately sixty parameters are monitored regularly as part of the SPDES permit requirements. The analytical results are reported to NYSDEC via Discharge Monitoring Reports, required under the SPDES program.

Although the goal of the low-level waste treatment facility and wastewater treatment facility operations is to maintain effluent water quality consistently within the permit requirements, occasionally SPDES permit limit exceptions do occur. All SPDES permit limit exceptions are evaluated to determine their cause and to identify corrective measures.

A Water Task Team composed of WVDP personnel with expertise in wastewater engineering, treatment plant operations and process monitoring, and National Pollutant Discharge Elimination System (NPDES)/SPDES permitting and compliance was formed in 1995 to address the causes of these exceptions.

The Water Task Team's efforts produced three consecutive years with no permit limit exceptions. In 2001, one permit limit exception for total recoverable lead occurred at outfall 008, the french drain for the LLWTF lagoon system. This exception was attributable to an increased lead concentration resulting from decreased flow and siltation within this aging groundwater drain system. (See Fig. 1-4 [*this page*].)

Although exceptions are not always related to operating deficiencies, corrective actions may include improved operation or treatment techniques. In 1997 the WVDP notified NYSDEC of the presence of mercury in the influent wastewater to the LLWTF and of its likely presence at outfall 001 at concentrations below the detectable level of 0.2 µg/L. In 1998 and 1999 an increase in the mercury concentration was observed in process wastewater from the liquid waste treatment system (LWTS) evaporator, water that is eventually treated at the LLWTF. The LWTS evaporator processes residual radioactive wastewater from the high-level radioactive waste processing and supernatant treatment operations.

During 2000 an engineering report and plans and specifications for a mercury pretreatment system, designed to remove mercury from the LWTS process water, were prepared by the WVDP and approved by NYSDEC. The system was subsequently installed and processing of LWTS wastewater through this system began in January 2001.

Waste Minimization and Pollution Prevention. In 2001 the WVDP continued its program

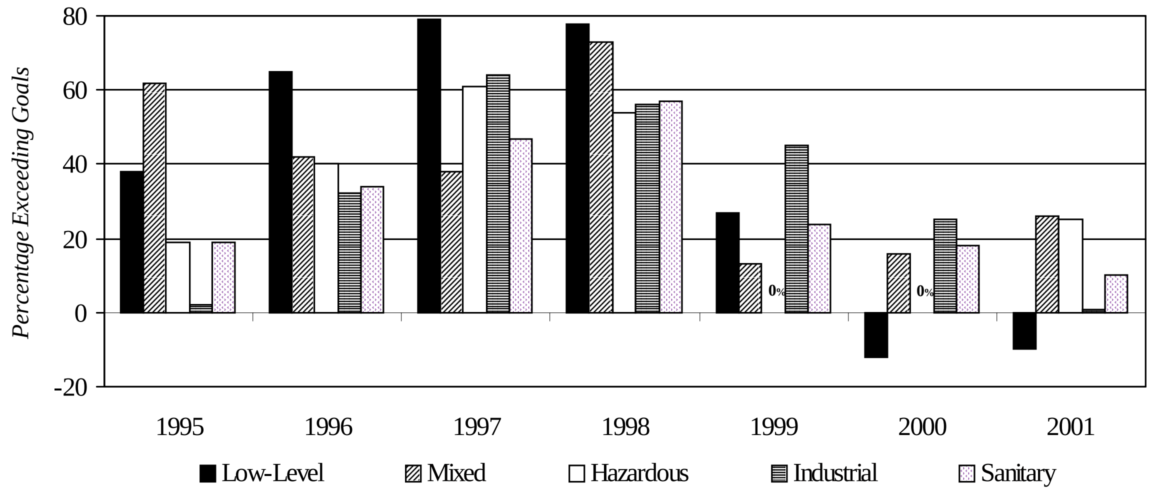

Figure 1-5. Percentage of Waste Reduction Exceeding Goals

of reducing and eliminating the amount of waste generated from site activities. Emphasis on good business practices, source-reduction, and recycling continued to reduce the generation of low-level radioactive waste, mixed waste, hazardous waste, industrial wastes, and sanitary wastes such as paper, glass, plastic, wood, and scrap metal. (See p. 1-12 for a list of specific waste minimization achievements.)

To demonstrate the effectiveness of the waste minimization program, a graph of the percentage of waste reduction achieved above the annual goal for each category is presented in Figure 1-5 (*above*) for calendar years 1995 through 2001.

The WVDP set the following cumulative nonvitrification waste-reduction goals for fiscal year 2001: an 80% reduction in the generation of low-level radioactive waste, a 71% reduction in the generation of mixed waste, a 42% reduction in the generation of hazardous waste, a 54% reduction in the generation of industrial waste, and a 67% reduction in the generation of sanitary waste. The above goals were based on quantities of routine waste generated in 1993. (As of fiscal year 2001, all WVDP pollution prevention goals are in alignment with the DOE's pollution prevention goals, which are now based on a federal fiscal year.)

All but one of these goals were exceeded during fiscal year 2001. Low-level radioactive waste generation was reduced by 70%, missing the established goal of 80% because the estimated goal set for 2001 was extremely aggressive. Mixed waste generation was reduced by 97%, hazardous waste by 67%, industrial waste by 55%, and sanitary waste by 77%.

A number of waste streams have been tracked over this period. Note that the low-level radioactive waste figures from 1995 include the volume of drummed waste produced in the cement solidification system. Hazardous waste and industrial waste volumes have been tracked separately for vitrification-related and nonvitrification-related waste streams since vitrification began in 1996. To maintain historical comparability, the percentages in Figure 1-5 include only the nonvitrification portions of these two waste streams.

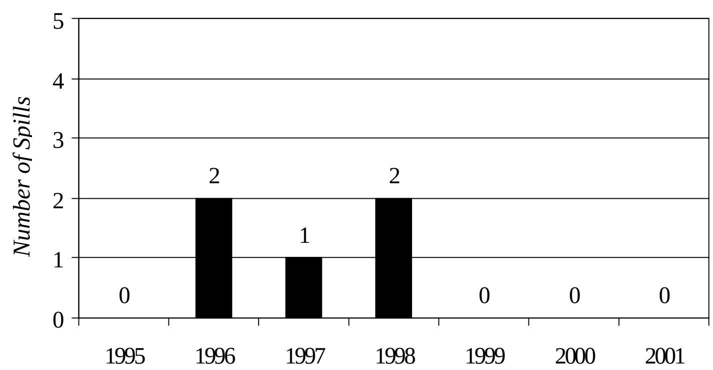

Figure 1-6. Number of Immediately Reportable Spills or Releases

Spills and Releases. Chemical spills greater than the applicable reportable quantity must be reported immediately to NYSDEC and the National Response Center and other agencies as required. There were no reportable chemical spills during 2001.

Petroleum spills greater than 5 gallons – or of any amount that travel to waters of the state – must be reported immediately to the NYSDEC spill hotline and entered in the monthly log. There were no reportable petroleum spills in 2001. Figure 1-6 (*at left*) is a bar graph of immediately reportable spills from 1995 to 2001.

Prevention is the best means of protection against oil, chemical, and hazardous substance spills or releases. WVDP employees are trained in applicable standard operating procedures for equipment that they use, and best management practices have been developed that identify potential spill sources and measures that will reduce the potential for releases to occur. Spill training, notification, and reporting policies have also been developed to emphasize the responsibility of each employee to report spills immediately upon discovery. This first-line reporting helps to ensure that spills will be properly documented and mitigated in accordance with applicable regulations.

Vitrification. To safely solidify the high-level radioactive waste in borosilicate glass, the high-level waste sludge is transferred in batches from the tank, where it currently is stored, to the vitrification facility. After transfer, the waste is solidified

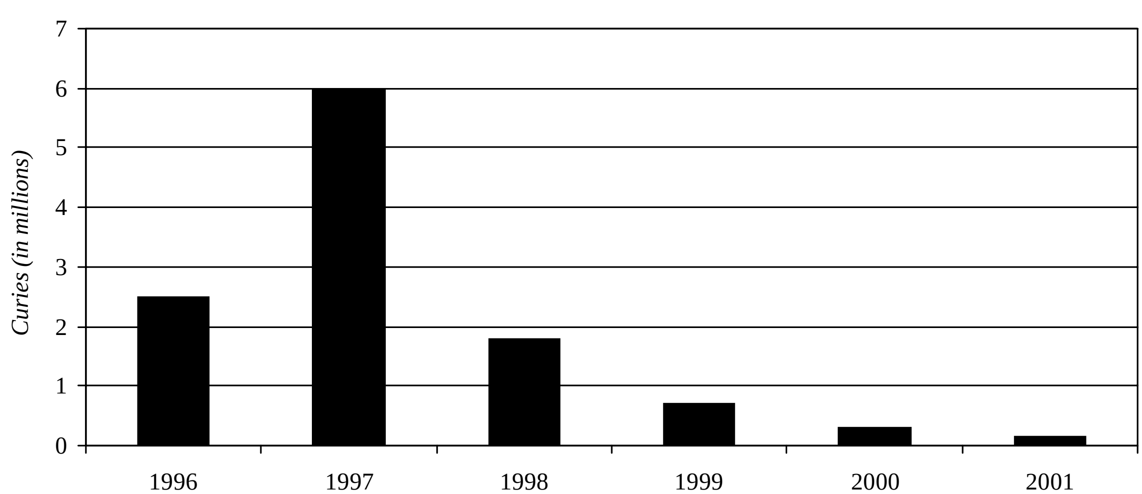

Figure 1-7. Number of Curies Transferred to the Vitrification Facility

into a durable glass for safe storage and future transport to a federal repository. It is estimated that roughly 12 million curies of strontium and cesium radioactivity in the high-level waste eventually will be vitrified. (Radioactive cesium and strontium isotopes account for 98% of the long-lived radioactivity.) To quantify the progress made toward completing the vitrification goal, Figure 1-7 (*facing page*) shows the number of curies transferred to the vitrification facility from 1996 through 2001.

On June 10, 1998, the WVDP marked completion of the Project's production phase (Phase I) of high-level waste processing, during which 210 canisters were filled with solidified waste glass. Phase II, vitrifying the high-level waste residuals, began in 1998 and continued through 2001. An additional fifty-four canisters have been filled in Phase II, ten of which were filled in 2001. A total of 264 canisters of immobilized waste, containing more than 11.9 million curies, have been generated thus far in the vitrification process.

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