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April 30, 2002
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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Gentlemen:

Subject: Saxton Nuclear Experimental Corporation (SNEC)
Operating License No. DPR-4
Docket Nos. 50-146
2001 Radiological Environmental Monitoring Report

In accordance with SNEC Technical Specification Section 3.8.2.3 and the SNEC Off-Site Dose Calculation Manual Part 3, Section 1.0, the 2001 SNEC Radiological Environmental Monitoring Report is enclosed.

Please contact Art Paynter (Radiation Safety Officer) at 814-635-4384 if you have any questions concerning this submittal.

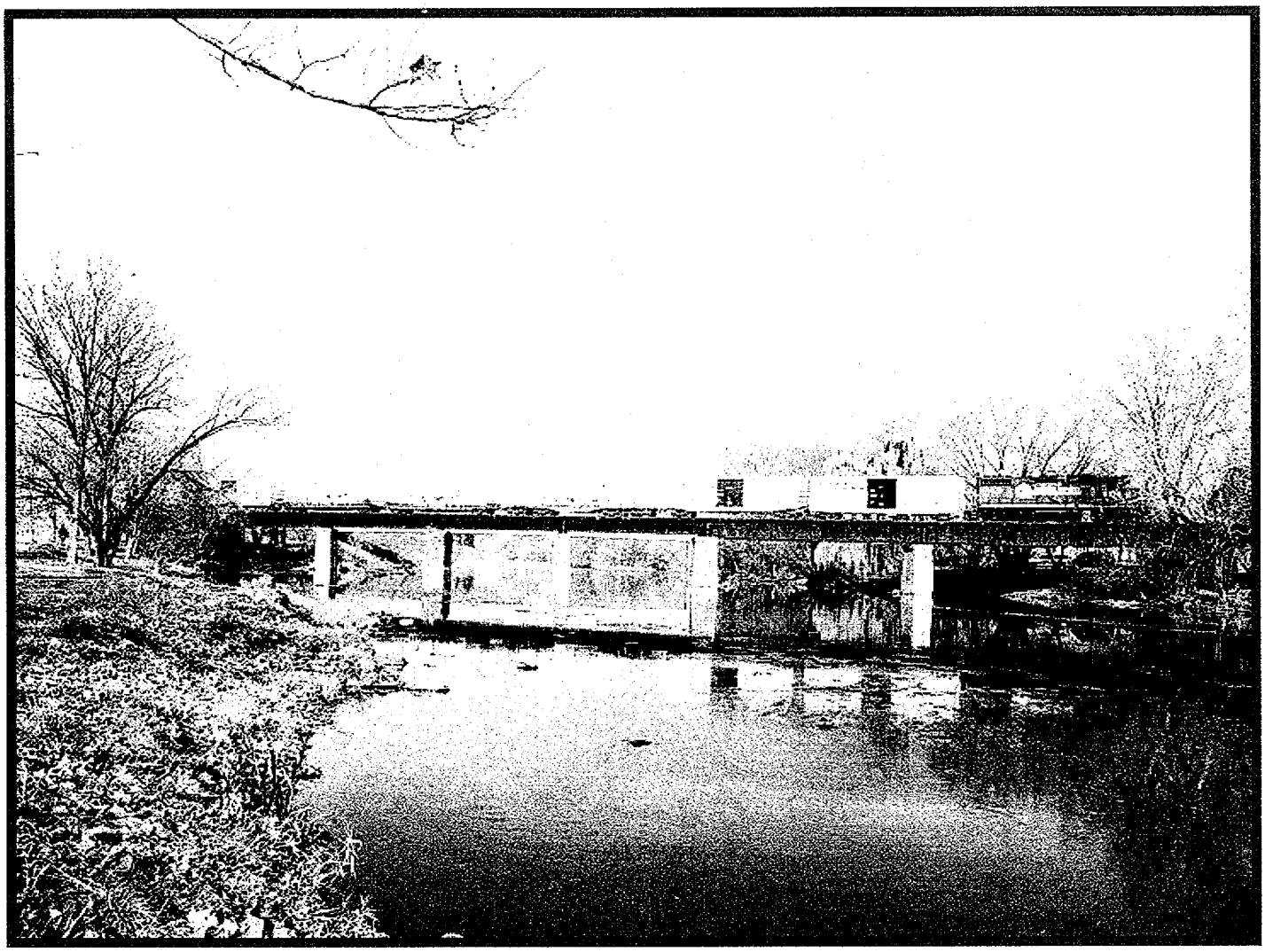
Sincerely,

G. A. Kuehn
Vice President SNEC

AFP
Enclosure

cc: NRC Project Manager NRR
NRC Project Scientist, Region 1

IE25



2001 Radiological Environmental Monitoring Report

Saxton Nuclear Experimental Corporation

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ABBREVIATIONS

actinium	Ac
antimony	Sb
argon	Ar
barium	Ba
becquerel	Bq
beryllium	Be
carbon	C
cesium	Cs
chromium	Cr
cobalt	Co
cubic meter(s)	m^3
curie(s) per year	Ci/yr
curie(s)	Ci
curium	Cm
east	E
east-northeast	ENE
east-southeast	ESE
gram(s)	g
hour(s)	h
hydrogen (tritium)	H-3
iodine	I
iron	Fe
krypton	Kr
lanthanum	La
liter(s)	L
manganese	Mn
mean sea level	msl
meter(s)	m
microroentgen per hour	μR/h
millirem per hour	mrem/h
millirem per standard month	mrem/std month
millirem per year	mrem/yr
millirem	mrem
milliroentgen per hour	mR/h
milliroentgen per standard month	mR/std month
milliroentgen	mR
niobium	Nb
nitrogen	N
northeast	NE
north	N
north-northeast	NNE
north-northwest	NNW
northwest	NW
percent	%
picocurie(s) per cubic meter	pCi/m^3
picocurie(s) per gram	pCi/g
picocurie(s) per liter	pCi/L
picocurie(s)	pCi
plutonium	Pu
potassium	K
radium	Ra
radon	Rn
rem per year	rem/yr
Roentgen equivalent man	rem
Roentgen	R
ruthenium	Ru
silver	Ag
south	S
southeast	SE
south-southwest	SSW
southwest	SW
standard deviation	std dev
standard month	std month
strontium	Sr
thorium	Th
uranium	U
west	W
west-northwest	WNW
west-southwest	WSW
year(s)	yr
zinc	Zn
zirconium	Zr

SUMMARY AND CONCLUSIONS

This report reviews the radiological environmental monitoring performed in 2001 for the Saxton Nuclear Experimental Corporation (SNEC) Facility. The environmental sample results indicated that SNEC operations in 2001 had no adverse effect on either the environment or the health and safety of the public.

Many of the radioactive materials discussed in this report are usually present in the environment, either from natural processes or as a result of non-SNEC activities such as prior atmospheric nuclear weapon tests and medical industry activities. To determine the impact of SNEC operations on the environment and the public, results from samples collected close to the SNEC Facility (indicator stations) were compared to results from samples obtained at distant sites (control or background stations).

The results of environmental measurements were used to assess the impact of SNEC decommissioning operations and to demonstrate compliance with the SNEC Facility Offsite Dose Calculation Manual (ODCM) (Reference 1), applicable Federal, and State regulations.

During 2001, samples of air, surface water, sediment, vegetation, and groundwater were collected. Direct radiation exposures were also measured in the vicinity of SNEC. Samples were analyzed for gross alpha and gross beta radioactivity, tritium (H-3), strontium-90 (Sr-90), and/or gamma emitting radionuclides. The results are discussed in the various sections of this report and are summarized in the following highlights:

- 224 samples were collected in 2001 from the aquatic, atmospheric and terrestrial environments around the SNEC Facility. There were approximately 500 analyses performed on these samples. In addition, 112 direct radiation exposure measurements were taken using thermoluminescent dosimeters (TLDs). The monitoring performed in 2001 met or exceeded the sample collection and analysis requirements of the SNEC Facility ODCM.

- The surface water collected downstream of the SNEC liquid discharge outfall resulted in less then detectable activities for radionuclides attributed to SNEC, including tritium (H-3).

- River sediments collected just downstream of the SNEC liquid discharge outfall and at the control station upstream of the site detected low concentrations of Cesium-137 (Cs-137). These concentrations are attributed to a combination of fallout from prior nuclear weapon tests and SNEC related activity from prior liquid releases. Cs-137 was also detected in aquatic sediments collected from storm drains that are located on site.

- All groundwater samples collected from the onsite monitoring and supply wells resulted in less than detectable activities for radionuclides attributed to SNEC, including tritium (H-3).

- Potable water samples obtained at station E1-1 resulted in less than detectable activities except for gross beta. Low levels of beta activity was detected in both E1-1 and G1-1 (off-site control) samples which ranged from 2.4 to 7.23 pCi/liter, well below the REMP reporting level of 50 pCi/liter. The activity is believed to be naturally occurring radioactivity.

- All vegetation samples collected onsite resulted in less than detectable activities for radionuclides attributed to SNEC.

- Gamma radiation exposure rates recorded at the offsite indicator TLD stations averaged 71.4 milliroentgens per year (mR/yr). These exposure rates were consistent with those presented by the National Council on Radiation Protection and Measurements (Reference 3). No increase in ambient gamma radiation levels was detected.

In conclusion, radioactive materials related to SNEC operations were detected in certain on-site environmental samples, but the measured concentrations were very low. During 2001, no measurable radioactive liquid effluents were released outside the site boundary and no SNEC related radioactivity was detected in the gaseous or particulate effluent releases that occurred from SNEC. Hence, no dose to the public should be attributed to SNEC activities. The environmental sample results indicated that there was no permanent buildup of radioactive materials in the environment and no increase in background radiation levels.

Therefore, based on the results of the radiological environmental monitoring program (REMP) SNEC operations in 2001 did not have any adverse effects on the health and safety of the public or on the environment.

INTRODUCTION

Characteristics of Radiation

Instability within the nucleus of radioactive atoms results in the release of energy in the form of radiation. Radiation is classified according to its nature - particulate and electromagnetic. Particulate radiation consists of energetic subatomic particles such as electrons (beta particles), protons, neutrons, and alpha particles. Because of its limited ability to penetrate the human body, particulate radiation in the environment contributes primarily to internal radiation exposure resulting from inhalation and ingestion of radioactivity.

Electromagnetic radiation in the form of x-rays and gamma rays has characteristics similar to visible light but is more energetic and, hence, more penetrating. Although x-rays and gamma rays are penetrating and can pass through varying thickness' of materials, once they are absorbed they produce energetic electrons which release their energy in a manner that is identical to beta particles. The principal concern for gamma radiation from radionuclides in the environment is their contribution to external radiation exposure.

The rate with which atoms undergo disintegration (radioactive decay) varies among radioactive elements, but is uniquely constant for each specific radionuclide. The term "half-life" defines the time it takes for half of any amount of an element to decay and can vary from a fraction of a second for some radionuclides to millions of years for others. In fact, the natural background radiation to which all mankind has been exposed is largely due to the radionuclides of uranium (U), thorium (Th), and potassium (K). These radioactive elements were formed with the creation of the universe and, owing to their long half-lives, will continue to be present for millions of years to come. For example, potassium-40 (K-40) has a half-life of 1.3 billion years and exists naturally within our bodies. As a result, approximately 4000 atoms of potassium emit radiation within each of us every second of our lives.

In assessing the impact of radioactivity on the environment, it is important to know the quantity of radioactivity released and the resultant radiation doses. The common unit of radioactivity is the curie (Ci). The curie represents the radioactivity in one-gram (g) of natural radium (Ra), which is equivalent to a decay rate of 37 billion radiation emissions every second. Because of the extremely small amounts of radioactive material in the environment, it is more convenient to use fractions of a curie. Subunits like picocurie, pCi, (one trillionth of a curie) are frequently used to express the radioactivity present in environmental and biological samples.

The biological effects of a whole body equivalent dose of radiation are the same whether the radiation source is external or internal to the body. The important factor is how much radiation energy or dose was deposited. The unit of radiation dose is the Roentgen equivalent man (rem), which also incorporates the variable effectiveness of different forms of radiation to produce biological change. For environmental radiation exposures, it is convenient to use the smaller unit of millirem (mrem) to express dose (1000 mrem equals 1 rem). When radiation exposure occurs over periods of time, it is appropriate to refer to the dose rate. Dose rates, therefore, define the total dose for a fixed interval of time, and environmental exposures are usually expressed with reference to one year (mrem/yr).

Sources of Radiation

Life on earth has evolved amid the constant exposure to natural radiation. In fact, the single major source of radiation to which the general population is exposed comes from natural sources. Although everyone on the planet is exposed to natural radiation, some people receive more than others. Radiation exposure from natural background has three components (i.e., cosmic, terrestrial, and internal) and varies with altitude and geographic location, as well as with living habits. For example, cosmic radiation originating from deep interstellar space and the sun increases with altitude, since there is less air which acts as a shield. Similarly, terrestrial radiation resulting from the presence of naturally occurring radionuclides in the soil and rocks varies and may be significantly higher in some areas of the country than in others. Even the use of particular building materials for houses, cooking with natural gas, and home insulation affect exposure to natural radiation. The presence of radioactivity in the human body results from the inhalation and ingestion of air, food, and water containing naturally occurring radionuclides. For example, drinking water contains trace amounts of uranium and radium while milk contains radioactive potassium. Table 1 summarizes the common sources of radiation and their average annual doses.

The average person in the United States receives about 300 mrem/yr (0.3 rem/yr) from natural background radiation sources (Reference 4). This estimate was revised from about 100 to 300 mrem because of the inclusion of radon gas which has always been present but was not previously included in the calculations. In some regions of the country, the amount of natural radiation is significantly higher. Residents of Colorado, for example, receive an additional 60 mrem/yr due to the increase in cosmic and terrestrial radiation levels. In fact, for every 100 feet above sea level, a person will receive an additional 1 mrem/yr from cosmic radiation. In several regions of the world, naturally high concentrations of uranium and radium deposits result in doses of several thousand mrem/yr to their residents (Reference 5).

TABLE 1

Sources and Doses of Radiation

Natural (82%)	
Source	**Radiation Dose in mrem/yr**
Radon	200 (55%)
Cosmic Rays	27 (8%)
Terrestrial	28 (8%)
Internal	40 (11%)
Approximate Total mrem/yr	300
Manmade (18%)	
Source	**Radiation Dose in mrem/yr**
Medical X-rays	39 (11%)
Nuclear Medicine	14 (4%)
Consumer Products	10 (3%)
Other (Releases from natural gas, phosphate mining, burning of coal, weapons fallout, & nuclear fuel cycle	<1 (<1%)
Approximate Total mrem/yr	60

* Percentage contribution of the total dose is shown in parentheses. This data was obtained from Reference 4.

Recently, public attention has focused on radon (Rn), a naturally occurring radioactive gas produced from uranium and radium decay. These elements are widely distributed in trace amounts in the earth's crust. Unusually high concentrations have been found in certain parts of eastern Pennsylvania and northern New Jersey. Radon levels in some homes in these areas are hundreds of times greater than levels found elsewhere in the United States. Additional surveys, however, are needed to determine the full extent of the problem nationwide.

Radon is the largest component of natural background radiation and may be responsible for a substantial number of lung cancer deaths annually. The National Council on Radiation Protection and Measurements (NCRP) estimates that the average individual in the United States receives an annual dose of about 2,400 mrem to the lung from natural radon gas (Reference 4). This lung dose is considered to be equivalent to a whole body dose of 200 mrem. The NCRP has recommended actions to control indoor radon sources and reduce exposures.

When radioactive substances are inhaled or swallowed, they are not uniformly distributed within the body. For example, radioactive iodine selectively concentrates in the thyroid gland, radioactive cesium is distributed throughout the body water and muscles, and radioactive strontium concentrates in the bones. The total dose to organs by a given radionuclide is influenced by the quantity and the duration of time that the radionuclide remains in the body, including its physical, biological and chemical characteristics. Depending on their rate of radioactive decay and biological elimination from the body, some radionuclides stay in the body for very short times while others remain for years.

In addition to natural radiation, we are exposed to radiation from a number of manmade sources. The single largest of these sources comes from diagnostic medical x-rays and nuclear medicine procedures. Some 180 million Americans receive medical x-rays and nuclear medicine treatment each year. The annual dose to an individual from such radiation averages about 53 mrem. Much smaller doses come from nuclear weapon fallout and consumer products such as televisions, smoke detectors, and fertilizers. Production of commercial nuclear power and its associated fuel cycle contributes less than 1 mrem to the annual dose of about 360 mrem for the average individual living in the United States.

Fallout commonly refers to the radioactive debris that settles to the surface of the earth following the detonation of a nuclear weapon. It is dispersed throughout the environment either by dry deposition or washed down to the earth's surface by precipitation. There are approximately 200 radionuclides produced in the nuclear weapon detonation process; a number of these are detected in fallout. The radionuclides found in fallout, which produce most of the fallout radiation exposures to humans are I-131, Cs-137, Sr-89, and Sr-90.

There has been no atmospheric nuclear weapon testing since 1980 and many of the radionuclides, still present in our environment, have decayed significantly. Consequently, doses to the public from fallout have been decreasing. As a result of the nuclear accident at Chernobyl, Ukraine, on April 26, 1986, radioactive materials were dispersed throughout the environment and detected in various media such as air, milk, and soil. Cesium-134, Cs-137, I-131 and other radionuclides were detected in the weeks following the Chernobyl accident.

Description of the SNEC Site

The site is located about 100 miles east of Pittsburgh and 90 miles west of Harrisburg, Pennsylvania in the Allegheny Mountains, three-fourths of a mile north of the Borough of Saxton in Liberty Township, Bedford County, Pennsylvania. The site is on the north side of Pennsylvania Route 913, 17 miles south of U.S. Route 22, and about 15 miles north of the Breezewood Interchange of the Pennsylvania Turnpike.

The SNEC Facility was built adjacent to the Saxton Steam Electric Generating Station of Pennsylvania Electric Company (Penelec), a subsidiary of GPU. This coal fired station operated from 1923 to 1974 and was demolished between 1975 and 1977. The SNEC site consists of 1.148 fenced acres of the approximate 150 acres owned by Penelec. An additional 9.6-acre fenced area contains an electrical switchyard and buildings under Penelec control. A general property layout is shown in Figure 1. The SNEC site, as well as a portion of the Penelec area and the surrounding uncontrolled lands, is in the 100-year floodplain of the

Raystown Branch of the Juniata River which borders the north and west portion of the property. A small stream known as Shoup Run crosses the central portion of the property and joins the Juniata River. Normal elevation of the river near the SNEC site is approximately 794 feet above mean sea level (msl).

The SNEC site and adjacent property lie about 17 feet above river level. Much of the property consists of gently sloping open grassland, a result of the restoration activities following the demolition of the Saxton Steam Generating Station (SSGS).

SNEC Decommissioning Operations

The Saxton Nuclear Experimental Facility was a pioneer in the development of the nuclear energy program for the United States. It operated for ten years, from 1962 to 1972, and provided valuable information on operations and training. The fuel was removed from the Containment Vessel (CV) in 1972 and shipped to the Atomic Energy Commission (AEC) Facility at Savannah River, South Carolina. Following fuel removal, equipment, tanks, and piping located outside the CV were removed. Final decontamination and dismantlement of reactor support structures and buildings were completed in 1992.

On April 20, 1998, the U.S. Nuclear Regulatory Commission (NRC) gave its approval for the final stage of decommissioning. The following is a list of work activities that had potential to impact sample results required by the SNEC Facility REMP since April 20, 1998:

- November 1998 - The large component structures, pressurizer, steam generator and reactor vessel, were removed and shipped to Chem-Nuclear's low-level waste facility in Barnwell, South Carolina.
- Early 2000 - The remaining miscellaneous components were removed from the CV and concrete remediation operations commenced.
- Late 2001 - Soil excavation and remediation activities of the CV North Yard were completed.
- Late 2001 - Soil excavation and remediation activities of the Saxton Steam Generating Station (SSGS) footprint were completed.

The only remaining SNEC Facility structures include the CV, a small section of the Steam Plant Tunnel under the Material Handling Building, and the Decommissioning Support Facility (DSF). Additional information can be obtained from the 2001 SNEC Annual Report (Reference 6).

Containment Vessel

The SNEC CV is a circular steel structure approximately 100 ft. tall by 50 ft. in diameter with approximately 50 percent of the structure below grade. The CV is subdivided into a Reactor Compartment/Storage Well, Primary Compartment, Auxiliary Compartment and an Operating Floor. Concrete walls, floors, and ceilings separate these areas from each other. The below grade portion of the CV is lined with concrete, as well.

Demography - Human Activities in the Environs

The area surrounding the SNEC site is generally rural forested and mountainous terrain. The population density of the area is low with small concentrations in the valleys and along main highways. The site lies about three-fourths of a mile north of the Borough of Saxton in Liberty Township, Bedford County, Pennsylvania. The population and population trends for the Borough of Saxton in Bedford County have decreased by approximately 4.2% between 1990 and 2000 (Reference 7). During CV construction, the estimated population of the Borough of Saxton was 975 as recorded during the 1960 census. Forty years later, the population as recorded during the 2000 census was 803, a decline of 17.6%.

The nearest population center (as defined by 10 CFR 100) of 25,000 or more is the city of Altoona in Blair County which lies approximately 20 miles north-northwest of the SNEC site. The 2000 population of Altoona was 49,523. The closest incorporated towns other than the Borough of Saxton are Coalmont Borough about 2.5 miles to the east (2000 population of 128), Dudley Borough about 3.4 miles to the east (2000 population of 192) and Broad Top about 5.3 miles also to the east (2000 population of 384).

Current uses of adjoining properties include undeveloped wooded and residential areas. A cemetery lies along the eastern property boundary while undeveloped wooded and residential areas border the northern, southern and western property boundaries.

The Raystown Branch of the Juniata River in the vicinity of the site is primarily used for recreational boating and fishing by local residences. The vast majority of recreational activities along the river, however, are located downstream of the site on Raystown Lake.

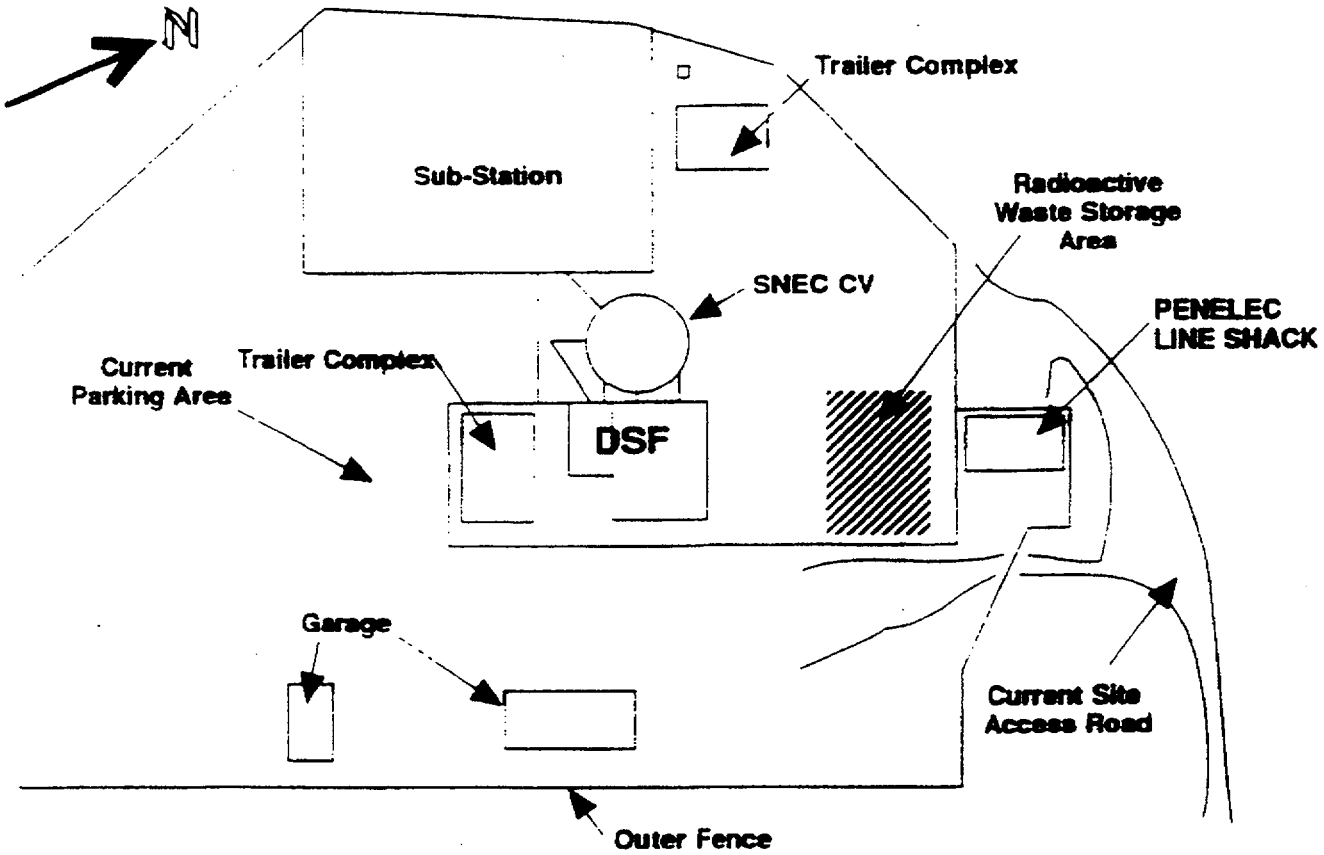
Approximately 34 miles downstream of the site, the Raystown Branch of the Juniata River is dammed, impounding the river to form Raystown Lake. The dam built by the US Army Corps of Engineers (COE) for flood control, recreation and water quality purposes was constructed from 1968 to 1973. At normal pool level, the lake is 27 miles long and has an area of 8,300 acres. Raystown Lake provides one of the most popular recreational areas for boating, fishing, camping, hunting, and picnicking in this part of Pennsylvania.

Geology

The SNEC site lies in the Appalachian Highlands in the Ridge and Valley Physiographic Province. This province comprises alternate successions of narrow ridges and broad or narrow valleys trending generally northeast. This region contains alternating hard and soft sedimentary rocks that have been severely folded by lateral compression into a series of anticlines and synclines. The ridge consists of Tuscarora quartzite and a small amount of Pleistocene gravel. Most of the area is underlain by strata of Upper Devonian age. Although coal was mined in the general area of the site, no coal has been reported to lie beneath the site, nor has the site been undermined. The ridges immediately to the northwest of the site rise to 1300 feet and to the southeast rise to 1500 feet with site elevation being approximately 811 feet above msl.

FIGURE 1

SNEC FACILITY SITE BOUNDARIES
(No Scale)



RADIOLOGICAL ENVIRONMENTAL MONITORING

A comprehensive Radiological Environmental Monitoring Program (REMP) is performed at the SNEC Facility to measure levels of radiation and radioactive materials in the environment. The information obtained from the REMP is then used to determine the effect of SNEC operations, if any, on the environment and the public.

The USNRC has established regulatory guides that contain acceptable monitoring practices. The SNEC REMP was designed on the basis of these regulatory guides along with the guidance provided by the USNRC Radiological Assessment Branch Technical Position for an acceptable radiological environmental monitoring program (Reference 8). The SNEC REMP meets or exceeds the monitoring requirements set forth by the USNRC.

The important objectives of the REMP are:

- To assess dose impacts to the public from the SNEC Facility.
- To verify decommissioning controls for the containment of radioactive materials.
- To determine buildup of long-lived radionuclides in the environment and changes in background radiation levels.
- To provide reassurance to the public that the program is capable of adequately assessing impacts and identifying noteworthy changes in the radiological status of the environment.
- To fulfill the requirements of the SNEC Technical Specifications.

Sampling

The program consists of taking radiation measurements and collecting samples from the environment, analyzing them for radioactivity content, and then interpreting the results. These samples include, but are not limited to; air, water, sediment, vegetation, groundwater and thermoluminescent dosimeters (TLDs) to measure gamma radiation levels.

The SNEC Facility ODCM (Reference 1) defines the sample types to be collected and the analyses to be performed. However, the minimum sampling and analysis requirements specified in the ODCM are maintained or exceeded. As appropriate, changes to the REMP are initiated by recommendations from SNEC Management and their contractors.

Sampling locations were established by considering topography, meteorology, population distribution, hydrology, and areas of public interest. The sampling locations are divided into two classes, indicator and control. Indicator locations are those that are expected to show effects from SNEC activities, if any exist. These locations were selected primarily on the basis of where the highest predicted environmental concentrations would occur. The indicator locations are typically within the site boundary, along the perimeter fence or a few miles from the SNEC Facility.

Control stations are located generally at distances greater than 10 miles from the SNEC Facility. The samples collected at these sites are expected to be unaffected by SNEC operations. Data from control locations provide a basis for evaluating indicator data relative to natural background radioactivity and fallout from prior nuclear weapon tests. Figures 2 and 3 show the current sampling locations around the SNEC Facility. Table 11 in Appendix A describes the sampling locations along with the type(s) of samples collected at each sampling location.

Analysis

In addition to specifying the media to be collected and the number of sampling locations, the ODCM also specifies the frequency of sample collection and the types and frequency of analyses to be performed. Also specified are analytical sensitivities (detection limits) and reporting levels. Table 12 in Appendix A provides a synopsis of the sample types, number of sampling locations, collection frequencies, number of samples collected, types and frequencies of analyses, and number of samples analyzed. Table 13 in Appendix "A" lists samples, which were not collected or analyzed as per the requirements of the ODCM. Samples that did not meet the required analytical sensitivities are described in Table 14 in Appendix B. Changes to the REMP are described in Appendix C.

Measurement of low radionuclide concentrations in environmental media requires special analysis techniques. Analytical laboratories use state-of-the-art laboratory equipment designed to detect all three types of radiation emitted (alpha, beta, and gamma). This equipment must meet the analytical sensitivities required by the ODCM. Examples of the specialized laboratory equipment used are germanium detectors with multichannel analyzers for determining specific gamma-emitting radionuclides, liquid scintillation counters for detecting H-3, low level proportional counters for detecting gross alpha and beta radioactivity and alpha spectroscopy for determining specific transuranic isotopes.

Counting equipment calibrations are performed by using standards traceable to the National Institute of Standards and Technology (NIST). Computer hardware and software are used in conjunction with the counting equipment to perform calculations and provide data management. Analysis methods are described in Appendix H.

Data Review

The REMP Coordinator and Quality Assurance Officer routinely review REMP analytical results to assure that sensitivities have been achieved and that the proper analyses have been performed. Investigations are conducted when action levels or USNRC reporting levels are reached or when anomalous values are discovered. This review process is discussed in more detail in Appendix D.

Tables 2 and 3 summarize gamma radiation exposure rates near the SNEC Facility from thermoluminescent dosimeter (TLD) measurements. Tables 4 and 5 depict airborne particulate gross beta and gross alpha results, respectively. Table 6 lists the tritium concentrations from station GEO-5 and Table 7 lists tritium results from all 2001 monitoring wells. Table 10 provides a summary of radionuclide concentrations detected in the aquatic

sediment samples for 2001. Statistical methods used to derive these tables along with other statistical conclusions are detailed in Appendix G. Quality control (QC) sample results were used mainly to verify the primary sample result or the first result in the case of a duplicate analysis. Therefore, the QC results were excluded from these tables and the main text of this report to avoid biasing the results.

Quality Assurance Program

A quality assurance (QA) program is conducted in accordance with guidelines provided in Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs" (Reference 9) and as required by the ODCM. SNEC maintains written policies, procedures, and records that encompass all aspects of the REMP including sample collection, equipment calibration, laboratory analysis, and data review.

The QA program is designed to identify possible deficiencies so that immediate corrective action can be taken. The program also provides assurance to the regulatory agencies and the public that the results are valid. The QA program for the measurement of radioactivity in environmental samples is implemented by:

- Auditing all REMP-related activities including analytical laboratories.
- Requiring analytical laboratories to participate in a cross-check program(s).
- Requiring analytical laboratories to split samples for separate analysis (recounts are performed when samples cannot be split).
- Splitting samples, having the samples analyzed by independent laboratories, and then comparing the results for agreement.
- Reviewing QC results of the analytical laboratories including spike and blank sample results and duplicate analysis results.

The QA program and the results of the cross-check programs are outlined in Appendix E and F, respectively.

The TLD readers are calibrated on a routine basis against recognized standards. Also, control TLDs are processed with each group of TLDs. The accuracy and variability of the results for the control TLDs are examined to assure the reader is functioning properly. In addition, each element (TLD) has an individual correction factor based on its response to a known exposure.

Other cross-checks, calibrations, and certifications used to assure the accuracy of the TLD program include:

- Every two years, each TLD is checked to ensure an appropriate correction factor is assigned to each element of the TLD.
- Every two years, the dosimetry program is examined and NVLAP recertified by the NIST.

- The environmental dosimeters were tested and qualified to the American National Standard Institutes (ANSI) publication N545-1975 and the USNRC Regulatory Guide 4.13 (References 10 and 11).

FIGURE 2

SNEC Facility Area Map

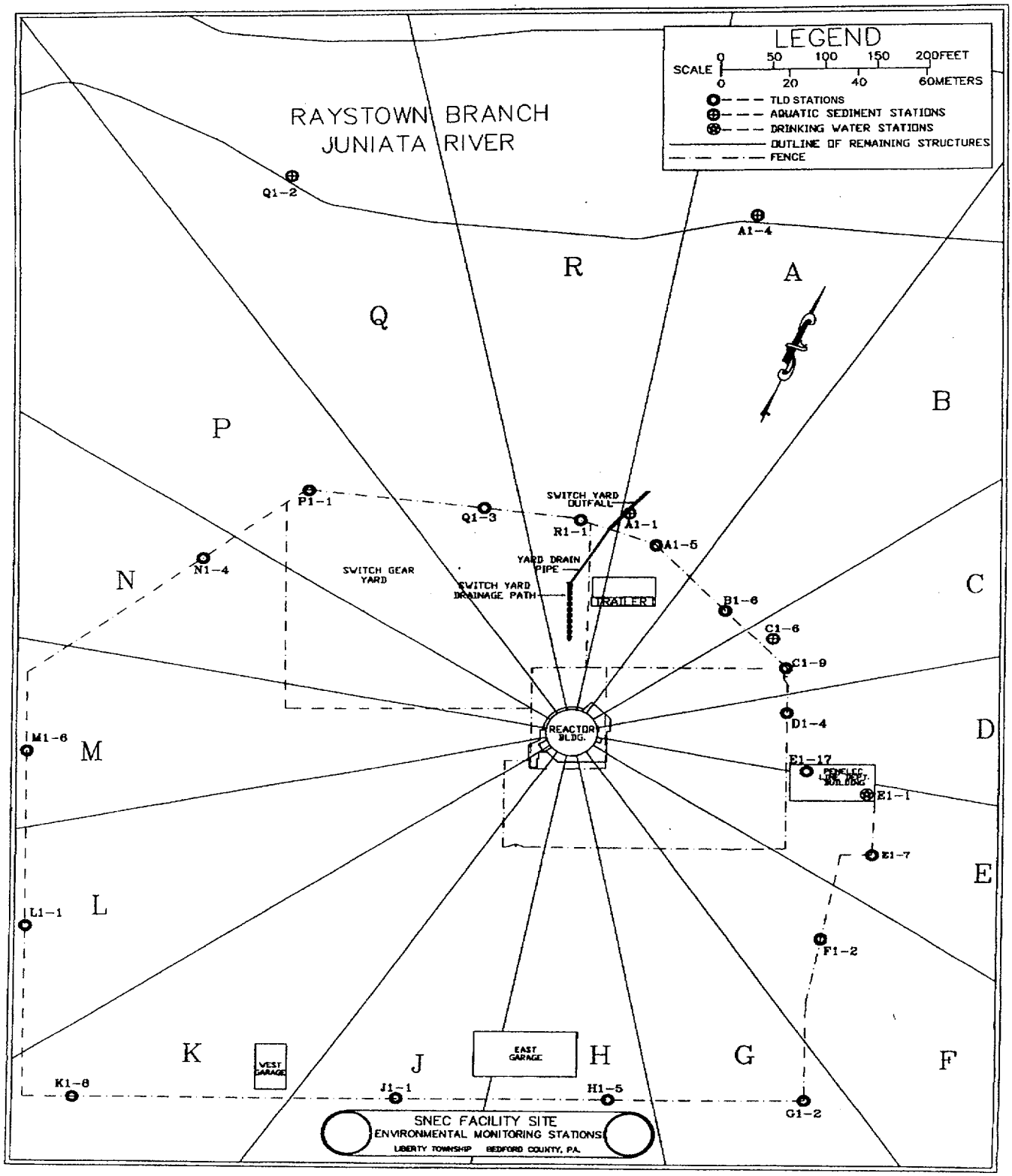
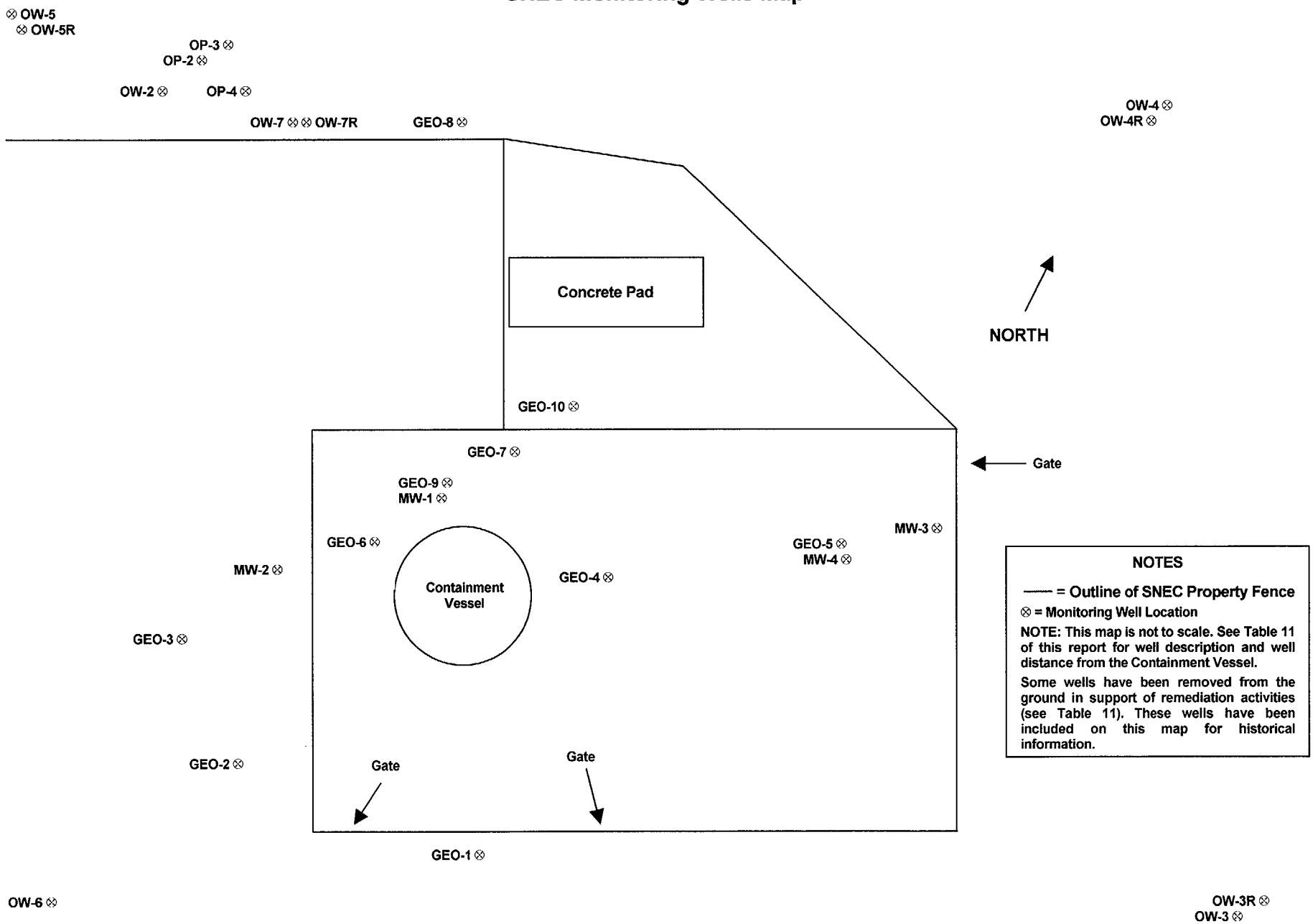


FIGURE 3
SNEC Monitoring Wells Map



DIRECT RADIATION MONITORING

Radiation is a normal component of the environment resulting primarily from natural sources, such as cosmic radiation and naturally occurring radionuclides, and to a lesser extent from manmade sources, such as fallout from prior nuclear weapon tests. The cessation of atmospheric nuclear weapon tests and the decay of fallout products have resulted in a gradual decrease in environmental radiation levels. Direct radiation monitoring is used to measure ionizing radiation primarily from cosmic and terrestrial sources.

Gamma radiation exposure rates near the SNEC Facility were measured using thermoluminescent dosimeters (TLDs). There are 28 TLDs that surround the SNEC Facility. Sixteen Indicator Stations, one per compass sector, are located at the outer perimeter fence. One station is located in the Penelec Line Department garage. There are nine Offsite Indicator Stations in various sectors within two miles of the site. There are also two Control Stations, each about 10 miles from the site. The indicator stations are used to detect any potential effect of SNEC Facility activities on environmental radiation levels. No relationship between the SNEC Facility activities and offsite exposure rates were detected at any station. The 2001 quarterly exposure rates for the individual TLD stations are contained in Appendix I.

Sample Collection and Analysis

A thermoluminescent dosimeter (TLD) is composed of a crystal (phosphor) which absorbs and stores energy in traps when exposed to ionizing radiation. These traps are so stable that they do not decay appreciably over time. When heated, the crystal emits light proportional to the amount of radiation received, and the light is measured to determine the integrated exposure. This process is referred to as thermoluminescence. The reading process 'rezeros' (anneals) the TLD and prepares it for reuse. The TLDs in use for environmental monitoring at the SNEC Facility are capable of accurately measuring exposures from a minimum of 1 mR (well below normal environmental exposures for the quarterly monitoring periods) to a maximum of 200,000 mR.

Each TLD station consists of 2 TLD badges, each of which has 4 phosphors or elements. Since each TLD responds to radiation independently, this provides 8 independent detectors at each station. The elements within the TLDs are composed of calcium sulfate and lithium borate. The calcium sulfate elements are shielded with a thin layer of lead making the response to different energies of gamma radiation more linear. The lead also shields the elements from beta radiation, making them sensitive to gamma radiation only. The lithium borate element is shielded differently to permit the detection of beta radiation as well as gamma. The combination of different phosphor materials, shielding, and multiple phosphors per badge permit quantification of both gamma and beta radiation. Only the calcium sulfate phosphors are used for environmental monitoring; however, the lithium borate elements can be used to evaluate beta exposures or as a backup to the calcium sulfate elements should more data be required.

Data from the TLDs were evaluated by obtaining the average of the usable element results at each station. All TLD exposure rate data presented in this report were normalized to a

standard month (std month) to adjust for variable field exposure periods. A std month is 30.4 days. Several control TLDs were used to quantify transit exposure during TLD storage and handling. Transit exposures were subtracted from gross field exposures to produce net field exposures.

Results

In 2001, the average annual exposure rate for offsite indicator stations was 5.95 mR/std month. Quarterly exposure rates ranged from 4.3 to 9.0 mR/std month. This equates to an annual exposure rate of 71.4 mR/yr. Exposure of this magnitude is comparable with the annual average dose a person receives from cosmic and terrestrial sources (Table 1, "Sources and Doses of Radiation").

Offsite indicator station E2-1, located 0.25 mile from the CV, displayed the highest elevated exposures. An investigation revealed that the elevated results were due to residual waste from the coal-fired station formerly located adjacent to the SNEC Facility. The soil at station E2-1 consists of a mixture of coal slag and cinders, which emit a slightly elevated gamma from naturally occurring Th-232 and Ra-226, and thus adding to the TLD results.

The average annual exposure rate for the two control stations, those stations farther than 10 miles from SNEC, was 5.7 mR/std month. Quarterly exposure rates at the control stations ranged from 4.8 to 7.0 mR/std month. Table 2 depicts the average offsite indicator results with the average control results. In 2000, the TLD along the perimeter fence from sector D showed the highest results due to the storage of radioactive materials proximal to the subject TLD station. In 2001, the radioactive materials area was relocated to sector F. This change caused the highest perimeter exposure to be recorded in sector F.

Elevated exposure rates were not observed at any offsite station that can be attributed to SNEC Facility activities. TLDs are sensitive and accurate mechanisms for measuring the low exposure rates characteristic of environmental levels. Effects of normal SNEC Facility activities, however, are too small to be discernible outside the normal range of background radiation levels. Table 3 compares the highest site boundary exposure result to the allowable maximum exposure rate based on 40 CFR 190 (Reference 12).

TABLE 2

2001 SNEC TLD Summary

Field Cycle: January 16, 2001 to January 22, 2002

	MEAN (mR/std month)	**MINIMUM** (mR/std month)	**MAXIMUM** (mR/std month)
Average Offsite Indicator Stations	5.95	4.3	9.0
Average Control Stations	5.7	4.8	7.0

TABLE 3

Highest Site Boundary Exposure Comparison

8.3	mR/std month	@ Station F1-2	Compared to an allowable maximum exposure rate of 0.37 mR/hr. This is equivalent to the 25 mR annual limit specified by 40 CFR 190 adjusted by the 67-hour recreational factor specified in Reg. Guide 1.109 (shoreline exposure for maximum exposed teenager) (Reference 12).
0.01	mR/hr		

ATMOSPHERIC MONITORING

A potential exposure pathway to humans is the inhalation of airborne radioactive materials. To monitor this exposure pathway, ambient air was sampled by a network of continuously operating samplers and then analyzed for radioactivity content. Based on the analytical results, no contribution to the general levels of airborne radioactivity was attributed to the SNEC Facility during 2001.

The indicator air sampling stations are located in the three predominant wind sectors around the Containment Vessel (CV), the north sector (A1-2), the east sector (D1-1), and the south sector (J1-3). The control air sampling station (G10-1), which is 10 miles from the site, provided background airborne radioactivity data for comparison.

Sample Collection and Analysis

Mechanical air samplers were used to continuously draw air through glass fiber filters. To maintain a constant flow rate throughout the collection period, each sampler was equipped with a mass flow probe. This electronic device maintains a constant airflow across the filter paper. All air samplers were calibrated semiannually and maintained by Radiological Instrument Technicians.

The glass fiber filters were used to collect airborne particulate matter. The filters were collected weekly or bi-weekly and analyzed for gross alpha and gross beta radioactivity. The filters were then combined (composited) quarterly by individual station locations and analyzed for gamma-emitting radionuclides.

Air Results

During 2001, 130 air particulate samples (filters) were collected and analyzed for gross alpha and gross beta radioactivity. The particulate matter (dust particles) collected on all indicator and control filters contained gross beta radioactivity above the minimum detectable concentration (MDC). The gross beta concentrations measured on the filters collected from indicator sites ranged from 0.0088 ± 0.0047 pCi/m^3 to 0.0366 ± 0.0061 pCi/m^3 and averaged 0.02 ± 0.0026 pCi/m^3. The air particulate samples collected from the control location had gross beta concentrations, which ranged from 0.01 ± 0.0005 pCi/m^3 to 0.039 ± 0.0063 pCi/m^3 and averaged 0.023 ± 0.0028 pCi/m^3. The average results are listed in Table 4.

Average weekly gross beta concentrations at indicator and control air monitoring locations were analogous and trended similarly throughout the monitoring period. The weekly gross beta concentrations and trends at individual air sampling sites also were similar. The 2001 data indicated that gross beta radioactivity levels did not change as a result of SNEC operations. Additionally, the gross beta radioactivity associated with airborne particulate was due to naturally occurring radionuclides.

Air particulate gross alpha concentrations (detected above the MDC) at indicator stations ranged from 0.00058 ± 0.00014 pCi/m^3 to 0.0041 ± 0.0013 pCi/m^3 and averaged 0.00133 ± 0.00053 pCi/m^3. Control samples averaged 0.0017 ± 0.0007 pCi/m^3 and ranged from 0.0008 ± 0.00015 pCi/m^3 to 0.0049 ± 0.0014 pCi/m^3.

Due to a naturally occurring alpha ingrowth that occurs in air particulate samples, variations in concentrations were observed. As the time between sample collection and sample analysis increased, so did the ingrowth of alpha resulting in higher sample activity. Inconsistent or late sample deliveries to the analytical laboratory promoted these variations of concentrations. Generally, the trends of average gross alpha concentrations at indicator and control sites were similar. The average results are listed in Table 5.

The data obtained in 2001 indicated that gross alpha radioactivity levels did not change as a result of SNEC Facility operations. The gross alpha radioactivity measured on the particulate filters was caused by naturally occurring radionuclides. Results indicated that the New Granada control station contained the highest gross alpha activity.

Gamma-emitting radionuclides related to the SNEC Facility were not detected on any of the quarterly composites that were analyzed in 2001. As expected, all of the quarterly composite samples contained naturally occurring beryllium-7 (Be-7). Concentrations detected on indicator samples were similar to those detected on control filters.

TABLE 4

2001 Average Gross Beta Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average ± 2 std deviations*
A1-2 (I)	North Sector	0.02 ± 0.0027
D1-1 (I)	East Sector	0.023 ± 0.0028
J1-3 (I)	South Sector	0.02 ± 0.0025
G10-1 (C)	New Granada	0.023 ± 0.0028

* Averages and standard deviations are based on concentrations > MDC.
(I) = Indicator Station (C) = Control Station

TABLE 5

2001 Average Gross Alpha Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average ± 2 std deviations*
A1-2 (I)	North Sector	0.0013 ± 0.0005
D1-1 (I)	East Sector	0.0014 ± 0.0005
J1-3 (I)	South Sector	0.0013 ± 0.0006
G10-1 (C)	New Granada	0.0017 ± 0.0007

* Averages and standard deviations are based on concentrations > MDC.
(I) = Indicator Station (C) = Control Station

GROUNDWATER MONITORING

Groundwater monitoring is conducted to check for water leakage, if any, from the SNEC Containment Vessel. An investigation was performed to define the depth of the bedrock surface and the orientation of the bedrock groundwater flow pathways (Reference 14). The site is immediately underlain by a fill-layer composed of fly ash, cinders and/or silt and sand-size sediment. A layer of boulders in a silty clay matrix underlies this fill-layer. The surface of the bedrock lies beneath this boulder layer at a depth of approximately 7.5 to 18 feet.

The results of this investigation indicate that the overburden groundwater occurs at a depth ranging from approximately 4 to 16 feet. Groundwater elevation contour maps of this data indicate that the groundwater within the overburden soil flows west toward the Raystown Branch of the Juniata River.

Groundwater movement within the bedrock beneath the site is predominately controlled by fractures in the bedrock. There are two major fracture patterns; one trends northeast to southwest, and dips moderately toward the northwest. The second fracture pattern trends northwest to southeast, and dips steeply toward the southwest (Reference 14). Groundwater also moves within the spaces (bedding planes) between the individual layers of the siltstone bedrock.

In 1994, eight overburden groundwater wells were restored. Four of the wells are hydraulically downgradient of the Containment Vessel (GEO-3, GEO-6, GEO-7, and GEO-8). The other four wells (GEO-1, GEO-2, GEO-4, and GEO-5) serve as background monitoring points, since these wells are located hydraulically upgradient of the Containment Vessel. Wells GEO-2, GEO-6, GEO-7, and GEO-9 were removed in 2000 to support soil remediation.

Two bedrock wells (MW-1 and MW-2) were also monitored. As part of the analysis performed by the contracted hydrogeologic consultants (GEO Engineering), it was determined that bedrock monitoring wells should be installed at an angle in order to maximize the interception of fractures and bedding planes. The boreholes were drilled into bedrock at an angle of approximately 25 degrees from vertical to accomplish this. Filling the annular space with a sand filter pack, a bentonite pellet seal and cement grout allows these wells to monitor only the significant fractures and bedding planes of the bedrock ground water. Well MW-1 was removed in 2000 to support soil remediation.

In May of 1998, three additional monitoring wells were installed. Two bedrock wells (MW-3 and MW-4) were installed to determine if there was contamination in the vicinity of the former Radwaste Facility Building. This area was monitored by GEO-5, which in the past was the only well to show positive tritium levels. An additional overburden well (GEO-10) was installed to supplement the existing monitoring wells to monitor for the possible migration of trace amounts of tritium or other contaminants.

Thirteen additional monitoring wells were installed in 2001 on the adjacent Penelec property to evaluate potential contamination migration issues. These wells include:

- Four bedrock wells (OW-3R, OW-4R, OW-5R, and OW-7R)

- Nine overburden wells (OP-2, OW-2, OP-3, OP4, OW-3, OW-4, OW-5, OW-6, OW-7)

In addition, two off-site (potable water) samples are collected. One site (E1-1) monitors the well water from the Penelec Line Department garage located adjacent to the site. The other sample (G1-1) is collected from a resident in the borough of Saxton. The resident water sample was initially believed to be well water, but it was later ascertained that this water was actually from the township water supply. All Saxton township residents get their domestic water from one of two sources. Putts Hollow reservoir is the primary source, but during low water levels, the township switches to the Seton Plant water supply, which draws from the Juniata River upstream of the SNEC Facility. No gamma or tritium activity was detected in any potable water sample collected in 2001. Low levels of beta activity was detected in both on-site and off-site samples in the range of 2.4 to 7.23 pCi/liter, well below the REMP reporting level of 50 pCi/liter. The activity is believed to be naturally occurring radioactivity.

Groundwater Results

Locations of the onsite groundwater stations sampled in 2001 are shown in Figure 3. Sixty-six (66) groundwater samples were collected in 2001. No plant-related radionuclides were identified in any sample. The required sensitivities for SNEC are contained in Table 16. Table 7 is a list of tritium results from all monitoring wells sampled in 2001.

As stated earlier, GEO-5 originally was the only well to show positive tritium levels. The first sample obtained from GEO-5 was collected and analyzed July of 1994. A "Less Than" result for tritium was reported. Gamma analysis performed on this sample yielded "Less Than" activities. The October 1994 sample reported 560 pCi/L tritium. A special collection was performed two weeks later to confirm the positive tritium and a result of 310 pCi/L was obtained. Gamma analysis continued to show no reportable activity. The highest activity of tritium (760 pCi/L) was observed in October 1995. Since that time, no concentrations above 200 pCi/L were observed. Upon review of these results, it appears that the activity in the GEO-5 area can be attributed to pockets of tritiated water trapped in fractures leading to the overburden groundwater. The REMP Coordinator will continue to evaluate sample results from GEO-5. Table 6 is a list of all tritium results that have been performed since the start of GEO-5 monitoring.

TABLE 6

SX-GW-GEO-5 Tritium Results in pCi/L
Activity ± 2σ

DATE	RESULTS
7/13/94	< 170
10/06/94	560 ± 130
10/27/94	310 ±120
1/12/95	< 190
4/05/95	< 180
5/30/95	270 ± 120
6/13/95	370 ± 130
7/13/95	370 ± 110
8/17/95	390 ± 130
9/15/95	410 ± 130
10/18/95	760 ± 140
11/17/95	< 200
1/25/96	< 190
4/03/96	< 150
7/10/96	< 140
10/03/96	< 140
1/08/97	< 140
4/16/97	< 150
7/09/97	< 150
10/01/97	180 ± 100
1/08/98	< 150
4/15/98	140 ± 80
7/09/98	< 120
10/08/98	< 130
1/19/99	200 ± 90
4/15/99	< 160
7/22/99	200 ± 90
10/14/99	< 130
1/06/00	< 130
4/06/00	< 120
7/13/00	190 ± 80
10/11/00	< 644
1/24/01	< 105
4/04/01	< 92
7/02/01	< 332
10/01/01	< 266

TABLE 7

2001 Tritium Results of Ground Water Analysis in pCi/l

Monitoring Well	First Qtr 01/24/01	Second Qtr 04/04/01	Third Qtr 07/02/01	Fourth Qtr 10/01/01
GEO-1	< 603	< 547	< 332	< 266
GEO-2	①	①	①	①
GEO-3	< 603	< 547	< 332	< 266
GEO-4	< 603	< 547	< 332	< 266
GEO-5	< 105	< 92	< 332	< 266
GEO-6	②	②	②	②
GEO-7	②	②	②	②
GEO-8	< 603	< 547	< 332	< 266
GEO-10	< 603	< 547	< 332	③
SX-GW-MW1	②	②	②	②
SX-GW-MW2	< 603	< 547	< 332	< 266
SX-GW-MW3	< 603	< 547	< 332	< 266
SX-GW-MW4	< 603	< 547	< 332	< 266
SX-GW-E1-1	< 603	< 547	< 332	< 266
SX-DW-G1-1	< 603	< 547	< 332	< 289
OW-3	④	< 600	< 332	< 266
OW-3R	④	< 600	< 332	< 266
OW-4	④	③	③	③
OW-4R	④	< 600	< 282	< 266
OW-5	④	< 600	< 332	③
OW-5R	④	< 600	< 332	< 266
OW-6	④	< 600	< 332	< 289
OW-7	④	④	③	③
OW-7R	④	④	< 332	< 266
OP-3	④	④	< 332	③
OP-4	④	④	< 332	< 289

① No sample collected. This well was removed in October 2000.
② No sample collected. This well was removed in May 2000.
③ No sample collected. See sampling and analysis exceptions in Table 13.
④ No sample collected. Well was not installed.

BROAD LEAF VEGETATION MONITORING

Radionuclides released into the atmosphere may deposit on vegetation. To assess the deposition, yearly broad leaf vegetation samples are collected and analyzed for gamma-emitting isotopes. Collection occurred during the growing season from two different sectors on site where the prevailing wind direction has been determined. No radionuclides attributable to SNEC operations were detected above the MDC.

TABLE 8

2001 Gamma Spectrometry Results from Broad Leaf Vegetation (pCi/g Wet)

Sample Designation	Date	Co-60	Cs-134	Cs-137
SX-BR-A1-6 (Sector A)	7/02/01	< 0.07	< 0.06	< 0.06
SX-BR-B1-7 (Sector B)	7/02/01	< 0.08	< 0.06	< 0.06

SURFACE WATER MONITORING

The Juniata River surface water was monitored for radionuclides of potential SNEC origin. Two grab samples, one control and one indicator, were collected on a quarterly basis and analyzed for gamma emitting radionuclides and tritium. The indicator sample was collected at the discharge bulkhead leading into the river, while the control sample was collected upstream of the discharge. No tritium or radionuclides attributed to SNEC operations were detected above the MDC.

TABLE 9

Quarterly Results of Surface Water in pCi/l

Sample Designation	First Qtr 01/24/01	Second Qtr 04/04/01	Third Qtr 07/02/01	Fourth Qtr 10/01/01
A1-4 (I)	< 8.5 Cs-137 < 8.0 Cs-134 < 9.8 Co-60 < 603 H-3	< 8.51 Cs-137 < 7.63 Cs-134 < 9.68 Co-60 < 547 H-3	< 11.7 Cs-137 < 11.9 Cs-134 < 13 Co-60 < 332 H-3	< 13.5 Cs-137 < 13.8 Cs-134 < 13.8 Co-60 < 266 H-3
Q1-2 (C)	< 5.4 Cs-137 < 5.5 Cs-134 < 6.9 Co-60 < 603 H-3	< 7.04 Cs-137 < 7.45 Cs-134 < 7.42 Co-60 < 547 H-3	< 9.7 Cs-137 < 9.9 Cs-134 < 8.5 Co-60 < 332 H-3	< 10.0 Cs-137 < 10.7 Cs-134 < 10.4 Co-60 < 266 H-3

(I) = Indicator Station
(C) = Control Station

AQUATIC SEDIMENT MONITORING

Sediment samples were collected from on-site storm drains on a quarterly basis (Stations A1-1 and C1-6). In addition, a sediment sample was taken directly from the Juniata River at the discharge bulkhead (A1-4) and a control sediment sample (Q1-2) was taken up river from the discharge. A new control sediment station (H1-1), up river at Warrior's Path Boat Launch, was sampled in the fourth quarter.

All samples were dried and then analyzed for gamma emitting radioisotopes. Low concentrations of cesium-137 (Cs-137) were detected in onsite and offsite sediment samples. The average offsite activity was 0.13 pCi/g. The average onsite activity was 0.77 pCi/g. Cs-137 is readily adsorbed by suspended particles and is concentrated in the storm drains.

TABLE 10

Quarterly Results of Sediment Analysis in pCi/g (Dry)

Sample Designation	First Qtr 01/24/01	Second Qtr 04/04/01	Third Qtr 07/02/01	Fourth Qtr 10/01/01
A1-1 (I)	0.083 Cs-137 < 0.026 Cs-134 < 0.02 Co-60	< 0.02 Cs-137 < 0.02 Cs-134 < 0.02 Co-60	1.1 Cs-137 < 0.1 Cs-134 < 0.1 Co-60	2.21 Cs-137 < 0.11 Cs-134 < 0.093 Co-60
C1-6 (I)	0.94 Cs-137 < 0.027 Cs-134 < 0.015 Co-60	< 0.04 Cs-137 < 0.04 Cs-134 < 0.03 Co-60	0.7 Cs-137 < 0.08 Cs-134 < 0.06 Co-60	1.09 Cs-137 < 0.07 Cs-134 < 0.05 Co-60
A1-4 (I)	0.216 Cs-137 < 0.019 Cs-134 < 0.013 Co-60	< 0.02 Cs-137 < 0.02 Cs-134 < 0.02 Co-60	0.5 Cs-137 < 0.06 Cs-134 < 0.06 Co-60	0.17 Cs-137 < 0.072 Cs-134 < 0.065 Co-60
Q1-2 (C)	0.031 Cs-137 < 0.009 Cs-134 < 0.011 Co-60	< 0.03 Cs-137 < 0.03 Cs-134 < 0.03 Co-60	< 0.03 Cs-137 < 0.08 Cs-134 < 0.08 Co-60	0.059 Cs-137 < 0.048 Cs-134 < 0.042 Co-60
H1-1 (C)	Not Sampled New Station	Not Sampled New Station	Not Sampled New Station	0.065 Cs-137 < 0.06 Cs-134 < 0.04 Co-60

(I) = Indicator Station (C) = Control Station

REFERENCES

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13. GEO Engineering "Phase I Report of Findings - Groundwater Investigation", November 18, 1992
14. GEO Engineering - "Summary of Field Work", June 7, 1994
15. Haley and Aldrich - "Summary of Field Work", July 24, 1998

APPENDIX A

REMP Sampling Locations and Descriptions, Synopsis of REMP, and Exceptions in Sampling and Analysis

TABLE 11

Radiological Environmental Monitoring Program Description

Station Code	Sample Medium	Description	Comments
A1-1	Sediment	Drain Outfall Outside Perimeter Fence	Water rarely present
A1-2	Air Particulate	Westinghouse Yard Area	
A1-4	Surface Water Sediment	Juniata River at the Westinghouse Weir Bulkhead	
A1-5	TLD	N Sector, Perimeter Fence	
A1-6	Broadleaf Vegetation	N Sector, Outside Perimeter Fence	
B1-4	Surface Water Sediment	Drop Weir In The Westinghouse Yard Area	Weir was removed from the ground
B1-6	TLD	NNE Sector, Perimeter Fence	
B1-7	Broadleaf Vegetation	NE Sector, Outside Perimeter Fence	
C1-6	Sediment	Drain Outfall, NE Corner Of Perimeter Fence	Water rarely present
C1-9	TLD	NE Sector, Perimeter Fence	
C2-1	TLD	Weaver Ridge, 0.8 Mile from CV	
D1-1	Air Particulate	Open Field ENE Sector	
D1-4	TLD	ENE Sector, Perimeter Fence	
D2-1	TLD	Weaver Bridge, 1.3 Miles from CV	
E1-1	Potable Water	Penelec Line Shack	
E1-7	TLD	E Sector, Perimeter Fence	
E1-17	TLD	Penelec Line Shack	
E2-1	TLD	E Sector, 0.25 Mile from CV	
E3-1	TLD	3 Miles East of CV in State Game Land #67	
F1-2	TLD	ESE Sector, Perimeter Fence	
G1-1	TLD and Potable Water	SE Sector, Private Residence in Saxton (Putts Hollow Reservoir or Seton Water Supply Plant	

TABLE 11 (Continued)

Radiological Environmental Monitoring Program Description

Station Code	Sample Medium	Description	Comments
G1-2	TLD	SE Sector, Perimeter Fence	
G2-1	TLD	SE Sector, Closest Private Residence	
G10-1	Air Particulate	Reichley Microwave Tower	
G10-2	TLD	New Granada	
H1-5	TLD	SSE Sector, Perimeter Fence	
H2-1	TLD	Tussey Mountain High School	
H10-1	TLD	Wells Tannery	Offsite Control Station
J1-1	TLD	Penelec Fence, 100 Feet from SE Corner of West Garage	
J1-3	Air Particulate	Penelec Area S Sector	
K1-5	TLD	Saxton Borough Hall	
K1-8	TLD	SSW Sector, Perimeter Fence	
L1-1	TLD	SW Sector, Perimeter Fence	
L2-1	TLD	SW Sector, Stonerstown, 1 Mile From CV	
M1-6	TLD	WSW Sector, Perimeter Fence	
N1-4	TLD	W Sector, Perimeter Fence	
P1-1	TLD	WNW Sector, Perimeter Fence	
Q1-2	Surface Water Sediment	Old Station Discharge	Upstream (Control)
Q1-3	TLD	NW Sector, Perimeter Fence	
R1-1	TLD	NNW Sector, Perimeter Fence	
GEO 1	Groundwater	Monitoring Well, South of SNEC Property Fence	126' from CV

TABLE 11 (Continued)

Radiological Environmental Monitoring Program Description

Station Code	Sample Medium	Description	Comments
GEO 2	Groundwater	Monitoring Well South of CV Fenced Area	②
GEO 3	Groundwater	Monitoring Well West of CV Fenced Area	102' from CV
GEO 4	Groundwater	Monitoring Well West of CV Fenced Area	51' from CV
GEO 5	Groundwater	Monitoring Well East of CV Fenced Area	134' from CV
GEO 6	Groundwater	Monitoring Well North of CV Fenced Area	①
GEO 7	Groundwater	Monitoring Well East of CV Fenced Area	①
GEO 8	Groundwater	Monitoring Well North of GPU Energy Fence	240' from CV
GEO 9	Groundwater	Piezometer Inside of CV Fenced Area	①
GEO 10	Groundwater	Monitoring Well NE of CV Fenced Area	66' from CV
MW-1	Groundwater	NE to NW Diagonal Well	①
MW-2	Groundwater	NW to SW Diagonal Well	99' from CV
MW-3	Groundwater	Monitoring Well East of CV Fenced Area	192' from CV
MW-4	Groundwater	Monitoring Well East of CV Fenced Area	144' from CV
OW-2	Groundwater	Overburden Well Northwest of SNEC Site	432' from CV Not routinely sampled
OW-3	Groundwater	Overburden Well East of SNEC Site	771' from CV
OW-3R	Groundwater	Bedrock Well East of SNEC Site	774' from CV
OW-4	Groundwater	Overburden Well Northeast of SNEC Site	825' from CV
OW-4R	Groundwater	Bedrock Well Northeast of SNEC Site	822' from CV
OW-5	Groundwater	Overburden Well West of SSGS Discharge Tunnel Bulkhead	698' from CV

① These wells were removed in May 2000.
② This well was removed in October 2000.

TABLE 11 (Continued)

Radiological Environmental Monitoring Program Description

Station Code	Sample Medium	Description	Comments
OW-5R	Groundwater	Bedrock Well West of SSGS Discharge Tunnel Bulkhead	696' from CV
OW-6	Groundwater	Overburden Well Southwest of SNEC Site	786' from CV
OW-7	Groundwater	Overburden Well Northwest of SNEC Site	294' from CV
OW-7R	Groundwater	Bedrock Well Northwest of SNEC Site	294' from CV
OP-2	Groundwater	Overburden Well Northwest of SNEC Site	444' from CV Not routinely sampled
OP-3	Groundwater	Overburden Well Northwest of SNEC Site	450' from CV
OP-4	Groundwater	Overburden Well Northwest of SNEC Site	390' from CV
H1-1	Surface Water/Sediment	Warrior's Path State Park, Boat Launch	Upstream/Control

TABLE 12

Synopsis of the 2001 Radiological Environmental Monitoring Program

Sample Type	Number of Sampling Locations	Collection Frequency	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed (2)
Air Particulate	4	Weekly or Biweekly	130	Gross Beta	Weekly/Biweekly	130
				Gross Alpha	Weekly/Biweekly	
				Gamma	Quarterly	16
Aquatic Sediment	5	Quarterly	17	Gamma	Quarterly	17
Broad Leaf Vegetation	2	Annually	2	Gamma	Annually	2
Groundwater	13	Quarterly	57	H-3	Quarterly	57
				Gamma	Quarterly	
				Sr-90	Quarterly	0
Potable Water	2	Quarterly	8	H-3	Quarterly	8
				Gamma	Quarterly	
				Gross Beta	Quarterly	
Dosimeters (TLD) (3)	28	Quarterly	671	Immersion Dose	Quarterly	671
Surface Water	2	Quarterly	8	Gamma	Quarterly	8
				H-3	Quarterly	

Notes:

(1) This table represents results from the primary (base) program. It does not include quality control (QC) results.
(2) The total number of analyses does not include duplicate analyses, recounts or reanalysis.
(3) For the purposes of this table, a dosimeter is considered to be a phosphor element.
(4) The total number of samples or elements (TLDs) used for data analysis.
(5) Biweekly means once every two weeks.

TABLE 13

Sampling and Analysis Exceptions 2001*

Period of Deviation	Description of Deviation and Corrective Action (as applicable)
First Quarter	GEO-10 - Could only obtain 125 ml of water from this well.
First Quarter	E1-1 - Sample was cross-contaminated by a contractor laboratory (BWXT Services) during analysis. Probable cause is contaminated glassware. Sample results for the first quarter are invalid.
First Quarter	G1-1 - Sample was cross-contaminated by a contractor laboratory (BWXT Services) during analysis. Probable cause is contaminated glassware. Sample results for the first quarter are invalid.
Second Quarter	GEO-3 - Could only obtain 100 ml of water from this well.
Second Quarter	GEO-10 - Could only obtain 200 ml of water from this well.
Second Quarter	OW-4 - Well was dry. No sample obtained.
Third Quarter	OW-4 - Well was dry. No sample obtained.
Third Quarter	OW-7 - Well was dry. No sample obtained.
Fourth Quarter	GEO 10 - Well was dry. No sample obtained.
Fourth Quarter	OW-4 - Well was dry. No sample obtained.
Fourth Quarter	OW-5 - Well was dry. No sample obtained.
Fourth Quarter	OW-7 - Well was dry. No sample obtained.
Fourth Quarter	OP-3 - Well was dry. No sample obtained.

* The exceptions described in this table are those that are considered deviations from radiological environmental monitoring as required by the ODCM.

APPENDIX B

LOWER LIMIT OF DETECTION (LLD) EXCEPTIONS

TABLE 14

Analytical Results that Failed to Meet the SNEC REMP Required LLD During 2001

Period of Deviation	Description of Deviation
First Quarter	GEO-10 - Could only obtain 125 ml of water from this well. BWXT Services could not achieve an acceptable LLD for Co-60 because of the low sample volume. A LLD of 18.4 pCi/liter was achieved. SNEC requires a LLD of 15 pCi/liter.
Second Quarter	GEO-3 - Could only obtain 100 ml of water from this well. BWXT Services could not achieve acceptable LLDs for Cs-137, Cs-134, and Co-60 because of the low sample volume. LLDs of 40.3 pCi/liter Cs-137, 40.3 pCi/liter Cs-134, and 42.4 pCi/liter Co-60 were achieved. SNEC requires LLDs of 18 pCi/liter Cs-137, 15 pCi/liter Cs-134, and 15 pCi/liter Co-60.
Second Quarter	GEO-10 - Could only obtain 200 ml of water from this well. BWXT Services could not achieve acceptable LLDs for Cs-137, Cs-134, and Co-60 because of the low sample volume. LLDs of 33.2 pCi/liter Cs-137, 30.3 pCi/liter Cs-134, and 38.8 pCi/liter Co-60 were achieved. SNEC requires LLDs of 18 pCi/liter Cs-137, 15 pCi/liter Cs-134, and 15 pCi/liter Co-60.

APPENDIX C

REMP CHANGES

TABLE 15

2001 REMP Changes

Date of Change	Description of Changes to SNEC Procedure E900-ADM-4500.22 (Environmental Monitoring)
3/26/01	1. Removed steps 2.2 and 2.3 from Section 2.0. These steps are stated in the "Responsibilities" section of the procedure. 2. Removed the title "Environmental Scientist" from the procedure. This title was replaced with "Rad Con" or "Quality Assurance Officer (QAO)". 3. Updated Exhibit 1 to reflect the removal of monitoring well GEO-2. This well was removed from the ground in the month of October 2000 to support soil remediation. 4. Removed Step 2.6 from the procedure. 5. Removed the CV Sump Sample (A1-2) and CV Pipe Tunnel Sample (G1-6) from the listing of REMP samples that are obtained on a quarterly basis. These samples are not required by the SNEC Facility ODCM.
11/12/01	1. Added Exhibit 6, "Sample Collection Procedure for Broad Leaf Vegetation" to the procedure. 2. Updated Exhibit 1, "Radiological Environmental Monitoring Program Description" to include the new monitoring well locations and yearly vegetation sampling. 3. Deleted Steps 2.3, 4.1.1, 4.1.2, 4.1.3, and 4.1.4. These steps provided procedural and not technical guidance applicable to REMP sampling. 4. Added the following to Section 4.1: All radiological instrumentation utilized for the REMP shall meet the minimum requirements stated in Reference 6.2. 5. Added the following to Section 4.1: Personnel who perform sampling under this procedure shall receive training to ensure proficiency is achieved and maintained. Training shall be performed and documented in accordance with the guidelines contained in Reference 6.3. Personnel approved by the Radiation Safety Officer (RSO) will provide training. 6. Added the following to Section 4.2: Air particulate samples for the REMP shall be obtained in accordance with Reference 6.4. 7. Added the following to Section 4.4: At least five percent of all REMP samples shall be analyzed in duplicate or recounted. Samples may be analyzed in their entirety or split to perform multiple analyses. Refer to Reference 6.1.

TABLE 15

2001 REMP Changes (Continued)

Date of Change	Description of Changes to SNEC Procedure E900-ADM-4500.22 (Environmental Monitoring)
11/12/01	8. Section 5.0, "Responsibilities" was rewritten to include the following: The Program Director, SNEC Facility is responsible for the overall administration and direction of the REMP. The Radiation Safety Officer (RSO) is responsible for managing the REMP. The REMP Coordinator is responsible for coordinating all phases of the program, including sample collection, sample delivery, sample analysis, and review of sample data. The REMP Coordinator is typically a Group Radiological Controls Supervisor (GRCS). The Quality Assurance Officer (QAO) is responsible for final review of REMP sample data and for preparation of the Annual REMP Report. 9. Added the following to Exhibits 3, 4, 5, and 6: Take the necessary precautions to prevent sample cross-contamination (i.e., rinse sampling equipment thoroughly between samples, use only radiologically clean sample containers, wear disposable gloves during sampling, etc.). 10. Added a requirement to add "Samplers Initials" to each sample container during sampling (Exhibits 3, 4, 5, and 6). 11. Added "Follow U.S. Coast Guard regulations during all boating work" to all exhibits that describe water or sediment sampling. 12. Updated Exhibit 10, "SNEC Facility Monitoring Wells Map" with the new monitoring well locations (OW-3R, OW-4R, OW-5R, OW-7R, OP-2, OW-2, OP-3, OP4, OW-3, OW-4, OW-5, OW-6, and OW-7).

APPENDIX D

ACTION LEVELS

Action Level Criteria

Analytical results of environmental samples were routinely reviewed and evaluated by the REMP Coordinator and Quality Assurance Officer (QAO). The results were checked for LLD violations, anomalous values, USNRC reporting levels, main sample and quality control (QC) sample agreement (Appendix E), and action levels.

Established by SNEC, the action level is defined as that level of reactor-related radioactivity which when detected in environmental samples initiates an investigation and subsequent actions, as necessary. An action level is reached if either of the following two criteria is met:

- The radioactivity concentration at an indicator station reaches or exceeds those concentrations listed in Table 16.
- The radioactivity concentration at the indicator station reaches or exceeds 10 times the mean concentration for the control locations. (This criteria applies only to those media and analyses which are not listed in Table 16.)

Action levels for gamma exposure rates measured by TLDs have also been established. For TLDs, an action level is reached if any of the following three criteria is met:

- The exposure rate at an indicator station not on the owner controlled area fence exceeds three times the mean of the control stations.
- The exposure rate at an indicator station on the owner controlled area fence exceeds 0.185mR/Hr (50% of the 40 CFR 190 limit of 25 mR/yr adjusted by a 67 hour recreational factor).
- The exposure rate at an indicator station not on the owner controlled area fence exceeds either two times the previous quarterly result or two times the historical average for the station.

Response for Exceeding an Action Level

If an action level is reached, an investigation is initiated which consists of some or all of the following actions:

- Examine the collection sheets for an indication of any equipment malfunctions, collection or delivery errors.
- Examine the running tables (prior data) for trends.
- Review control station data.
- Review QC or duplicate sample data (if available).
- Recount and/or reanalyze the sample.

- Collect and analyze an additional sample.

The results of the investigation are then documented. As appropriate, site personnel are apprised of plant-related radioactivity that exceeds the SNEC action level. If it is concluded that the detected activity is related to SNEC operations and also exceeds the USNRC reporting limits as defined in the ODCM, a detailed report will be issued to the USNRC.

There were no sample results that equaled or exceeded action level violations in 2001.

TABLE 16

SNEC REMP Analytical Required Sensitivities (LLD) & Reporting Levels

Exposure/Pathways and/or Sample	Units	Analysis	Required LLD	Reporting Level
Air Particulate (AP)	pCi/m3	Gross Alpha	1.5 E-3	1.0 E-1
		Gross Beta	1.0 E-2	1.0
		Cs-134	5.0 E-2	1.0 E1
		Cs-137	6.0 E-2	2.0 E1
		Sr-90	1.0 E-2	1.0 E-1
Sediment/Soil (SD/S)	pCi/g (Dry)	Cs-134	1.5E-1	1.0
		Cs-137	1.8E-1	5.0
		Sr-90	5.0 E-2	5.0 E-1
Water (SW/GW)	pCi/L	Gross Alpha	5.0	1.0 E2
		Gross Beta	4.0	5.0 E1
		Tritium	2.0 E3	2.0 E4
		Co-60	1.5 E1	3.0 E2
		Cs-134	1.5 E1	3.0 E1
		Cs-137	1.8 E1	5.0 E1
		Sr-90	2.0	8.0
Vegetation	pCi/g (Wet)	Cs-134	6.0 E-2	1.0
		Cs-137	8.0 E-2	2.0
		Sr-90	1.0 E-2	1.0 E-1

APPENDIX E

QUALITY CONTROL PROGRAM

Basis for a Quality Assurance Program

A quality assurance (QA) program is an essential part of any radiological environmental monitoring program (REMP). It provides reasonable assurance that the results of radiation measurements are valid. To be effective, elements of quality assurance must be evident in all phases of the monitoring program. These include, but are not limited to, sample collection, preservation and shipment, receipt of samples by the analysis laboratory, preparation and analysis of samples and data review and reporting. An effective QA program will allow for the identification of deficiencies in all monitoring processes so that appropriate investigative and corrective actions can be implemented.

The USNRC published Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment", which defines an acceptable QA program (Reference 9). SNEC has adopted the guidance contained in Regulatory Guide 4.15. To meet the objectives of this position document, procedures and plans have been written and implemented.

In the laboratory, samples are typically analyzed one time. Therefore, laboratory personnel must be reasonably confident with the analytical results which are generated. One means of achieving confidence in the results is through the analysis of quality control (QC) samples.

Three types of QC samples are routinely analyzed as part of SNEC's QA Program. They include intralaboratory-split samples, cross-check program samples, and interlaboratory split samples. A discussion of each QC sample type is provided below.

Intralaboratory Split Samples

SNEC's laboratory is required to split, at a minimum, every twentieth sample (at least 5%) and perform an analysis (or analyses) on each portion. The samples which can not be split (e.g., air particulate filters) are counted twice. The results of the two analyses are then checked by the Quality Assurance Officer for agreement using the criteria defined in procedure E900-ADM-4500.22, "Environmental Monitoring". Agreement is considered acceptable if the value of the ratio fall within certain limits similar to those listed in USNRC Inspection Procedure 84750, "Radioactive Waste Treatment, Effluent and Environmental Monitoring" with minor adjustments to account for activity concentrations with large uncertainties. Non-agreement of the sample concentrations may result in recounting or reanalyzing the sample(s) in question. There were no REMP sample intralaboratory non-agreements during the year 2001.

Cross-check Program Samples

SNEC participates in two separate cross-check programs; the United States Department of Energy Environmental Measurements Laboratory (DOE-EML) Cross-check Program and DOE Mixed Analyte Performance Evaluation Program (MAPEP). At least semi-annually, the DOE submits blind spike samples to the SNEC Facility for analysis on the Gamma Spectroscopy System(s) and Tri-Carb Liquid Scintillation Analyzer, as applicable. Samples are analyzed and results are sent to the DOE for accuracy evaluation. Results are reviewed by the QAO for trends and sample non-agreement. As a minimum, investigations are performed for all

sample non-agreements.

Two SNEC Facility Cross-check Program discrepancies were identified in 2001. They involved:

- One soil gamma scan Pb-212 sample analysis result from SNEC (30.03 ± 3.41 Bq/Kg) did not agree with the DOE/EML result (41.5 ± 2.2 Bq/Kg).
- One vegetation sample analysis received marginal performance ratings for all reported radionuclides.

Each contractor laboratory that analyzes environmental samples for the SNEC Facility participates in at least two separate cross-check programs, which may include DOE-EML, DOE-MAPEP, USEPA, ERA, or Analytics. All samples are sent to the contractor laboratories as unknowns. Participation in these programs provides an independent check on the ability of each laboratory to perform analyses on various kinds of samples containing detectable concentrations of radioactivity. If sample results are outside the established limits or agreement criteria, the laboratories perform an investigation and take corrective action, as necessary.

The 2001 cross-check program results from each laboratory are listed in Appendix F. Explanations are provided for those results which were not within the established limits.

Interlaboratory Split Samples

The third type of QC sample is the interlaboratory split sample. These samples are routinely collected for the REMP. After or during the collection process, the sample is thoroughly mixed (as necessary) to ensure that, as much as possible, the distribution of radioactivity in the sample is homogeneous. The sample is then split into two portions. One portion is sent to the primary (main) laboratory and the other portion is sent to the QC laboratory.

Analysis results from the QC laboratory are then compared to those from the primary laboratory. The agreement criteria are the same as that used for the intralaboratory-split samples. Corrective action for disagreements may include recounting or reanalyzing the sample(s).

There was one interlaboratory non-agreement during 2001. REMP sample SX-GW-E1-1 (Third Quarter) from the GPU Energy Line Department Building faucet was analyzed for gross beta and the initial result (7.23 ± 2.11 pCi/liter) did not agree with the duplicate result (<3.0 pCi/liter). Contractor laboratories (BWXT and Teledyne) performed the analyses on this sample. Representatives from each laboratory confirmed gross beta results by review of data (i.e., calculations) and/or reanalysis. The results (7.23 and <3.0 pCi/liter) are well below the gross beta action level of 50 pCi/liter and each met the required LLD listed in SNEC procedure E900-ADM-4500.22, "Environmental Monitoring". There are no obvious reasons for the conflicting results. The conservative result of 7.23 pCi/liter was used as the reported result.

APPENDIX F

CROSS-CHECK PROGRAM RESULTS

TABLE 17

SNEC Facility and DOE/EML Cross-check Program Results for 2001 (QAP 103)

Sample ID	Radio nuclide	Repetition (b)	Reported Value	Reported Error	EML Value (c)	EML Error (d)	Reported/EML	Evaluation (a)
Air (Bq/filter)								
0103AISX	54Mn	1	6.45	0.71	6.52	0.28	.989	A
0103AISX	60Co	1	17.81	0.93	19.44	0.5	.916	A
0103AISX	134Cs	1	2.36	0.29	2.83	0.16	.834	A
0103AISX	137Cs	1	8.56	0.76	8.76	0.34	.977	A
Soil (Bq/Kg)								
0103SOSX	40K	1	439.14	52.98	468.0	25.0	.938	A
0103SOSX	137Cs	1	1662.83	87.94	1740.0	90.0	.956	A
0103SOSX	212Pb	1	30.03	3.41	41.5	2.2	.724	N (h)
0103SOSX	214Bi	1	30.18	5.06	32.6	1.4	.926	A
0103SOSX	214Pb	1	26.57	5.43	34.3	1.6	.775	W
Vegetation (Bq/Kg)								
0103VESX	40K	1	594.73	72.79	603.0	32.0	.986	A
0103VESX	60Co	1	27.29	3.31	30.4	1.2	.898	A
0103VESX	137Cs	1	817.84	45.14	842.0	42.0	.971	A
Water (Bq/L)								
0103WASX	3H	1	82.62	6.57	79.3	2.0	1.042	A
0103WASX	60Co	1	99.71	4.67	98.2	3.6	1.015	A
0103WASX	137Cs	1	72.56	4.84	73.0	3.7	.994	A

TABLE 17 (Continued)

SNEC Facility and DOE/EML Cross-check Program Results for 2001 (QAP 103)

Table 17 - Notes:

(a) Evaluation: A = Acceptable, W = Acceptable with Warning, N = Not Acceptable

(b) The SNEC Facility value is an average of 1 to 4 determinations.

(c) The DOE EML value is the mean of replicate determinations for each nuclide.

(d) The DOE EML uncertainty is the standard error of the mean.

(e) The control limit concept was established from percentiles of historic data distributions (1982-1992). The evaluation of this historic data and the development of the control limits are presented in DOE report EML-564. The control limits for QAP-LV were developed from percentiles of data distributions for the years 1993-1999.

(f) Participants' analytical performance is evaluated based on the historical analytical capabilities for individual analyte/matrix pairs. The criteria for acceptable performance, "A", has been chosen to be between the 15th and 85th percentile of the cumulative normalized distribution, which can be viewed as the middle 70% of all historic measurements. The acceptable with warning criteria, "W", is between the 5th and 15th percentile and between the 85th and 95th percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5th – 15th (10%) and 85th – 95th percentiles (10%) are in the warning area. The not acceptable criteria, "N", is established at less than the 5th percentile and greater than the 95th percentile, that is, the outer 10% of the historical data.

(g) Units are Bq/L for Water, Bq/kg (dry) for Soil, Bq/kg for Vegetation and total Bq for Air Filter.

(h) Sample 0103SOSX was reanalyzed at the SNEC Facility for 50,000 seconds. The Pb-212 reanalysis results (30.5 ± 2.9 Bq/Kg) once again did not agree with the DOE/EML analysis results (41.5 ± 2.2 Bq/Kg). The calculated resolution was 21 with a ratio of 0.73. The ratio acceptance criterion for this analysis is 0.75 to 1.33. The System Manager for the Gamma Spectroscopy Systems reviewed the data and checked the instrumentation for irregularities. No problems were identified. Pb-212 is a naturally occurring isotope that is found in environment. It is not an isotope of concern at the SNEC Facility. Therefore, no further action is required. Pb-212 will not be reported in future cross-check program samples.

TABLE 18

SNEC Facility and DOE/EML Cross-check Program Results for 2001 (QAP 109)

Sample ID	Radio-nuclide	Repetition (b)	Reported Value	Reported Error	EML Value (c)	EML Error (d)	Reported/EML	Evaluation (a)
Air (Bq/filter)								
0109AISX	54Mn	1	81.04	4.33	81.15	4.76	0.999	A
0109AISX	60Co	1	16.56	0.69	17.5	0.47	0.946	A
0109AISX	134Cs	1	11.0	0.42	12.95	0.362	0.849	A
0109AISX	137Cs	1	17.02	0.94	17.1	0.58	0.995	A
Soil (Bq/Kg)								
0109SOSX	40K	1	566.29	30.82	623.33	33.04	0.908	A
0109SOSX	137Cs	1	537.98	29.26	612.33	30.62	0.879	W (h)
Vegetation (Bq/Kg)								
0109VESX	40K	1	795.5	52.28	898.67	48.23	0.885	W (h)
0109VESX	60Co	1	30.03	1.44	35.3	1.436	0.851	W (h)
0109VESX	137Cs	1	881.71	50.83	1030.0	51.8	0.856	W (h)
Water (Bq/L)								
0109WASX	3H	1	260.48	24.14	207.0	2.69	1.258	A
0109WASX	60Co	1	181.72	8.07	209.0	7.59	0.869	W
0109WASX	137Cs	1	42.87	3.4	45.133	2.467	0.950	A

TABLE 18 (Continued)

SNEC Facility and DOE/EML Cross-check Program Results for 2001 (QAP 109)

Table 18 - Notes:

(a) Evaluation: A = Acceptable, W = Acceptable with Warning, N = Not Acceptable

(b) The SNEC Facility value is an average of 1 to 4 determinations.

(c) The DOE EML value is the mean of replicate determinations for each nuclide.

(d) The DOE EML uncertainty is the standard error of the mean.

(e) The control limit concept was established from percentiles of historic data distributions (1982-1992). The evaluation of this historic data and the development of the control limits are presented in DOE report EML-564. The control limits for QAP-LV were developed from percentiles of data distributions for the years 1993-1999.

(f) Participants' analytical performance is evaluated based on the historical analytical capabilities for individual analyte/matrix pairs. The criteria for acceptable performance, "A", has been chosen to be between the 15th and 85th percentile of the cumulative normalized distribution, which can be viewed as the middle 70% of all historic measurements. The acceptable with warning criteria, "W", is between the 5th and 15th percentile and between the 85th and 95th percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5th – 15th (10%) and 85th – 95th percentiles (10%) are in the warning area. The not acceptable criteria, "N", is established at less than the 5th percentile and greater than the 95th percentile, that is, the outer 10% of the historical data.

(g) Units are Bq/L for Water, Bq/kg (dry) for Soil, Bq/kg for Vegetation and total Bq for Air Filter.

(h) The QAO inspected the sample in its original counting container, a 125-ml jar. The sample contained the appropriate volume of sample material (approximately 100 cc) to meet the required counting geometry. The QAO checked the sample weight using a calibrated balance and then compared the data to the analysis records. The sample weights conflicted. The sample was approximately 17 grams less then the analysis records. It was determined that the Count Room RCT did not include the counting container lid when the tare weight was obtained. Therefore the reported sample weight was approximately 17 grams high, which led SNEC to underestimate the sample activity. Sample 0109SOSX (DOE/EML soil spike sample) was also approximately 17 grams high and therefore received similar crosscheck results.

Corrective Actions:

1. The correct sample weights were entered into the Gamma Spectroscopy System database. The samples were reanalyzed and an "Acceptable" result was obtained when a replicate analysis calculation was performed.
2. An extent evaluation was performed to determine the significance of this deficiency. Approximately 100 samples that were previously analyzed and stored in the SNEC Sample Storage Van were re-weighed. Two sample weights differed by approximately 160 grams from the weights that were written on the sample containers and logged on analysis records. The sample weight discrepancies were due to improper use of the balance "TARE" function. A Corrective Action Process (CAP) form (CAP S2001-016) was initiated and additional samples were weighed and verified.
3. Analytical procedures were changed to require verification of sample weights immediately before an analysis is performed.
4. The CAP investigation concluded that no REMP samples were affected by this deficiency.

TABLE 19
SNEC Facility and MAPEP Cross-check Program Results for 2001 (MAPEP-01-S8)

Sample ID	Radio-nuclide	Repetition (b)	Reported Value	Reported Uncertainty	MAPEP Reference Value	Bias	Acceptance Range	Evaluation (a)
Soil (Bq/Kg)								
MAPEP-01-S8	Cs-134	1	81.32	3.097	91.1	-10.7	63.77 - 118.43	A
MAPEP-01-S8	Cs-137	1	1269.655	71.065	1240	2.4	868 - 1612	A
MAPEP-01-S8	Co-57	1	105.339	4.666	103	2.3	72.1 - 133.9	A
MAPEP-01-S8	Co-60	1	1403.077	54.52	1270	10.5	889 - 1651	A
MAPEP-01-S8	Mn-54	1	228.549	15.969	203	12.6	142.1 - 263.9	A
MAPEP-01-S8	K-40	1	746.179	45.566	652	14.4	456.4 - 847.6	A
MAPEP-01-S8	Zn-65	1	463.370	28.425	382	21.3	267.4 - 496.6	W

Table 19 - Notes:

(a) Evaluation: A = Result Acceptable (Bias ≤ 20%), W = Result Acceptable with Warning (Bias > 20% and ≤ 30%), N = Result Not Acceptable (Bias > 30%)

(b) The SNEC Facility value is an average of 1 to 4 determinations.

(c) Units are in Bq/kg (dry).

TABLE 20

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation (a)
March, 2001	E2584-93	Milk	I-131	pCi/L	75	77	0.97	A
			Ce-141	pCi/L	166	162	1.03	A
			Cr-51	pCi/L	433	418	1.04	A
			Cs-134	pCi/L	212	223	0.95	A
			Cs-137	pCi/L	165	176	0.94	A
			Co-58	pCi/L	81	82	0.99	A
			Mn-54	pCi/L	172	175	0.98	A
			Fe-59	pCi/L	151	146	1.03	A
			Zn-65	pCi/L	314	322	0.98	A
			Co-60	pCi/L	254	254	1.00	A
May, 2001	A14428-55	Water	Sr-89	uCi/mL	2.50E-03	2.95E-03	0.85	A
			Sr-90	uCi/mL	2.00E-04	2.27E-04	0.88	A
May, 2001	A14429-55	Water	Gr-Alpha	uCi/mL	1.70E-04	1.45E-04	1.17	A
May, 2001	A14434-55	Water	Fe-55	uCi/mL	2.40E-04	2.53E-04	0.95	A
June, 2001	2707	Charcoal	I-131	pCi	104.5	81	1.29	W
June, 2001	2708	Charcoal	I-131	pCi	84.8	72	1.18	A
June, 2001	2709	Charcoal	I-131	pCi	99.6	92	1.08	A
August, 2001	E2755-396	Milk	Mn-54	pCi/L	131	124	1.06	A
			Co-58	pCi/L	68	68	1.00	A
			Fe-59	pCi/L	53	50	1.06	A
			Co-60	pCi/L	134	132	1.02	A
			Zn-65	pCi/L	172	162	1.06	A
			I-131	pCi/L	76	86	0.88	A
			Cs-134	pCi/L	141	128	1.10	A
			Cs-137	pCi/L	126	120	1.05	A
			Ce-141	pCi/L	72	76	0.95	A

TABLE 20 (Continued)

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation (a)
August, 2001	E2757-396	AP Filter	Ce-141	pCi	79	74	1.07	A
			Cr-51	pCi	100	90	1.11	A
			Cs-134	pCi	109	125	0.87	A
			Cs-137	pCi	140	116	1.21	W
			Co-58	pCi	72	66	1.09	A
			Mn-54	pCi	161	134	1.20	A
			Fe-59	pCi	51	49	1.04	A
			Zn-65	pCi	200	158	1.27	W
			Co-60	pCi	148	128	1.16	A
August, 2001	E2756A-396	Charcoal	I-131	pCi	87	93	0.94	A
September, 2001	A14734-148	Liquid	Sr-89	Total uCi	1.30E-03	1.55E-03	0.84	A
			Sr-90	Total uCi	1.00E-04	1.12E-04	0.89	A
September, 2001	A14735-148	Gas	Xe-133	Total uCi	0.606	0.585	1.04	A
			Kr-85	Total uCi	8.53	8.42	1.01	A
September, 2001	A14736-148	Charcoal	I-131	Total uCi	0.483	0.495	0.98	A
September, 2001	A14737-148	Air Filter	Ce-141	Total uCi	4.99E-02	5.25E-02	0.95	A
			Cr-51	Total uCi	1.68E-01	1.85E-01	0.91	A
			Cs-134	Total uCi	2.47E-02	2.97E-02	0.83	A
			Cs-137	Total uCi	5.18E-02	5.73E-02	0.90	A
			Co-58	Total uCi	4.60E-02	4.75E-02	0.97	A
			Mn-54	Total uCi	3.96E-02	4.02E-02	0.99	A
			Fe-59	Total uCi	2.99E-02	2.92E-02	1.02	A
			Zn-65	Total uCi	5.22E-02	5.12E-02	1.02	A
			Co-60	Total uCi	4.71E-02	4.83E-02	0.98	A
September, 2001	E2773-396	Charcoal	I-131	Total uCi	68.6	67	1.02	A
September, 2001	A14738-148	Liquid	Gr-Alpha	Total uCi	5.80E-04	4.67E-04	1.24	A

TABLE 20 (Continued)

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation (a)
September, 2001	E2772-396	Milk	I-131	pCi/L	100	91	1.10	A
			Ce-141	pCi/L	126	121	1.04	A
			Cr-51	pCi/L	349	366	0.95	A
			Cs-134	pCi/L	147	160	0.92	A
			Cs-137	pCi/L	321	319	1.01	A
			Co-58	pCi/L	190	177	1.07	A
			Mn-54	pCi/L	205	205	1.00	A
			Fe-59	pCi/L	85	86	0.99	A
			Zn-65	pCi/L	246	254	0.98	A
			Co-60	pCi/L	261	266	0.98	A
September, 2001	E2774-396	Air Filter	Ce-141	pCi	118	116	1.02	A
			Cr-51	pCi	362	351	1.03	A
			Cs-134	pCi	135	153	0.88	A
			Cs-137	pCi	350	307	1.14	A
			Co-58	pCi	184	170	1.08	A
			Mn-54	pCi	230	197	1.17	A
			Fe-59	pCi	100	82	1.22	W
			Zn-65	pCi	305	244	1.25	W
			Co-60	pCi	267	255	1.05	A
September, 2001	A14286-148	Liquid	Gr-Alpha	uCi/cc	1.70E-04	1.45E-04	1.17	A
			H-3	uCi/cc	2.92E-03	1.77E-03	1.65	A
December, 2001	E2980-396	Milk	Sr-89	pCi/L	75	85	0.96	A
			Sr-90	pCi/L	44	59	0.75	W
			Fe-55	pCi/L	108	99	1.09	A
December, 2001	E-2981-396	Milk	I-131	pCi/L	50	61	0.82	A
			Ce-141	pCi/L	352	379	0.93	A
			Cr-51	pCi/L	468	497	0.94	A
			Cs-134	pCi/L	173	199	0.87	A

TABLE 20 (Continued)

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation (a)
December, 2001	E-2981-396	Milk	Cs-137	pCi/L	312	318	0.98	A
			Co-58	pCi/L	92	90	1.02	A
			Mn-54	pCi/L	148	149	0.99	A
			Fe-59	pCi/L	101	102	0.99	A
			Zn-65	pCi/L	192	206	0.93	A
			Co-60	pCi/L	322	353	0.93	A
December, 2001	E-2983-396	Air Filter	Ce-141	pCi	185	181	1.02	A
			Cr-51	pCi	190	237	0.80	A
			Cs-134	pCi	74	95	0.78	W
			Cs-137	pCi	163	152	1.07	A
			Co-58	pCi	46	43	1.07	A
			Mn-54	pCi	80	71	1.13	A
			Fe-59	pCi	57	49	1.16	A
			Zn-65	pCi	119	99	1.2	A
			Co-60	pCi	165	169	0.98	A
December, 2001	E-2982-396	Charcoal	I-131	pCi	89	92	0.93	A

Table 20 - Notes:

(a) Evaluation: A = Result Acceptable, W = Result Acceptable with Warning, N = Result Not Acceptable

TABLE 21

Teledyne Brown Engineering Environmental Services & DOE/EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units (c)	Reported Value	Known Value (b)	Ratio TBE/EML	Evaluation (a)
March, 2001	QAP 103	Air Filter	Mn-54	Bq/filter	6.96	6.52	1.07	A
			Co-60	Bq/filter	19.4	19.44	1.00	A
			Cs-134	Bq/filter	2.59	2.83	0.92	A
			Cs-137	Bq/filter	9.52	8.76	1.09	A
			Pu-238	Bq/filter	0.23	0.215	1.07	A
			Pu-239	Bq/filter	0.17	0.136	1.25	W
			Am-241	Bq/filter	0.93	0.486	1.91	W
			Gr-Alpha	Bq/filter	3.33	3.97	0.84	A
			Gr-Beta	Bq/filter	2.26	2.58	0.88	W
			Sr-90	Bq/filter	7.46	7.1	1.05	A
March, 2001	QAP 103	Soil	K-40	Bq/kg	464.8	468	0.99	A
			Cs-137	Bq/kg	1696	1740	0.97	A
			Pu-239/40	Bq/kg	24.32	25.6	0.95	A
			Sr-90	Bq/kg	80.8	69	1.17	A
March, 2001	QAP 103	Vegetation	K-40	Bq/kg	728	603	1.21	A
			Co-60	Bq/kg	34	30.4	1.12	A
			Cs-137	Bq/kg	1005	842	1.19	A
			Pu-239	Bq/kg	10.54	9.58	1.10	A
			Am-241	Bq/kg	7.03	6.17	1.14	A
			Cm-244	Bq/kg	2.26	3.69	0.61	W
			Sr-90	Bq/kg	1283	1330	0.96	A
March, 2001	QAP 103	Water	Co-60	Bq/L	100.3	98.2	1.02	A
			Cs-137	Bq/L	75.8	73	1.04	A
			Gr-Alpha	Bq/L	1600	1900	0.84	A
			Gr-Beta	Bq/L	1200	1297	0.93	A
			Pu-238	Bq/L	1.78	1.58	1.13	W
			Pu-239	Bq/L	1.99	1.64	1.21	W
			Am-241	Bq/L	2.2	1.67	1.32	W

TABLE 21 (Continued)

Teledyne Brown Engineering Environmental Services & DOE/EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units (c)	Reported Value	Known Value (b)	Ratio TBE/EML	Evaluation (a)
May, 2001	QAP 103	Water	Sr-90	Bq/L	4.57	4.4	1.04	A
			H-3	Bq/L	61.0	79.3	0.77	W
June, 2001	QAP 2009	Air Filters	Mn-54	Bq/filter	49.5	43.2	1.15	A
			Co-57	Bq/filter	15.2	14.5	1.05	A
			Co-60	Bq/filter	8.79	8.43	1.04	A
			Cs-137	Bq/filter	8.26	7.41	1.11	A
			Gr-Alpha	Bq/filter	2.31	2.35	0.98	A
			Gr-Beta	Bq/filter	1.79	1.52	1.18	A
June, 2001	QAP 2009	Soil	K-40	Bq/Kg	839.2	713	1.18	A
			Cs-137	Bq/Kg	1164	1020	1.14	A
			Pb-212	Bq/Kg	95.5	79.3	1.20	A
			Bi-214	Bq/Kg	84.0	83.3	1.01	A
			Pb-214	Bq/Kg	92.9	86.3	1.08	A
			Ac-228	Bq/Kg	84.8	80.2	1.06	A
			U-234	Bq/Kg	117	157	0.75	W
			U-238	Bq/Kg	122	163	0.75	W
June, 2001	QAP 2009	Vegetation	K-40	Bq/Kg	827.4	639	1.29	W
			Co-60	Bq/Kg	34.4	32.8	1.05	A
			Cs-137	Bq/Kg	949.4	867	1.10	A
June, 2001	QAP 2009	Water	Co-60	Bq/L	75.7	73.7	1.03	A
			Cs-137	Bq/L	69.3	67.0	1.03	A
			U-234	Bq/L	0.39	0.481	0.81	W
			U-238	Bq/L	0.32	0.368	0.87	W
September, 2001	QAP 0109	Vegetation	K-40	Bq/kg	1090.0	898.67	1.213	A
			Co-60	Bq/kg	39.8	35.3	1.127	A
			Sr-90	Bq/kg	1253.0	1612.8	0.777	A
			Cs-137	Bq/kg	1235.0	1030.0	1.199	A
			Pu-239	Bq/kg	11.6	11.022	1.052	A

TABLE 21 (Continued)

Teledyne Brown Engineering Environmental Services & DOE/EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units (c)	Reported Value	Known Value (b)	Ratio TBE/EML	Evaluation (a)
September, 2001	QAP 0109	Air Filters	Mn-54	Bq/filter	97.1	81.15	1.197	A
			Co-60	Bq/filter	18.8	17.5	1.074	A
			Sr-90	Bq/filter	2.56	3.481	0.735	W
			Cs-134	Bq/filter	12.7	12.95	0.981	A
			Cs-137	Bq/filter	20.8	17.1	1.216	W
			Pu-238	Bq/filter	0.0595	0.071	0.838	W
			Pu-239	Bq/filter	0.287	0.2291	1.253	W
			Am-241	Bq/filter	0.089	0.088	1.011	A
			Gr-Alpha	Bq/filter	5.42	5.362	1.011	A
			Gr-Beta	Bq/filter	12.0	12.77	0.94	A
September, 2001	QAP 0109	Soil	K-40	Bq/kg	673.0	623.33	1.080	A
			Sr-90	Bq/kg	29.6	30.596	0.967	A
			Cs-137	Bq/kg	680.5	612.33	1.111	A
			Pu-239	Bq/kg	7.42	8.948	0.829	W
September, 2001	QAP 0109	Water	H-3	Bq/L	212.3	207.0	1.026	A
			Co-60	Bq/L	207.3	209.0	0.992	A
			Ni-63	Bq/L	50.7	45.25	1.1	A
			Sr-90	Bq/L	4.76	3.729	1.276	W
			Cs-137	Bq/L	47.7	45.133	1.057	A
			Pu-238	Bq/L	1.21	1.0882	1.112	W
			Pu-139	Bq/L	1.86	1.628	1.143	W
			Am-241	Bq/L	0.763	0.7597	1.004	A
			Gr-Alpha	Bq/L	1333.0	1150.0	1.159	W
			Gr-Beta	Bq/L	8533.0	7970.0	1.071	A

Table 21 - Notes:

(a) Evaluation: A = Acceptable, W = Acceptable with Warning, N = Not Acceptable

(b) The DOE EML value is the mean of replicate determinations for each nuclide.

(c) Units are Bq/L for Water, Bq/kg (dry) for Soil, Bq/kg for Vegetation and total Bq for Air Filter.

(d) The control limit concept was established from percentiles of historic data distributions (1982-1992). The evaluation of this historic data and the development of the control limits are presented in DOE report EML-564. The control limits for QAP-LV were developed from percentiles of data distributions for the years 1993-1999.

(e) Participants' analytical performance is evaluated based on the historical analytical capabilities for individual analyte/matrix pairs. The criteria for acceptable performance, "A", has been chosen to be between the 15th and 85th percentile of the cumulative normalized distribution, which can be viewed as the middle 70% of all historic measurements. The acceptable with warning criteria, "W", is between the 5th and 15th percentile and between the 85th and 95th percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5th – 15th (10%) and 85th – 95th percentiles (10%) are in the warning area. The not acceptable criteria, "N", is established at less than the 5th percentile and greater than the 95th percentile, that is, the outer 10% of the historical data.

TABLE 22

Teledyne Brown Engineering Environmental Services & ERA Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/ERA	Evaluation (a)
February, 2001	Rad-29	Liquid	Co-60	pCi/L	95.5	91.1	1.05	A
			Cs-134	pCi/L	60.5	59.8	1.01	A
			Cs-137	pCi/L	48	45	1.07	A
September, 2001	Rad-38	Liquid	Ba-133	pCi/L	35.5	36	0.99	A
			Co-60	pCi/L	47.6	46.8	1.02	A
			Cs-134	pCi/L	15.5	15.9	0.97	A
			Cs-137	pCi/L	206	197	1.05	A
			Zn-65	pCi/L	35.4	36.2	0.98	A
August, 2001	Rad-39	Liquid	Total U	pCi/L	60.3	52.9	1.14	A
			Ra-226	pCi/L	14.7	15.4	0.95	A
September, 2001	Rad-40	Liquid	Sr-89	pCi/L	26.4	31.2	0.85	A
			Sr-90	pCi/L	28.2	25.9	1.09	A
August, 2001	Rad-41	Liquid	Gr-Alpha	pCi/L	15.2	17.8	0.85	A
			Gr-Beta	pCi/L	52.0	53.0	0.98	A
September, 2001	Rad-42	Liquid	H-3	pCi/L	2370	2730	0.87	A
December, 2001	12130109	Liquid	I-131	pCi/L	3.77	4.38	0.86	A

Table 22 - Notes:

(a) Evaluation: A = Result Acceptable, W = Result Acceptable with Warning, N = Result Not Acceptable

TABLE 23

Teledyne Brown Engineering Environmental Services & MAPEP Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Acceptance Range	Evaluation (a)
March, 2001	00-W8	Liquid	Mn-54	Bq/L	3.04	2.87	2.01 - 3.73	A
			Co-57	Bq/L	92.4	95.5	66.85 - 124.15	A
			Co-60	Bq/L	2.20	2.19	1.53 - 2.85	A
			Zn-65	Bq/L	4.65	4.59	3.21 - 5.97	A
			Cs-134	Bq/L	260	283	198.1 - 367.9	A
			Cs-137	Bq/L	91.5	94.4	66.08 - 122.72	A
			Zn-65	Bq/L	4.65	4.59	3.21 - 5.97	A
November, 2001	01-S8	Soil	Mn-54	Bq/kg	217	203	142.1-263.9	A
			Co-57	Bq/kg	97.2	103	72.10-133.9	A
			Co-60	Bq/kg	1280	1270	889-1651	A
			Zn-65	Bq/kg	408.3	382	267.4-496.6	A
			Cs-134	Bq/kg	87.4	91.1	63.77-118.43	A
			Cs-137	Bq/kg	1233	1240	868-14612	A
			Ni-63	Bq/kg	569	550	385-715	A
			Sr-90	Bq/kg	170	209	146.3-271.7	A

Table 23 - Notes:

(a) Evaluation: A = Result Acceptable, W = Result Acceptable with Warning, N = Result Not Acceptable

TABLE 24

BWXT Services & MAPEP Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Acceptance Range	Evaluation (a)
March, 2001	00-W8	Liquid	Mn-54	Bq/L	3.07	2.87	2.01 - 3.73	A
			Am-241	Bq/L	1.04	1.06	0.74 - 1.38	A
			Co-57	Bq/L	96.9	95.5	66.85 - 124.15	A
			Co-60	Bq/L	2.18	2.19	1.53 - 2.85	A
			Zn-65	Bq/L	4.85	4.59	3.21 - 5.97	A
			Cs-134	Bq/L	241	283	198.1 - 367.9	A
			Cs-137	Bq/L	90.3	94.4	66.08 - 122.72	A
			Ni-63	Bq/L	124	120	84 - 156	A
			U-234/233	Bq/L	1.19	0.99	0.69 - 1.29	W
			U-238	Bq/L	1.2	1.02	0.71 - 1.33	A
			Pu-238	Bq/L	2.5	2.12	1.48 - 2.76	A
			Pu-239/240	Bq/L	2.1	1.86	1.3 - 2.42	A
November, 2001	01-S8	Soil	Mn-54	Bq/kg	215	203	142.1-263.9	A
			K-40	Bq/kg	684	652	456.4 - 847.6	A
			Co-57	Bq/kg	101	103	72.10-133.9	A
			Fe-55	Bq/L	609	1320	924 - 1716	N (b)
			Co-60	Bq/kg	1390	1270	889-1651	A
			Zn-65	Bq/kg	448	382	267.4-496.6	A
			Cs-134	Bq/kg	84.4	91.1	63.77-118.43	A
			Cs-137	Bq/kg	1230	1240	868-1612	A
			Ni-63	Bq/kg	349	550	385-715	N (b)
			Sr-90	Bq/kg	151	209	146.3-271.7	W
			U-234/233	Bq/L	59.2	60	42 - 78	A
			U-238	Bq/L	212	191	133.7 - 248.3	A
			Pu-238	Bq/L	86.4	115	80.5 - 149.5	W
			Pu-239/240	Bq/L	74.1	83.4	58.38 - 108.42	A

Table 24 - Notes:

(a) Evaluation: A = Result Acceptable, W = Result Acceptable with Warning, N = Result Not Acceptable

TABLE 25

BWXT Services & DOE EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio BWXT/EML	Evaluation (a)
December, 2001	QAP 0109	Air Filter	Am-241	Bq/filter	0.086	0.088	0.977	A
			Co-60	Bq/filter	18.6	17.5	1.063	A
			Cs-134	Bq/filter	12.9	12.95	0.996	A
			Cs-137	Bq/filter	18.3	17.1	1.070	A
			Gross Alpha	Bq/filter	5.15	5.362	0.960	A
			Gross Beta	Bq/filter	10.8	12.77	0.846	W
			Mn-54	Bq/filter	85.5	81.15	1.054	A
			Pu-238	Bq/filter	0.077	0.071	1.080	A
			Pu-239	Bq/filter	0.236	0.229	1.030	A
			Sr-90	Bq/filter	3.1	3.481	0.891	A
			U-234	Bq/filter	0.122	0.108	1.128	A
			U-238	Bq/filter	0.119	0.109	1.089	A
December, 2001	QAP 0109	Soil	Ac-228	Bq/Kg	52.9	59.57	0.888	W
			Am-241	Bq/Kg	4.77	4.432	1.076	A
			Bi-212	Bq/Kg	38.8	62.067	0.625	A
			Bi-214	Bq/Kg	35.7	36.9	0.967	A
			Cs-137	Bq/Kg	636.0	612.33	1.039	A
			K-40	Bq/Kg	618	623.33	0.991	A
			Pb-212	Bq/Kg	64.8	58.33	1.111	A
			Pb-214	Bq/Kg	39.6	39.67	0.998	A
			Pu-239	Bq/Kg	9.01	8.948	1.007	A
			Sr-90	Bq/kg	23.4	30.596	0.765	W
			Th-234	Bq/kg	48.8	100.067	0.488	N (b)
			U-234	Bq/kg	89.1	92.23	0.966	A
			U-238	Bq/kg	91.6	98.33	0.932	A
December, 2001	QAP 0109	Water	Am-241	Bq/L	0.727	0.760	0.957	A
			Co-60	Bq/L	212	209	1.014	A
			Cs-137	Bq/L	44.8	45.133	0.993	A

TABLE 25 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio BWXT/EML	Evaluation (a)
December, 2001	QAP 0109	Water	Gross Alpha	Bq/L	1210	1150	1.052	A
			Gross Beta	Bq/L	6790	7970	0.852	A
			H-3	Bq/L	233	207	1.126	A
			Ni-63	Bq/L	37.6	45.25	0.831	W
			Pu-238	Bq/L	1.13	1.088	1.038	A
			Pu-239	Bq/L	1.74	1.628	1.069	A
			Sr-90	Bq/L	3.2	3.729	0.858	A
			U-234	Bq/L	1.27	1.166	1.089	A
			U-238	Bq/L	1.27	1.169	1.086	A
December, 2001	QAP 0109	Vegetation	Am-241	Bq/Kg	8.07	6.915	1.167	A
			Cm-244	Bq/Kg	5.37	4.308	1.247	A
			Co-60	Bq/Kg	41.1	35.3	1.164	A
			Cs-137	Bq/Kg	1180	1030	1.146	A
			K-40	Bq/Kg	1040	898.67	1.157	A
			Pu-239	Bq/Kg	11.2	11.022	1.016	A
			Sr-90	Bq/Kg	1550	1612.8	0.961	A
June, 2001	QAP 0103	Air Filter	Am-241	Bq/filter	0.478	0.486	0.984	A
			Co-60	Bq/filter	19.7	19.44	1.013	A
			Cs-134	Bq/filter	2.35	2.83	0.83	A
			Cs-137	Bq/filter	8.84	8.76	1.009	A
			Gross Alpha	Bq/filter	2.66	3.97	0.670	W
			Gross Beta	Bq/filter	2.06	2.58	0.798	W
			Mn-54	Bq/filter	6.77	6.52	1.038	A
			Pu-238	Bq/filter	0.229	0.215	1.065	A
			Pu-239	Bq/filter	0.14	0.136	1.029	A
			Sr-90	Bq/filter	6.5	7.1	0.915	A

TABLE 25 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio BWXT/EML	Evaluation (a)
June, 2001	QAP 0103	Air Filter	U-234	Bq/filter	0.055	0.046	1.198	A
			U-238	Bq/filter	0.06	0.046	1.3	W
June, 2001	QAP 0103	Soil	Ac-228	Bq/Kg	41.4	42.7	0.97	A
			Am-241	Bq/Kg	11.1	14.8	0.75	W
			Bi-212	Bq/Kg	33	42	0.786	A
			Bi-214	Bq/Kg	28.9	32.6	0.887	A
			Cs-137	Bq/Kg	1910	1740	1.098	A
			K-40	Bq/Kg	511	468	1.092	A
			Pb-212	Bq/Kg	49.6	41.5	1.195	A
			Pb-214	Bq/Kg	32.4	34.3	0.945	A
			Pu-239	Bq/Kg	21.3	25.6	0.832	W
			Th-234	Bq/kg	64.8	46.6	1.391	A
			U-234	Bq/kg	41.5	43.6	0.952	A
			U-238	Bq/kg	43.7	46.1	0.948	A
June, 2001	QAP 0103	Vegetation	Am-241	Bq/Kg	6.88	6.17	1.115	A
			Cm-244	Bq/Kg	3.26	3.69	0.883	A
			Co-60	Bq/Kg	36.7	30.4	1.207	A
			Cs-137	Bq/Kg	1030	842	1.223	A
			K-40	Bq/Kg	870	603	1.443	N (b)
			Pu-239	Bq/Kg	9.47	9.58	0.989	A
			Sr-90	Bq/Kg	1070	1330	0.805	A
June, 2001	QAP 0103	Water	Am-241	Bq/L	1.58	1.67	0.946	A
			Co-60	Bq/L	94.7	98.2	0.964	A
			Cs-137	Bq/L	68.1	73	0.933	A
			Gross Alpha	Bq/L	1970	1900	1.037	A
			Gross Beta	Bq/L	1310	1297	1.01	A
			H-3	Bq/L	98.5	79.3	1.242	A
			Pu-238	Bq/L	1.51	1.58	0.956	A

TABLE 25 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2001

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio BWXT/EML	Evaluation (a)
June, 2001	QAP 0103	Water	Pu-239	Bq/L	1.45	1.64	0.884	W
			Sr-90	Bq/L	3.48	4.4	0.791	W
			U-234	Bq/L	1.16	1.04	1.115	A
			U-238	Bq/L	1.2	1.04	1.154	A

Table 25 - Notes:

(a) Evaluation: A = Result Acceptable, W = Result Acceptable with Warning, N = Result Not Acceptable

(b) The status of the investigation of these proficiency results remains open and is being tracked within NEL Services Non-Conformance Program.

APPENDIX G

DATA REPORTING AND ANALYSIS

Environmental samples frequently contain very little, if any, radioactivity. Even when very sensitive, state-of-the-art counting equipment is used, many of the sample count rates can not be differentiated from the background count rate or the count rate of the blank sample. When this occurs, the sample is said to have a radioactivity level or concentration at or below the sensitivity of the analysis method. In this case, the analysis result is reported as less than a numerical value, which corresponds to the sensitivity of the analysis method. Sensitivities are influenced by parameters such as sample volume, background or blank sample count rate and efficiency of the counting device.

The terms used to describe the sensitivity are the lower limit of detection (LLD) and minimum detectable concentration (MDC). For this report, these two terms are considered to be synonymous. They are defined as:

$$\text{LLD (MDC)} = \frac{4.66\ Sb}{E * V * 2.22 * Y * \exp^{-(\lambda\ \Delta t)}}$$

Where:

Sb	=	the standard deviation of the background counting rate or the counting rate of a blank sample, as counts per minute,
E	=	the counting efficiency of the equipment, as counts per disintegration,
V	=	the volume or mass of the sample, such as L, g or m^3,
2.22	=	the number of disintegrations per minute per picocurie,
Y	=	the chemical yield, if applicable,
λ	=	the radioactive decay constant for the particular radionuclide and
Δt	=	the elapsed time between sample collection (or end of sample collection period) and counting.

The applicable LLD or MDC for each radionuclide and analysis is listed in Table 16. A large percentage of the 2001 sample results were reported as less than the LLD or MDC. Results which were reported as less than the LLD or MDC were not included in the calculations of averages, standard deviations and ranges (by station or group) in the text and tables of this report.

The data from samples that contained concentrations above the LLD or MDC were used in the calculations (averages, standard deviations and ranges) contained in this report. The individual results were generally reported to two significant figures. Each result also included a two-sigma counting uncertainty (95% confidence interval) to the same decimal place. At a minimum, a counting uncertainty equal to 10 percent of the measured concentration was reported. The counting uncertainties were not used in any statistical calculations in this report.

The data used in a few tables and all annual graphs were actual sample concentrations. The actual concentration is calculated by subtracting the background count rate or the count rate of a blank sample from the count rate of the sample. The net count rate is then converted to a net sample concentration which is either positive, negative or zero.

There are several advantages of using actual sample concentrations. Biases in the data (averages, ranges, etc.), such as those caused by averaging only sample concentrations above the MDC, are eliminated. Missing data points on graphs also are eliminated. It should be noted that negative sample concentrations are important to the overall averages and trends in the data, but they have no physical significance. A negative sample concentration simply means that the background or blank sample count rate is greater than the sample.

Quality control results (interlaboratory and intralaboratory) were not statistically analyzed with other data. Including quality control data would introduce a bias at selected stations while providing little additional interpretive information.

APPENDIX H

REMP SAMPLE COLLECTION AND ANALYSIS METHODS

TABLE 26

SNEC Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 2001

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Gr-Alpha	AP	Continuous weekly or biweekly air sampling through filter paper	1 filter (500-1000 Cubic Meters)	BWXT-TP-316 TBE - PRO-032-10	Low background gas flow proportional counting
Gr-Beta	AP	Continuous weekly or biweekly air sampling through filter paper	1 filter (500-1000 Cubic Meters)	BWXT-TP-316 TBE - PRO-032-10	Low background gas flow proportional counting
	GW	Quarterly grab sample	500 ml	BWXT-TP-316 TBE - PRO-032-1	Sample evaporated on stainless steel planchet for low background gas flow proportional counting
Gamma Spectroscopy	AP	Quarterly composite of filter paper collected weekly or biweekly.	6 to 15 filters (6,900 - 9,300 Cubic Meters)	E900-OPS-4524.33	Sample placed in counting container for gamma isotopic analysis
	BR	Annual grab sample	1 kg	E900-OPS-4524.33	Edible portion placed in counting container for gamma isotopic analysis. Only root vegetables and fruits washed prior to analysis.
	GW	Quarterly grab sample which are collected with a gas displacement gromon system or from a faucet.	1 liter	E900-OPS-4524.33 BWXT-TP-398 TBE - PRO-042-5	Sample decanted and liquid portion placed in counting container for gamma isotopic analysis. Potable samples are mixed (not decanted) prior to analysis

TABLE 26 (Continued)

SNEC Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 2001

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Gamma Spectroscopy (Cont'd)	SD	Quarterly grab sample	1 kg (if possible)	E900-OPS-4524.33 BWXT-TP-398 TBE - PRO-042-5	Dried and sieved sample placed in counting container for gamma isotopic analysis.
	SW	Quarterly grab samples	1 Liter	E900-OPS-4524.33 BWXT-TP-398 TBE - PRO-042-5	Sample placed in counting container for gamma isotopic analysis.
Tritium	GW	Quarterly grab sample	7-10 ml	E900-OPS-4524.46 TBE - PRO-052-2 & PRO-052-35 BWXT-TP-642	Sample is filtered, mixed with scintillation fluid for scintillation counting.
	SW	Quarterly grab samples	7-10 ml	E900-OPS-4524.46 TBE - PRO-052-2 & PRO-052-35 BWXT-TP-642	Sample is filtered, mixed with scintillation fluid for scintillation counting.
Gamma (Direct Radiation)	ID	Dosimeters exchanged quarterly	2 TLDs/8 Elements	6610-OPS-4243.01 (AmerGen)	Thermoluminescent dosimetry using optical heating of crystals and PM tube for light measurement.
Sr-89, Sr-90	GW	Quarterly grab sample	1 liter	BWXT-TP-692 TBE - PRO-032-128	

TABLE 26 (Continued)

SNEC Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 2001

NOTES

IDENTIFICATION KEY	APPROXIMATE SAMPLE SIZE COLLECTED PER STATION
AP = Air Particulate	1 Filter is approximately 500 cubic meters per week or biweekly
BR = Broad Leaf Vegetation	1 kg annually
GW = Ground Water	1 Gallon (if available) quarterly
ID = Immersion Dose (TLD)	2 TLDs / 8 elements quarterly
SD = Aquatic Sediment	1 kg semiannually
SW = Surface/Drinking Water	1 Gallon

APPENDIX I

TLD QUARTERLY DATA

TABLE 27

2001 TLD Quarterly Data
mR/Std Month ± 2σ

STATION	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
A1-5	5.9	5.3	7.0	5.9
B1-6	5.9	5.7	7.1	5.4
C1-9	5.4	4.7	6.6	5.3
C2-1	6.0	5.4	7.2	6.0
D1-4	5.7	5.3	7.1	5.5
D2-1	6.0	6.1	8.0	6.6
E1-7	5.6	5.4	6.9	5.8
E1-17	4.6	4.3	5.9	4.5
E2-1	6.4	7.4	9.0	7.9
E3-1	5.8	5.8	7.2	5.9
F1-2	6.4	6.4	8.3	6.6
G1-1	5.4	5.2	7.0	5.6
G1-2	5.9	5.8	7.6	6.6
G2-1	4.9	5.0	6.0	4.9
G10-2	5.7	5.6	7.0	5.9
H1-5	5.7	6.1	7.3	6.1
H2-1	6.0	6.0	7.5	6.2
H10-1	5.0	4.8	6.3	5.1
J1-1	5.1	5.1	6.6	5.4
K1-5	4.7	4.5	5.6	4.6
K1-8	5.5	5.0	6.8	5.9
L1-1	5.5	5.4	7.0	5.8
L2-1	5.3	5.2	6.8	5.6
M1-6	5.5	5.7	7.0	5.9
N1-4	5.4	5.3	6.8	5.9
P1-1	5.9	5.5	7.0	6.0
Q1-3	4.8	4.5	5.9	4.7
R1-1	6.1	5.4	6.9	5.6