GPU NUCLEAR

GPU Nuclear, Inc.
Three Mile Island
Nuclear Station
Route 441 South
Post Office Box 480
Middletown, PA 17057-0480
Tel 717-948-8461
717-948-8720

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Gentlemen:

Subject: Saxton Nuclear Experimental Corporation (SNEC)
Operating License No. DPR-4
Docket Nos. 50-146
2002 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 2002 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

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A009

2002 Radiological Environmental Monitoring Report

Saxton Nuclear Experimental Corporation

David Sarge
SNEC REMP Coordinator

William Stoner
SNEC Quality Assurance Officer

Art Paynter
SNEC Radiation Safety Officer

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ABBREVIATIONS

actinium	Ac
antimony	Sb
argon	Ar
barium	Ba
becquerel	Bq
beryllium	Be
carbon	C
cerium	Ce
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
lead	Pb
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 2002 for the Saxton Nuclear Experimental Corporation (SNEC) Facility. The environmental sample results indicated that SNEC operations had no adverse effect on either the environment or the health and safety of the public in 2002.

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), and applicable Federal and State regulations.

During 2002, 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:

- 304 samples were collected in 2002 from the aquatic, atmospheric and terrestrial environments around the SNEC Facility. In addition, 111 direct radiation exposure measurements were taken using thermoluminescent dosimeters (TLDs). The monitoring performed in 2002 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 1.72 to 4.13 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 70.2 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. No measurable radioactive liquid effluents were released outside the site boundary in 2002. Some low level H-3 was detected in gaseous effluent releases that occurred from SNEC, resulting in a calculated whole body dose of 1.73 E-4 Person-Rem. 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 did not have any adverse effects on the health and safety of the public or on the environment in 2002.

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. Sub-units 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. Cs-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:

- Late 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.
- Early 2002 - Total CV concrete removal commences.
- Late 2002 - CV concrete removal was completed.

The only remaining SNEC Facility structures include the CV steel liner, a small section of the Steam Plant Tunnel, and the Decommissioning Support Facility (DSF). Additional information can be obtained from the 2002 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 was subdivided into a Reactor Compartment/Storage Well, Primary Compartment, Auxiliary Compartment and an Operating

Floor. Concrete walls, floors, and ceilings separated these areas from each other. The below grade portion of the CV was 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.

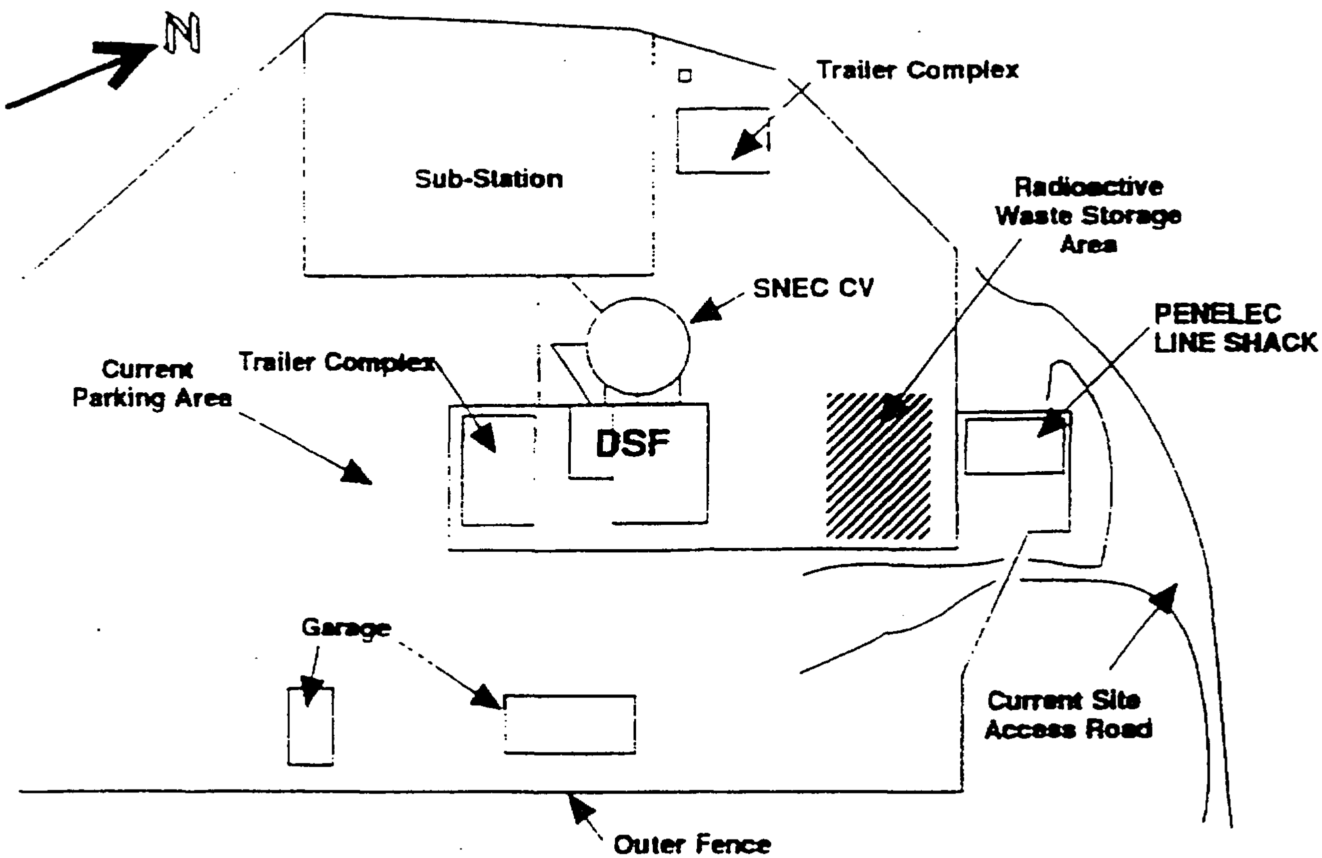
Approximately 34 miles downstream of the site, the Raystown Branch of the Juniata River is dammed, impounding the river to form Raystown Lake. The dam built by the US Army Corps of Engineers (COE) for flood control, recreation and water quality purposes was constructed from 1968 to 1973. At normal pool 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 2002 monitoring wells and potable water. Table 8 lists the gamma results from broad leaf vegetation. Table 9

lists the gamma and tritium results from surface water monitoring. Table 10 provides a summary of radionuclide concentrations detected in the aquatic sediment samples for 2002. 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.

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

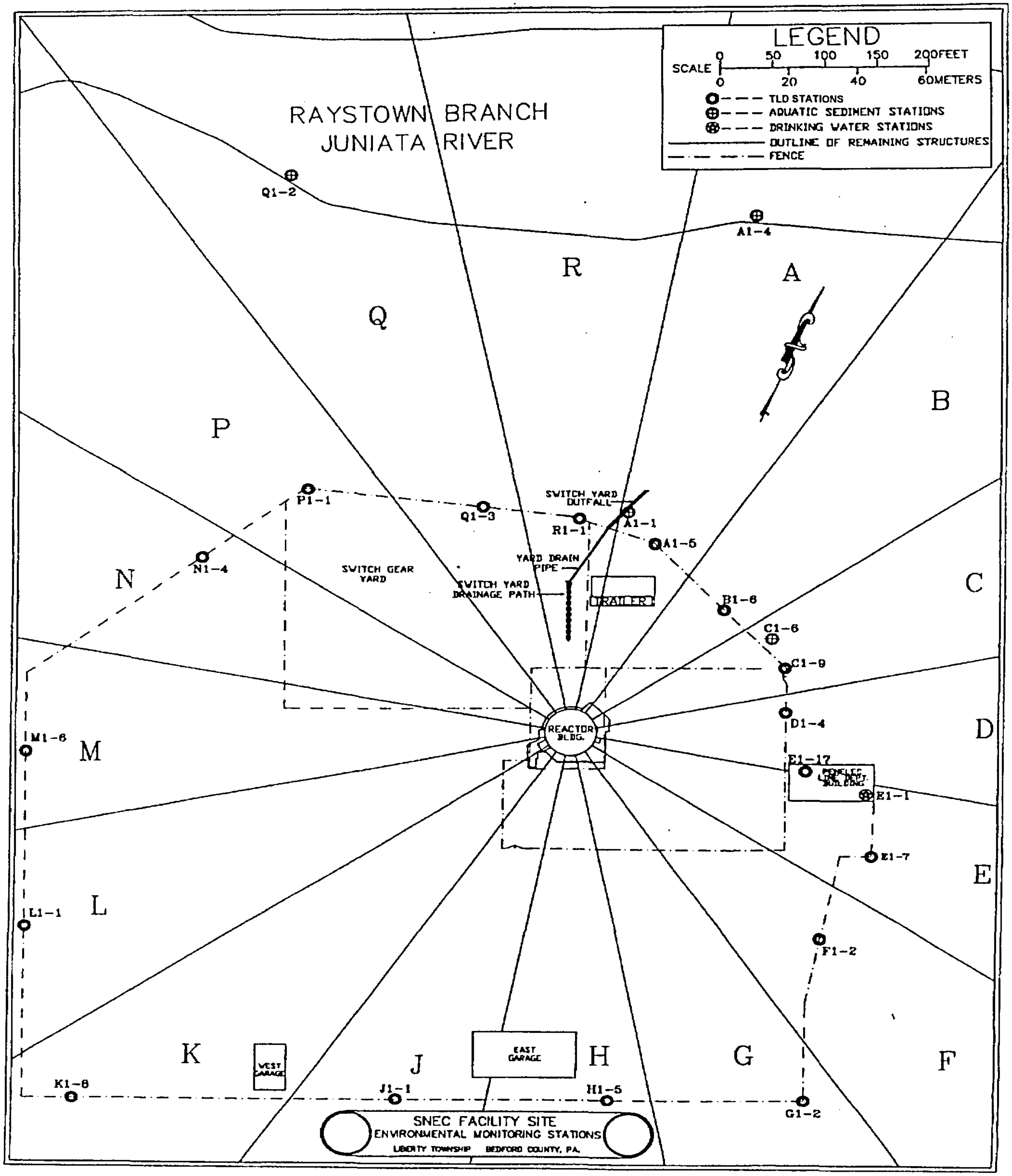
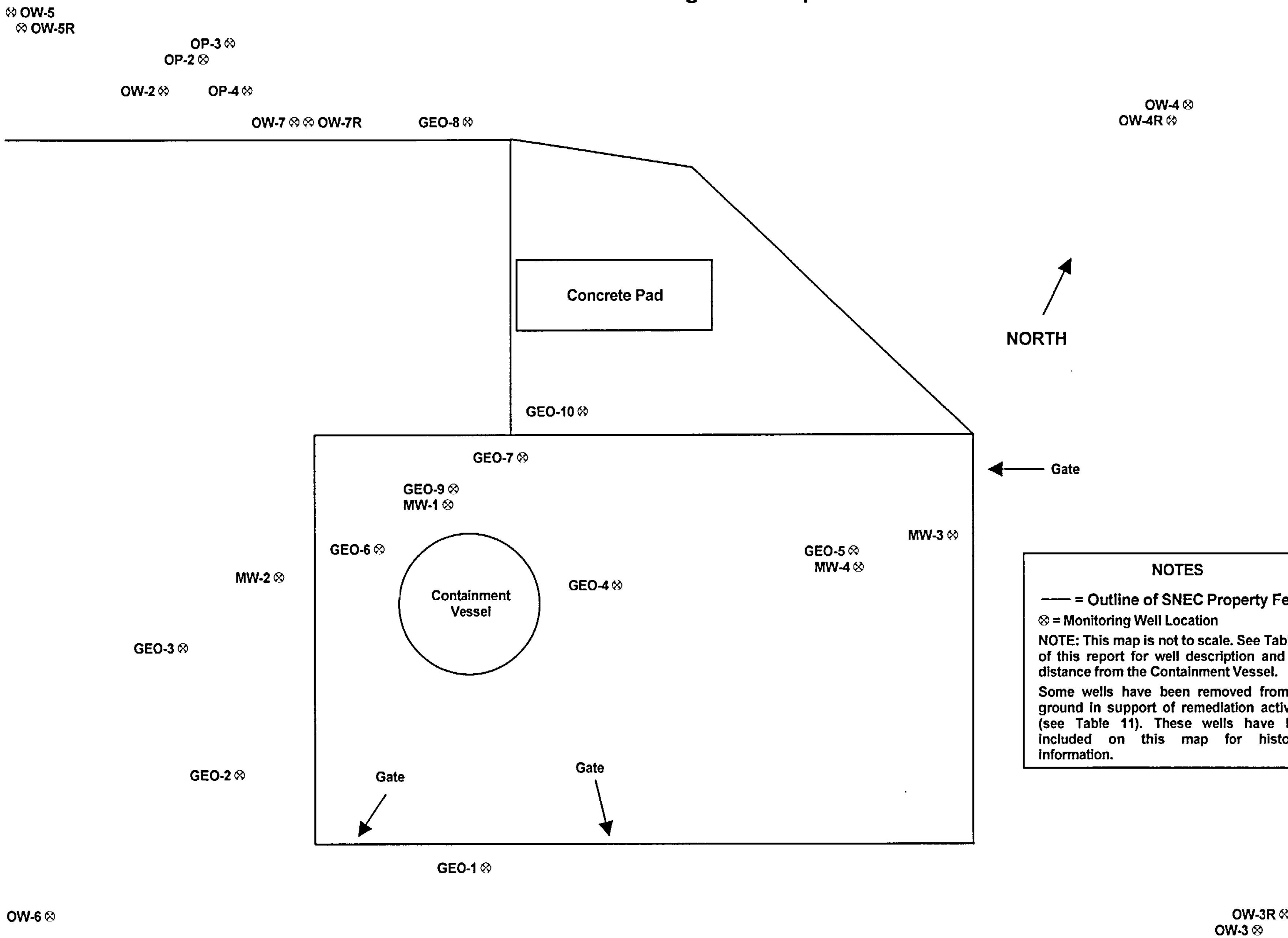


FIGURE 3
SNEC Monitoring Wells Map



NOTES

—— = Outline of SNEC Property Fence

⊗ = Monitoring Well Location

NOTE: This map is not to scale. See Table 11 of this report for well description and well distance from the Containment Vessel.

Some wells have been removed from the ground in support of remediation activities (see Table 11). These wells have been included on this map for historical information.

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 ten 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 2002 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 2002, the average annual exposure rate for offsite indicator stations was 5.85 mR/std month. Quarterly exposure rates ranged from 3.7 to 8.9 mR/std month. This equates to an annual exposure rate of 70.2 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 5.5 mR/std month. Quarterly exposure rates at the control stations ranged from 4.2 to 6.7 mR/std month. Table 2 depicts the average offsite indicator results with the average control results. In 2002, the TLD along the perimeter fence from Sector F showed the highest results due to the storage of radioactive materials proximal to the subject TLD station.

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

2002 SNEC TLD Summary

Field Cycle: January 22, 2002 to January 08, 2002

	MEAN (mR/std month)	MINIMUM (mR/std month)	MAXIMUM (mR/std month)
Average Offsite Indicator Stations	5.85	3.7	8.9
Average Control Stations	5.5	4.2	6.7

TABLE 3

Highest Site Boundary Exposure Comparison

7.2	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 2002.

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 Controls 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

203 air particulate samples (filters) were collected and analyzed for gross alpha and gross beta radioactivity during 2002. The particulate matter (dust particles) collected on a majority of the 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 0.0107 ± 0.0025 pCi/m^3 to 0.0386 ± 0.00356 pCi/m^3 and averaged 0.02 ± 0.00277 pCi/m^3. The air particulate samples collected from the control location had gross beta concentrations, which ranged from 0.00951 ± 0.00285 pCi/m^3 to 0.0342 ± 0.00337 pCi/m^3 and averaged 0.02 ± 0.0039 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 2002 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 0.00083 ± 0.00057 pCi/m^3 to 0.004 ± 0.0013 pCi/m^3 and averaged 0.00123 ± 0.0006 pCi/m^3. Control samples averaged 0.0013 ± 0.0006 pCi/m^3 and ranged from 0.000998 ± 0.000713 pCi/m^3 to 0.0039 ± 0.000923 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 2002 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 2002. 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

2002 Average Gross Beta Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average ± 2 std deviations*
A1-2 (I)	North Sector	0.02 ± 0.0028
D1-1 (I)	East Sector	0.021 ± 0.0028
J1-3 (I)	South Sector	0.021 ± 0.0027
G10-1 (C)	New Granada	0.02 ± 0.0039

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

TABLE 5

2002 Average Gross Alpha Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average ± 2 std deviations*
A1-2 (I)	North Sector	0.001 ± 0.000514
D1-1 (I)	East Sector	0.0012 ± 0.0006
J1-3 (I)	South Sector	0.0015 ± 0.0007
G10-1 (C)	New Granada	0.0013 ± 0.0006

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

GROUNDWATER MONITORING

Groundwater monitoring is conducted to check for potential radiological contamination leakage 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. 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 2002 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 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 2002. Low levels of beta activity was detected in both on-site and off-site samples in the range of 1.72 to 4.13 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 2002 are shown in Figure 3. Fifty-seven (57) groundwater samples were collected in 2002. 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 all tritium results from 2002 monitoring wells and potable water.

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
1/07/02	<298
4/01/02	<308
7/10/02	<336
10/11/02	<358

TABLE 7

2002 Tritium Results of Monitoring Wells and Potable Water (pCi/l)

Station Code	First Qtr 01/07/02	Second Qtr 04/01/02	Third Qtr 07/08/02	Fourth Qtr 10/08/02
GEO-1	<286	<342	<336	<348
GEO-2	①	①	①	①
GEO-3	<298	③	<336	<372
GEO-4	<286	<326	<336	<351
GEO-5	<298	<308	<336	<358
GEO-6	②	②	②	②
GEO-7	②	②	②	②
GEO-8	<331	<308	<357	③
GEO-9	②	②	②	②
GEO-10	<286	③	③	③
MW-1	②	②	②	②
MW-2	<286	<342	<336	<372
MW-3	<298	<342	<336	③
MW-4	<286	<308	<336	<358
OW-3	<331	<342	<336	<358
OW-3R	<286	<308	<336	<358
OW-4	③	③	③	③
OW-4R	<298	<308	<336	<358
OW-5	③	<342	<397	③
OW-5R	<331	<310	<336	<358
OW-6	<331	<308	<397	<358
OW-7	③	③	③	③
OW-7R	<286	<308	<397	<358
OP-3	③	③	③	③
OP-4	③	<342	③	③
E1-1 ④	<298	<342	<336	<372
G1-1 ④	<312	<342	<336	<372

NOTES:

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 Potable water station

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

2002 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)	7/30/02	<0.05	<0.04	<0.04
SX-BR-B1-7 (Sector B)	7/30/02	<0.055	<0.05	<0.065

SURFACE WATER MONITORING

The Juniata River surface water was monitored for radionuclides of potential SNEC origin. Three grab samples, two controls and one indicator, were collected on a quarterly basis and analyzed for gamma emitting radionuclides and tritium. The indicator sample (A1-4) was collected at the discharge bulkhead leading into the river. Q1-2 control sample was collected approximately 40 feet upstream of the Saxton Steam Generating Station Discharge Tunnel and H1-1 control sample was collected at the Warrior's Path State Park boat launch. 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 1/07/02	Second Qtr 4/01/02	Third Qtr 7/11/02	Fourth Qtr 10/15/02
A1-4 (I)	Cs-137 <10.4 Cs-134 <9.8 Co-60 <7.6 H-3 <324	Cs-137 <11.7 Cs-134 <9.0 Co-60 <10.7 H-3 <342	Cs-137 <9.5 Cs-134 <11.3 Co-60 <10.6 H-3 <336	Cs-137 <7.8 Cs-134 <7.7 Co-60 <8.1 H-3 <351
Q1-2 (C)	Cs-137 <11.5 Cs-134 <12.1 Co-60 <11.7 H-3 <324	Cs-137 <9.4 Cs-134 <9.4 Co-60 <9.4 H-3 <342	Cs-137 <10.6 Cs-134 <9.8 Co-60 <10.2 H-3 <336	Cs-137 <6.9 Cs-134 <6.6 Co-60 <7.7 H-3 <351
H1-1 (C)	Cs-137 <11.6 Cs-134 <11.4 Co-60 <12.7 H-3 <324	Cs-137 <9.2 Cs-134 <8.9 Co-60 <9.2 H-3 <342	Cs-137 <11.4 Cs-134 <12.2 Co-60 <11.5 H-3 <336	Cs-137 <13.2 Cs-134 <12.5 Co-60 <14.9 H-3 <372

(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, quarterly sediment samples were taken directly from the Juniata River at the discharge bulkhead (A1-4). Q1-2 control sample was collected approximately 40 feet upstream of the Saxton Steam Generating Station Discharge Tunnel and H1-1 control sample was collected at the Warrior's Path State Park boat launch.

All samples were dried and then analyzed for gamma emitting radioisotopes. Low concentrations of Cs-137 were detected in onsite and offsite sediment samples. The average control sample activity was 0.08 pCi/g. The average discharge bulkhead sample activity was 0.18 pCi/g. The average onsite storm drain activity was 0.79 pCi/g. Cs-137 is readily adsorbed by suspended particles and is concentrated in site storm drains.

TABLE 10

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

Sample Designation	First Qtr 1/07/02	Second Qtr 4/01/02	Third Qtr 7/11/02	Fourth Qtr 10/15/02
A1-1 (I)	Cs-137 1.3 Cs-134 <0.11 Co-60 <0.09	Cs-137 1.12 Cs-134 <0.05 Co-60 <0.05	Cs-137 1.13 Cs-134 <0.09 Co-60 <0.07	Cs-137 0.94 Cs-134 <0.07 Co-60 <0.06
C1-6 (I)	Cs-137 0.89 Cs-134 <0.06 Co-60 <0.04	Cs-137 0.29 Cs-134 <0.09 Co-60 <0.08	Cs-137 0.5 Cs-134 <0.08 Co-60 <0.06	Cs-137 0.15 Cs-134 <0.06 Co-60 <0.05
A1-4 (I)	Cs-137 0.23 Cs-134 <0.07 Co-60 <0.06	Cs-137 0.33 Cs-134 <0.07 Co-60 <0.06	Cs-137 0.09 Cs-134 <0.05 Co-60 <0.05	Cs-137 0.08 Cs-134 <0.07 Co-60 <0.06
Q1-2 (C)	Cs-137 <0.07 Cs-134 <0.06 Co-60 <0.06	Cs-137 <0.1 Cs-134 <0.1 Co-60 <0.08	Cs-137 0.1 Cs-134 <0.07 Co-60 <0.06	Cs-137 <0.06 Cs-134 <0.08 Co-60 <0.06
H1-1 (C)	Cs-137 0.1 Cs-134 <0.08 Co-60 <0.08	Cs-137 <0.1 Cs-134 <0.09 Co-60 <0.09	Cs-137 0.05 Cs-134 <0.05 Co-60 <0.05	Cs-137 0.08 Cs-134 <0.07 Co-60 <0.06
(I) = Indicator Station	(C) = Control Station			

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APPENDIX A

REMP Sampling Locations & Descriptions, Synopsis of REMP, & 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	
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	Yearly sample during growing season
C1-6	Sediment	Drain Outfall, NE Corner Of Perimeter Fence	
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	Offsite Control Station
G10-2	TLD	New Granada	Offsite Control Station
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 2002 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
Air Particulate	4	Weekly or Biweekly	203	Gross Beta	Weekly/Biweekly	203
				Gross Alpha	Weekly/Biweekly	
				Gamma	Quarterly	16
Aquatic Sediment	5	Quarterly	20	Gamma	Quarterly	20
Broad Leaf Vegetation	2	Annually	4	Gamma	Annually	2
Groundwater	20	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) (2)	28	Quarterly	666	Immersion Dose	Quarterly	666 (3)
Surface Water	3	Quarterly	12	Gamma	Quarterly	12
				H-3	Quarterly	

NOTES:

(1) This table represents results from the primary (base) program. It does not include quality control (QC) samples.
(2) For the purposes of this table, a dosimeter is considered to be a phosphor element.
(3) The total number of samples or elements (TLDs) used for data analysis.

TABLE 13

Sampling and Analysis Exceptions 2002*

Period of Deviation	Description of Deviation and Corrective Action (as applicable)
Third Quarter	Stations A1-6 and B1-7 (broadleaf vegetation samples) dried out before the analyses were performed. SNEC Procedure E900-PLN-4542.08, "SNEC Facility Offsite Dose Calculation Manual" requires that REMP vegetation samples be analyzed wet (fresh). The Quality Assurance Officer (QAO) determined that the samples were invalid. New samples were obtained and analyzed successfully. See Sample Deviation Reports SDR-02-011 and SDR-02-012 in the June 30, 2002 through December 31, 2002 SNEC Count Room QA Report.
Second Quarter	The TLDs at TLD Station D2-1 were found on the ground.
Third Quarter	The TLDs at TLD Station H2-1 were found missing. No sample was obtained for this quarter.
Second Quarter	No sample was obtained at GEO-3 because well was dry.
Second, Third & Fourth Quarters	No sample was obtained at GEO-10 because well was dry.
Fourth Quarter	No sample was obtained at MW-3 because well was dry.
First, Second, Third, & Fourth Quarters	No sample was obtained at OW-4 because well was dry.
First & Fourth Quarters	No sample was obtained at OW-5 because well was dry.
First, Second, Third, & Fourth Quarters	No sample was obtained at OW-7 because well was dry.
First, Second, Third, & Fourth Quarters	No sample was obtained at OP-3 because well was dry.
First, Third, & Fourth Quarters	No sample was obtained at OP-4 because well was dry.

* 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 2002

All 2002 REMP sample analytical results met the LLD requirements specified in SNEC procedure E900-ADM-4500.22, "Environmental Monitoring" (Reference 16).

APPENDIX C

REMP CHANGES

TABLE 15

2002 REMP Changes

Date of Change	Description of Changes to Procedures Affecting REMP
4/04/02	Procedure E900-ADM-4500.22 (Environmental Monitoring) Added requirements to track REMP samples in accordance with the SNEC Chain of Custody Program (procedure E900-ADM-4500.39). Added instructions for completion of a REMP Field Sample Collection Sheet and a REMP TLD Collection/Receipt Sheet. These sheets were added to assist in sample and TLD tracking.
4/08/02	Procedure E900-ADM-4500.39 (Chain of Custody for Samples) Added requirements to track REMP samples in accordance this procedure.
2/20/02	Procedure E900-OPS-4524.33 (Operation of the SNEC Gamma Spectroscopy System Added a requirement to re-verify sample weights with a balance immediately before sample analysis. Added a requirement to perform sample processing in accordance with SNEC procedure E900-IMP-4520.02, "Preparation of Sample Materials for Analysis".

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 2002.

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" (Reference 16). 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 2002.

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.

Three SNEC Facility Cross-check Program sample non-agreements were identified in 2002. They involved:

- One soil Cs-137 sample analysis result from SNEC (1051.17 ± 55.1 Bq/Kg) did not agree with the DOE/EML result of 1326.67 ± 66.51 Bq/Kg.
- One vegetation Co-60 sample analysis result from SNEC (8.52 ± 0.92 Bq/Kg) did not agree with the DOE/EML result of 11.23 ± 0.677 Bq/Kg.
- One water Cs-134 sample analysis result from SNEC (2.54 ± 0.55 Bq/L) did not agree with the DOE/EML result of 3.357 ± 0.2 Bq/L.

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. 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 2002 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 were three interlaboratory non-agreements during 2002. A description of each sample non-agreement is listed below:

- First quarter Station E1-1 (Penelec Line Shack domestic water) failed replicate analysis for gross beta activity. This sample was split at SNEC and sent to two vendor laboratories, Teledyne and BWXT. The Teledyne sample showed an unusually high activity compared to the BWXT analysis result and previous REMP sample data. SNEC requested that Teledyne re-analyze the sample. The re-analysis result was determined to be in agreement with BWXT results when the replicate analysis calculation was performed. The investigation

concluded that the initial sample may have been cross-contaminated during analysis at Teledyne. The results of the investigation were documented in Sample Deviation Report SDR-02-007 and can be found in the January 1, 2002 through June 30, 2002 SNEC Count Room QA Report.

- Particulate air sample SX-AP-D1-1, which was collected from the open field ENE sector on 10/17/02, failed replicate analysis for gross alpha. This sample was split at SNEC and sent to two vendor laboratories, Teledyne and BWXT. The investigation concluded that although the analysis results did not agree when a replicate analysis calculation was performed, the results were not statistically different when the 2-sigma counting uncertainty was applied and results were reevaluated. Each result was well below the REMP reporting level. The higher or more conservative result was used for the record data.

- Particulate air sample SX-AP-J1-3, which was collected from the Penelec area SE sector on 10/17/02, failed replicate analysis for gross alpha. This sample was split at SNEC and sent to two vendor laboratories, Teledyne and BWXT. The investigation concluded that although the analysis results did not agree when a replicate analysis calculation was performed, the results were not statistically different when the 2-sigma counting uncertainty was applied and results were reevaluated. Each result was well below the REMP reporting level. The higher or more conservative result was used for the record data.

APPENDIX F

CROSS-CHECK PROGRAM RESULTS

2002 SNEC RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

TABLE 17

SNEC FACILITY AND DOE/EML CROSS-CHECK PROGRAM RESULTS (QAP 0203) JUNE 2002

Sample ID (a)	Radionuclide	Repetition (b)	Reported Value (c)	Reported Error (d)	EML Value (e)	EML Error (d)	Reported/EML (f)	Evaluation (g)
				Air (Bq/filter)				
0203AISX	Co-60	1	30.07	1.16	30.52	0.652	0.985	A
0203AISX	Co-60	2	30.29	1.16	30.52	0.652	0.992	A
0203AISX	Cs-137	1	28.28	1.61	28.23	0.701	1.002	A
0203AISX	Cs-137	2	28.39	1.62	28.23	0.701	1.006	A
0203AISX	Mn-54	1	36.94	5.77	38.53	0.867	0.959	A
0203AISX	Mn-54	2	37.04	5.79	38.53	0.867	0.961	A
				Soil (Bq/Kg)				
0203SOSX	Cs-137	1	1051.17	55.1	1326.67	66.51	0.792	N (h)
0203SOSX	Cs-137	2	1081.14	55.5	1326.67	66.51	0.815	W
0203SOSX	K-40	1	499.13	30.32	621.67	33.86	0.803	W
0203SOSX	K-40	2	515.04	33.19	621.67	33.86	0.828	W
				Vegetation (Bq/Kg)				
0203VESX	Co-60	1	8.52	0.92	11.23	0.677	0.759	N (h)
0203VESX	Co-60	2	9.74	0.8	11.23	0.677	0.867	W
0203VESX	Cs-137	1	283.66	15.29	313.667	15.91	0.904	A
0203VESX	Cs-137	2	284.43	15.1	313.667	15.91	0.907	A
0203VESX	K-40	1	799.57	49.25	864.33	47.22	0.925	A
0203VESX	K-40	2	745.55	55.4	864.33	47.22	0.863	W
				Water (Bq/L)				
0203WASX	Co-60	1	390.04	15.08	347.33	12.4	1.123	W
0203WASX	Co-60	2	337.88	13.09	347.33	12.4	0.973	A
0203WASX	Cs-134	1	2.54	0.55	3.357	0.2	0.757	N (i)
0203WASX	Cs-134	2	3.45	0.4	3.357	0.2	1.028	A
0203WASX	Cs-137	1	56.03	3.1	56.067	2.929	0.999	A
0203WASX	Cs-137	2	61.72	3.41	56.067	2.929	1.101	A
0203WASX	H-3	1	307.36	13.1	283.7	3.38	1.083	A
0203WASX	H-3	2	321.86	13.52	283.7	3.38	1.135	A

TABLE 17 - NOTES

(a) Sample ID - Sample Identification Number assigned by EML

(b) Repetition - Two analyses were reported by SNEC for each radionuclide.

(c) Reported Value - SNEC reported analysis value in Bq/filter, Bq/Kg, or Bq/L as listed for each sample media

(d) Reported and EML Error - Reported and EML Value 1 sigma uncertainty

(e) EML Value - EML Value is the mean of replicate determinations for each nuclide in Bq/filter, Bq/Kg, or Bq/L as listed for each sample media

(f) Reported/EML - Reported Value (c) divided by the EML Value (e)

(g) Evaluation - 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 15^{th} and 85^{th} 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 5^{th} and 15^{th} percentile and between the 85^{th} and 95^{th} percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5^{th} - 15^{th} (10%) and 85^{th} - 95^{th} percentiles (10%) are in the warning area. The not acceptable criteria "N", is established at less than the 5^{th} percentile and greater than the 95^{th} percentile, that is, the outer 10% of the historical data. A = Acceptable, W = Acceptable with Warning, N = Not Acceptable.

(h) The height of sample material was compared to the source that was used for calibration of the Gamma Spectroscopy System in that geometry. A difference was noted between the height of the source (3.1 cm) and the sample materials (3.6 to 3.8 cm). Testing was conducted which examined the effect of sample height on activity. This testing established that the cause of the problem was analyzing samples in a geometry that did not conform to the calibration geometry. The height of sample material was found to be more critical to analysis results than was previously evaluated. The sample was reanalyzed using the appropriate calibration geometry, which produced results that would have been in the DOE/EML "ACCEPTABLE" range. All SNEC samples that may have been affected by this deficiency were re-analyzed. Since REMP samples require use of the 1-liter sample geometry, REMP analytical data was not impacted. Investigation results have been documented in Sample Deviation Reports SDR-02-008, SDR-02-010, and Corrective Action Program Form (CAP S2002-036).

(i) The sample was inspected in its original counting geometry, a 1-liter marinelli. The sample container was appropriately filled to the required level. A second comparison was performed using the 2 sigma counting uncertainties for each analysis. The SNEC value ranged from 1.44 to 3.64 Bq/L and the EML value ranged from 2.96 to 3.76 Bq/L. It was obvious that the concentrations with their associated counting uncertainties overlap. Therefore, the sample results are not statistically different. A third comparison was performed by using SNEC's Replicate Analysis Calculation program (USNRC Inspection Procedure 84750 "Radioactive Waste Treatment, and Effluent and Environmental Monitoring" with minor adjustments to account for activity concentrations with large uncertainties). Both sample results were determined to be in agreement. Investigation results have been documented in SDR-02-009.

TABLE 18

SNEC FACILITY AND DOE/EML CROSS-CHECK PROGRAM RESULTS (QAP 0209) DECEMBER 2002

Sample ID (a)	Radionuclide	Repetition (b)	Reported Value (c)	Reported Error (d)	EML Value (e)	EML Error (d)	Reported/EML (f)	Evaluation (g)
Air (Bq/filter)								
0209AISX	54Mn	1	45.58	2.57	52.2	1.17	0.873	W
0209AISX	60Co	1	19.92	0.68	23.0	0.0592	0.866	W
0209AISX	137Cs	1	28.85	1.61	32.5	0.777	0.888	A
Soil (Bq/Kg)								
0209SOSX	40K	1	620.12	30.25	637.67	34.26	0.972	A
0209SOSX	137Cs	1	784.4	41.26	829.33	41.58	0.946	A
Vegetation (Bq/Kg)								
0209VESX	40K	1	1494.25	73.08	1480.0	77.8	1.010	A
0209VESX	60Co	1	9.45	0.74	9.66	0.63	0.978	A
0209VESX	137Cs	1	309.51	16.4	300.67	15.25	1.029	A
Water (Bq/L)								
0209WASX	3H	1	251.74	12.35	227.3	5.6152	1.108	A
0209WASX	60Co	1	265.42	8.88	268.67	9.71	0.988	A
0209WASX	137Cs	1	82.14	4.51	81.43	4.28	1.009	A

TABLE 18 - NOTES

(a) Sample ID - Sample Identification Number assigned by EML

(b) Repetition - Only one analysis was reported by SNEC for each radionuclide.

(c) Reported Value - SNEC reported analysis value in Bq/filter, Bq/Kg, or Bq/L as listed for each sample media

(d) Reported and EML Error - Reported and EML Value 1 sigma uncertainty

(e) EML Value - EML Value is the mean of replicate determinations for each nuclide in Bq/filter, Bq/Kg, or Bq/L as listed for each sample media

(f) Reported/EML - Reported Value (c) divided by the EML Value (e)

(g) Evaluation - 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 15^{th} and 85^{th} 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 5^{th} and 15^{th} percentile and between the 85^{th} and 95^{th} percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5^{th} - 15^{th} (10%) and 85^{th} - 95^{th} percentiles (10%) are in the warning area. The not acceptable criteria "N", is established at less than the 5^{th} percentile and greater than the 95^{th} percentile, that is, the outer 10% of the historical data. A = Acceptable, W = Acceptable with Warning, N = Not Acceptable.

TABLE 19

SNEC FACILITY AND MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP) CROSS-CHECK PROGRAM RESULTS FOR 2002

Sample ID [(a)]	Matrix	Radionuclide	Units	Reported Value [(b)]	Reported Error [(c)]	Acceptance Range [(d)]	Bias % [(e)]	Evaluation [(f)]
MAPEP-01-W9	Water	Cs-134	Bq/L	24.81	0.85	19.95 - 37.05	-12.9	A
		Cs-137	Bq/L	264.52	16.38	200.2 - 371.8	-7.5	A
		Co-57	Bq/L	140.42	5.62	100.1 - 185.9	-1.8	A
		Co-60	Bq/L	138.08	5.36	98.7 - 183.3	-2.1	A
		Mn-54	Bq/L	244.75	15.38	172.2 - 319.8	-0.5	A
		Zn-65	Bq/L	71	4.12	47.11 - 87.49	5.5	A
MAPEP-02-S9	Soil	Cs-134	Bq/Kg	663.5	16.43	603.4 - 1120.6	-23	W
		Cs-137	Bq/Kg	100.88	5.46	77.7 - 144.3	-9.1	A
		Co-57	Bq/Kg	216.55	9.88	172.2 - 319.8	-12	A
		Co-60	Bq/Kg	88.95	2.95	61.25 - 113.75	1.7	A
		Mn-54	Bq/Kg	527.52	28.31	382.2 - 709.8	-3.4	A
		K-40	Bq/Kg	600.51	29.31	456.4 - 847.6	-7.9	A

TABLE 19 - NOTES

(a) Sample ID - Sample Identification Number assigned by MAPEP

(b) Reported Value - SNEC reported analysis value

(c) Reported Error - Reported Value 1 sigma uncertainty

(d) Acceptance Range - MAPEP analysis acceptance range

(e) Bias % - Reported Value percent difference from the MAPEP Acceptance Range mean

(f) Evaluation - A = Result Acceptable (Bias $\leq$ 20%), W = Result Acceptable with Warning (Bias > 20% but $\leq$ 30%), N = Result Not Acceptable (Bias $\geq$ 30%)

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TABLE 20

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation [a]
February, 2002	A14942-148	Liquid	Gross Alpha	uCi/ml	0.0019	0.00157	1.21	A
March, 2002	E3064-396	Milk	Sr-89	pCi/L	80	83	0.96	A
			Sr-90	pCi/L	28	27	1.04	A
	E3065-396	Milk	I-131	pCi/L	86	92	0.93	A
			Ce-141	pCi/L	300	326	0.92	A
			Cr-51	pCi/L	256	267	0.96	A
			Cs-134	pCi/L	94	122	0.77	W
			Cs-137	pCi/L	252	266	0.95	A
			Mn-54	pCi/L	217	224	0.97	A
			Fe-59	pCi/L	108	116	0.93	A
			Zn-65	pCi/L	218	221	0.99	A
			Co-60	pCi/L	147	158	0.93	A
	E3067-396	Air Particulate	I-131	pCi	202	199	1.02	A
			Cr-51	pCi	166	163	1.02	A
			Cs-134	pCi	77	74	1.04	A
			Cs-137	pCi	162	162	1.00	A
			Mn-54	pCi	135	136	0.99	A
			Fe-59	pCi	70	70	1.00	A
			Zn-65	pCi	128	134	0.96	A
			Co-60	pCi	95	96	0.99	A
			Fe-55	pCi	106	104	1.02	A
	E3066-396	Charcoal	I-131	pCi	66	77	0.86	A
June, 2002	E3220-396	Milk	I-131	pCi/L	86	87	0.99	A
			Ce-141	pCi/L	84	90	0.93	A
			Cr-51	pCi/L	197	235	0.84	A
			Cs-134	pCi/L	110	120	0.92	A
			Cs-137	pCi/L	96	91	1.05	A

TABLE 20 (Continued)

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation [a]
June, 2002	E3220-396	Milk	Co-58	pCi/L	95	100	0.95	A
			Mn-54	pCi/L	106	95	1.12	A
			Fe-59	pCi/L	95	81	1.17	A
			Zn-65	pCi/L	186	180	1.03	A
			Co-60	pCi/L	132	125	1.06	A
June, 2002	E3222-396	Air Particulate	Ce-141	pCi	85	75	1.13	A
			Cr-51	pCi	199	196	1.02	A
			Cs-134	pCi	96	100	0.96	A
			Cs-137	pCi	92	76	1.21	W
			Co-58	pCi	98	83	1.18	A
			Mn-54	pCi	87	79	1.10	A
			Fe-59	pCi	85	67	1.27	W
			Zn-65	pCi	182	150	1.21	W
			Co-60	pCi	121	104	1.16	A
			Fe-55	pCi	111	115	0.97	A
September, 2002	A15989-148	Liquid	Gross Alpha	uCi/ml	0.000213	0.000199	1.07	A
			Sr-89	uCi/ml	0.00402	0.00499	0.81	A
			Sr-90	uCi/ml	0.000249	0.000264	0.94	A
	E3324-396	Milk	Sr-89	pCi/L	106	92	1.15	A
			Sr-90	pCi/L	39	39	1.00	A
	E3325-396	Milk	I-131	pCi/L	105	80	1.31	A
			Ce-141	pCi/L	168	160	1.05	A
			Cr-51	pCi/L	210.5	227	0.93	A
			Cs-134	pCi/L	127	132	0.96	A
			Cs-137	pCi/L	136	127	1.07	A
			Co-58	pCi/L	93	97	0.96	A
			Mn-54	pCi/L	165	152	1.09	A
			Fe-59	pCi/L	90	89	1.01	A

TABLE 20 (Continued)

Teledyne Brown Engineering Environmental Services & Analytics Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/Analytics	Evaluation [a]
September, 2002	E3325-396	Milk	Zn-65	pCi/L	196	187	1.05	A
			Co-60	pCi/L	147	149	0.99	A
	E3327-396	Filter	Ce-141	pCi	115	110	1.05	A
			Cr-51	pCi	163.6	156	1.05	A
			Cs-134	pCi	79	90	0.88	A
			Cs-137	pCi	95	87	1.09	A
			Co-58	pCi	71	67	1.06	A
			Mn-54	pCi	118	104	1.13	A
			Fe-59	pCi	76	61	1.25	A
			Zn-65	pCi	155	130	1.19	A
			Co-60	pCi	108	102	1.06	A
			Fe-55	pCi	91	108	0.84	A
	E3326-396	Charcoal	I-131	pCi	73	85	0.86	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 2002

Month/Year	Sample ID	Matrix	Nuclide	Units [c]	Reported Value	Known Value [b]	Evaluation [a]
June, 2002	QAP 203	Air Filter	Am-241	Bq/filter	0.078	0.088	A
			Co-60	Bq/filter	31.7	30.52	A
			Cs-137	Bq/filter	30.4	28.23	A
			Gross Alpha	Bq/filter	0.545	0.534	A
			Gross Beta	Bq/filter	1.21	1.3	A
			Mn-54	Bq/filter	38.3	38.53	A
			Pu-238	Bq/filter	0.062	0.057	A
			Pu-239	Bq/filter	0.187	0.187	A
			Sr-90	Bq/filter	4.68	4.832	A
			U-234	Bq/filter	0.299	0.297	A
			U-238	Bq/filter	0.339	0.298	A
June, 2002	QAP 203	Soil	Ac-228	Bq/kg	50	51.167	A
			Am-241	Bq/kg	11.3	10.927	A
			Bi-212	Bq/kg	35.9	53.430	A
			Bi-214	Bq/kg	46.3	53.933	W
			Cs-137	Bq/kg	1300	1326.67	A
			K-40	Bq/kg	608	621.67	A
			Pb-212	Bq/kg	49.4	51.1	A
			Pb-214	Bq/kg	49.1	54.367	A
			Pu-239	Bq/kg	25.9	19.098	N (i)
			Sr-90	Bq/kg	46.6	53.756	A
			Th-234	Bq/kg	90.1	89.3	A
			U-234	Bq/kg	90.5	93.885	A
			U-238	Bq/kg	102	96.778	A
June, 2002	QAP 203	Vegetation	Am-241	Bq/kg	2.73	2.228	A
			Cm-244	Bq/kg	2.43	1.32	N (j)
			Co-60	Bq/kg	11.7	11.23	A
			Cs-137	Bq/kg	346	313.667	A

TABLE 21 (Continued)

Teledyne Brown Engineering Environmental Services & DOE/EML Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units [c]	Reported Value	Known Value [b]	Evaluation [a]
June, 2002	QAP 203	Vegetation	K-40	Bq/kg	952	864.33	A
			Pu-239	Bq/kg	3.62	3.543	A
			Sr-90	Bq/kg	477	586.28	A
June, 2002	QAP 203	Water	Am-241	Bq/L	1.44	1.474	A
			Co-60	Bq/L	367	347.33	A
			Cs-134	Bq/L	2.93	3.357	W
			Cs-137	Bq/L	59.6	56.067	A
			Gross Alpha	Bq/L	427	375	W
			Gross Beta	Bq/L	895	1030	A
			H-3	Bq/L	285	283.7	A
			Pu-238	Bq/L	0.54	0.49	W
			Pu-239	Bq/L	4.73	4.219	W
			Sr-90	Bq/L	5.78	7.579	W
			U-234	Bq/L	1.3	1.402	A
			U-238	Bq/L	1.29	1.381	A
December, 2002	QAP 209	Air Filter	Am-241	Bq/filter	0.171	0.191	A
			Co-60	Bq/filter	24.1	23	A
			Cs-137	Bq/filter	36.1	32.5	A
			Gross Alpha	Bq/filter	0.412	0.287	N (f)
			Gross Beta	Bq/filter	0.82	0.871	A
			Mn-54	Bq/filter	58.3	52.2	A
			Pu-238	Bq/filter	0.114	0.119	A
			Pu-239	Bq/filter	0.239	0.206	W
			Sr-90	Bq/filter	5.86	5.561	A
			U	Bq/filter	16	18.59	W
			U-234	Bq/filter	0.22	0.228	A
			U-238	Bq/filter	0.194	0.23	W

TABLE 21 (Continued)

Teledyne Brown Engineering Environmental Services & DOE/EML Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units (c)	Reported Value	Known Value (b)	Evaluation (a)
December, 2002	QAP 209	Soil	Am-241	Bq/kg	6.93	6.767	A
			Bi-212	Bq/kg	23.2	45.93	W
			Bi-214	Bq/kg	21.3	33.63	N (g)
			Cs-137	Bq/kg	835	829.33	A
			K-40	Bq/kg	671	637.67	A
			Pb-212	Bq/kg	42	43.43	A
			Pb-214	Bq/kg	2.6	35.2	N (h)
			Pu-239	Bq/kg	15.4	12.903	W
			Sr-90	Bq/kg	41	41.16	A
			Th-234	Bq/kg	60	48.4	A
December, 2002	QAP 209	Vegetation	Am-241	Bq/kg	2.08	2.253	A
			Cm-244	Bq/kg	0.87	1.247	W
			Co-60	Bq/kg	11.5	9.66	A
			Cs-137	Bq/kg	345	300.67	A
			K-40	Bq/kg	1690	1480	A
			Pu-239	Bq/kg	3.74	3.427	A
			Sr-90	Bq/kg	457	476.26	A
December, 2002	QAP 209	Water	Am-241	Bq/L	2.89	3.043	A
			Co-60	Bq/L	303	268.67	W
			Cs-134	Bq/L	59	60.2	A
			Cs-137	Bq/L	85.8	81.43	A
			Gross Beta	Bq/L	817	900	A
			H-3	Bq/L	353	227.3	W
			Pu-239	Bq/L	2.3	2.07	W
			Sr-90	Bq/L	8.58	8.69	A
			U	Bq/L	0.255	0.273	A
			U-238	Bq/L	3.280	3.37	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.

(f) The air filter for gross alpha analysis was not performed as prescribed by the instructions accompanying the sample. Specifically, a Styrofoam blank disk was not employed in the blank analysis, and the radionuclide used for the efficiency calibration was Am-241 and not Th-230 as suggested.

(g) The sample was re-analyzed to determine a possible cause for disagreement with the Bi-214 result. The sample was placed on the gamma counter with no additional preparation, and was determined to have been in agreement. It was determined that daughter products in the sample were not in a steady state. To mitigate recurrence of this problem, the sample will be allowed to set two weeks after being placed in the sample container, prior to counting to ensure all radon in-growth.

(h) Upon review of the final report and the raw data, it was determined that a typographical error was made on the website entry. The TBE result for Pb-214 was 26.0, which is in agreement. However, 2.60 was the TBE result provided in the EML final report.

(i) When the error terms for both results were considered, it was determined that these terms overlapped, and were therefore statistically equivalent values.

(j) The biased high result was apparently due to matrix interference from the vegetation. The laboratory's database was researched and it was discovered that Teledyne does not supply this analysis for any of the current customers for vegetation samples. Therefore, there is no negative impact on any client's results. Teledyne has elected to discontinue reporting a curium value to EML for this matrix until justified by customer needs.

TABLE 22

Teledyne Brown Engineering Environmental Services & ERA Cross-check Program Results for 2002

Month/Year	Sample ID	Matrix	Nuclide	Units	Reported Value	Known Value	Ratio TBE/ERA	Evaluation (a)
May, 2002	Rad 49	Water	Ra-226	pCi/L	4.5	6.07	0.74	W
			Gross Alpha	pCi/L	19.1	22.8	0.84	A
			Gross Beta	pCi/L	162	189	0.86	A
			Co-60	pCi/L	39.3	39.1	1.01	A
			Cs-134	pCi/L	15.5	17.1	0.91	A
			Cs-137	pCi/L	52.2	52.1	1.00	A
			Sr-89	pCi/L	27.2	31.7	0.86	A
			Sr-90	pCi/L	25.1	28.3	0.89	A
			I-131	pCi/L	13.35	14.7	0.91	A
			H-3	pCi/L	14600	17400	0.84	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 2002

Sample ID [(a)]	Matrix	Radionuclide	Units	Reported Value [(b)]	Reported Error [(c)]	Acceptance Range [(d)]	Bias % [(e)]	Evaluation [(f)]
MAPEP-01-W9	Water	AM-241	Bq/L	1.35	0.15	0.83 - 1.55	13.4	A
		CS-134	Bq/L	26	1.2	19.95 - 37.05	-8.8	A
		CS-137	Bq/L	270	8.7	200.2 - 371.8	-5.6	A
		CO-57	Bq/L	141	3.9	100.1 - 185.9	-1.4	A
		CO-60	Bq/L	143	3.4	98.7 - 183.3	1.4	A
		MN-54	Bq/L	253	7.3	172.2 - 319.8	2.8	A
		NI-63	Bq/L	92.8	3.0	61.81 - 114.79	5.1	A
		PU-239/240	Bq/L	2.78	0.81	2.09 - 3.89	-7.0	A
		Sr-90	Bq/L	4.71	0.41	3.36 - 6.24	-1.9	A
		U-234/233	Bq/L	1.04	0.12	0.69 - 1.27	6.1	A
		U-238	Bq/L	8.11	0.63	5.46 - 10.14	4.0	A
MAPEP-02-S9	Soil	AM-241	Bq/Kg	44.2	6.64	30.45 - 56.55	1.6	A
		CS-134	Bq/Kg	948	7.93	603.4 - 1120.6	10.	A
		CS-137	Bq/Kg	131	2.37	77.7 - 144.3	18.0	A
		CO-57	Bq/Kg	289	4.86	172.2 - 319.8	17.5	A
		CO-60	Bq/Kg	109	1.6	61.25 - 113.75	24.6	W
		MN-54	Bq/Kg	679	8.49	382.2 - 709.8	24.4	W
		NI-63	Bq/Kg	1010	60.7	826 - 1534	-14.4	A
		PU-238	Bq/Kg	30.65	6.35	23.31 - 43.29	-8.0	A
		PU-239/240	Bq/Kg	71.9	12.4	51.03 - 94.77	-1.4	A
		K-40	Bq/Kg	722	19.7	456.4 - 847.6	10.7	A
		U-234/233	Bq/Kg	231	59.5	160.3 - 297.7	0.9	A
		U-238	Bq/Kg	234	59.9	154 - 286	6.4	A
		ZN-65	Bq/Kg	1020	14.7	566.3 - 1051.7	26.1	W

TABLE 23 - NOTES

(a) Sample ID - Sample Identification Number assigned by MAPEP

(b) Reported Value - SNEC reported analysis value in Bq/Kg

(c) Reported Error - Reported Value 1 sigma uncertainty

(d) Acceptance Range - MAPEP analysis acceptance range in Bq/Kg

(e) Bias % - Reported Value percent difference from the MAPEP Acceptance Range mean

(f) Evaluation - A = Result Acceptable (Bias $\leq$ 20%), W = Result Acceptable with Warning (Bias > 20% but $\leq$ 30%), N = Result Not Acceptable (Bias $\geq$ 30%)

TABLE 24

BWXT Services & DOE EML Cross-check Program Results for 2002

Month/Year	Identification Number	Matrix	Nuclide	Units [c]	Reported Value	Known Value [b]	Evaluation [a]
June, 2002	QAP 203	Air Filter	AM241	Bq/filter	0.082	0.088	A
			CO60	Bq/filter	30	30.52	A
			CS137	Bq/filter	27.3	28.23	A
			Gross Alpha	Bq/filter	0.539	0.534	A
			Gross Beta	Bq/filter	1.18	1.3	A
			MN54	Bq/filter	38.1	38.53	A
			PU238	Bq/filter	0.059	0.057	A
			PU239	Bq/filter	0.192	0.187	A
			SR90	Bq/filter	4.14	4.832	A
			U234	Bq/filter	0.358	0.297	A
			U238	Bq/filter	0.358	0.298	A
June, 2002	QAP 203	Soil	AC228	Bq/kg	47	51.167	A
			AM241	Bq/kg	8.58	10.927	W
			BI212	Bq/kg	38.1	53.43	A
			BI214	Bq/kg	46.6	53.933	W
			CS137	Bq/kg	1400	1326.67	A
			K40	Bq/kg	592	621.67	A
			PB212	Bq/kg	57.4	51.1	A
			PB214	Bq/kg	50	54.367	A
			PU239	Bq/kg	15.7	19.098	W
			SR90	Bq/kg	47.7	53.756	A
			TH234	Bq/kg	121	89.3	A
			U234	Bq/kg	91.7	93.885	A
			U238	Bq/kg	98.7	96.778	A
June, 2002	QAP 203	Vegetation	AM241	Bq/kg	2.16	2.228	A
			CM244	Bq/kg	1.24	1.32	A
			CO60	Bq/kg	13.7	11.23	A
			CS137	Bq/kg	360	313.667	A

TABLE 24 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2002

Month/Year	Identification Number	Matrix	Nuclide	Units (c)	Reported Value	Known Value (b)	Evaluation (a)
June, 2002	QAP 203	Vegetation	K40	Bq/kg	947	864.33	A
			PU239	Bq/kg	2.36	3.543	N (i)
			SR90	Bq/kg	556	586.28	A
June, 2002	QAP 203	Water	AM241	Bq/L	1.45	1.474	A
			CO60	Bq/L	368	347.33	A
			CS134	Bq/L	3.16	3.357	A
			CS137	Bq/L	55.9	56.067	A
			Gross Alpha	Bq/L	468	375	W
			Gross Beta	Bq/L	899	1030	A
			H3	Bq/L	335	283.7	A
			PU238	Bq/L	0.526	0.49	A
			PU239	Bq/L	4.4	4.219	A
			SR90	Bq/L	6.67	7.579	A
			U234	Bq/L	1.67	1.402	W
			U238	Bq/L	1.62	1.381	W
December, 2002	QAP 209	Air Filter	AM241	Bq/filter	0.194	0.191	A
			CO60	Bq/filter	19.9	23	W
			CS137	Bq/filter	27.4	32.5	W
			Gross Alpha	Bq/filter	0.283	0.287	A
			Gross Beta	Bq/filter	0.769	0.871	A
			MN54	Bq/filter	40	52.2	N (h)
			PU238	Bq/filter	0.125	0.119	A
			PU239	Bq/filter	0.203	0.206	A
			SR90	Bq/filter	4.73	5.561	A
			U234	Bq/filter	0.6	0.228	N (f)
			U238	Bq/filter	0.55	0.23	N (f)
December, 2002	QAP 209	Soil	AC228	Bq/kg	40.7	42.3	A
			AM241	Bq/kg	2.9	6.767	N (i)
			BI212	Bq/kg	25.1	45.93	W

TABLE 24 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2002

Month/Year	Identification Number	Matrix	Nuclide	Units [c]	Reported Value	Known Value [b]	Evaluation [a]
December, 2002	QAP 209	Soil	BI214	Bq/kg	33.5	33.63	A
			CS137	Bq/kg	873	829.33	A
			K40	Bq/kg	655	637.67	A
			PB212	Bq/kg	46.6	43.43	A
			PB214	Bq/kg	34.2	35.2	A
			PU239	Bq/kg	8.7	12.903	N (i)
			SR90	Bq/kg	20.1	41.16	N (i)
			TH234	Bq/kg	46.6	48.4	A
			U234	Bq/kg	103	42.32	N (f)
			U238	Bq/kg	98.2	44.89	N (f)
December, 2002	QAP 209	Vegetation	AM241	Bq/kg	2.48	2.253	A
			CM244	Bq/kg	1.43	1.247	A
			CO60	Bq/kg	10.5	9.66	A
			CS137	Bq/kg	363	300.67	W
			K40	Bq/kg	1660	1480	A
			PU239	Bq/kg	3.46	3.427	A
			SR90	Bq/kg	705	476.26	N (g)
December, 2002	QAP 209	Water	AM241	Bq/L	3.17	3.043	A
			CO60	Bq/L	283	268.67	A
			CS134	Bq/L	55.1	60.2	A
			CS137	Bq/L	83.2	81.43	A
			Gross Alpha	Bq/L	226	210	A
			Gross Beta	Bq/L	826	900	A
			H3	Bq/L	276	227.3	A
			PU238	Bq/L	3.84	4.331	W
			PU239	Bq/L	1.96	2.07	A
			SR90	Bq/L	11.8	8.69	N (g)
			U234	Bq/L	7.52	3.323	N (f)
			U238	Bq/L	7.77	3.37	N (f)

TABLE 24 (Continued)

BWXT Services & DOE EML Cross-check Program Results for 2002

TABLE 24 - NOTES

(a) (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 15^{th} and 85^{th} 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 5^{th} and 15^{th} percentile and between the 85^{th} and 95^{th} percentile. In other words, the middle 90% of all reported values are acceptable, while the outer 5^{th} – 15^{th} (10%) and 85^{th} – 95^{th} percentiles (10%) are in the warning area. The not acceptable criteria, "N", is established at less than the 5^{th} percentile and greater than the 95^{th} percentile, that is, the outer 10% of the historical data.

(f) The results reported for U-234 and U-238, in all sample matrices, were incorrectly calculated. The volume of U-232 tracer, used for chemical recovery, was incorrectly entered into the calculation spreadsheets. Recalculation, using the corrected volume, yields activity results in agreement with those specified by EML. To minimize the occurrence of calculation errors, Laboratory Technical Staff will continue to be reminded frequently of the importance of detailed and accurate data review. This corrective action remains ongoing.

(g) The results reported for Sr-90, in vegetation and water, were incorrectly calculated. The counting times were incorrectly entered into the STRONT-5 Calculation Sheets. Recalculation, using corrected times, yields activity results in agreement with those specified by EML. To minimize the occurrence of calculation errors, Laboratory Technical Staff will continue to be reminded frequently of the importance of detailed and accurate data review. This corrective action remains ongoing.

(h) The result for Mn-54, in air filter was incorrectly calculated. The sample decay reference date, provided by EML, was incorrectly entered at the time of Gamma Spectroscopy Analysis. Recalculation, using the corrected decay reference date, yields an activity result in agreement with that specified by EML. To minimize the occurrence of calculation errors, Laboratory Technical Staff will continue to be reminded frequently of the importance of detailed and accurate data review. This corrective action remains ongoing.

(i) Results for Am-242, Pu-239, and Sr-90 remain under investigation. Historically, the NELS determination of these analytes in EML samples has been problematic in that the activity levels of these cross-check samples is substantially lower than that typical of the laboratory's day-to-day analytical work. The laboratory is continuing its development effort to allow larger sample aliquots to be prepared and analyzed, to allow greater accuracy at lower activity concentrations. As with previous EML QAP's, ongoing work with QAP-58 samples (currently in process with a closing date of 6/03/03) will continue such developmental work to improve accuracy. This corrective action remains ongoing.

TABLE 25

BWXT Services & MAPEP Cross-check Program Results for 2002

Sample ID [(a)]	Matrix	Radionuclide	Units	Reported Value [(b)]	Reported Error [(c)]	Acceptance Range [(d)]	Bias % [(e)]	Evaluation [(f)]
MAPEP-01-W9	Water	AM-241	Bq/L	1.25	0.25	0.83 - 1.55	5.0	A
		CS-134	Bq/L	23.9	1.7	19.95 - 37.05	-16.1	A
		CS-137	Bq/L	271	10	200.2 - 371.8	-5.2	A
		CO-57	Bq/L	142	5	100.1 - 185.9	-0.7	A
		CO-60	Bq/L	150	7	98.7 - 183.3	6.4	A
		Fe-55	Bq/L	6.22	1.04	6.44 - 11.96	-32.4	N (g)
		MN-54	Bq/L	258	21	172.2 - 319.8	4.9	A
		NI-63	Bq/L	85.7	14.6	61.81 - 114.79	-2.9	A
		PU-239/240	Bq/L	2.77	0.26	2.09 - 3.89	-7.4	A
		Sr-90	Bq/L	3.32	0.22	3.36 - 6.24	-30.8	N (g)
		U-234/233	Bq/L	1.17	0.13	0.69 - 1.27	19.4	A
		U-238	Bq/L	9.2	0.77	5.46 - 10.14	17.9	A
		Zn-65	Bq/L	78.1	5.9	47.11 - 87.49	16	A
MAPEP-02-S9	Soil	AM-241	Bq/Kg	43.2	5.2	30.45 - 56.55	-0.7	A
		CS-134	Bq/Kg	866	88	603.4 - 1120.6	0.5	A
		CS-137	Bq/Kg	126	13	77.7 - 144.3	13.5	A
		CO-57	Bq/Kg	299	31	172.2 - 319.8	21.5	W
		CO-60	Bq/Kg	110	11	61.25 - 113.75	25.7	W
		MN-54	Bq/Kg	662	71	382.2 - 709.8	21.2	W
		NI-63	Bq/Kg	1240	230	826 - 1534	5.1	A
		PU-238	Bq/Kg	31.3	3.7	23.31 - 43.29	-6.0	A
		PU-239/240	Bq/Kg	65.2	6.5	51.03 - 94.77	-10.6	A
		K-40	Bq/Kg	722	73	456.4 - 847.6	10.7	A
		U-234/233	Bq/Kg	252	22	160.3 - 297.7	10.0	A
		U-238	Bq/Kg	263	23	154 - 286	19.5	A
		ZN-65	Bq/Kg	1030	100	566.3 - 1051.7	27.3	W

TABLE 25 - NOTES

(a) Sample ID - Sample Identification Number assigned by MAPEP
(b) Reported Value - SNEC reported analysis value
(c) Reported Error - Reported Value 1 sigma uncertainty
(d) Acceptance Range - MAPEP analysis acceptance range
(e) Bias % - Reported Value percent difference from the MAPEP Acceptance Range mean
(f) Evaluation - A = Result Acceptable (Bias ≤ 20%), W = Result Acceptable with Warning (Bias > 20% but ≤ 30%), N = Result Not Acceptable (Bias ≥ 30%)
(g) Not acceptable performance evaluation for Fe-55 and Sr-90 were still under investigation during the development of this report.

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 2002 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 2002

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 2002

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 2002

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

2002 TLD Quarterly Data

mR/Std Month ± 2σ

STATION	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
A1-5	6.8 ± 0.8	6.8 ± 0.6	6.1 ± 0.3	4.6 ± 0.5
B1-6	5.8 ± 0.4	6.7 ± 0.4	6.1 ± 1.0	4.8 ± 0.3
C1-9	5.9 ± 0.4	6.1 ± 0.4	5.7 ± 0.6	4.5 ± 0.6
C2-1	6.6 ± 0.4	6.9 ± 0.3	6.2 ± 0.5	5.1 ± 0.4
D1-4	6.6 ± 0.7	6.9 ± 0.6	6.1 ± 0.8	4.8 ± 0.4
D2-1	7.1 ± 0.4	7.3 ± 1.0	6.7 ± 0.4	5.4 ± 0.7
E1-7	6.0 ± 0	6.1 ± 1.0	5.8 ± 0.7	4.6 ± 0.6
E1-17	5.3 ± 0.5	5.4 ± 0.4	3.8 ± 0.3	3.7 ± 0.4
E2-1	8.4 ± 0.6	8.9 ± 0.7	7.7 ± 1.0	6.9 ± 0.5
E3-1	6.6 ± 0.5	6.5 ± 0.3	5.3 ± 0.7	5.0 ± 0.9
F1-2	7.1 ± 0.5	7.2 ± 0.5	5.7 ± 1.0	5.2 ± 0.7
G1-1	6.0 ± 0.6	6.5 ± 0.6	5.0 ± 0.7	4.8 ± 0.4
G1-2	6.8 ± 0.8	6.9 ± 0.6	5.5 ± 0.5	5.0 ± 0.5
G2-1	5.9 ± 0.8	5.9 ± 0.8	4.5 ± 0.6	4.1 ± 0.3
G10-2 (C)	6.6 ± 0.5	6.7 ± 1.0	5.1 ± 0.5	5.2 ± 0.4
H1-5	7.0 ± 0.4	6.8 ± 1.2	5.3 ± 0.5	4.8 ± 0.5
H2-1	6.8 ± 0.5	7.0 ± 1.0	❶	5.2 ± 0.3
H10-1 (C)	5.9 ± 0.8	6.1 ± 1.0	4.4 ± 0.3	4.2 ± 0.7
J1-1	6.1 ± 0.4	6.1 ± 0.4	4.9 ± 0.6	4.2 ± 0.4
K1-5	5.5 ± 0.5	5.7 ± 0.4	4.0 ± 0.2	3.9 ± 0.3
K1-8	6.5 ± 0.4	6.8 ± 0.5	5.7 ± 0.2	5.7 ± 0.3
L1-1	6.3 ± 0.4	6.3 ± 0.6	5.1 ± 0.2	5.2 ± 0.5
L2-1	6.0 ± 0.3	6.2 ± 0.4	5.1 ± 0.8	5.0 ± 0.6
M1-6	6.6 ± 0.5	6.7 ± 0.4	5.7 ± 0.4	5.1 ± 0.9
N1-4	6.2 ± 0.5	6.5 ± 0.7	5.4 ± 0.7	4.9 ± 1.4
P1-1	6.6 ± 0.5	6.8 ± 0.3	5.2 ± 0.4	4.9 ± 0.4
Q1-3	5.8 ± 0.5	5.8 ± 0.7	4.2 ± 0.5	3.7 ± 0.2
R1-1	6.3 ± 0.9	6.8 ± 0.7	5.1 ± 0.4	4.9 ± 0.6

TABLE 27 – NOTES

(C) = Control Station

❶ The TLDs at TLD Station H2-1 were found missing. No measurement was obtained for this quarter.