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

Subject: Saxton Nuclear Experimental Corporation
Operating License No. DPR-4
Docket 50-146
2005 Radiological Environmental Monitoring Report

Gentlemen:

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 2005 SNEC Radiological Environmental Monitoring Report is enclosed. This will be the Final report; SNEC has completed all on-site work activities related to remediation and Final Status Surveys and is anticipating license termination in November 2005.

If there are any questions regarding this submittal, please contact Mr. Art Paynter of my staff at (717) 948-8425.

Sincerely

A handwritten signature in black ink, appearing to read "James J. Byrne".

James J. Byrne
Program Director, SNEC

Enclosure

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

JES

2005 SNEC RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

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ABBREVIATIONS

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

SUMMARY AND CONCLUSIONS

This report reviews the radiological environmental monitoring performed in 2005 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 2005.

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 2005, 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), and/or gamma emitting radionuclides. The results are discussed in the various sections of this report and are summarized in the following highlights:

- 165 samples were collected in 2005 from the aquatic, atmospheric and terrestrial environments around the SNEC Facility. In addition, 55 direct radiation exposure measurements were taken at 28 monitoring stations using thermoluminescent dosimeters (TLDs). The monitoring performed in 2005 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 had less than detectable activities for radionuclides attributed to SNEC, including tritium (H-3).
- No SNEC related activity was detected in any river sediment samples collected just downstream of the SNEC liquid discharge or in control samples. Cs-137 was detected in sediments collected from storm drains that are located on site. These concentrations are attributed to a combination of fallout from prior nuclear weapon tests and SNEC related activity. These results are consistent with results from previous years.
- 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).
- All potable water samples obtained in 2005 resulted in less than detectable activities for all analyses except for positive gross beta results from stations E1-1 and G1-1. These sample results were well below the REMP reporting level of 50 pCi/liter and although positive results, did not exceed the minimum detection requirements. The activity is

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probably naturally occurring radioactivity and results were similar in the on-site and off-site samples.

- All vegetation samples collected onsite had less than detectable activities for radionuclides attributed to SNEC.
- Gamma radiation exposure rates recorded at the offsite indicator Thermo-Luminescent Dosimeters (TLD) stations averaged 63 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.
- Positive gross beta and alpha activity was detected in both onsite indicator and offsite control air particulate samples. Control and indicator station results are similar. The activity can be attributed to naturally occurring radionuclides.

Due to the completion of decommissioning work on the site and as discussed with the NRC, the Radiological Environmental Monitoring Program sampling was terminated in anticipation of license termination, following the sample collections conducted in early July for the third quarter sampling program.

In conclusion, radioactive materials related to SNEC operations were detected in certain on-site environmental samples, but measured concentrations were very low. Because of the fully dismantled condition of the SNEC Facility, there were no liquid or gaseous effluent releases in 2005. The environmental sample results indicate no changes in the radiological conditions in the environment surrounding the SNEC Facility.

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 2005.

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).

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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).

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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
Man made (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.

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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 (SSGS) of Pennsylvania Electric Company (Penelec), now a subsidiary of First Energy. 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 2. 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

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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. Dismantlement activities were completed in late 2003. Final Status Survey activities and final site demobilization were completed in the summer of 2005. Additional information can be obtained from the 2005 SNEC Annual Report (Reference 6).

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 borders the northern boundary of the site. This section of river is primarily used for recreational boating and fishing. The vast majority of recreational activities, however, are located downstream of the site on Raystown Lake.

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The Raystown Branch of the Juniata River is dammed approximately 34 miles downstream of the site, impounding the river to form Raystown Lake. The US Army Corps of Engineers (COE) constructed the dam from 1968 to 1973 for flood control, recreation, and water quality purposes. 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.

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 Offsite Dose Calculation Manual (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.

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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 1 and 2 show the current sampling locations around the SNEC Facility. Table 10 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 11 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 12 in Appendix A lists samples that were not collected or analyzed as per the requirements of the ODCM. 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 listed 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 tritium results from all 2005 monitoring wells and potable water. Table 7 lists the gamma results from broad leaf vegetation. Table 8 lists the gamma and tritium results from surface water monitoring. Table 9 provides a summary of radionuclide concentrations detected in the aquatic sediment samples

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for 2005. 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:

- Monitoring 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 and then comparing the results for agreement. Recounts are performed when samples cannot be split.
- 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.

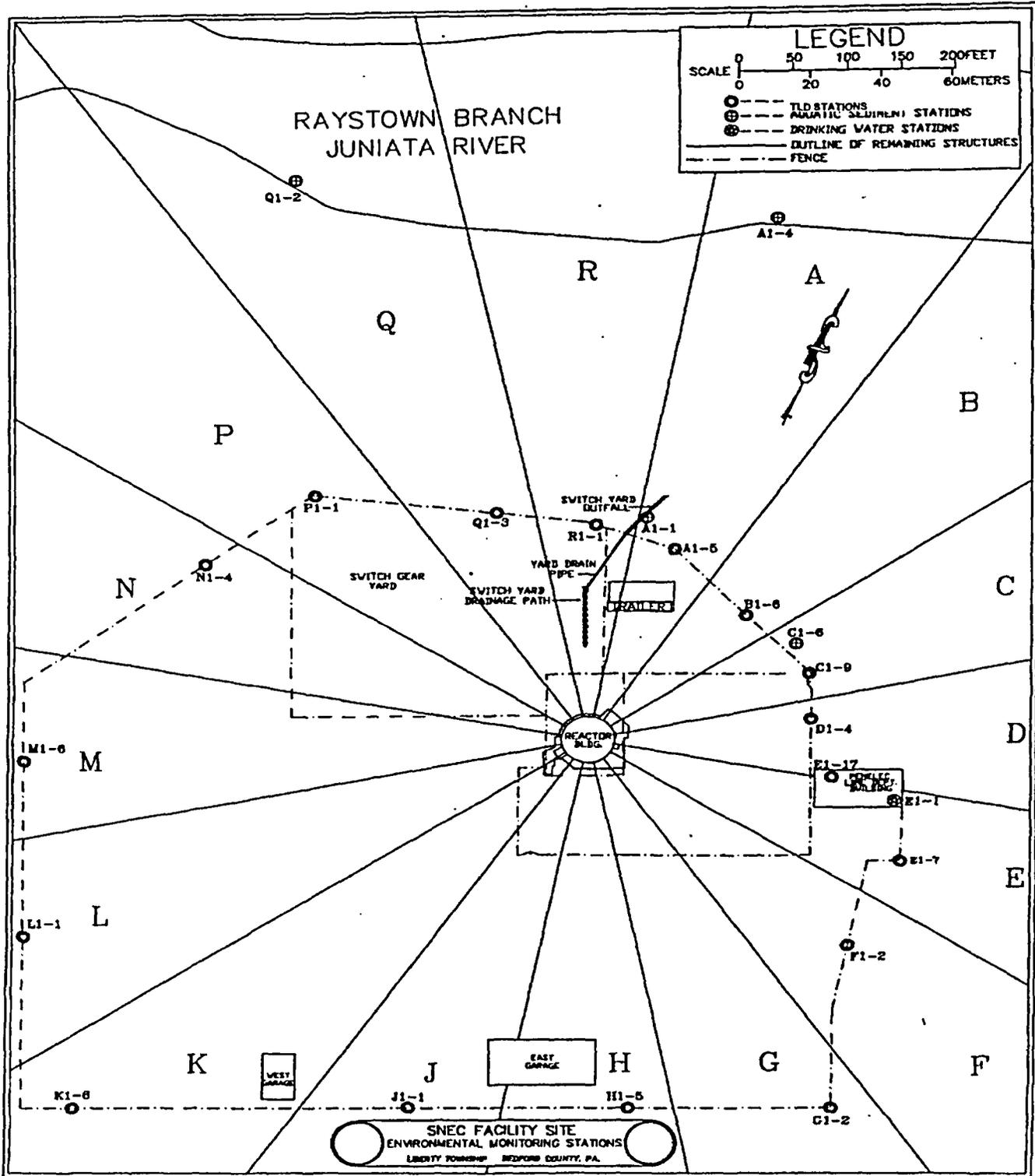
TLD readers are calibrated on a routine basis against recognized standards. Also, control TLDs are processed with each group of TLDs. The accuracy and variability of the results for the control TLDs are examined to assure the reader is functioning properly. In addition, each element (TLD) has an individual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

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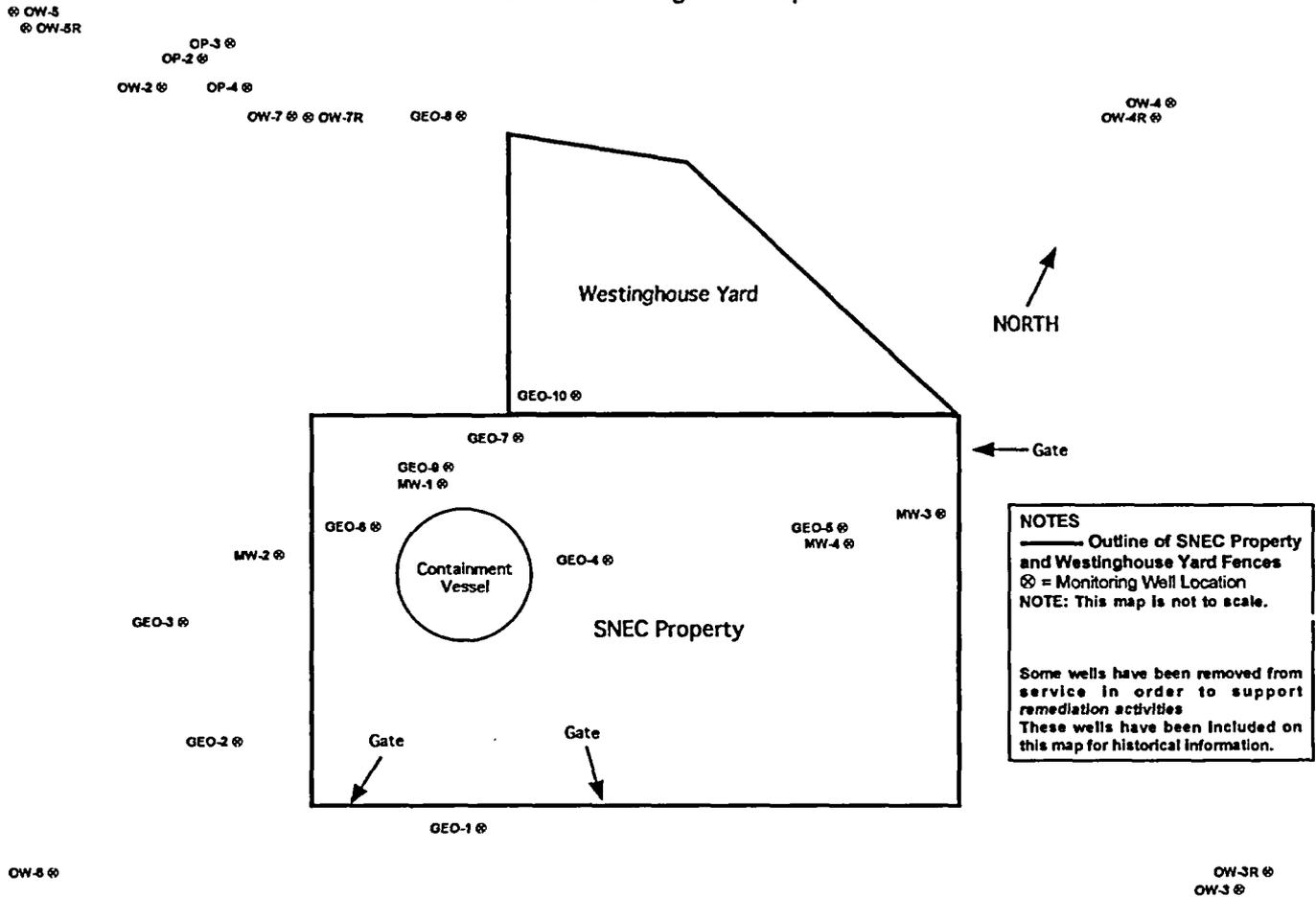
FIGURE 1
SNEC Facility Area Map



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Figure 2

SNEC Monitoring Wells Map



Note: Containment Vessel was removed in the 1st quarter of 2004. CV placed on drawing for reference point.

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 monitoring locations that surround the SNEC Facility. Sixteen Indicator Stations, one per compass sector, are located at the outer perimeter fence. There are ten Offsite Indicator Stations in various sectors within two miles of the site, including one station located in the Penelec Line Department garage. 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 2005 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 're-zeros' (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 element 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

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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 2005, the average exposure rate for onsite indicator stations was 5.1 mR/std month. This equates to an annual exposure rate of 61 mR/yr. The onsite indicator stations B1-6 and K1-8, indicated the highest annual average exposure with 5.8 mR/std month. Table 3 lists this result and provides a comparison to the allowable maximum exposure rate per 40 CFR 190 adjusted by the 67-hour recreational factor specified in Reg. Guide 1.109.

Offsite indicator stations averaged 5.3 mR/std month and the control stations averaged 4.6 mR/std month. 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"). Table 2 depicts the average offsite indicator results with the average control results.

Offsite indicator station E2-1, located 0.25 mile from the CV's former location, displayed the highest average exposure rate. 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. This station has historically exhibited the highest average (approx. 2 mR/std month above the controls).

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 17) and USNRC Regulatory Guide 1.109 (Reference 12).

Given the natural variability of background radiation, these results indicate that SNEC operations had no direct radiation effect on the environment or the public in 2005.

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TABLE 2

2005 SNEC TLD Summary

Field Cycle: January 10&11, 2005 to July 21, 2005

	Mean (mR/std month)
Average Onsite Indicator Stations	5.1
Average Offsite Indicator Stations	5.3
Average Control Stations	4.6

TABLE 3

Highest Site Boundary Exposure Comparison

5.8	mR/std month (average)	Station K1-8	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 (reference 17) adjusted by the 67-hour recreational factor specified in Reg. Guide 1.109 (shoreline exposure for maximum exposed teenager) (Reference 12).
0.0018	mR/hr(minus controls average)		

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 2005.

The indicator air sampling stations are located in the three predominant wind sectors around the Containment Vessel (CV) location, 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

102 air particulate samples (filters) were collected and analyzed for gross alpha and gross beta radioactivity during 2005. The particulate matter (dust particles) collected on a majority of the indicator and control filters contained gross beta and alpha radioactivity above the minimum detectable concentration (MDC).

The gross beta activity measured on the indicator stations filters ranged from 0.0083 pCi/m³ to 0.028 pCi/m³ and averaged 0.017 pCi/m³. The gross beta activity measured on the control station filters ranged from 0.0086 pCi/m³ to 0.0256 pCi/m³ and averaged 0.017 pCi/m³. The average results are listed in Table 4.

Average gross beta activity at indicator and control air monitoring locations was analogous and trended similarly throughout the monitoring period. The weekly gross beta activity and trends at individual air sampling stations also were similar. The 2005 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.

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The gross alpha activity measured at the indicator stations ranged from 0.00074 pCi/m³ to 0.0037 pCi/m³ and averaged 0.0017 pCi/m³. The gross alpha activity measured at the control station ranged from 0.00069 pCi/m³ to 0.0029 pCi/m³ and averaged 0.0017 pCi/m³.

Average gross alpha activity at indicator and control air monitoring locations was analogous and trended similarly throughout the monitoring period. The weekly gross alpha activity and trends at individual air sampling stations also were similar. The 2005 data indicated that gross alpha radioactivity levels did not change as a result of SNEC operations. Additionally, the gross alpha radioactivity associated with airborne particulate was due to naturally occurring radionuclides. Generally, the trends of average gross alpha activity at indicator and control sites were similar. The average results are listed in Table 5.

Gamma-emitting radionuclides related to the SNEC Facility were not detected on any of the quarterly composites that were analyzed in 2005. As expected, the quarterly composite samples indicated naturally occurring radioisotopes, e.g. Be-7. The activity indicated on the indicator samples was similar to the control filters.

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TABLE 4

**2005 Average Gross Beta Concentrations in Airborne Particulates
(pCi/m³)**

Station	Description	Average *
A1-2 (I)	North Sector	0.016
D1-1 (I)	East Sector	0.016
J1-3 (I)	South Sector	0.018
G10-1 (C)	Reichley Station	0.017

* Averages assume that concentrations less than MDC are positive at the MDC.
(I) = Indicator Station (C) = Control Station

TABLE 5

**2005 Average Gross Alpha Concentrations in Airborne Particulates
(pCi/m³)**

Station	Description	Average *
A1-2 (I)	North Sector	0.0016
D1-1 (I)	East Sector	0.0017
J1-3 (I)	South Sector	0.0020
G10-1 (C)	Reichley Station	0.0017

* Averages assume that concentrations less than MDC are positive at the 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. Well MW-4 was removed in the third quarter of 2003 because of severe damage caused during excavation of contaminated soil within the SNEC yard. Wells GEO-4, GEO-5, and GEO-10 were removed in September 2004 to facilitate soil remediation.

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

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

In addition, two potable water samples are collected each quarter. 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 is 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 2005. Low level gross beta activity was detected in the samples at both locations in the second and third quarters. Results were similar at both stations and were below the REMP minimum sensitivity requirements (Table 14) and were well below the REMP reporting level of 50 pCi/liter. The activity is believed to be naturally occurring radioactivity.

In 2001 and 2002, a site dewatering system was installed and placed into service in support of CV concrete removal. Dewatering wells were strategically installed around the site to remove groundwater that surrounded the CV. The primary purpose of the system was to reduce the risk of CV flotation during concrete removal operations. The system was fully operational throughout 2002 and most of 2003. Several REMP wells were affected by the dewatering system because the water table was lowered well below the bottom of the sampling tubes making them unusable. A significant reduction in the total number of samples was evident during 2003.

Groundwater Results

A total of 37 groundwater samples were collected in 2005. Tritium and gamma analysis was performed on each. No plant-related radionuclides were identified in any sample. The required sensitivities for SNEC are contained in Table 14. Table 6 is a list of all tritium results from 2005 monitoring wells and potable water. Locations of the onsite groundwater stations sampled in 2005 are shown in Figure 2.

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 positive activity above 200 pCi/L was detected. The activity in the GEO-5 area can be attributed to pockets of tritiated water trapped in fractures leading to the overburden groundwater. GEO-5 was taken out of service in 2003.

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TABLE 6

2005 Tritium Results of Monitoring Wells and Potable Water (pCi/l)

Station Code	1st Quarter	2nd Quarter	3rd Quarter
GEO-1	①	<382	<402
GEO-3	①	<382	<402
GEO-8	<459	<382	①
MW-2	<414	<382	<402
MW-3	①	<382	<402
OW-3	<481	<382	<402
OW-3R	<414	<382	<402
OW-4R	<414	<382	<402
OW-5	<465	<381	①
OW-5R	<452	<381	<402
OW-6	<414	<381	<402
OW-7R	<479	<382	<402
E1-1	<414	<382	<402
G1-1	<414	<382	<402

① - No Sample

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 7

2005 Gamma Spectrometry Results from Broad Leaf Vegetation
(pCi/g Wet)

Sample Designation	Date	Co-60	Cs-134	Cs-137
A1-6	7/7/2005	<0.016	<0.013	<0.015
B1-7	7/7/2005	<0.015	<0.013	<0.012

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 8
Quarterly Results of Surface Water in pCi/l

Sample Designation	1 st Quarter	2 nd Quarter	3 rd Quarter
A1-4 (I)	Cs-137 <12.4 Cs-134 <12.4 Co-60 <11.8 H-3 <477	Cs-137 <6.6 Cs-134 <5.8 Co-60 <6.6 H-3 <382	Cs-137 <6.0 Cs-134 <5.7 Co-60 <5.8 H-3 <402
Q1-2 (C)	Cs-137 <7.9 Cs-134 <8.6 Co-60 <7.4 H-3 <463	Cs-137 <5.9 Cs-134 <6.2 Co-60 <5.9 H-3 <382	Cs-137 <7.6 Cs-134 <7.3 Co-60 <7.4 H-3 <402
H1-1 (C)	Cs-137 <13.6 Cs-134 <11.8 Co-60 <12.8 H-3 <461	Cs-137 <6.7 Cs-134 <6.7 Co-60 <8.3 H-3 <382	Cs-137 <5.7 Cs-134 <5.8 Co-60 <6.0 H-3 <402

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. No Cs-137 was detected in offsite indicator or control sample locations. All samples of the on-site drain outfalls indicated positive Cs-137. The average result was 0.75 pCi/g. The media of these samples is primarily bottom ash originating from the Saxton Steam Generating Station and distributed throughout the entire site, including land adjacent to the SNEC Facility. Residual Cs-137 is readily adsorbed by the bottom ash due to its surface structure.

TABLE 9
2005 Quarterly Results of Sediment Analysis in pCi/g (Dry)

Sample Designation/ Location	1 st Quarter		2 nd Quarter		3 rd Quarter	
A1-1 / Drain Outfall Outside Perimeter Fence (I)	Cs-137	0.78	Cs-137	0.73	Cs-137	0.96
	Cs-134	<0.15	Cs-134	<0.086	Cs-134	<0.085
	Co-60	<0.11	Co-60	<0.064	Co-60	<0.074
C1-6 / Drain Outfall, NE Corner of Perimeter Fence (I)	Cs-137	0.48	Cs-137	0.80	Cs-137	0.74
	Cs-134	<0.10	Cs-134	<0.080	Cs-134	<0.096
	Co-60	<0.095	Co-60	<0.064	Co-60	<0.074
A1-4 /Juniata River at the Weir Bulkhead (I)	Cs-137	<0.075	Cs-137	<0.065	Cs-137	<0.060
	Cs-134	<0.062	Cs-134	<0.062	Cs-134	<0.057
	Co-60	<0.054	Co-60	<0.057	Co-60	<0.061
Q1-2 / Old Station Discharge (C)	Cs-137	<0.034	Cs-137	0.066	Cs-137	<0.055
	Cs-134	<0.049	Cs-134	<0.072	Cs-134	<0.050
	Co-60	<0.035	Co-60	<0.067	Co-60	<0.048
H1-1 / Warriors Path State Park Boat Launch(C)	Cs-137	<0.070	Cs-137	<0.074	Cs-137	<0.056
	Cs-134	<0.072	Cs-134	<0.073	Cs-134	<0.054
	Co-60	<0.052	Co-60	<0.057	Co-60	<0.048

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APPENDIX A

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

2005 SNEC RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

TABLE 10

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	The Weir was removed. No samples taken
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 centerline	
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 centerline	
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 centerline	
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	

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TABLE 10 (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 centerline	
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 centerline

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TABLE 10 (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 centerline
GEO 4	Groundwater	Monitoring Well West of CV Fenced Area	④
GEO 5	Groundwater	Monitoring Well East of CV Fenced Area	④
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 First Energy Fence	240' from CV centerline
GEO 9	Groundwater	Piezometer Inside of CV Fenced Area	①
GEO 10	Groundwater	Monitoring Well NE of CV Fenced Area	④
MW-1	Groundwater	NE to NW Diagonal Well	①
MW-2	Groundwater	NW to SW Diagonal Well	99' from CV centerline
MW-3	Groundwater	Monitoring Well East of CV Fenced Area	192' from CV centerline
MW-4	Groundwater	Monitoring Well East of CV Fenced Area	③
OW-2	Groundwater	Overburden Well Northwest of SNEC Site	432' from CV centerline Not routinely sampled
OW-3	Groundwater	Overburden Well East of SNEC Site	771' from CV centerline
OW-3R	Groundwater	Bedrock Well East of SNEC Site	774' from CV centerline
OW-4	Groundwater	Overburden Well Northeast of SNEC Site	825' from CV centerline
OW-4R	Groundwater	Bedrock Well Northeast of SNEC Site	822' from CV centerline
OW-5	Groundwater	Overburden Well West of SSGS Discharge Tunnel Bulkhead	698' from CV centerline

- ① These wells were removed in May 2000.
 ② This well was removed in October 2000.
 ③ This well was severely damaged during yard excavation and was removed in the third quarter of 2003.
 ④ This well was removed in September 2004.

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TABLE 10 (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 centerline
OW-6	Groundwater	Overburden Well Southwest of SNEC Site	786' from CV centerline
OW-7	Groundwater	Overburden Well Northwest of SNEC Site	294' from CV centerline
OW-7R	Groundwater	Bedrock Well Northwest of SNEC Site	294' from CV centerline
OP-2	Groundwater	Overburden Well Northwest of SNEC Site	444' from CV centerline Not routinely sampled
OP-3	Groundwater	Overburden Well Northwest of SNEC Site	450' from CV centerline
OP-4	Groundwater	Overburden Well Northwest of SNEC Site	390' from CV centerline
H1-1	Surface Water/Sediment	Warrior's Path State Park, Boat Launch	Upstream/Control

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TABLE 11

Synopsis of the 2005 Radiological Environmental Monitoring Program ⁽¹⁾

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	102	Gross Beta	Weekly/Biweekly	102
				Gross Alpha	Weekly/Biweekly	
				Gamma	Quarterly	8
Aquatic Sediment	5	Quarterly	15	Gamma	Quarterly	15
Broad Leaf Vegetation	2	Annually	2	Gamma	Annually	2
Groundwater	14 ⁽²⁾	Quarterly	37	H-3	Quarterly	37
				Gamma	Quarterly	
Potable Water	2	Quarterly	6	H-3	Quarterly	6
				Gamma	Quarterly	
				Gross Beta	Quarterly	
Dosimeters (TLD)	28	Quarterly	55	Immersion Dose	Quarterly	330 ⁽³⁾
Surface Water	3	Quarterly	9	Gamma	Quarterly	9
				H-3	Quarterly	

NOTES:

- (1) This table represents results from the primary (base) program. It does not include quality control (QC) samples.
- (2) Number of wells with at least one sample in 2005.
- (3) The total number of samples or elements (TLDs) used for data analysis.

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**TABLE 12
Sampling and Analysis Exceptions 2005***

Period of Deviation	Description of Deviation and Corrective Action (as applicable)
All 2005	GEO-4, GEO-5 – Sample stations removed in 2004. No samples obtained.
All 2005	B1-4 sediment not collected, the weir system was previously removed
1 st Quarter	GEO-1, GEO-3 –No samples collected - well water level too low to obtain sample
1 st Quarter	A1-2 Air Particulate sampler for week ending 2/3/2005 not collected – sampler was not running due to tripped power breaker
1 st Quarter	D1-1 Air Particulate sampler for week ending 2/9/2005 not collected – sampler was not running
2 nd Quarter	D2-1 TLD station – no TLDs present at time of collection
3 rd Quarter	GEO-8 – No sample collected - well water level too low to obtain sample
	REMP sampling was terminated in July 2005. Therefore there are no direct radiation results or air particulate results for the third or fourth quarters, and no water or sediment results for the fourth quarter.

* 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

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**Analytical Results that Failed to Meet
SNEC REMP Required LLD During 2005**

Sample SX-SD-09027, an aquatic sediment sample, had an LLD of 0.152 pCi/g for Cs134 compared to the required LLD of 0.15 pCi/g. Since this LLD would be acceptable if only two significant digits had been reported, no action is required. This particular sample had positive Cs137.

APPENDIX C

REMP CHANGES

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TABLE 13
2005 REMP Changes

Date of Change	Description of Changes to REMP Sampling
July 2005	Because the Final Status Survey was complete and the site demobilized, REMP sampling was terminated following sampling conducted for the third quarter grab samples, collection of the second quarter deployment period for the direct radiation dosimeters, and the last second quarter sample collection for the air particulates.

APPENDIX D

ACTION LEVELS

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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 14.
- 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 14.)

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.

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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 2005.

TABLE 14
SNEC REMP Analytical Required Sensitivities (LLD)
& Reporting Levels

Exposure/Pathways and/or Sample	Units	Analysis	Required LLD	Reporting Level
Air Particulate (AP)	pCi/m ³	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

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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 perform a replicate analysis on at least 5% of samples. 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 falls 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 REMF sample intralaboratory non-agreements during the year 2005.

Cross-check Program Samples

During the first quarter of 2004, the DOE/EML became part of the Department of Homeland Security. As a result, only laboratories performing work for that department were permitted to utilize EML services. All non-participating labs were dropped from the program. SNEC was not a participant in Homeland Security activities and therefore, was no longer eligible to utilize EML for the cross-check program. SNEC continued to participate in MAPEP.

SNEC participates in the DOE Mixed Analyte Performance Evaluation Program (MAPEP). This program typically provides semi-annual blind spike samples to the SNEC Facility for analysis on the Gamma Spectroscopy System(s) and Tri-Carb Liquid Scintillation Analyzer, as

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applicable. Samples are analyzed and results are sent to the DOE for accuracy evaluation. One SNEC Facility Cross-check Program sample non-agreement was identified in 2005. See the note on Table 15 for explanation.

Routine sample results and duplicate / replicate analyses are reviewed by the QAO for trends and sample non-agreement. As a minimum, investigations are performed for all sample non-agreements.

Each contractor laboratory that analyzes environmental samples for the SNEC Facility participates in cross-check programs, which may include DOE-EML or DOE-MAPEP. 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 2005 cross-check program results from each laboratory are listed in Reference 18.

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 to ensure that the distribution of radioactivity in the sample is homogeneous. The sample is then split into two portions. One portion is analyzed on the SNEC counting systems 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 no interlaboratory non-agreements during 2005.

APPENDIX F

CROSS-CHECK PROGRAM RESULTS

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**TABLE 15
SNEC & MAPEP CROSS-CHECK PROGRAM RESULTS (Series 13)**

MAPEP-05-MaW13: Water Standard

Sample ID ^(a)	Matrix	Radionuclide	Units	Reported Value ^(b)	Reference Value ^(c)	Reported Error ^(d)	Acceptance Range ^(e)	Bias % ^(f)	Evaluation ^(g)
MAPEP-05-MaW13	Water	Cs-134	Bq/L	107.65	127	2.98	88.90 – 165.10	-15.2	A
		Cs-137		321.90	332	11.33	232.40 – 431.60	-3.0	A
		Co-60		248.34	251	5.64	175.70 – 326.30	-1.1	A
		H-3		368.52	280	16.13	196.00 – 364.00	31.6	N
		Mn-54		329.30	331	14.71	231.70 – 430.30	-0.5	A

MAPEP-05-MaS13: Soil Standard

Sample ID ^(a)	Matrix	Radionuclide	Units	Reported Value ^(b)	Reference Value ^(c)	Reported Error ^(d)	Acceptance Range ^(e)	Bias % ^(f)	Evaluation ^(g)
MAPEP-05-MaS13	Soil	Am-241	Bq/kg	104.78	109	8.61	76.30– 141.70	-3.9	A
		Cs-134		668.52	759	13.25	531.30 – 986.70	-11.9	A
		Cs-137		317.61	315	11.69	220.50 – 409.50	0.8	A
		Co-60		217.11	212	5.55	148.40 – 275.60	2.4	A
		Mn-54		520.89	485	25.80	339.50 – 630.50	7.4	A
		K-40		648.46	604	33.85	422.80 – 785.20	7.4	A

MAPEP-05-RdF13: Air Filter Standard

Sample ID ^(a)	Matrix	Radionuclide	Units	Reported Value ^(b)	Reference Value ^(c)	Reported Error ^(d)	Acceptance Range ^(e)	Bias % ^(f)	Evaluation ^(g)
MAPEP-05-RdF13	Air Filter	Cs-134	Bq/sample	2.82	3.51	0.23	2.46 – 4.56	-19.7	A
		Cs-137		2.03	2.26	0.28	1.58 – 2.94	-10.2	A
		Co-60		2.99	3.03	0.27	2.12 – 3.94	-1.3	A
		Mn-54		2.99	3.33	0.38	2.33 – 4.33	-10.2	A

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TABLE 15 (Continued)
SNEC & MAPEP CROSS-CHECK PROGRAM RESULTS (Series 13)

TABLE 15 NOTES:

Tritium and Vegetation sample results not submitted by SNEC for this round (Series 13) of MAPEP.

Sample ID - Sample Identification Number assigned by MAPEP

Reported Value - SNEC reported analysis value // Reference Value - MAPEP target analyte value // Reported Error - Reported Value 1 sigma uncertainty

Acceptance Range - MAPEP analysis acceptance range // Bias % - Reported Value percent difference from the MAPEP Acceptance Range mean

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

A Not Acceptable result occurred for the tritium in the MAPEP water sample. Water samples provided by the DOE's Mixed-Analyte Performance Evaluation Program (MAPEP) contain chemical and radiological constituents that create significant interferences that must be addressed by sample-processing techniques that are not normally required for routine SNEC samples. In April of 2005, the MAPEP sample was distilled in addition to filtration. Three processed samples were analyzed. The acceptable range for the MAPEP tritium analysis was 196.00 – 364.00 Bq/L. The value submitted by SNEC for an unfiltered distilled sample exceeded the allowable range by 4.52 Bq/L (368.52 Bq/L) . The result for a filtered distilled aliquot, that was not submitted to MAPEP was in the acceptable range.

APPENDIX G

DATA REPORTING AND ANALYSIS

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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:

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

Where:

- S_b = 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 m³,
- 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 14. A large percentage of the 2005 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.

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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

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TABLE 16

**SNEC Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 2005**

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)	TBE - 2008	Low background gas flow proportional counting
Gr-Beta	AP	Continuous weekly or biweekly air sampling through filter paper	1 filter (500-1000 Cubic Meters)	TBE -- 2008	Low background gas flow proportional counting
	GW	Quarterly grab sample	500 ml	TBE - 2008	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)	SNEC - E900-OPS-4524.33	Sample placed in counting container for gamma isotopic analysis
	BR	Annual grab sample	1 kg	SNEC - 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	SNEC - E900-OPS-4524.33 TBE - 2007	Sample decanted and liquid portion placed in counting container for gamma isotopic analysis. Potable samples are mixed (not decanted) prior to analysis