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A Special Radiological Survey at

Selected Sites in the Vicinity of BNFP

October 1983 and January 1984

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Summary

This radiation survey was conducted to document current levels of radioactivity at sites on or near Barnwell Nuclear Fuel Plant (BNFP) and to compare these with historical data. In October 1983 litter, humus and soil samples were collected at eleven sites and analyzed in the laboratory. *In situ* gamma-ray radiometric measurements were performed at twelve sites. From this *in situ* data there appeared to be evidence of the presence of elevated concentrations of 137Cs and 60Co near the eastern boundary of the site at the Osborne Road air/rain station. However, because of the proximity of possible radiation sources on the adjacent property, special litter, humus and soil samples were taken at seven locations in January 1984 to resolve whether the high activities measured *in situ* at the Osborne Road site resulted from contamination in the soil or from possible sources of radiation on the adjacent property. Gamma-ray analyses of these samples confirm that the 137Cs levels in the soil and litter/humus at the Osborne Road site are consistent with normal 137Cs fallout levels measured throughout the area. Cobalt-60 is present in the soil and litter/humus at the Osborne Road site, but in concentrations consistent with levels reported in 1976-1979. Neither the 137Cs nor the 60Co concentrations in these terrestrial samples accounted for the high *in situ* readings at Osborne Road. The most likely sources to produce these high *in situ* readings are parked trucks and other operations on the adjacent Chem-Nuclear property. There is no evidence that past operations at BNFP have contributed measurable activity to the local environment.

1.0 Introduction

The radiological survey presented in this report is part of the process of preparing the Barnwell Nuclear Fuel Plant for a period of inactivity. Although the plant has never been utilized for any of the principle functions for which it was constructed, i.e., fuel storage and reprocessing, it was decided to conduct a radiological survey to assure for the record that no adverse radiological impacts have resulted from any operations conducted on the site.

2.0 Description of Study

The survey conducted was designed to provide a rapid but illustrative indication of the presence of radioactivity other than that expected from fallout and naturally occurring radionuclides. Since the initial *in situ* survey conducted in October 1983 showed the presence of unexpected radioactivity in the vicinity of the Osborne Road air/rain station, further sampling and analysis were performed in this area in January 1984. The radiological survey consisted of the following:

2.1 Laboratory Litter/Humus and Soil Measurements

The October 1983 study consisted of laboratory-conducted gamma-ray spectrometric analyses of litter/humus and soil samples collected at eleven of the twelve representative sites. At each site litter/humus was collected from three randomly chosen 0.5 square meter plots. A core consisting of the top 5 centimeters of soil was taken from each of the three plots at each site. The soil and litter/humus was dried and composited to give a single soil and a single litter/humus composite sample from each site. These samples were then analyzed for the presence of radioactivity by high resolution gamma-ray spectroscopy.

For the January 1984 study seven sampling locations were selected in the vicinity of the Osborne Road air/rain monitoring station. Litter, humus and soil was collected at each of these locations in the manner previously described and subsequently analyzed in the laboratory for the presence of radioactivity.

2.2 *In Situ* Gamma-Ray Analysis

In situ gamma-ray radiometric measurements were performed in October 1983 at twelve terrestrial sites near or similar to those used over the past years for the preoperational program at BNFP (1-2). This measurement technique has been used with great success for a number of years to make rapid and effective determinations of environmental radiation fields and the resulting radiation exposure rates. (3-13). The *in situ*

method, when properly applied and interpreted is a powerful tool for long term radiological environmental monitoring. *In situ* spectroscopy can provide the concentration of certain radionuclides in the soil, the deposition in pCi/cm of air deposited radionuclides and the total gamma-ray exposure rate at a particular site. However, because of the sensitivity of this method to all sources of radiation, care must be used when measuring and reporting soil concentrations that the source of radiation is in fact in the soil layer and not extraneous to it. The *in situ* method is used to detect and characterize the radiation environment at nuclear facilities and to identify changes in the levels of radioactivity on subsequent surveys (10, 14). Of particular importance is the rapidity with which this technique can furnish a good estimate of the spectrometrically specified gamma-ray exposure rate, dose assessment being an important goal of any environmental monitoring program. A detailed description of the equipment and *in situ* methodology is presented in Appendix A.

2.3 Water Sample Analysis

Gross alpha, gross beta and tritium concentration measurements were made of water samples taken at six specially selected sites within the boundary of BNFP. Elevated concentrations if found would indicate the need for gamma-ray spectrometric analysis of the sample.

3.0 Description of Sites

3.1 October 1983 Sites

The twelve terrestrial sites are listed in Table 1 and shown in figures 1 and 2. Samples from these sites are identified by the letter S for soil and LH for composite litter/humus. For example, the soil composite sample from Terrestrial Station 3 is identified as sample number TS3S. Terrestrial sites 1, 2 and 5 are located on the boundaries of the plant site. Site 3 lies near the process area; site 4 is located north of Osborne Road; and the Osborne Road site is located near the road at the eastern boundary of BNFP, adjacent to Chem-Nuclear property. The Circular Turkey Oak and Carolina Bay sites are at the northern boundary of the plant. The sites outside the plant boundary are located in sectors 4, 5 and 6 of the eastern quadrant shown in figure 2.

The water samples were taken from Beacon Pond (samples 1-3), from a ditch near the process area (sample 4) and near the boundary in the flow direction from the process area (samples 5 and 6). Plans had been made to sample several carolina bays and pond holding areas; however, sufficient ground water was not present at the time of the study for these samples to be collected.

3.2 January 1984 Sites

The seven sampling locations for January 1984 are shown in Figure 3. The sampling locations are numbered 1 through 7. The samples are identified by the letters OR for Osborne Road, LH for Litter/Humus or S for Soil, and then the sampling location number, e.g. ORLH1 is the litter/humus composite sample from sampling location number 1. Locations 1 through 5 are along the unimproved road which parallels the BNFP/Chem-Nuclear boundary fence on the BNFP property. These five sites have little litter and almost no humus layer. The soil in this location has been graded and disturbed. The road area is well washed and covered by low, thorny undergrowth. At sampling location number 3 (Osborne Road air/rain station) no litter or humus was present and no litter/humus sample was collected. Sampling locations 6 and 7 are away from the road and are relatively undisturbed forest sites.

The following is a brief description of each location sampled in the vicinity of the Osborne Road air/rain station in January 1984.

Location 1. At the telephone pole on Chem-Nuclear Road approximately 30 meters from the gate on to Osborne Road. Samples taken between boundary fence and Chem-Nuclear Road.

Location 2. In bend of Chem-Nuclear Road where Ohio Road intersects. One sample between Chem-Nuclear Road and boundary fence, two samples across Chem-Nuclear Road.

Location 3. At the Osborne Road air/rain station. Three soil samples within 1 meter of Air/Rain Station. No litter/humus samples collected.

Location 4. Approximately 60 meters from the Osborne Road air/rain station north on Chem-Nuclear Road. Samples collected from area on BNFP side of Chem-Nuclear Road. Location adjacent to Chem-Nuclear shop building.

Location 5. Approximately 120 meters from the Osborne Road air/rain station north on Chem-Nuclear Road. At intersection of Chem-Nuclear Road and an unimproved Road on BNFP property. Location adjacent to telephone pole and large tree stump on Chem-Nuclear Property.

Location 6. Approximately 40 meters perpendicular to Chem-Nuclear Road toward BNFP plant site from the Osborne Road air/rain station.

Location 7. Approximately 80 meters perpendicular to Chem-Nuclear Road toward BNFP plant site from the Osborne Road air/rain station.

4.0 Results

4.1 Radionuclides in Soil - October 1983

The concentrations of radionuclides in soil measured in the laboratory are summarized in tables 2 through 4. Spectrometric data from each individual sample is presented in Appendix B. The radionuclides observed in the soil are the fallout nuclide 137Cs and the terrestrially naturally-occurring 226Ra, 214Pb, 232Th, 228Ac and 40K. The concentrations of 137Cs ranged from 1.3 pCi/g to 0.39 pCi/g.

4.2 Radionuclides in Litter/Humus - October 1983

The concentrations of radionuclides in litter/humus samples taken at all terrestrial sites and measured in the laboratory are summarized in Tables 5 through 7. Spectrometric data from each individual sample is presented in Appendix C.

The radionuclides observed in the litter/humus are the nuclear weapon fallout radionuclides 144Ce, 137Cs and 125Sb; cosmic-ray produced 7Be; 60Co; and the terrestrially naturally-occurring radionuclides 226Ra, 214Pb, 232Th, 228Ac and 40K. The concentrations of the fallout radionuclides, although very small, were still observable in the laboratory but not in the *in situ* measurements. The main reason for this was the relatively higher gamma-ray efficiency and higher resolution of the laboratory Ge(Li) detector and the longer counting times (12 hours) used in the laboratory compared to the field measurements. Table 5 shows that no significant concentrations of fallout radionuclides except 137Cs were observed in the litter/humus samples. The 137Cs concentrations were, as expected, about twice those found in the soil.

4.3 Radionuclides in Soil - Osborne Road - January 1984

The radionuclides occurring naturally in soil, 226Ra, 214Pb, 232Th, 228Ac and 40K appear in the soil samples collected near the Osborne Road air/rain station in concentrations similar to those at the sites sampled in October 1983. This may be seen by a comparison of Table 8 with Table 2. The mean concentration of 40K near the Osborne Road site is higher than the mean for all other sites although the range is similar. No significance is attached to this. The mean concentration of 137Cs in the soil near the Osborne Road site is almost exactly that of the mean for all stations sampled in October 1983.

Table 9 presents the measured concentrations of the radionuclides 60Co, 134Cs, 137Cs and 7Be in soil at the seven Osborne Road sampling locations. These three radionuclides were not detected in any soil samples collected at any station sampled in October 1983. They were, however, observed in the *in situ* spectrum taken at the Osborne Road Site. A trace amount of naturally occurring 7Be was detected once at location number 1. Cobalt-60 and 134Cs appear in concentrations less than those measured in 1976-1977 (15) in soil from the Osborne Road Air/Rain Station Site. Concentrations of 137Cs in the top 5 centimeters of soil near the Osborne Road air/rain station are comparable to or lower than 137Cs concentrations in soil measured in 1976-1977 (15). The Sample Analysis Reports for each soil sample are contained in Appendix D.

4.4 Radionuclides in Litter/Humus - Osborne Road-January 1984

Concentrations of the naturally occurring radionuclides 226Ra, 214Pb, 232Th, 228Ac and 40K in litter/humus samples from the sampling locations in the vicinity of the Osborne Road air/rain station are generally similar to concentrations of these radionuclides in litter/humus samples from the stations sampled in October, 1983. A comparison of Table 10 with Table 5 shows this, and also shows the wide variation in the concentration of these radionuclides from site to site. There is nothing unusual in the concentration of these naturally occurring radionuclides in the vicinity of the Osborne Road site.

Table 11 presents concentrations of the radionuclides 60Co, 65Zn, 134Cs, 137Cs, 7Be, 54Mn, 141Ce, 144Ce and 125Sb in litter/humus samples from the vicinity of the Osborne Road site collected in January, 1984. Table 12 shows the concentrations of these radionuclides measured in 1976-1977. Concentrations of 137Cs, 144Ce, 125Sb and 7Be in litter/humus samples collected near the Osborne Road site in January, 1984 are similar to those from all stations sampled in October 1983 and are also consistent with measurements made in 1976-1977 (16, 17), (Table 5). The radionuclides 134Cs, 54Mn and 141Ce were not detected at stations sampled in October 1983 . These radionuclides were detected near the Osborne Road air/rain station in 1976-1977 (2,3) (Table 12) at mean levels considerably higher than those measured in this study. Zinc-65 was detected at one location; this radionuclide has not been previously observed in the vicinity of BNFP. The radionuclide 60Co appears at the locations sampled in this study at levels above those at the stations sampled in October 1983. Cobalt-60 ground contamination was studied in the vicinity of the Osborne Road site in 1978-1979 (18). Present 60Co levels in the vicinity of the site are consistent with

concentrations of this radionuclide reported in 1978-1979 (18). Sample Analysis Reports for litter/humus samples are contained in Appendix E.

4.5 *In Situ* Gamma-Ray Analysis

The results of the *in situ* gamma-ray measurements are presented in Tables 13 through 17. The principle radionuclides observed at all sites were the fallout nuclide 137Cs, cosmic-ray produced 7Be and the terrestrial nuclides 40K and those of the Uranium and Thorium series. With the exception of 137Cs and 60Co readings at Osborne Road, the concentrations of these nuclides are similar to those observed in the preoperational program.

Assuming a value of 0.24 cm^{-1} for α for 137Cs (the average value measured during the preoperational years), the depositions for 137Cs were calculated. These are shown in Table 17 with the exception of Osborne Road. The value for α for the terrestrially naturally-occurring nuclides was taken to be infinity. For 7Be, α was zero, since this radionuclide is assumed to be entirely deposited on the surface.

Elevated levels of 137Cs and 60Co were measured at the Osborne Road site. The radionulides 134Cs, 54Mn and 58Co were also observed at Osborne Road. Because no litter/humus or soil samples were collected at the Osborne Road site in October 1983, these samples were taken in January 1984 to determine if in fact these radionuclides were in or on the soil. Assuming that the radionuclides are all situated on the surface, that is, $\alpha = 0$, the depositions in pCi/cm^2 would have been: 210+/-17 for 137Cs, 3.6+/-0.4 for 134Cs, 1.4+/-0.2 for 54Mn, 109+/-9 for 60Co and 15+/-1 for 58Co (see Table 18). This assumption, $\alpha = 0$, is probably not correct, but it permits calculation of what the approximate deposition would have to be to result in the observed radiation levels. However, laboratory measurements of the litter/humus and soil samples collected in January 1984 confirm that these readings result primarily from sources located on the adjacent Chem-Nuclear property rather than from the presence or unusual concentrations of these radionuclides in the soil near the Osborne Road site.

The gamma-ray exposure rate in $\mu R/hr$ at one meter above the ground is calculated based on known contributions from each radionuclide detected. This includes all gamma-rays from parents and daughters in the decay chain. When these are summed over all radionuclides present an exposure rate for each site is obtained. The total gamma-ray exposure rate at each site is shown is Table 19, however, it should be noted that the exposure rate at the Osborne Road site was found to be a result of sources and operations on the adjacent Chem-Nuclear property and not from soil contamination at BNFP.

4.5 Water Sample Analysis

The radiological measurement data for the water samples are shown in Table 20. Gross alpha and gross beta positive results were only found for one sample which was taken near the process area. A subsequent gamma-ray spectral analysis showed no gamma-rays from fission or activation products. One other sample, sample 6, showed no gross alpha activity, but did show a gross beta concentration of 9+/-2 pCi/l.

Two samples showed the presence of tritium - sample 4 with a tritium concentration of 7.6+/-0.4 pCi/ml and sample 5 with a tritium concentration of 2.0+/-0.3 pCi/ml. These levels are consistent with concentrations observed in the SRP monitoring program (Appendix F, Table 22).

5.0 Discussion

5.1 Litter/Humus and Soil Laboratory Measurements

At all sites sampled with the exception of the Osborne Road air/rain station the concentrations of radionuclides measured in the litter/humus and in the soil are those expected to be observed from current fallout predictions and the presence of naturally-occurring radionuclides. Exceptions may be ^{60}Co and ^{137}Cs levels which are not in any case attributable to BNFP operations. All measured concentrations are so low to be of no environmental significance. Concentrations of ^{137}Cs in soil similar to those measured in this survey in litter and humus have been measured by SRP during their 1982 program (15 and Appendix F, Table 13). The presence of ^{54}Mn, ^{144}Ce and ^{125}Sb at some of the BNFP sites is questionable due to the difficulty of observing these small peaks in the spectrum.

Types and concentrations of radionuclides at the seven locations in the vicinity of the Osborne Road air/rain station measured in January, 1984, while certainly different from those stations sampled in October 1983, represent no significant changes from similar data taken five years previously at the Osborne Road site. The types and concentrations of radionuclides appearing now at the Osborne Road site are naturally occurring, fallout or consistent with measurements made in 1976-1979. At that time these unusual radioisotopes appear to have been the result of the removal of an underground storage tank at Chem-Nuclear in 1977 (16).

The types and concentrations of radionuclides measured in January 1984 in soil and litter/humus in the vicinity of the Osborne Road site are not consistent with the October 1983 *in situ* exposure measurement results given in Table 19. In particular, ^{137}Cs levels measured in the laboratory in soil

and litter/humus samples collected near the Osborne Road site are no different from the 137Cs levels at all other stations sampled in October 1983 and yet the deposition of 137Cs measured *in situ* at the Osborne Road site is higher than that at the other sites by an order of magnitude. Cobalt-58 was not observed in the soil and litter/humus samples collected at Osborne Road but was observed *in situ* at the same location. Cobalt-60 levels in the soil and in the litter/humus are consistent with levels measured in 1978-1979; however, the *in situ* results from these time periods at the Osborne Road site are different. This is shown in Table 18 and in reference 18. The concentrations of the naturally occurring radionuclides 226Ra, 214Pb, 40K, 228Ac and 232Th measured in this study are similar from site to site over the BNFP property.

It appears from this study that the elevated levels and presence of the radionuclides observed *in situ* in the vicinity of the Osborne Road air/rain station in October 1983 are not attributable to sources located in the soil and litter/humus on the BNFP property, and therefore must be attributable to sources on the Chem-Nuclear property.

5.2 *In Situ* Measurements

With the exception of the Osborne Road site the concentrations, depositions and exposure rates measured *in situ* are similar within the experimental uncertainty to measurements made in the preoperational years since 1975. At Osborne Road in October 1983 there is definite evidence of increased levels of 137Cs and 60Co. These increased levels definitely are not the result of soil contamination on BNFP property but rather are attributable to sources located close to the Osborne Road site outside the plant boundary. The radioactivity in air measured in the SRP 1982 program at the nearest air/rain station to BNFP (Highway 21/17) showed no unusual concentration of radioactivity (Appendix F, Table 5).

5.3 Water Sample Analysis

The radiological studies of water samples show no unusual levels of either gross alpha, gross beta, tritium or gamma-ray activity. The concentrations of alpha and beta in one sample, beta in one ssample and tritium in two samples are similar to those expected from the background in this area. Similar concentrations were observed in water sample measurements taken by SRP during their 1982 program (Appendix F, Table 22).

6.0 Conclusion

Based on the measurements made in this survey it is concluded that there is no evidence that any unusual concentrations of radionuclides exist on the plant site. Very

low levels of 60Co and 137Cs are present at some sites but these were expected to be present. The 60Co is the resuit of a slight contamination arising from operations at Chem-Nuclear and has been present for several years and the 137Cs is from world-wide fallout. Operations at the Barnwell Nuclear Fuel Plant have contributed no measurable radioactivity to the local environment.

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Figures and Tables

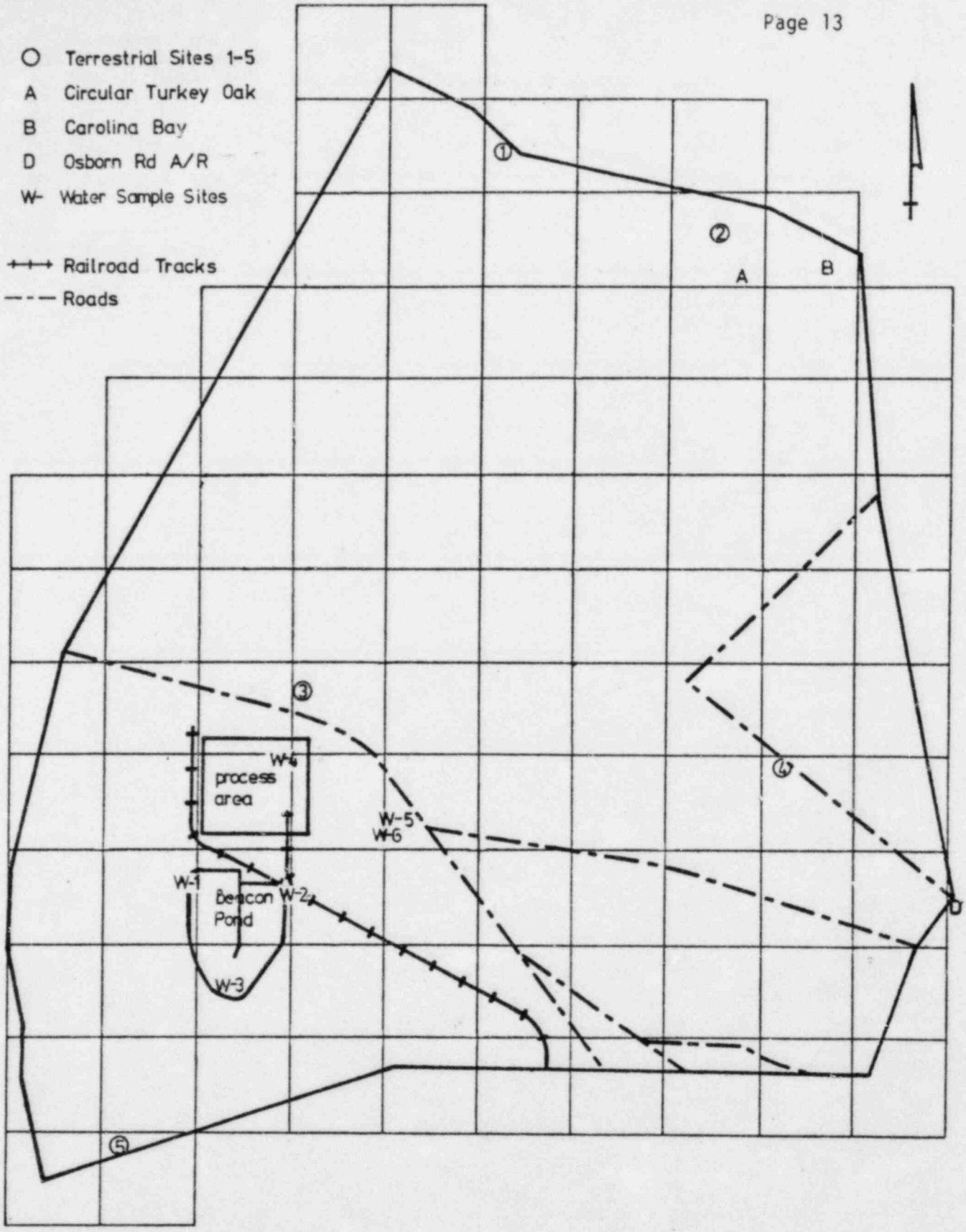

Figure 1: On-Site Stations for <u>In Situ</u> Gamma Ray Spectroscopy, and Water Sample Sites, BNFP, October 1983.

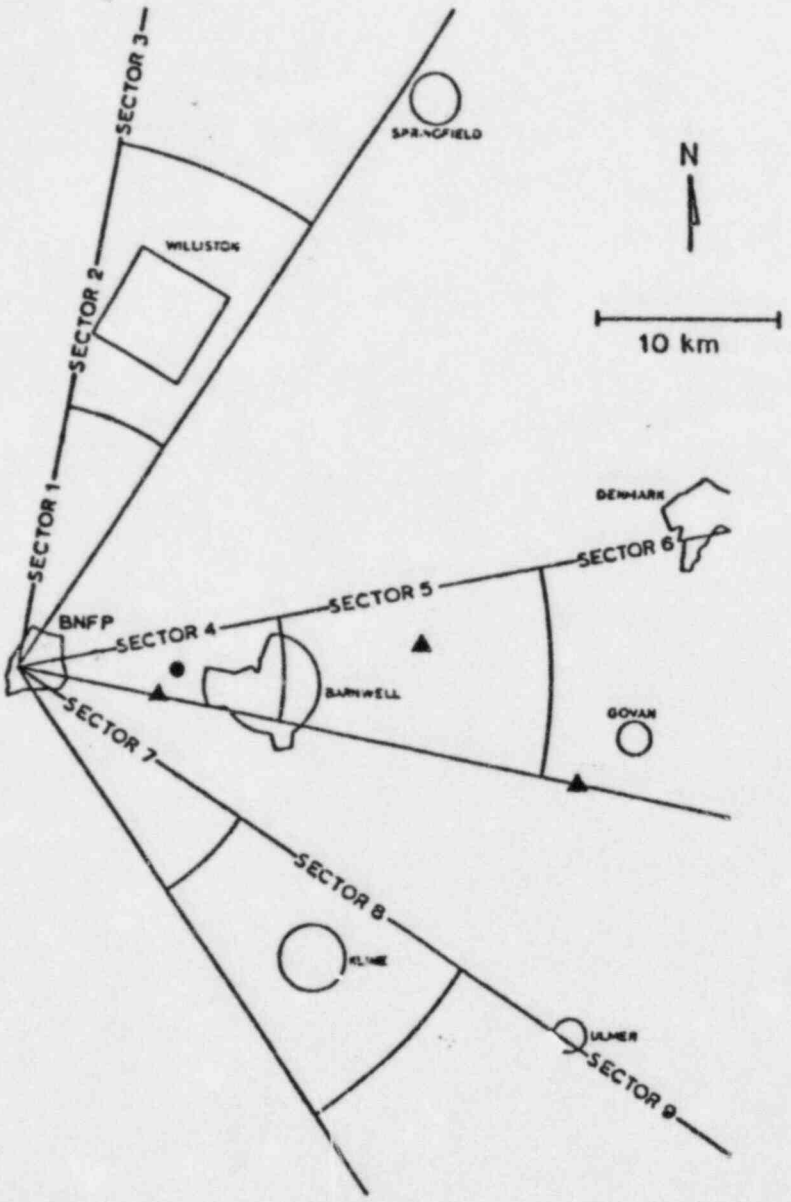

Figure 2: Off-Site Stations for In Situ Gamma Ray Spectroscopy, BNFP, October 1983.

● - Natural Station 1

▲ - Forest Soil Litter Stations

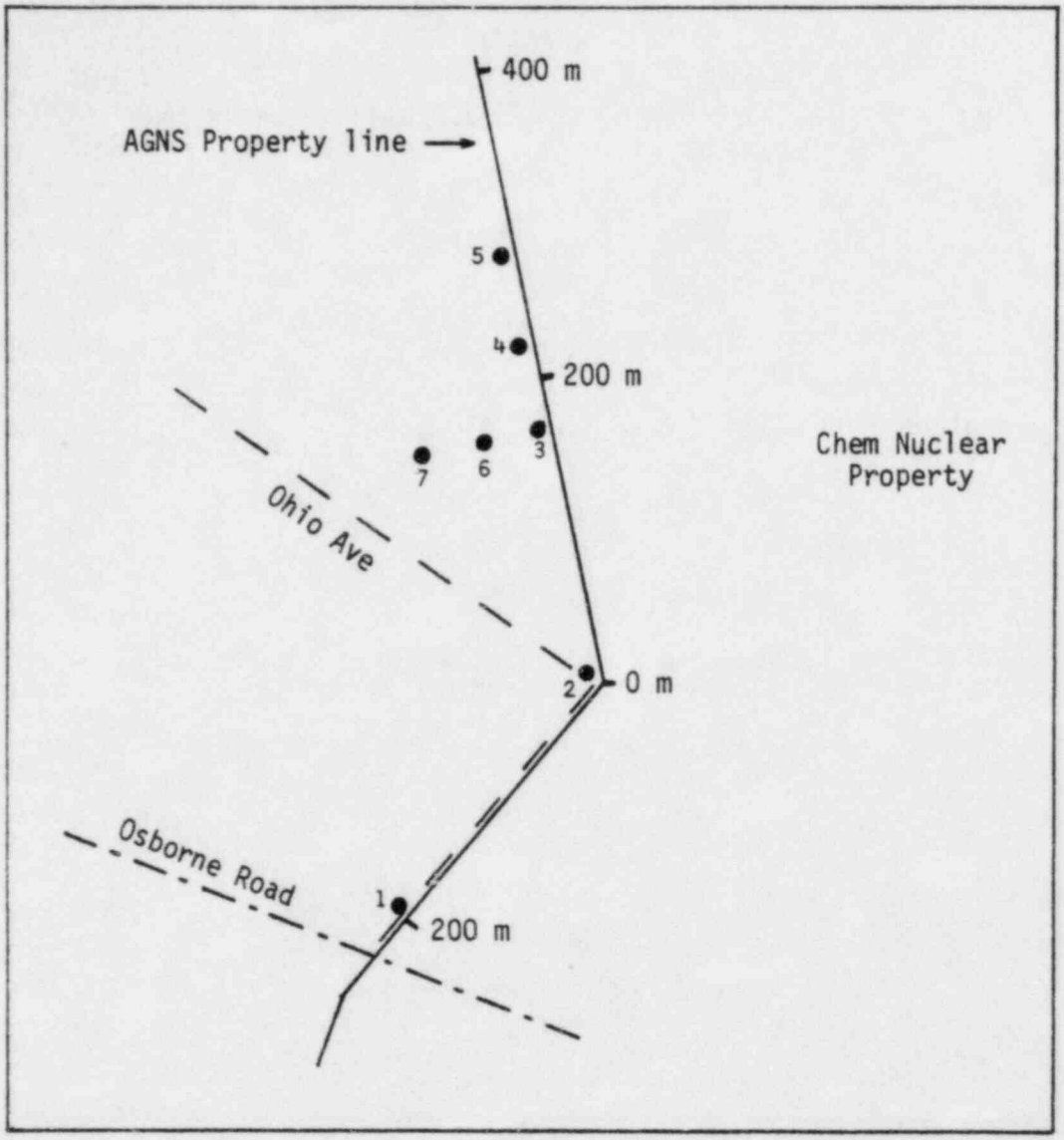

Figure 3: Soil and Litter/Humus Sampling Locations in the Vicinity of the Osborne Road Air/Rain Station, BNFP, January, 1984

Table 1

Abbreviations of Site Names for October 1983 *In Situ* Investigation in the Vicinity of BNFP

Station	Abreviation
Terrestrial Station 1	TS1
Terrestrial Station 2	TS2
Terrestrial Station 3	TS3
Terrestrial Station 4	TS4
Terrestrial Station 5	TS5
Circular Turkey Oak	CTO
Carolina Bay	CB
Osborne Road A/R	OR
Natural Station 1	NS1
Forest Soil Litter 4	FSL4
Forest Soil Litter 5	FSL5
Forest Soil Litter 6	FSL6

Table 2

Summary

Soil Core Composites

BNFP October 1983

pCi/gm

All stations except Osborn Road

SAMPLE TYPE: SOIL*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
226RA	0.5493E+00	0.2181E+00	11/ 11	0.1064E+01	0.3294E+00
214PB	0.4698E+00	0.1593E+00	11/ 11	0.8951E+00	0.3339E+00
232TH	0.5481E+00	0.1562E+00	11/ 11	0.8330E+00	0.3343E+00
137CS	0.7773E+00	0.2539E+00	11/ 11	0.1337E+01	0.3880E+00
228AC	0.5912E+00	0.1701E+00	11/ 11	0.9246E+00	0.3452E+00
40K	0.4232E+00	0.2490E+00	11/ 11	0.1138E+01	0.2495E+00

Table 3

Summary

Soil Core Composites

Terrestrial Stations 1-5

BNFP October 1983

pCi/gm

SAMPLE TYPE: SOIL*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
226RA	0.6270E+00	0.2850E+00	5/ 5	0.1064E+01	0.3372E+00
214PB	0.5448E+00	0.2104E+00	5/ 5	0.8951E+00	0.3929E+00
232TH	0.6148E+00	0.1535E+00	5/ 5	0.8330E+00	0.4560E+00
137CS	0.7480E+00	0.1712E+00	5/ 5	0.1019E+01	0.5522E+00
228AC	0.6563E+00	0.1614E+00	5/ 5	0.9246E+00	0.5267E+00
40K	0.5110E+00	0.3522E+00	5/ 5	0.1138E+01	0.3253E+00

Table 4

Summary

Soil Core Composites

Forest-Soil-Litter (FSL) Stations 4-6

BNFP October 1983

pCi/gm

SAMPLE TYPE: SOIL*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
226RA	0.4239E+00	0.1589E-01	3/ 3	0.4367E+00	0.4061E+00
214PB	0.3731E+00	0.4265E-01	3/ 3	0.4185E+00	0.3339E+00
232TH	0.3887E+00	0.5496E-01	3/ 3	0.4442E+00	0.3343E+00
137CS	0.6996E+00	0.2886E+00	3/ 3	0.9576E+00	0.3880E+00
228AC	0.4202E+00	0.6624E-01	3/ 3	0.4706E+00	0.3452E+00
40K	0.3450E+00	0.1220E+00	3/ 3	0.4824E+00	0.2495E+00

Table 5

Summary

Litter and Humus Composites
BNFP October 1983

pCi/gm
All stations except Osborn Road

SAMPLE TYPE: LITTER*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
144CE	0.1282E+00	0.3390E-01	7/ 11	0.1589E+00	0.7192E-01
226RA	0.3805E+00	0.1560E+00	11/ 11	0.7160E+00	0.1768E+00
214PB	0.3142E+00	0.8839E-01	11/ 11	0.5226E+00	0.2228E+00
7BE	0.1431E+01	0.4044E+00	11/ 11	0.2068E+01	0.6021E+00
232TH	0.3536E+00	0.7514E-01	11/ 11	0.5242E+00	0.2632E+00
137CS	0.1880E+01	0.4431E+00	11/ 11	0.2633E+01	0.1077E+01
228AC	0.3989E+00	0.9665E-01	11/ 11	0.6088E+00	0.2901E+00
60CO	0.2289E-01	0.1280E-01	3/ 11	0.3607E-01	0.1050E-01
40K	0.6762E+00	0.2008E+00	11/ 11	0.1118E+01	0.4755E+00
125SB	0.4949E-01	0.5756E-02	7/ 11	0.5586E-01	0.4250E-01

Table 6

Summary

Litter and Humus Composites

Terrestrial Stations 1-5

BNFP October 1983

pCi/gm

SAMPLE TYPE: LITTER*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
144CE	0.1146E+00	0.6030E-01	2/ 5	0.1572E+00	0.7192E-01
226RA	0.4298E+00	0.1819E+00	5/ 5	0.7160E+00	0.2716E+00
214PB	0.3327E+00	0.1095E+00	5/ 5	0.5226E+00	0.2543E+00
125SB	0.4853E-01	0.5518E-02	4/ 5	0.5586E-01	0.4250E-01
7BE	0.1463E+01	0.3632E+00	5/ 5	0.2068E+01	0.1201E+01
232TH	0.3701E+00	0.9634E-01	5/ 5	0.5242E+00	0.2759E+00
137CS	0.1761E+01	0.6080E+00	5/ 5	0.2633E+01	0.1077E+01
228AC	0.4135E+00	0.1308E+00	5/ 5	0.6088E+00	0.2901E+00
40K	0.6682E+00	0.2640E+00	5/ 5	0.1118E+01	0.4755E+00
60CO	0.2209E-01	0.0000E+00	1/ 5	0.2209E-01	0.2209E-01

Table 7

Summary

Litter and Humus Composites

Forest-Soil-Litter (FSL) Stations 4-6

BNFP October 1983

pCi/gm

SAMPLE TYPE: LITTER*

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
144CE	0.1329E+00	0.3670E-01	2/ 3	0.1589E+00	0.1070E+00
226RA	0.3969E+00	0.1616E+00	3/ 3	0.5280E+00	0.2163E+00
214PB	0.3582E+00	0.5029E-01	3/ 3	0.3877E+00	0.3001E+00
7BE	0.1250E+01	0.5961E+00	3/ 3	0.1775E+01	0.6021E+00
232TH	0.3670E+00	0.5756E-01	3/ 3	0.4269E+00	0.3121E+00
137CS	0.2019E+01	0.3094E+00	3/ 3	0.2231E+01	0.1664E+01
228AC	0.4086E+00	0.5726E-01	3/ 3	0.4690E+00	0.3551E+00
60CO	0.1050E-01	0.0000E+00	1/ 3	0.1050E-01	0.1050E-01
40K	0.7725E+00	0.1667E+00	3/ 3	0.9460E+00	0.6136E+00
125SB	0.4838E-01	0.8004E-02	2/ 3	0.5404E-01	0.4272E-01

Table 8

Summary

Soil Core Composites

Osborne Road Air/Rain Station

BNFP January 1984

pCi/g

SAMPLE TYPE: *SOIL*

SPECIES: *
REMARKS: *

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
226RA	0.6487E+00	0.1704E+00	7/ 7	0.9375E+00	0.4109E+00
214PB	0.5144E+00	0.1014E+00	7/ 7	0.6544E+00	0.3628E+00
7BE	0.7902E-01	0.0000E+00	1/ 7	0.7902E-01	0.7902E-01
232TH	0.6858E+00	0.1658E+00	7/ 7	0.9389E+00	0.4664E+00
137CS	0.7785E+00	0.5384E+00	7/ 7	0.1859E+01	0.1961E+00
228AC	0.7664E+00	0.1897E+00	7/ 7	0.1039E+01	0.5097E+00
40K	0.8514E+00	0.5031E+00	7/ 7	0.1635E+01	0.3632E+00
60CO	0.2658E+00	0.2367E+00	6/ 7	0.6076E+00	0.1263E-01
134CS	0.2107E-01	0.1445E-01	4/ 7	0.3368E-01	0.8382E-02

Table 9

Concentrations of Radionuclides in Soil at Sites in the Vicinity of New Osborne Road Air Rain Station

January, 1984

pCi/gm-dry wt

Site	60Co	134Cs	137Cs	7Be
1	-	-	0.20+/-0.01	0.08+/-0.03
2	0.013+/-0.003	-	0.31+/-0.02	-
3	0.61+/-0.03	0.034+/-0.008	0.75+/-0.04	-
4	0.20+/-0.01	0.008+/-0.005	0.72+/-0.04	-
5	0.43+/-0.02	0.009+/-0.006	0.76+/-0.04	-
6	0.34+/-0.02	0.033+/-0.009	1.9+/-0.1	-
7	0.014+/-0.003		0.85+/-0.05	-

Table 10

Summary

Litter and Humus Composites

Osborne Road Air/Rain Station

BNFP January 1984

pCi/g

SAMPLE TYPE: *LITTER*

SPECIES: *
REMARKS: *

NUCLIDE	MEAN	STD DEV	FREQUENCY	MAXIMUM	MINIMUM
226RA	0.5801E+00	0.3464E+00	6/ 6	0.1130E+01	0.2854E+00
214PB	0.4122E+00	0.2212E+00	6/ 6	0.7864E+00	0.1661E+00
7BE	0.5627E+01	0.3294E+01	6/ 6	0.8753E+01	0.1211E+01
232TH	0.5947E+00	0.3350E+00	6/ 6	0.1090E+01	0.2556E+00
137CS	0.7065E+00	0.5193E+00	6/ 6	0.1394E+01	0.2288E+00
228AC	0.7545E+00	0.4627E+00	6/ 6	0.1378E+01	0.2429E+00
60CO	0.4513E+00	0.3573E+00	6/ 6	0.8676E+00	0.7669E-01
40K	0.1721E+01	0.1694E+01	6/ 6	0.4856E+01	0.5870E+00
134CS	0.4615E-01	0.5398E-01	2/ 6	0.8432E-01	0.7987E-02
54MN	0.1588E-01	0.4985E-02	2/ 6	0.1941E-01	0.1236E-01
144CE	0.1102E+00	0.0000E+00	1/ 6	0.1102E+00	0.1102E+00
141CE	0.1900E-01	0.0000E+00	1/ 6	0.1900E-01	0.1900E-01
125SB	0.4978E-01	0.0000E+00	1/ 6	0.4978E-01	0.4978E-01
65ZN	0.3370E-01	0.0000E+00	1/ 6	0.3370E-01	0.3370E-01

Table 11

Concentrations of Radionuclides in Litter and Humus at Sites in the Vicinity of New Osborne Road Air Rain Station

January, 1984

pCi/gm-dry wt

Site	60Co	134Cs	137Cs	7Be
1	0.104+/-0.009	-	0.23+/-0.01	8.1+/-0.4
2	0.077+/-0.009	-	0.23+/-0.02	3.9+/-0.2
3 *				
4	0.60+/-0.03	0.008+/-0.006	0.52+/-0.03	8.7+/-0.5
5	0.82+/-0.04	-	0.55+/-0.03	3.1+/-0.2
6	0.87+/-0.05	0.08+/-	1.31+/-0.07	8.8+/-0.5
7	0.24+/-0.02	-	1.39+/-0.07	1.2+/-0.1

* No Litter and Humus sample collected this site.

Table 11 Continued

Concentrations of Radionuclides in Litter and Humus at
Sites in the Vicinity of New Osborne Road Air Rain Station

January, 1984

pCi/gm-dry wt

Site	54Mn	141Ce	144Ce	125Sb
1	-	-	-	-
2	-	-	-	-
3 *				
4	-	-	-	-
5 ③	-	-	-	-
6	0.019+/-0.009	-	-	-
7	0.012+/-0.005	0.019+/-0.009	0.11+/-0.03	0.05+/-0.01

* No litter and Humus sample collected at this site.

③ 65Zn detected at Site 5 -- 0.034+/-0.009 pCi/g-dry wt.

Table 12

GAMMA-EMITTERS IN FOREST LITTER

AT THE OSBORN ROAD AIR/RAIN STATION
June, 1976 - November 1977
pCi/g

	^{7}Be	^{40}K	^{54}Mn	^{60}Co	^{95}Zr	^{103}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
Mean[a]	9.1	5.0	0.20	2.1	1.0	0.55	0.40	2.0	0.95	1.8
se	1.47	-	0.026	0.62	0.21	0.05	0.195	0.10	0.029	0.32
Frequency of Detection	5/5	1/5	3/5	5/5	5/5	4/5	2/5	5/5	4/5	5/5

a) Means calculated on basis of detectable values which are given as the numerator value in Frequency of Detection.

Table 13

Activity of 7Be Measured by *In Situ* Gamma Ray Spectroscopy in the Vicinity of BNFP in October 1983

pCi/cm^2

Station①	Activity
TS1	0.6 +/- 0.1
TS2	0.4 +/- 0.1
TS3	0.3 +/- 0.1
TS4	0.1 +/- 0.1
TS5	0.3 +/- 0.1
CTO	0.5 +/- 0.2
CB	0.4 +/- 0.2
NS1	0.7 +/- 0.1
FSL4	0.4 +/- 0.1
FSL5	0.6 +/- 0.1
FSL6	0.4 +/- 0.1

① Legend appears in Table 1.

Table 14

Activity of 40K Measured by *In Situ* Gamma Ray Spectroscopy in the Vicinity of BNFP since 1975

pCi/gram

Station@	October 1983	1977-1979*	1976*	1975*
TS1	0.40 +/- 0.06	0.43	0.26	
TS2	0.32 +/- 0.06	0.33	0.35	0.31
TS3	0.39 +/- 0.06	0.49	0.38	0.24
TS4	0.47 +/- 0.07	0.50		0.37
TS5	0.9 +/- 0.1	0.9	0.8	1.2
CTO	0.45 +/- 0.06	0.45	0.38	0.38
CB	0.20 +/- 0.05	0.22	0.18	0.15
NS1	0.46 +/- 0.07		0.50	0.39
FSL4	0.45 +/- 0.07		0.58	0.45
FSL5	0.27 +/- 0.05		0.30	0.26
FSL6	0.40 +/- 0.06		0.15	0.31

@ Legend appears in Table 1.
* Mean of one or more measurements made during the calendar year.

Table 15

Activity of 214Pb Measured by *In Situ* Gamma Ray Spectroscopy in the Vicinity of BNFP since 1975

pCi/gram

Station①	October 1983	1977-1979*	1976*	1975*
TS1	0.46 +/- 0.04	0.5	0.48	
TS2	0.46 +/- 0.05	0.45	0.63	0.55
TS3	0.52 +/- 0.05	0.55	0.47	0.36
TS4	0.62 +/- 0.06	0.68		0.69
TS5	0.73 +/- 0.07	0.77	0.82	0.75
CTO	0.45 +/- 0.04	0.42	0.48	0.45
CB	0.55 +/- 0.05	0.63	0.48	0.63
NS1	0.84 +/- 0.07		0.71	0.59
FSL4	0.56 +/- 0.05		0.45	0.44
FSL5	0.48 +/- 0.05		0.37	0.38
FSL6	0.56 +/- 0.05		0.33	0.29

① Legend appears in Table 1.
* Mean of one or more measurements made during the calendar year.

Table 16

Activity of 232Th Measured by *In Situ* Gamma Ray Spectroscopy in the Vicinity of BNFP since 1975

pCi/gram

Station①	October 1983	1977-1979*	1976*	1975*
TS1	0.46 +/- 0.05	0.62	0.50	
TS2	0.52 +/- 0.05	0.55	0.54	0.75
TS3	0.51 +/- 0.05	0.50	0.46	0.44
TS4	0.66 +/- 0.06	0.74		0.57
TS5	0.74 +/- 0.07	0.85	0.81	0.86
CTO	0.50 +/- 0.05	0.51	0.52	0.50
CB	0.69 +/- 0.06	0.68	0.66	0.68
NS1	0.60 +/- 0.06		0.59	0.54
FSL4	0.42 +/- 0.04		0.49	0.40
FSL5	0.47 +/- 0.05		0.40	0.43
FSL6	0.35 +/- 0.04		0.22	0.20

① Legend appears in Table 1.
* Mean of one or more measurements made during the calendar year.

Table 17

Activity of 137Cs* Measured by *In Situ* Gamma Ray Spectroscopy in the Vicinity of BNFP since 1975

pCi/cm^2

Station@	October 1983	1977-1979#	1976#	1975#
TS1	7.8 +/- 0.7	5.3	11	
TS2	6.7 +/- 0.6	9.7	12	11
TS3	7.5 +/- 0.6	11	11	11.2
TS4	6.2 +/- 0.5	9		10
TS5	6.5 +/- 0.6	7.4	8.9	10.2
CTO	7.8 +/- 0.7	11	12	11
CB	8.4 +/- 0.7	12	13	13
NS1	8.3 +/- 0.7		12	12.6
FSL4	7.2 +/- 0.6		12	12
FSL5	9.0 +/- 0.8		11	9.9
FSL6	7.0 +/- 0.6		12	11.9

* Distribution of 137Cs with depth is proportional to $\exp(-\alpha z)$ where α is taken to be 0.24 inverse cm.

@ Legend appears in Table 1.

\# Mean of one or more measurements made during the calendar year.

Table 18

Trends in Selected Radionuclides Measured by *In Situ* Gamma Ray Spectoscopy at the Osborne Road Air/Rain Station

	Isotope	Oct 83	Aug 79	Jul 79	Jul 78	Feb 77
pCi/cm^2	137Cs	#	14	8.3	10	9
	134Cs	3.6 +/- 0.4	1.6	1.4	1	0.7
	54Mn	1.4 +/- 0.2	2.1		.6	
	60Co	$	31	9.6	1.1	5
	58Co	15 +/- 1	*		*	
pCi/gm	40K	1.2 +/- 0.2	0.8	1.2	0.9	0.8
	214Pb	0.6 +/- 0.2	0.9	0.5	0.7	0.5
	232Th	0.8 +/- 0.2	0.7	0.6	0.6	0.6

\# The deposition of 137Cs of 210+/-17 pCi/cm^2 results from radiation sources on Chem-Nuclear property, not from soil contamination on the BNFP site.

$ The deposition of 60Co of 109+/-9 pCi/cm^2 is not due to sources in the soil but from radiation sources on Chem-Nuclear property. The deposition of 31 pCi/cm measured in 1979 is believed to be due to the same cause.

* Detected on these occasions, no data available.

Table 19

Terrestrial Exposure Rate Inferred from *In Situ* Measurements in the Vicinity of BNFP in October 1983

uR/hr

Station	Exposure Rate
Terrestrial Station 1	2.5 +/- 0.1
Terrestrial Station 2	2.7 +/- 0.2
Terrestrial Station 3	2.7 +/- 0.2
Terrestrial Station 4	3.3 +/- 0.2
Terrestrial Station 5	3.8 +/- 0.2
Circular Turkey Oak	2.6 +/- 0.2
Carolina Bay	3.3 +/- 0.2
Osborne Road A/R	57 +/- 5 *
Natural Station 1	3.6 +/- 0.3
Forest Soil Litter 4	2.6 +/- 0.1
Forest Soil Litter 5	2.6 +/- 0.2
Forest Soil Litter 6	2.4 +/- 0.1

* This value does not arise from soil contamination on the BNFP site but from radiation sources on Chem-Nuclear property.

Table 20

Analysis of Water Samples taken at BNFP in 1983

Analytical Results

Sample	Sample No.	Radioactivity level, pCi/L, Gross alpha	Gross beta	H-3
#1 Beacon Pond	S2290	< 5	< 5	< 200
#2 Beacon Pond	S2291	< 5	< 5	< 200
#3 Beacon Pond	S2292	< 5	< 5	< 200
#4 AGNS	S2293	8 ± 3	11 ± 3	7,600 ± 400
#5 AGNS	S2294	< 5	< 5	2,000 ± 300
#6 AGNS	S2295	< 5	9 ± 2	< 200

Notes:
1. Samples were filtered with 0.45-micron membrane filter and acidified with 1 ml conc. HNO_3 per liter. They were counted on November 18 - 19, 1983.
2. Sample S2293 was also measured by gamma-ray spectral analysis. No gamma rays from fission or activation products were detected (Cs-137 <20 pCi/L).
3. Measurements performed by Professor Bernd Kahn, Georgia Institute of Technology.

Appendix A

Equipment Description and *In Situ* Method

Appendix A

Equipment Description and *In Situ* Method

A.0 Equipment Description and Method

The method and evaluation of the *in situ* gamma-ray measurement technique have been published in several articles.[3,4,15] By placing a high resolution and high efficiency gamma-ray detector at the site from which environmental radiation data is required, the effective source intensity of that radiation is enlarged many times. Instead of analyzing a series of samples collected in the field and tediously processed in the laboratory, the entire site is analyzed in a few hours.

The detector used in this particular survey is a high resolution Ge(Li) downlooker with self-contained power supplies. All the other equipment, including the analyzer, amplifier and computer, is transported to the site in a rugged four-wheel drive truck especially configured for *in situ* work.

A.1 Equipment Description

A.1.1 Vehicle

The Mobile Environmental Radiation Laboratory consists of a 1975 GMC Jimmy truck with all the equipment necessary to accumulate and analyze *in situ* gamma-ray spectra. This vehicle is large enough to contain all the electronic gear and yet small enough to be completely maneuverable off the road. It is designed to operate in remote areas and is fitted with heavy-duty equipment wherever possible. A three inch thick bulkhead athwart the rear of the truck divides the cargo space into two sections, one at ambient temperature accessible through the tailgate, where the Ge(Li) detector is carried, and one inside the truck, where the electronic equip-

ment is located, maintained at room temperature by the vehicle air conditioner or heater as appropriate. On the ambient temperature side of the bulkhead is a 2.5 kilowatt generator which supplies 120 VAC for operating the electronic gear. It is shock mounted to the floor of the truck and exhausts through the open tailgate.

A.1.2 Detector and Electronic Equipment

The Ge(Li) detector is a Canberra 7229 downlooker with Canberra 970 preamplifier. It is mounted on a tripod 1 m above ground for in situ counting and is connected to the truck by a 30 m long coaxial cable carrying the energy signal. The preamplifier power and detector high voltage are supplied by batteries which hang from a yoke attached to the detector dewar. The absence of the usual high voltage and power cables eliminates ground loops and increases the energy resolution.

The electronic components are installed in a cut down, shock mounted relay rack in the air conditioned part of the truck. These include a 4096 channel Northern Scientific NS-720 multichannel analyzer, Northern Scientific NS-442 calculator interface, Hewlett-Packard 9810A desk top calculator, Hewlett-Packard 9865A cassette memory, and a Canberra 1413 linear amplifier. This equipment has been adapted to fit the requirements of the Mobile Laboratory, rather than having been purchased specifically for in situ work. The detector, calculator, and analyzer are used for fixed geometry counting in the laboratory while the truck is not actually in the field.

A.1.3 Method

The analysis of each gamma-ray spectrum is performed by a Hewlett Packard microcomputer. The calculator is interfaced to the multichannel analyzer through a Northern Scientific NS-422 two-way calculator interface. The guiding principle is that the complete analysis be performed on-site in as short a time as possible. It is thought that this capability is unique. The software system consists of programs recorded on a tape cassette in their exact order of use so that no time is lost in tape transport, and tape commands are held to the minimum. The analysis is initiated and controlled by the operator, leaving the calculator free for other use during spectrum accumulation.

Prior to each analysis a two point energy calibration is made, using the in situ spectrum just acquired. Experience has shown this to be necessary due to gain shifts caused by temperature changes inside the truck. The energy calibration requires about 1 minute to complete.

The analysis program calculates the intensity of each photopeak in the spectrum and the activity and gamma-ray exposure rate for each isotope in the library.

The intensities of the 352 keV ^{214}Pb line and 583 keV ^{208}Tl line are stored for use in the interference correction described below. The peak detection subroutine closely follows that developed by Wood and Palms (1974), with the addition that a limit of sensitivity, denoted LOSI, is given by $2\sqrt{\Sigma N}$, where ΣN is the sum of the points in the continuum if a peak is detected or ΣN is the sum of six points at the peak position if it is not detected but is in the library. This subroutine will resolve peaks only four channels apart. For each peak the output, which may be suppressed, is energy, centroid, number of channels in the peak, intensity, and error in intensity.

A library search is performed for each peak detected. If successful, the activity, A, error, ΔA, and Minimum Detectable Activity, MDA, are output.

The activity is given by

$$A = \frac{I - kI_i}{4\pi\varepsilon T\ 0.037\Gamma\phi_c(\frac{\alpha}{\rho})\ell} = \frac{I - kI_i}{b} \qquad (1)$$

where I = Intensity (counts in photopeak)

I_i = Interference Intensity

T = Count time

ℓ = Height of detector above ground

ε = Absolute efficiency of detector

$0.037\Gamma\phi_c(\frac{\alpha}{\rho})$ = Conversion from flux to pCi/cm^2 or pCi/g

k = Interference factor

ρ = Soil density

α = Relaxation length of exponentially distributed source activity with soil depth

Γ = Gamma fraction

0.037 = Disintegrations/sec/pCi

The considerations leading to the above equation are given by Beck et al. (1972), along with a more general discussion of the problem than is desirable here. The value of $\phi_c(\frac{\alpha}{\rho})$ used above is obtained by fitting curves to the data given in Table 1 of HASL-258. The curves are of the form

$$\phi_c(\tfrac{\alpha}{\rho}) = e^{-\{e^{b_1(\frac{\alpha}{\rho})^{m_1}}\}_w \{e^{b_2(\frac{\alpha}{\rho})^{m_2}}\}}, \quad 0 < \alpha < \infty \qquad (2)$$

$$\phi_c(\tfrac{\alpha}{\rho}) = e^{b_\infty w^{m_\infty}}, \qquad \alpha = \infty \qquad (3)$$

$$\phi_c(0) = \text{tabulated}, \qquad \alpha = 0 \qquad (4)$$

where w = energy in keV. $\alpha = 0$ corresponds to a source distributed uniformly in the soil, in which case A has units of pCi/gram. $\alpha = \infty$ is a plane source. Otherwise an exponential distribution with depth is assumed, with

a relaxation length of $\frac{1}{\alpha}$. $\underline{A}$ has units pCi/cm^2 in these cases ($\alpha \neq 0$). The interference factor is given by

$$k = \frac{\varepsilon\Gamma\phi_c(0) \text{ interferring line, i.e., 665.6 keV } ^{214}\text{Bi}}{\varepsilon\Gamma\phi_c(0) \text{ interference series, i.e., 352 keV } ^{214}\text{Pb}}. \quad (5)$$

This is the fraction of the intensity of, for example, the 352 keV ^{214}Pb line to be subtracted from the 661.6 keV ^{137}Cs line to correct for interference from the 665.6 keV ^{214}Bi line. The error in the activity is

$$\Delta A = \frac{\{\Delta I^2 + (0.07I)^2 + (k\Delta I_i)^2 + (0.03I)^2\}^{1/2}}{b} \quad (6)$$

where ΔI is the statistical error in the photopeak integration, 0.07I is an estimate of the error introduced in the efficiency calibration and curve fitting, $k\Delta I_i$ is the error in the interference subtraction and 0.03I is an estimate of the effect of a reasonable error in soil density determination. $\underline{b}$ is the denominator in equation (1). The Minimum Detectable Activity, calculated for each isotope in the library whether detected or not, is given by

$$MDA = \frac{LOSI}{b}. \quad (7)$$

The gamma-ray exposure rate, ER, for each isotope or decay chain as appropriate, is also calculated. The exposure rate in μR/hr is

$$ER = A\phi_E\left(\frac{\alpha}{\rho}\right) \quad (8)$$

where $\phi_E(\frac{\alpha}{\rho})$ is obtained from Tables 8 and 9 of HASL-258. These data are fit to curves of the form

$$\phi_E\left(\frac{\alpha}{\rho}\right) = e^{b_3\left(\frac{\alpha}{\rho}\right)^{m_3}}, \qquad 0 < \alpha < \infty. \quad (9)$$

$\phi_E(\frac{\alpha}{\rho})$ is tabulated for $\alpha = 0$ and $\alpha = \infty$. The error in the exposure rate

includes a five percent calibration term. A Minimum Detectable Exposure Rate (MDER) is also provided.

Peaks with a right hand continuum which rose above the threshold, that is, did not decrease monotonically, are flagged. This may indicate poor statistics or the presence of another peak which was missed in the scan. In these cases a program which allows the continuum to be specified by the operator is used and the calculation proceeds as described. Spectra can be stored on tape cassettes and reloaded into the multichannel analyzer at a later time. Other programs print sections of the spectrum, calculate efficiency and alter the isotope library. The absolute efficiency of the detector is given by

$$E(w) = \{1 - e^{(e_1+e_2\ln(w))}\}\{e^{(e_3+e_4\ln(w))}\} \qquad (10)$$

where e_1, e_2, e_3, and e_4 are measured and w is the energy in keV.

Appendix B

Sample Analysis Reports for Soil Collected at all Stations except Osborne Road Air/Rain Station

October 1983

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS1S
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 1
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
322 1983	789.5900 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.5	+/-	0.1
214PB	0.45	+/-	0.03
232TH	0.51	+/-	0.03
137CS	0.77	+/-	0.04
228AC	0.54	+/-	0.04
40K	0.34	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS2S
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 2
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
320 1983	773.5900 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.3	+/-	0.1
214PB	0.40	+/-	0.03
232TH	0.57	+/-	0.04
137CS	1.02	+/-	0.05
228AC	0.61	+/-	0.04
40K	0.33	+/-	0.05

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS3S
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 3
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
320 1983	875.2900 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.5	+/-	0.1
214PB	0.39	+/-	0.02
232TH	0.46	+/-	0.03
137CS	0.55	+/-	0.03
228AC	0.53	+/-	0.04
40K	0.34	+/-	0.05

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS4S
COLLECTED: 301 1983
STATION: TERRESTRIAL STATION 4
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
321 1983	776.7500 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.2
214PB	0.59	+/-	0.03
232TH	0.71	+/-	0.04
137CS	0.71	+/-	0.04
228AC	0.68	+/-	0.05
40K	0.41	+/-	0.07

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS5S
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 5
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
321 1983	702.7100 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	1.1	+/-	0.2
214PB	0.90	+/-	0.05
232TH	0.83	+/-	0.05
137CS	0.69	+/-	0.04
228AC	0.92	+/-	0.06
40K	1.1	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: CTOS
COLLECTED: 301 1983
STATION: CIRCULAR TURKEY OAK
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
319 1983	809.0700 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.3	+/-	0.1
214PB	0.34	+/-	0.02
232TH	0.46	+/-	0.03
137CS	0.62	+/-	0.03
228AC	0.50	+/-	0.04
40K	0.28	+/-	0.05

SAMPLE ANALYSIS REPORT

SAMPLE CODE: CBS
COLLECTED: 300 1983
STATION: CAROLINA BAY
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
321 1983	711.1800 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.2
214PB	0.50	+/-	0.03
232TH	0.74	+/-	0.05
137CS	1.34	+/-	0.07
228AC	0.83	+/-	0.05
40K	0.31	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: NS1S
COLLECTED: 301 1983
STATION: NATURAL STATION 1
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
320 1983	851.0900 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.6	+/-	0.1
214PB	0.48	+/-	0.03
232TH	0.58	+/-	0.04
137CS	0.75	+/-	0.04
228AC	0.63	+/-	0.04
40K	0.48	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL43
COLLECTED: 302 1983
STATION: FSL 4
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
322 1983	764.5500 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.37	+/-	0.02
232TH	0.39	+/-	0.03
137CS	0.96	+/-	0.05
228AC	0.44	+/-	0.03
40K	0.48	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL5S
COLLECTED: 302 1983
STATION: FSL 5
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
320 1983	794.8600 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.33	+/-	0.02
232TH	0.44	+/-	0.03
137CS	0.75	+/-	0.04
228AC	0.47	+/-	0.03
40K	0.30	+/-	0.05

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL6S
COLLECTED: 302 1983
STATION: FSL 6
LOCATION: BNFP
SAMPLE TYPE: SOIL CORE COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
319 1983	807.1600 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.42	+/-	0.03
232TH	0.33	+/-	0.02
137CS	0.39	+/-	0.02
228AC	0.35	+/-	0.03
40K	0.25	+/-	0.05

Appendix C

Sample Analysis Reports for Litter/Humus Collected at all Stations except Osborne Road Air/Rain Station

October 1983

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS1LH
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 1
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
322 1983	308.9000 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.25	+/-	0.02
7BE	1.2	+/-	0.1
232TH	0.28	+/-	0.03
137CS	1.81	+/-	0.09
228AC	0.31	+/-	0.03
40K	0.58	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS2LH
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 2
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
323 1983	484.2200 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.16	+/-	0.03
226RA	0.3	+/-	0.1
214PB	0.27	+/-	0.02
125SB	0.05	+/-	0.01
7BE	2.1	+/-	0.1
232TH	0.39	+/-	0.03
137CS	2.6	+/-	0.1
228AC	0.48	+/-	0.03
40K	0.49	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS3LH
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 3
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
324 1983	482.7000 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.07	+/-	0.02
226RA	0.5	+/-	0.1
214PB	0.32	+/-	0.02
125SB	0.05	+/-	0.01
7BE	1.20	+/-	0.09
232TH	0.36	+/-	0.03
137CS	2.0	+/-	0.1
228AC	0.38	+/-	0.03
40K	0.48	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS4LH
COLLECTED: 301 1983
STATION: TERRESTRIAL STATION 4
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
325 1983	303.3000 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.3	+/-	0.1
214PB	0.30	+/-	0.02
125SB	0.06	+/-	0.01
7BE	1.5	+/-	0.1
232TH	0.31	+/-	0.03
137CS	1.08	+/-	0.06
228AC	0.29	+/-	0.03
60CO	0.022	+/-	0.005
40K	0.68	+/-	0.09

SAMPLE ANALYSIS REPORT

SAMPLE CODE: TS5LH
COLLECTED: 300 1983
STATION: TERRESTRIAL STATION 5
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
323 1983	402.8800 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.1
214PB	0.52	+/-	0.03
125SB	0.04	+/-	0.01
7BE	1.3	+/-	0.1
232TH	0.52	+/-	0.04
137CS	1.31	+/-	0.07
228AC	0.61	+/-	0.04
40K	1.1	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: CTOLH
INSTALLED: 301 1983
COLLECTED: 302 1983
STATION: CIRCULAR TURKEY OAK
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
325 1983	337.1400 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.16	+/-	0.04
226RA	0.2	+/-	0.1
214PB	0.22	+/-	0.02
125SB	0.06	+/-	0.01
7BE	1.4	+/-	0.1
232TH	0.31	+/-	0.03
137CS	2.1	+/-	0.1
228AC	0.33	+/-	0.03
40K	0.54	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: CBLH
COLLECTED: 300 1983
STATION: CAROLINA BAY
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NE+JELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
325 1983	285.9600 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.14	+/-	0.04
226RA	0.3	+/-	0.2
214PB	0.26	+/-	0.02
7BE	2.0	+/-	0.1
232TH	0.37	+/-	0.03
137CS	2.1	+/-	0.1
228AC	0.46	+/-	0.04
60CO	0.036	+/-	0.007
40K	0.7	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: NS1LH
INSTALLED: 301 1983
COLLECTED: 302 1983
STATION: NATURAL STATION 1
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
321 1983	271.0300 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.10	+/-	0.03
226RA	0.3	+/-	0.1
214PB	0.23	+/-	0.02
7BE	1.3	+/-	0.1
232TH	0.26	+/-	0.03
137CS	1.62	+/-	0.08
228AC	0.31	+/-	0.03
40K	0.53	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL4LH
COLLECTED: 302 1983
STATION: FSL 4
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
324 1983	366.2100 GRAM	47638. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.11	+/-	0.02
226RA	0.5	+/-	0.1
214PB	0.39	+/-	0.02
7BE	1.8	+/-	0.1
232TH	0.36	+/-	0.03
137CS	2.2	+/-	0.1
228AC	0.40	+/-	0.03
60CO	0.011	+/-	0.003
40K	0.95	+/-	0.09

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL5LH
COLLECTED: 302 1983
STATION: FSL 5
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
325 1983	353.4800 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.16	+/-	0.03
226RA	0.2	+/-	0.1
214PB	0.30	+/-	0.02
125SB	0.05	+/-	0.02
7BE	1.4	+/-	0.1
232TH	0.43	+/-	0.03
137CS	2.2	+/-	0.1
228AC	0.47	+/-	0.04
40K	0.76	+/-	0.09

SAMPLE ANALYSIS REPORT

SAMPLE CODE: FSL6LH
COLLECTED: 302 1983
STATION: FSL 6
LOCATION: BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
324 1983	480.4600 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.39	+/-	0.02
125SB	0.04	+/-	0.01
7BE	0.60	+/-	0.06
232TH	0.31	+/-	0.03
137CS	1.66	+/-	0.09
228AC	0.36	+/-	0.03
40K	0.61	+/-	0.07

Appendix D

Sample Analysis Reports for Soil Collected in the Vicinity of Osborne Road Air/Rain Station

January 1984

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS1
COLLECTED: 28 1984
LOCATION: TELEPHONE POLE AT O.R. & C.N. ROAD NEAR GATE
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
39 1984	927.2000 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.6	+/-	0.1
214PB	0.50	+/-	0.03
7BE	0.08	+/-	0.03
232TH	0.69	+/-	0.04
137CS	0.20	+/-	0.01
228AC	0.67	+/-	0.04
40K	0.39	+/-	0.06

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS2
COLLECTED: 28 1984
LOCATION: BEND OF C.N. ROAD WHERE OHIO ROAD INTERSECTS
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
39 1984	898.9000 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.1
214PB	0.56	+/-	0.03
232TH	0.73	+/-	0.04
137CS	0.31	+/-	0.02
228AC	0.82	+/-	0.05
60CO	0.013	+/-	0.003
40K	0.87	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS3
COLLECTED: 28 1984
LOCATION: NEW OSBORNE ROAD A/R
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
37 1984	822.0200 GRAM	21600. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.1
214PB	0.55	+/-	0.03
232TH	0.75	+/-	0.04
137CS	0.75	+/-	0.04
134CS	0.034	+/-	0.008
228AC	0.85	+/-	0.05
60CO	0.61	+/-	0.03
40K	1.4	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS4
COLLECTED: 28 1984
LOCATION: APPROX 60 M FROM NEW O.R. A/R ON C.N. ROAD
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
39 1984	844.9000 GRAM	21600. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.5	+/-	0.1
214PB	0.40	+/-	0.02
232TH	0.47	+/-	0.03
137CS	0.72	+/-	0.04
134CS	0.008	+/-	0.005
228AC	0.57	+/-	0.04
60CO	0.20	+/-	0.01
40K	0.45	+/-	0.05

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS5
COLLECTED: 28 1984
LOCATION: APPROX 120 M FROM NEW O.R. A/R ON C.N. ROAD
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
38 1984	731.8300 GRAM	21600. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.7	+/-	0.1
214PB	0.56	+/-	0.03
232TH	0.74	+/-	0.04
137CS	0.76	+/-	0.04
134CS	0.009	+/-	0.006
228AC	0.91	+/-	0.05
60CO	0.43	+/-	0.02
40K	0.87	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS6
COLLECTED: 28 1984
LOCATION: APPROX 40 M FROM NEW O.R. A/R TOWARD BNFP
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
40 1984	689.6500 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.9	+/-	0.2
214PB	0.65	+/-	0.04
232TH	0.94	+/-	0.06
137CS	1.9	+/-	0.1
134CS	0.033	+/-	0.009
228AC	1.04	+/-	0.07
60CO	0.34	+/-	0.02
40K	1.6	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORS7
COLLECTED: 28 1984
LOCATION: APPROX 80 M FROM NEW O.R. A/R TOWARD BNFP
SAMPLE TYPE: SOIL COMPOSITE
REMARKS: 0-5 CM

DETECTOR: BIGJELLY
GEOMETRY: MS

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
40 1984	817.0300 GRAM	14400. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.36	+/-	0.02
232TH	0.48	+/-	0.03
137CS	0.85	+/-	0.05
228AC	0.51	+/-	0.04
60CO	0.014	+/-	0.003
40K	0.36	+/-	0.06

Appendix E

Sample Analysis Reports for Litter/Humus Collected in the Vicinity of Osborne Road Air/Rain Station

January 1984

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH1
COLLECTED: 28 1984
LOCATION: TELEPHONE POLE AT O.R. & C.N. ROAD NEAR GATE
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
39 1984	422.5000 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.5	+/-	0.1
214PB	0.39	+/-	0.02
7BE	8.1	+/-	0.4
232TH	0.44	+/-	0.03
137CS	0.23	+/-	0.01
228AC	0.54	+/-	0.04
60CO	0.104	+/-	0.009
40K	0.64	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH2
COLLECTED: 28 1984
LOCATION: BEND OF C.N. ROAD WHERE OHIO ROAD INTERSECTS
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
39 1984	384.4600 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	1.1	+/-	0.2
214PB	0.79	+/-	0.04
7BE	3.9	+/-	0.2
232TH	1.09	+/-	0.06
137CS	0.23	+/-	0.02
228AC	1.38	+/-	0.08
60CO	0.077	+/-	0.009
40K	4.9	+/-	0.3

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH4
COLLECTED: 28 1984
LOCATION: APPROX 60 M FROM NEW O.R. A/R ON C.N. ROAD
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
40 1984	362.0300 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.3	+/-	0.1
214PB	0.25	+/-	0.02
7BE	8.7	+/-	0.5
232TH	0.34	+/-	0.03
137CS	0.52	+/-	0.03
134CS	0.008	+/-	0.006
228AC	0.44	+/-	0.04
60CO	0.60	+/-	0.03
40K	0.59	+/-	0.08

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH5
COLLECTED: 28 1984
LOCATION: APPROX 120 M FROM NEW O.R. A/R ON C.N. ROAD
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
38 1984	427.4800 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.4	+/-	0.1
214PB	0.36	+/-	0.02
7BE	3.1	+/-	0.2
232TH	0.52	+/-	0.04
137CS	0.55	+/-	0.03
228AC	0.65	+/-	0.05
65ZN	0.034	+/-	0.009
60CO	0.82	+/-	0.04
40K	1.0	+/-	0.1

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH6
COLLECTED: 28 1984
LOCATION: APPROX 40 M FROM NEW O.R. A/R TOWARD BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: BIGJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
38 1984	287.8800 GRAM	21600. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
226RA	0.9	+/-	0.2
214PB	0.53	+/-	0.04
7BE	8.8	+/-	0.5
232TH	0.92	+/-	0.06
137CS	1.31	+/-	0.07
134CS	0.08	+/-	0.01
54MN	0.019	+/-	0.009
228AC	1.27	+/-	0.09
60CO	0.87	+/-	0.05
40K	2.5	+/-	0.2

SAMPLE ANALYSIS REPORT

SAMPLE CODE: ORLH7
COLLECTED: 28 1984
LOCATION: APPROX 80 M FROM NEW O.R. A/R TOWARD BNFP
SAMPLE TYPE: LITTER AND HUMUS COMPOSITE

DETECTOR: NEWJELLY
GEOMETRY: ML

DATE COUNTED	WEIGHT COUNTED	COUNT TIME
40 1984	319.4400 GRAM	28800. SEC

NUCLIDE	ACTIVITY PCI/GRAM		
144CE	0.11	+/-	0.03
141CE	0.019	+/-	0.009
226RA	0.3	+/-	0.1
214PB	0.17	+/-	0.02
125SB	0.05	+/-	0.01
7BE	1.2	+/-	0.1
232TH	0.26	+/-	0.02
137CS	1.39	+/-	0.07
54MN	0.012	+/-	0.005
228AC	0.24	+/-	0.03
60CO	0.24	+/-	0.02
40K	0.75	+/-	0.09

Appendix F

Representative Data from SRP's 1982 Report,
"Environmental Monitoring in the Vicinity of the
Savannah River Plant," Annual Report for 1982,
Report No. DPSPU-83-20-1

TABLE 5. RADIOACTIVITY IN AIR

ALPHA, PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	ARITHMETIC 2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	39	0.27	±0.10	0.02	±0.04	0.12	±0.12
A-14	41	0.28	±0.13	0.04	±0.04	0.12	±0.12
BARNWELL GATE	41	0.29	±0.12	0.02	±0.04	0.12	±0.12
D AREA	41	0.33	±0.14	-0.01	±0.02	0.09	±0.18
DARK HORSE	41	0.29	±0.11	0.02	±0.02	0.11	±0.14
EAST TALATHA	43	0.34	±0.13	0.03	±0.03	0.13	±0.14
GREENPOND	43	0.31	±0.08	0.03	±0.03	0.14	±0.14
HIGHWAY 21/167	41	0.39	±0.13	0.05	±0.03	0.14	±0.18
JACKSON	42	0.36	±0.13	0.04	±0.04	0.15	±0.16
PATTERSONS MILL	41	0.27	±0.10	0.01	±0.03	0.12	±0.12
TALATHA GATE	42	0.27	±0.10	0.00	±0.10	0.13	±0.14
WEST JACKSON	39	0.27	±0.13	0.03	±0.02	0.12	±0.12
WINDSOR ROAD	43	0.41	±0.14	0.00	±0.10	0.13	±0.14
AVERAGE						0.12	±0.14
25 MILE RADIUS							
AIKEN AIRPORT	44	0.42	±0.13	0.04	±0.05	0.14	±0.16
AIKEN STATE PARK	44	0.34	±0.14	0.04	±0.03	0.13	±0.14
ALLENDALE	44	0.30	±0.18	0.01	±0.02	0.09	±0.10
AUGUSTA	44	0.21	±0.08	0.00	±0.03	0.12	±0.10
HIGHWAY 301	44	0.33	±0.11	-0.02	±0.04	0.11	±0.16
LANGLEY	42	0.25	±0.10	0.03	±0.04	0.15	±0.12
LEES	44	0.38	±0.16	0.03	±0.05	0.12	±0.14
OLAR	43	0.32	±0.11	0.05	±0.05	0.13	±0.12
PERKINS	42	0.27	±0.10	0.01	±0.02	0.10	±0.10
SOUTH RICHMOND	44	0.32	±0.12	0.01	±0.03	0.13	±0.12
SPRINGFIELD	44	0.32	±0.11	0.00	±0.04	0.12	±0.12
WAYNESBORO	43	0.33	±0.11	0.02	±0.04	0.12	±0.14
AVERAGE						0.12	±0.13
100 MILE RADIUS							
COLUMBIA	53	0.55	±0.18	0.10	±0.06	0.27	±0.22
GREENVILLE	53	0.52	±0.15	0.02	±0.04	0.22	±0.22
MACON	42	0.30	±0.12	0.05	±0.03	0.14	±0.14
SAVANNAH	49	0.49	±0.13	0.02	±0.04	0.17	±0.22
AVERAGE						0.20	±0.23

NONVOL BETA, PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	ARITHMETIC 2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	39	3.8	±0.69	0.19	±1.5	2.3	±1.7
A-14	41	3.7	±1.1	0.28	±1.4	2.2	±1.6
BARNWELL GATE	41	3.6	±1.5	0.10	±3.6	2.3	±1.6
D AREA	41	4.3	±1.4	-0.17	±1.0	1.9	±2.4
DARK HORSE	41	4.0	±1.2	0.82	±0.40	2.0	±1.5
EAST TALATHA	43	6.6	±1.0	0.54	±0.81	2.4	±2.5
GREENPOND	43	4.2	±1.0	0.73	±0.90	2.6	±1.7
HIGHWAY 21/167	41	4.8	±1.1	1.3	±1.1	2.5	±1.4
JACKSON	42	5.7	±6.7	1.1	±0.79	2.7	±1.8
PATTERSONS MILL	41	3.6	±1.2	0.78	±0.81	2.3	±1.5
TALATHA GATE	42	7.0	±6.0	0.76	±0.43	2.8	±2.4
WEST JACKSON	39	6.3	±0.94	1.6	±0.90	2.6	±1.7
WINDSOR ROAD	43	8.9	±6.9	0.65	±0.98	2.9	±2.7
AVERAGE						2.4	±2.0
25 MILE RADIUS							
AIKEN AIRPORT	44	4.8	±0.87	0.51	±0.94	2.3	±1.7
AIKEN STATE PARK	44	4.7	±0.86	0.54	±0.73	2.5	±1.7
ALLENDALE	44	3.3	±0.58	0.25	±0.78	1.6	±1.4
AUGUSTA	44	3.8	±0.98	-0.02	±0.87	2.0	±1.8
HIGHWAY 301	44	4.8	±0.91	-0.26	±0.68	2.3	±2.3
LANGLEY	44	4.5	±0.91	0.00	±6.7	2.5	±2.0
LEES	44	3.9	±1.2	0.55	±0.79	2.3	±1.8
OLAR	43	4.1	±1.4	1.0	±0.81	2.5	±1.6
PERKINS	42	4.3	±0.92	1.0	±0.81	2.4	±1.7
SOUTH RICHMOND	44	3.8	±1.1	0.41	±0.49	2.5	±1.7
SPRINGFIELD	44	4.2	±0.91	1.3	±0.85	2.4	±1.5
WAYNESBORO	43	4.5	±0.89	0.61	±0.74	2.4	±1.8
AVERAGE						2.3	±1.8
100 MILE RADIUS							
COLUMBIA	53	5.8	±1.8	0.60	±1.2	2.9	±2.1
GREENVILLE	52	6.5	±1.2	1.1	±0.89	2.7	±2.2
MACON	48	4.4	±1.1	0.54	±0.87	2.2	±1.8
SAVANNAH	51	5.3	±1.2	0.55	±0.83	2.2	±2.0
AVERAGE						2.5	±2.1

- INSUFFICIENT DATA

TABLE 5. RADIOACTIVITY IN AIR, CONT'D

H-3 , PCI/CU M

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	21	81	±7.4	12	±8.7	39	±37
A-14	18	220	±6.6	50	±2.8	100	±110
BARNWELL GATE	21	260	±4.9	17	±2.4	75	±120
D-AREA	21	480	±12	99	±9.0	210	±210
DARKHORSE	21	220	±9.7	15	±2.3	75	±110
EAST TALATHA	19	250	±10	17	±6.5	67	±110
GREENPOND	20	200	±11	19	±4.5	78	±110
HIGHWAY 21/167	21	230	±4.7	13	±3.8	73	±96
JACKSON	21	210	±11	13	±2.3	85	±110
PATTERSON'S MILL	18	160	±10	12	±8.7	56	±77
TALATHA GATE	20	330	±11	2.6	±2.5	100	±190
WEST JACKSON	21	270	±4.6	39	±3.7	110	±130
WINDSOR ROAD	21	170	±9.5	9.0	±3.3	75	±100
AVERAGE						89	±150
25 MILE RADIUS							
AIKEN AIRPORT	22	85	±8.9	2.8	±2.2	29	±48
AIKEN STATE PARK	21	74	±8.7	7.2	±3.3	32	±43
ALLENDALE	21	35	±7.4	-61	±2.4	11	±26
AUGUSTA	19	50	±8.9	6.4	±2.4	25	±25
HIGHWAY 301	22	44	±7.1	2.6	±8.5	21	±29
LANGLEY	22	110	±9.0	4.3	±2.5	34	±50
LEES	21	290	±12	0.54	±3.5	40	±120
OLAR	19	77	±4.9	5.2	±3.6	25	±40
PERKINS	21	55	±7.8	0.00	±8.7	20	±27
SOUTH RICHMOND	22	70	±9.6	6.0	±3.2	25	±27
SPRINGFIELD	22	180	±4.3	3.2	±3.6	38	±73
WAYNESBORO	22	120	±8.6	8.1	±7.1	47	±51
AVERAGE						29	±56
100 MILE RADIUS							
COLUMBIA	6	34	±6.9	5.5	±2.5	16	-
GREENVILLE	2	26	±8.5	0.37	±5.0	13	-
MACON	2	14	±8.0	-1.7	±6.5	6.3	-
SAVANNAH	3	4.1	±3.6	-1.5	±2.3	1.9	-
AVERAGE						9.2	±23

H-3 , PCI/ML (ATMOSPHERIC MOISTURE)

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	23	8.0	±0.46	0.60	±0.44	4.0	±4.3
A-14	21	23	±0.70	3.0	±0.46	9.9	±13
BARNWELL GATE	23	46	±0.89	2.4	±0.46	7.4	±16
D-AREA	24	59	±0.97	6.0	±0.55	20	±21
DARK HORSE	23	22	±0.71	2.0	±0.38	6.7	±10
EAST TALATHA	22	14	±0.57	1.1	±0.43	5.7	±6.8
GREENPOND	23	13	±0.63	1.3	±0.45	6.8	±5.8
HIGHWAY 21/167	24	42	±0.85	1.7	±0.49	7.1	±15
JACKSON	24	22	±0.73	1.9	±0.35	7.4	±8.3
PATTERSON'S MILL RD	21	11	±0.57	0.60	±0.44	5.3	±6.2
TALATHA GATE	22	18	±0.61	0.36	±0.34	7.7	±9.7
WEST JACKSON	24	32	±0.82	2.9	±0.45	11	±15
WINDSOR ROAD	24	18	±0.66	1.0	±0.37	6.7	±7.5
AVERAGE						8.1	±14
25 MILE RADIUS							
AIKEN AIRPORT	25	5.9	±0.50	0.42	±0.33	2.4	±3.2
AIKEN STATE PARK	24	4.6	±0.53	0.80	±0.37	2.8	±2.2
ALLENDALE	23	4.2	±0.49	-0.27	±0.32	1.4	±2.2
AUGUSTA	22	5.4	±0.54	1.0	±0.43	2.5	±2.1
HIGHWAY 301	25	4.4	±0.53	0.12	±0.40	2.1	±2.4
LANGLEY	25	6.7	±0.56	0.59	±0.34	2.8	±3.0
LEES	24	15	±0.61	0.07	±0.46	3.1	±7.3
OLAR	23	9.1	±0.58	0.67	±0.47	2.5	±4.1
PERKINS	24	5.4	±0.47	0.80	±0.44	2.0	±2.5
SOUTH RICHMOND	25	4.6	±0.48	0.30	±0.45	2.2	±2.1
SPRINGFIELD	25	32	±0.78	0.42	±0.47	3.9	±12
WAYNESBORO	24	11	±0.58	0.44	±0.39	4.6	±5.3
AVERAGE						2.7	±5.2
100 MILE RADIUS							
COLUMBIA, SC	4	1.5	±0.44	0.74	±0.34	1.2	-
GREENVILLE, SC	3	1.4	±0.46	0.04	±0.53	0.75	-
MACON, GA	2	0.77	±0.43	-0.12	±0.47	0.33	-
SAVANNAH, GA	4	3.6	±0.48	-0.22	±0.34	1.5	-
AVERAGE						0.95	±2.1

- INSUFFICIENT DATA

TABLE 5. RADIOACTIVITY IN AIR, CONT'D

BE-7 PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	38	±8.5	5.5	±3.1	17	±17
25 MILE RADIUS	11	36	±8.7	6.6	±1.7	16	±17
100 MILE RADIUS	13	36	±23	0.19	±7.2	15	±20

SR-89, 90 PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	10	0.01	±0.02	-0.01	±0.02	0.00	-
25 MILE RADIUS	10	0.03	±0.02	-0.01	±0.02	0.01	±0.02
100 MILE RADIUS COMP	11	0.06	±0.09	-0.04	±0.07	0.01	±0.04

ZR-95, NB-95, PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	0.09	±0.13	0.00	±0.13	0.03	±0.08
25 MILE RADIUS	11	0.10	±0.13	0.00	±0.13	0.03	±0.08
100 MILE RADIUS	13	0.31	±1.2	0.00	±0.43	0.06	±0.20

RU-106 PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	0.80	±1.7	0.00	±0.79	0.27	±0.56
25 MILE RADIUS	11	0.69	±0.89	0.00	±0.83	0.18	±0.50
100 MILE RADIUS	13	0.84	±2.8	0.00	±3.0	0.15	±0.46

CS-137 , PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	0.45	±0.11	0.12	±0.10	0.23	±0.22
25 MILE RADIUS	11	0.20	±0.10	0.03	±0.09	0.10	±0.14
100 MILE RADIUS	13	0.32	±0.33	0.00	±0.25	0.10	±0.20

CE-144 , PCI/CU M E-2

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	0.21	±0.40	0.00	±0.31	0.05	±0.14
25 MILE RADIUS	11	0.22	±0.62	0.00	±0.33	0.04	±0.14
100 MILE RADIUS	13	0.94	±1.3	0.00	±1.3	0.12	±0.54

- INSUFFICIENT DATA

TABLE 13
1982 RADIOACTIVITY IN SOIL
(5-cm Depth)

	Concentration, pCi/g (Dry Weight)			
	Cs-137[a]	SR-90[a]	Pu-238[c]	Pu-239[c]
Plant Perimeter				
Northeast quadrant	1.090 ± 0.027	0.100 ± 0.13	0.004 ± 0.005	0.0163 ± 0.0110
Northwest quadrant	0.607 ± 0.031	0.030 ± 0.13	0.004 ± 0.001	0.0134 ± 0.0050
Southeast quadrant	0.761 ± 0.035	0.012 ± 0.13	0.006 ± 0.003	0.0116 ± 0.0070
Southwest quadrant	0.862 ± 0.027	-0.085 ± 0.14	0.002 ± 0.002	0.0220 ± 0.0250
Average[b]	0.830 ± 0.030	0.014 ± 0.13	0.004 ± 0.003	0.0160 ± 0.0120
100-Mile Radius				
Clinton, SC	0.460 ± 0.030	0.170 ± 0.14	0.0003 ± 0.001	0.0013 ± 0.001
Savannah, GA	0.516 ± 0.019	0.128 ± 0.13	-0.0003 ± 0.001	0.0015 ± 0.001
Average[b]	0.488 ± 0.025	0.150 ± 0.14	0.0003 ± 0.0003	0.0014 ± 0.0002

	Deposition, mCi/km^2			
	Cs-137	Sr-90	Pu-238	Pu-239
Plant Perimeter				
Northeast quadrant	81.8 ± 2.0	7.5 ± 9.8	0.3 ± 0.4	1.22 ± 0.82
Northwest quadrant	45.5 ± 2.3	2.2 ± 9.8	0.3 ± 0.1	1.00 ± 0.38
Southeast quadrant	57.1 ± 2.6	0.9 ± 9.8	0.4 ± 0.2	0.87 ± 0.52
Southwest quadrant	64.6 ± 2.0	-6.4 ± 10.5	0.2 ± 0.2	1.65 ± 1.87
Average[b]	62.2 ± 2.2	1.0 ± 9.8	0.3 ± 0.2	1.20 ± 0.90
100-Mile Radius				
Clinton, SC	34.5 ± 2.2	12.8 ± 10.5	0.02 ± 0.04	0.10± 0.02
Savannah, GA	38.7 ± 1.4	9.6 ± 9.8	-0.02 ± 0.01	0.11± 0.01
Average[b]	36.6 ± 1.9	11.2 ± 10.5	0.02 ± 0.02	0.10± 0.02

[a] The ± value represents the two sigma statistical counting error.
[b] The ± value is the root mean square.
[c] The ± value represents the two sigma standard deviation of triplicate sample analyses for individual values.

TABLE 14
RADIOACTIVITY IN SURFACE SOIL SUMMARY, mCi/km^2

	Plant Perimeter				100-Mile Radius			
Year	Pu-239	Pu-238	Cs-137[a]	Sr-90	Pu-239	Pu-238	Cs-137	Sr-90
1973[a]	1.78	0.08	78	79	1.69	0.12	105	120
1974	1.19	0.11	73	-	1.26	0.13	59	-
1975	1.13	0.07	88	-	0.68	0.02	72	-
1976	1.30	0.07	63	6	1.09	0.06	74	25
1977	1.18	0.07	52	8	1.22	0.04	54	14
1978	1.90	0.12	57	8	1.10	0.06	57	11
1979	1.2	0.10	54	7	0.23	0.08	52	9
1980	1.2	0.22	32	8	0.45	0.08	23	9
1981	1.1	0.15	31	-	0.72	0.08	42	-
1982	1.2	0.30	62	1	0.10	0.02	37	11

[a] Prior to 1976, ^{137}Cs was analyzed annually in 10 cores 15-cm deep.

TABLE 22. RADIOACTIVITY IN SAVANNAH RIVER WATER

ALPHA , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SAVANNAH RIVER							
R-2 DISSOLVED	54	4.7	±5.9	-0.13	±0.19	0.18	±1.3
R-2 SUSPENDED	48	1.3	±5.6	-5.3	±5.5	0.02	±0.50
R-4 ABOVE 4 MILE CK	54	4.3	±5.9	-1.2	±5.5	0.09	±1.2
R-8 BELOW STEEL CK	54	2.9	±5.7	-4.1	±5.6	0.05	±0.88
R-9 BELOW L3R CREEK	54	9.3	±5.9	-1.4	±5.7	0.23	±2.5
R-10 DISSOLVED	54	0.65	±5.6	-2.2	±5.6	0.02	±0.30
R-10 SUSPENDED	43	0.46	±0.48	-0.13	±0.26	0.05	±0.20

NONVOL BETA , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SAVANNAH RIVER							
R-2 DISSOLVED	49	11	±6.5	-4.0	±6.0	1.3	±5.0
R-2 SUSPENDED	44	3.7	±6.1	-8.3	±6.2	0.72	±1.6
R-4 ABOVE 4 MILE CK	48	7.3	±5.7	-3.8	±6.3	1.9	±5.5
R-8 BELOW STEEL CK	48	7.6	±6.5	-4.5	±6.3	1.8	±5.2
R-9 BELOW L3R CREEK	48	10	±6.5	-7.0	±5.8	1.7	±5.9
R-10 DISSOLVED	49	8.4	±6.8	-4.6	±6.0	1.4	±4.8
R-10 SUSPENDED	44	4.7	±5.6	-5.6	±5.8	0.41	±2.8

H-3 , PCI/ML

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SAVANNAH RIVER							
R-2 ABOVE PLANT	50	3.8	±0.44	-0.30	±0.53	0.36	±1.3
R-4 ABOVE 4 MILE CK	52	10	±0.59	0.03	±0.35	3.2	±4.3
R-10 HIGHWAY 301	49	10	±0.58	1.9	±0.49	4.3	±3.0

S-35 , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	12	1.9	±3.7	0.00	±0.00	0.19	±1.1
R-10 HIGHWAY 301 IC	12	1.5	±2.6	0.00	±0.00	0.15	±0.86

CR-51 , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	44	6.9	±20	0.00	±23	1.4	±4.9
R-10 HIGHWAY 301 IC	51	12	±25	0.00	±16	1.6	±5.9

MN-54 , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	44	1.3	±4.1	0.00	±2.3	0.11	±0.48
R-10 HIGHWAY 301 IC	51	0.47	±1.8	0.00	±2.1	0.06	±0.24

CO-60 , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	44	6.5	±27	0.00	±13	0.58	±2.7
R-10 HIGHWAY 301 IC	51	6.3	±13	0.00	±14	0.48	±2.7

ZN-65 , PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	44	3.2	±14	0.00	±9.1	0.37	±1.4
R-10 HIGHWAY 301 IC	51	3.4	±9.6	0.00	±6.7	0.40	±1.5

- INSUFFICIENT DATA

TABLE 22. RADIOACTIVITY IN SAVANNAH RIVER WATER, CONT'D.

SR-90, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT	12	0.71	± 0.48	-0.15	± 0.12	0.17	-
R-10 HIGHWAY 301	12	0.73	± 0.43	-0.01	± 0.11	0.22	-

ZR-95, NB-95, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT	44	0.90	±4.5	0.00	±2.2	0.09	±0.36
R-10 HIGHWAY 301	51	0.77	±2.3	0.00	±2.4	0.10	±0.34

RU-103, 106, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT	44	45	±110	0.00	±60	3.8	±18
R-10 HIGHWAY 301	51	28	±56	0.00	±56	3.7	±14

I-131, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT	44	4.5	±9.5	0.00	±3.7	0.72	±2.8
R-10 HIGHWAY 301	51	4.4	±7.7	0.00	±3.4	0.63	±1.9

CS-134, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	MINIMUM	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES					
R-2 ABOVE PLANT	6	0.0	0.0	0.0	-
R-10 HIGHWAY 301	21	0.00037	0.00003	0.00011	0.00011

CS-137, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	MINIMUM	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES					
R-2 ABOVE PLANT	6	0.0031	0.00006	0.0019	±0.00075
R-10 HIGHWAY 301	21	0.014	0.0041	0.0084	±0.0031

CE-141, 144, PCI/L

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
R-2 ABOVE PLANT IC	44	7.5	±14	0.00	±11	0.70	±3.2
R-10 HIGHWAY 301 IC	51	5.8	±10	0.00	±8.1	0.47	±2.3

- INSUFFICIENT DATA

ENCLOSURE 2

R - 3/27/84

Form RHA-200
(5-79)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

APPLICATION FOR RADIOACTIVE MATERIAL LICENSE

INSTRUCTIONS: Complete Items 1 through 16 if this is initial application. Supplementary sheets shall be used where applicable. If application is for renewal, Items 1 through 16 shall be completed and indicate new information or changes in the program. If there has been no changes, all items must be completed with reference to a previous application or document and date. Item 16 must be completed on all applications. Mail one copy to: South Carolina Department of Health & Environmental Control, Bureau of Radiological Health, 2600 Bull Street, Columbia, South Carolina 29201. Upon approval of this application, the applicant will receive a State of South Carolina Radioactive Materials License issued in accordance with the general requirements contained in the South Carolina Department of Health & Environmental Control, Regulation 61-63, Radioactive Materials (Title A), and the Atomic Energy and Radiation Control Act, Section 13-7-40 et. seq. of the 1976 Code.

1. (a) NAME AND STREET ADDRESS OF APPLICANT. (Institution, firm, persons, etc.)

Allied-General Nuclear Services
P. O. Box 847
Barnwell, SC 29812

Telephone No.: Area Code (803) 259 1711

(b) STREET ADDRESS(ES) AT WHICH RADIOACTIVE MATERIAL WILL BE USED (if different from 1 (a).)

West end of Osborn Road
Snelling, South Carolina

2. DEPARTMENT TO USE RADIOACTIVE MATERIAL

No Use - Decommissioned Facility
See Attachment 1

3. PREVIOUS LICENSE NUMBER(S). (If this is an application for renewal of a license, please indicate and give number.)

South Carolina License No. 144

4. INDIVIDUAL USER(S). (Name and title of individual(s) who will use or directly supervise use of radioactive material. Give training and experience in Items 8 and 9.)

None - However, Company Representative is Mr. Christian T. Nielsen.
See Attachment 3.

5. RADIATION PROTECTION OFFICER (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9).

CNSI - Director of Regulatory Affairs/
Barnwell - Dr. Michael T. Ryan.
See Attachment 2.

6. RADIOACTIVE MATERIAL. (Element and mass number of each.)

Natural Uranium
Plutonium - 238-239-240

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)

Natural Uranium <5 kg
Plutonium <1 gram
As residual material described in Attachment 1.

7. DESCRIBE PURPOSE FOR WHICH RADIOACTIVE MATERIAL WILL BE USED. Provide sufficient detail to allow potential personnel exposures to be evaluated. If radioactive material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.) Attach extra sheets if necessary.

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 5 (Use supplemental sheets if necessary)

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection			Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity	See Attachment 2		Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION (Actual use of radioisotopes or equivalent experience.)

Isotope	Maximum Amount	Where Experience Was Gained	Duration of Experience	Type of Use
		See Attachment 2		

10. RADIATION DETECTION INSTRUMENTS (Use supplemental sheets if necessary.)

Type of Instruments (Include make and model number of each)	Number Available	Radiation Detected	Sensitivity Range (mr/hr)	Window Thickness (mg/cm^2)	Use (Monitoring, Surveying, Measuring)
	See Attachment 2				

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE

See Attachment 2

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED (For film badges, specify method of calibrating and processing, or name of supplier.)

See Attachment 2

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment storage containers, shielding, fume hoods, etc. Attach an explanatory sketch of the facilities. See Attachment 2.

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. See Attach. 2

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. Chem-Nuclear System, Inc., Barnwell, SC

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL executing this certificate on behalf of the applicant named in Item 1, certify that this application is prepared in conformity with South Carolina Department of Health and Environmental Control Regulations for Control of Radiation and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

Allied-General Nuclear Services
Applicant named in Item 1.

Date March 27, 1984 By: J. A. Buchanan