

VIRGINIA ELECTRIC AND POWER COMPANY  
RICHMOND, VIRGINIA 23261

November 2, 2001

United States Nuclear Regulatory Commission  
Attention: Document Control Desk  
Washington, D. C. 20555

Serial No. 01-243A  
NAPS/JHL  
Docket Nos. 50-338  
50-339  
72-16  
License Nos. NPF-4  
NPF-7  
SNM-2507


Gentlemen:

**VIRGINIA ELECTRIC AND POWER COMPANY**  
**NORTH ANNA POWER STATION UNITS 1 AND 2**  
**INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)**  
**ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT**

Our letter dated April 27, 2001 (Serial No. 01-243) provided the 2000 Annual Radiological Environmental Operating Report for North Anna Units 1 and 2 and the North Anna Independent Spent Fuel Storage Installation. The April 2001 submittal indicated that the report was not complete due to the vendor, Teledyne Brown Engineering, relocating their laboratory from New Jersey to Tennessee. We stated that the 2000 Annual Radiological Environmental Operating Report will be updated following receipt of final analyses from the vendor. The purpose of this letter is to provide the updated 2000 Annual Radiological Environmental Operating Report

If you have any questions or require additional information, please contact us.

Very truly yours,

  
D. A. Heacock  
Site Vice President

Enclosure

Commitments made by this letter: None

IE25

cc: U. S. Nuclear Regulatory Commission  
Region II  
Atlanta Federal Center  
61 Forsyth St., SW, Suite 23T85  
Atlanta, Georgia 30303

Director, Nuclear Material Safety and Safeguards  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

Mr. M. J. Morgan  
NRC Senior Resident Inspector  
North Anna Power Station

**DOMINION VIRGINIA POWER  
NORTH ANNA POWER STATION**

***Radiological Environmental Monitoring Program***

***January 1, 2000 to December 31, 2000***

***Final Report***

***Prepared by***

**DOMINION VIRGINIA POWER**

***and***


**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**

***Annual Radiological Environmental Operating Report***


***North Anna Power Station***

***January 1, 2000 to December 31, 2000***

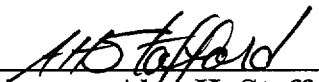
***Prepared by:***

  
\_\_\_\_\_  
**James B. Breeden**  
**Supervisor Radiological Analysis and Material Control**

***Reviewed by***

  
\_\_\_\_\_  
**Erich W. Dreyer**  
**Supervisor Health Physics Technical Services**

***Approved by:***

  
\_\_\_\_\_  
**Alan H. Stafford**  
**Manager Radiological Protection**

## Table of Contents

<u>Section</u>	<u>Title</u>	<u>Page</u>
	Preface.....	6
	Executive Summary .....	7
I.	Introduction.....	9
II.	Sampling and Analysis Program.....	12
III.	Program Exceptions .....	28
IV.	Summary and Discussion of 2000 Analytical Results.....	31
	A. Airborne Exposure Pathway .....	32
	1. Air Iodine/Air Particulates.....	32
	2. Precipitation .....	34
	3. Soil.....	34
	B. Waterborne Exposure Pathway.....	34
	1. Ground/Well Water.....	34
	2. River Water .....	35
	3. Surface Water.....	35
	C. Aquatic Exposure Pathway .....	35
	1. Sediment/Silt.....	35
	2. Shoreline Soil.....	36
	D. Ingestion Exposure Pathway .....	40
	1. Milk.....	40
	2. Fish.....	40
	3. Food/Vegetation.....	40
	E. Direct Radiation Exposure Pathway .....	41
	1. TLD Dosimeters.....	41
V.	Conclusion .....	43

**Table of Contents (Continued)**

<b><u>Section</u></b>	<b><u>Title</u></b>	<b><u>Page</u></b>
VI.	References.....	47
VII.	Appendices.....	49
	Appendix A - Radiological Environmental Monitoring ..... Program Annual Summary Tables - 2000	50
	Appendix B - Data Tables.....	58
	Appendix C - Land Use Census -2000 .....	82
	Appendix D - Synopsis of Analytical Procedures .....	86
	Appendix E - Interlaboratory Comparison Program.....	98

**List of Trending Graphs**

1.	Gross Beta in Air Particulates.....	33
2.	Tritium in River Water.....	33
3.	Tritium in Surface Water .....	37
4.	Cobalt-58 in Sediment Silt.....	37
5.	Cobalt-60 in Sediment Silt.....	38
6.	Cesium-134 in Sediment Silt .....	38
7.	Cesium-137 in Sediment Silt .....	39
8.	Cesium-134 in Fish.....	39
9.	Cesium-137 in Fish.....	42
10.	Environmental Radiation-TLDs.....	42

*Table of Contents (Continued)*

**List of Tables**

<u><b>Section</b></u>	<u><b>Page</b></u>
1. Radiological Sampling Station Distance and Direction from Unit 1.....	14
2. North Anna Power Station Sample Analysis Program .....	25
3. REMP Exceptions for Scheduled Sampling and Analysis during 2000 .....	29

**Appendix B Tables**

B-1 Iodine-131 Concentrations in Filtered Air .....	59
B-2 Concentrations of Gross Beta in Air Particulates .....	61
B-3 Gamma Emitter and Strontium Concentrations in Air Particulates .....	65
B-4 Gross Beta, Tritium and Gamma Emitter Concentrations in Precipitation .....	68
B-5 Concentrations of Gamma Emitter and Strontium in Soil .....	69
B-6 Gamma Emitter, Strontium and Tritium Concentrations in Ground/Well Water .....	70
B-7 Gamma Emitter, Strontium, Tritium, and Iodine Concentrations in River Water .....	70
B-8 Gamma Emitter, Strontium and Tritium Concentrations in Surface Water .....	71
B-9 Gamma Emitter and Strontium Concentrations in Sediment Silt .....	72
B-10 Gamma Emitter and Strontium Concentrations in Shoreline Soil .....	73
B-11 Gamma Emitter and Strontium Concentrations in Milk .....	74
B-12 Gamma Emitter Concentrations in Fish .....	76
B-13 Gamma Emitter Concentrations in Food/Vegetation .....	77
B-14 Direct Radiation Measurements - Quarterly & Annual TLD Results .....	79
B-15 Direct Radiation Measurements - Sector Quarterly TLD Results .....	80

## *Preface*

This report is submitted in accordance with North Anna Unit 1 and 2 Technical Specification 6.9.1.8 and North Anna Independent Spent Fuel Storage Installation (ISFSI) Technical Specification 5.5.2b.



## ***EXECUTIVE SUMMARY***

This document is a detailed report on the 2000 North Anna Nuclear Power Station Radiological Environmental Monitoring Program (REMP). Radioactivity levels from January 1 through December 31, 2000 in water, silt, shoreline sediment, milk, aquatic biota, food products, vegetation, and direct exposure pathways have been analyzed, evaluated and summarized. The REMP is designed to ensure that radiological effluent releases are As Low As is Reasonably Achievable (ALARA), no undue environmental effects occur, and the health and safety of the public is protected. The program also detects any unexpected environmental processes which could allow radiation accumulations in the environment or food pathways chains.

Radiation and radioactivity in the environment is constantly monitored within a 25 mile radius of the station. Dominion Virginia Power (DVP) also collects samples within the area. A number of sampling locations for each medium were selected using available meteorological, land use, and water use data. Two types of samples are obtained. The first type, control samples, are collected from areas that are beyond the measurable influence of North Anna Nuclear Power Station or any other nuclear facility. These samples are used as reference data. Normal background radiation levels, or radiation present due to causes other than North Anna Power Station, can thus be compared to the environment surrounding the nuclear power station. Indicator samples are the second sample type obtained. These samples show how much radiation is contributed to the environment by the plant. Indicator samples are taken from areas close to the station where any plant contribution will be at the highest concentration.

Prior to station operations, samples were collected and analyzed to determine the amount of radioactivity present in the area. The resulting values are used as a "pre-operational baseline." Analysis results from the indicator samples are compared to both current control sample values and the pre-operational baseline to determine if changes in radioactivity levels are attributable to station operations, other causes such as the Chernobyl accident, or natural variation.

Teledyne Brown Engineering Environmental Services provides sample analyses for various radioisotopes as appropriate for each sample media. Participation in an interlaboratory comparison program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the Nuclear Regulatory Commission (NRC) requires that equipment used for radiological environmental monitoring must be able to detect specified minimum Lower Limits of Detection (LLD). This ensures that analyses are as accurate as possible. Samples with extreme low levels of radiation which cannot be detected are therefore reported as being below the LLD. The NRC also mandates a "reporting level." Licensed nuclear facilities must report any releases equal to or greater than this reporting level. Environmental radiation levels are sometimes referred to in percent of reporting level.

Analytical results are divided into five categories based on exposure pathways: Airborne, waterborne, aquatic, ingestion, and direct radiation. Each of these pathways is described below:

- The airborne exposure pathway includes airborne iodine, airborne particulate, precipitation, and soil samples. The overall 2000 airborne results were very similar to previous years and

to preoperational levels. No increase was noted and there was no detection of fission products or other man-made isotopes in the airborne particulate media during 2000.

- The waterborne exposure pathway includes ground/well water, river water, and surface water samples. No man-made isotopes were detected in Lake Anna surface water except for tritium. The average tritium activity in surface water for 2000 was 2850 pCi/liter which was 14.25% of the reporting level for a water sample. The 1999 tritium level was 3975 pCi/liter. The preoperational level was 150 pCi/liter and has risen since 1978, though it has remained relatively consistent since 1986. Naturally occurring potassium-40 was measured in one of twenty-four samples at 39.8 pCi/liter. No other gamma emitters were detected.
- River water collected from the North Anna River, 5.8 miles downstream of the site had an average tritium level of 3025 pCi/liter. The average tritium level in 1999 was 3350 pCi/liter. Naturally occurring potassium-40 was measured in three out of twelve samples at an average concentration of 148 pCi/liter. No other gamma emitters were detected.
- The aquatic exposure pathway includes sediment/silt and shoreline samples. North Anna sediment contained some cesium-137 and europium-152 was detected. During the preoperational period, cesium-137 was detected. The europium-152 was attributed to possible cross-contamination in the laboratory. Sediment contamination, however, does not provide a direct dose pathway to man. In shoreline soil, which may provide a direct dose pathway, cesium-137 was measured in one of two samples at 167 pCi/kg (dry).
- The ingestion exposure pathway includes milk, fish, and food/vegetation samples. Iodine-131 was not detected in any 2000 milk samples. Although cesium-137 has been detected in the past, it was not detected in 2000 milk samples. Strontium-90 was detected at levels lower than 1999, and preoperational years. Both strontium-90 and cesium-137 are attributable to atmospheric nuclear weapons testing in the past. Naturally occurring potassium-40 was detected at normal environmental levels. Fish samples during 2000 contained cesium-137 at a slightly higher activity than preoperational levels. Steam generator repairs and better liquid waste processing, however, have reduced these activity levels from previous years. Vegetation samples were statistically similar to both control and preoperational levels.
- The direct radiation exposure pathway measures environmental radiation doses by use of thermoluminescent dosimeters (TLDs). The TLD results have remained essentially the same since the preoperational period in 1977.

During 2000, as in previous years, operation of the North Anna Nuclear Power Station and the Independent Spent Fuel Storage Installation (ISFSI) created no adverse environment affects or health hazards. The maximum total body dose calculated for a hypothetical individual at the North Anna Power Station site boundary due to liquid and gaseous effluents released from the site during 2000 would be approximately 0.31 millirem. For reference, this dose may be compared to the 360 millirem average annual exposure to every person in the United States from natural and man-made sources. Natural sources in the environment provide approximately 82% of radiation exposure to man while Nuclear Power contributes to less than 0.1%. These results demonstrate not only compliance with federal and state regulations, but also demonstrate the adequacy of radioactive effluent control at the North Anna Nuclear Power Station.

## **I. INTRODUCTION**

**DOMINION VIRGINIA POWER COMPANY**

**NORTH ANNA POWER STATION**

**RADIOLOGICAL ENVIRONMENTAL OPERATING PROGRAM**

**I. INTRODUCTION**

The operational radiological environmental monitoring program conducted for 2000 for the North Anna Power Station is provided in this report. The result of measurement and analyses of data obtained from samples collected from January 1, 2000 through December 31, 2000 are summarized.

- A. The North Anna Power Station of Dominion Virginia Power Company is located on Lake Anna in Mineral, Virginia, approximately 35 miles southwest of Fredericksburg, Virginia. The site consists of two units, each with a pressurized water reactor (PWR) nuclear steam supply system and turbine generator furnished by Westinghouse Electric Corporation. Each unit was designed with a gross electrical output of 979 megawatts electric (MWe). Unit 1 achieved commercial operation on June 6, 1978 and Unit 2 on December 14, 1980. An independent spent fuel storage facility was licensed for dry cask storage of spent fuel in 1998.
- B. The United States Nuclear Regulatory Commission (USNRC) regulations require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as is reasonably achievable (ALARA). To ensure these criteria are met, the operating license for North Anna Power Station includes Technical Specifications which address the release of radioactive effluents. Inplant monitoring is used to ensure release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in North Anna Power Station Offsite Dose Calculation Manual (ODCM).
- C. Dominion Virginia Power Company is responsible for collecting the various indicator and control environmental samples. Teledyne Brown Engineering Environmental Services is responsible for sample analysis and submitting report of radioanalysis. The results are used to determine if changes in radioactivity levels could be attributed to station operations. Measured values are compared with control levels, which vary with time due to such external events as cosmic ray bombardment, weapons test fallout, and seasonal variations of naturally occurring isotopes. Data collected prior to the plant operation is used to indicate the degree of natural variation to be expected. This preoperational data is compared with data collected during the operational phase to assist in evaluating the radiological impact of the plant operation.
- D. Occasional samples of environment media show the presence of man-made isotopes. As a method of referencing the measured radionuclide concentrations in the sample media to a dose consequence to man, the data is compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8 and North Anna's ODCM. These

concentrations are based upon the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion of "As Low As Is Reasonably Achievable".

- E. This report documents the results of the Radiological Environmental Monitoring Program for 2000 and satisfies the following objectives of the program:
1. Provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of the maximum exposed members of the public resulting from the station operation.
  2. Supplements the radiological effluent monitoring program by verifying that radioactive effluents are within allowable limits.
  3. Identifies radioactivity changes in the environment.
  4. Verifies that the plant operations have no detrimental effect on the health and safety of the public.

## **II. SAMPLING AND ANALYSIS PROGRAM**

## **II. SAMPLING AND ANALYSIS PROGRAM**

### **A. Sampling Program**

1. Table 1 summarizes the sampling program for environmental monitoring stations for North Anna Power Station during 2000. The relative location of these stations is shown.
2. For routine TLD measurements, two dosimeters made of  $\text{CaSO}_4:\text{Dy}$  in a teflon card are deployed at each sampling location. Several TLDs are co-located with NRC and Commonwealth of Virginia direct radiation recording devices.
3. In addition to the Radiological Environmental Monitoring Program required by North Anna Technical Specifications, samples are split if requested by the Commonwealth of Virginia. Routine splitting of Dominion Virginia Power Company samples with the Commonwealth of Virginia has been discontinued. All samples listed in Table 1 are shipped to Teledyne Brown Engineering Environmental Services located in Knoxville, TN.
4. All samples listed in Table 1 are taken at indicator locations except those labeled "control".

**TABLE 1**

(Page 1 of 4)

NORTH ANNA POWER STATION – 2000

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
<b>Environmental Thermoluminescent Dosimetry (TLD)</b>	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Quarterly & Annually	
	Fredericks Hall	02	5.30	SSW	225°	Quarterly & Annually	
	Mineral, Va	03	7.10	WSW	243°	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	287°	Quarterly & Annually	
	Route 752	05	4.20	NNE	20°	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	115°	Quarterly & Annually	
	Bumpass, VA	07	7.30	SSE	167°	Quarterly & Annually	
	End of Route 685	21	1.00	WNW	301°	Quarterly & Annually	
	Route 700	22	1.00	WSW	242°	Quarterly & Annually	
	"Aspen Hills"	23	0.93	SSE	158°	Quarterly & Annually	
	Orange, VA	24	22.00	NW	325°	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	10°	Quarterly	
	Sturgeon's Creek Marina	N-2/34	3.20	N	11°	Quarterly	
	Parking Lot "C" (on-site)	NNE-3/35	0.24	NNE	32°	Quarterly	
	Good Hope Church	NNE-4/36	4.96	NNE	25°	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	42°	Quarterly	
	Lake Anna Marina	NE-6/38	1.46	NE	34°	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	74°	Quarterly	
	Route 689	ENE-8/40	2.43	ENE	65°	Quarterly	
Near Training Facility	E-9/41	0.30	E	91°	Quarterly		



**TABLE 1**

(Page 2 of 4)

NORTH ANNA POWER STATION – 2000

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
<b>Environmental Thermoluminescent Dosimetry (TLD)</b>	"Morning Glory Hill"	E-10/42	2.85	E	93°	Quarterly	
	Island Dike	ESE-11/43	0.12	ESE	103°	Quarterly	
	Route 622	ESE-12/44	4.70	ESE	115°	Quarterly	
	DVP Biology Lab	SE-13/45	0.75	SE	138°	Quarterly	
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	137°	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	158°	Quarterly	
	Elk Creek	SSE-16/48	2.33	SSE	165°	Quarterly	
	NAPS Access Rd.	S-17/49	0.47	S	173°	Quarterly	
	Elk Creek Church	S-18/50	1.55	S	178°	Quarterly	
	NAPS Access Rd.	SSW-19/51	0.42	SSW	197°	Quarterly	
	Route 618	SSW-20/52	5.30	SSW	205°	Quarterly	
	500kv Tower	SW-21/53	0.6	SW	218°	Quarterly	
	Route 700	SW-22/54	4.36	SW	232°	Quarterly	
	NAPS Radio Tower	WSW-23/55	0.38	WSW	237°	Quarterly	
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242°	Quarterly	
	South Gate Switchyard	W-25/57	0.32	W	279°	Quarterly	
	Route 685	W-26/58	1.55	W	274°	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301°	Quarterly	
	Route 685	WNW-28/60	1.40	WNW	303°	Quarterly	
	North Gate - Construction Side Laydown Area	NW-29/61	0.45	NW	321°	Quarterly	
	Lake Anna Campground	NW-30/62	2.54	NW	319°	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349°	Quarterly	
	Route 208	NNW-32/64	3.43	NNW	344°	Quarterly	
	Bumpass Post Office	C-1/2	7.30	SSE	167°	Quarterly	Control
	Orange, VA	C-3/4	22.00	NW	325°	Quarterly	Control
	Mineral, VA	C-5/6	7.10	WSW	243°	Quarterly	Control
	Louisa, VA	C-7/8	11.54	WSW	257°	Quarterly	Control

**TABLE 1**

(Page 3 of 4)

NORTH ANNA POWER STATION – 2000

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks	
<b>Airborne Particulate and Radioiodine</b>	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Weekly		
	Fredericks Hall	02	5.30	SSW	205°	Weekly		
	Mineral, VA	03	7.10	WSW	243°	Weekly		
	Wares Crossroads	04	5.10	WNW	287°	Weekly		
	Route 752	05	4.20	NNE	20°	Weekly		
	Sturgeon's Creek Marina	05A	3.20	N	11°	Weekly		
	Levy, VA	06	4.70	ESE	115°	Weekly		
	Bumpass, VA	07	7.30	SSE	167°	Weekly		
	End of Route 685	21	1.00	WNW	301°	Weekly		
	Route 700	22	1.00	WSW	242°	Weekly		
	"Aspen Hills"	23	0.93	SSE	158°	Weekly		
	Orange, VA	24	22.00	NW	325°	Weekly	Control	
	<b>Surface Water</b>	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Monthly	
		*Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320°	Monthly	Control
*Lake Anna (upstream) (Route 669 Bridge)		09A	12.90	WNW	295°	Monthly	Control	
<b>River Water</b>	North Anna River (downstream)	11	5.80	SE	128°	Monthly		
<b>Ground Water (Well Water)</b>	Biology Lab	01A	0.75	SE	138°	Quarterly		
<b>Precipitation</b>	Biology Lab	01A	0.75	SE	138°	Monthly		
<b>Aquatic Sediment</b>	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Semi-Annually		
	Lake Anna (upstream) (Route 669 Bridge)	09A	12.90	WNW	320°	Semi-Annually	Control	
	North Anna River (Downstream)	11	5.80	SSE	128°	Semi-Annually		
<b>Shoreline Soil</b>	Waste Heat Treatment Facility (Second Cooling Lagoon)	08 **	1.10	SSE	148°	Semi-Annually		

\* In October 1991 the Surface Water Sample location at station 09 was moved to 09A.  
 \*\* Shoreline soil was changed from station 09 to 08 effective with the August 1996 sample.

**TABLE 1**

(Page 4 of 4)

NORTH ANNA POWER STATION – 2000

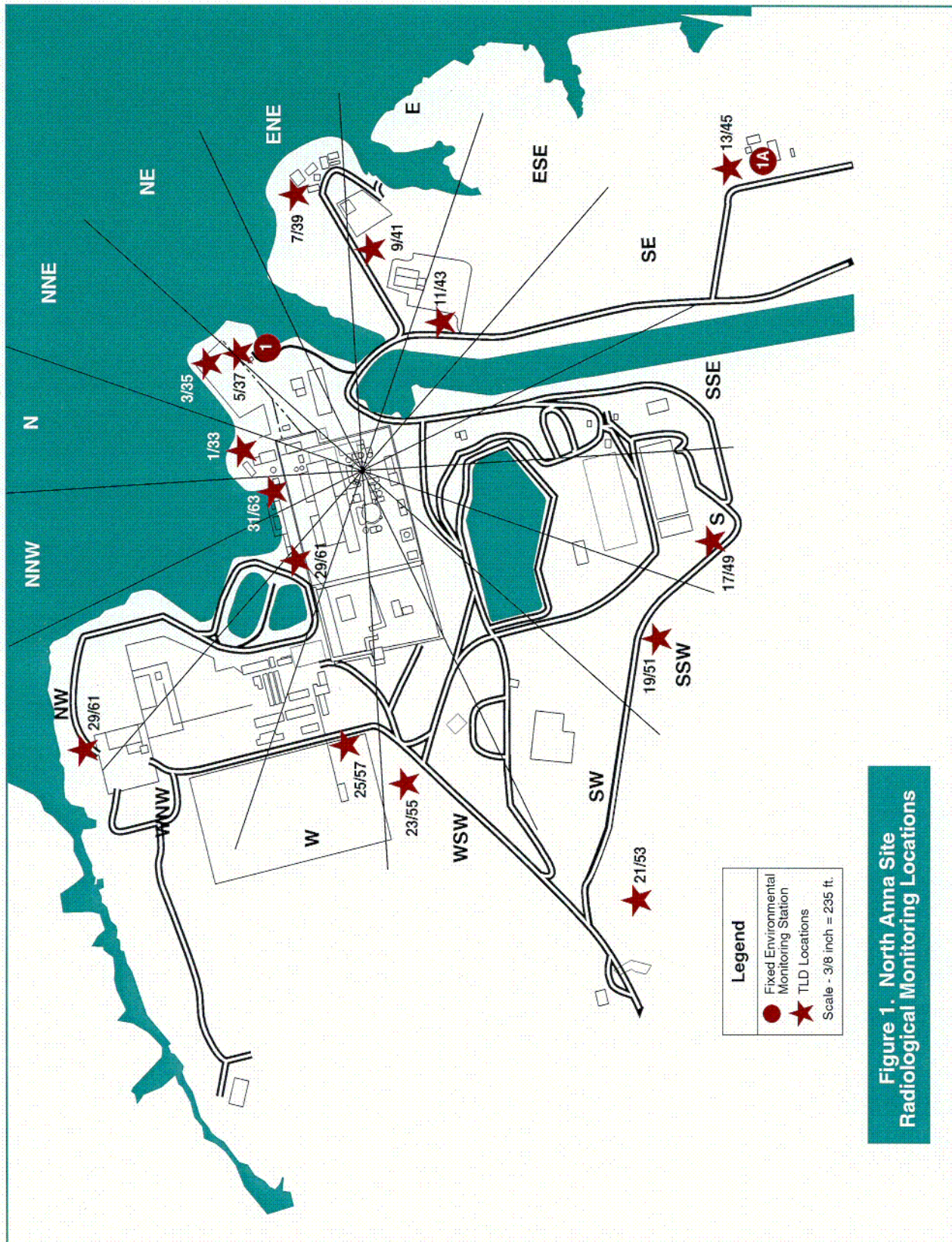
**RADIOLOGICAL SAMPLING STATIONS****DISTANCE AND DIRECTION FROM UNIT NO. 1**

<b>Sample Media</b>	<b>Location</b>	<b>Station</b>	<b>Distance Miles</b>	<b>Compass Direction</b>	<b>Degrees</b>	<b>Collection Frequency</b>	<b>Remarks</b>	
<b>Soil</b>	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Once/3 years		
	Fredericks Hall	02	5.30	SSW	205°	Once/3 years		
	Mineral, VA	03	7.10	WSW	243°	Once/3 years		
	Wares Crossroads	04	5.10	WNW	287°	Once/3 years		
	Route 752	05	4.20	NNE	20°	Once/3 years		
	Sturgeon's Creek Marina	05A	3.20	N	11°	Once/3 years		
	Levy, VA	06	4.70	ESE	115°	Once/3 years		
	Bumpass, VA	07	7.30	SSE	167°	Once/3 years		
	End of Route 685	21	1.00	WNW	301°	Once/3 years		
	Route 700	22	1.00	WSW	242°	Once/3 years		
	(Exclusion Boundary) "Aspen Hills"	23	0.93	SSE	158°	Once/3 years		
	Orange, VA	24	22.00	NW	325°	Once/3 years	Control	
	<b>Milk</b>	Holladay Dairy (R.C. Goodwin)	12	8.30	NW	310°	Monthly	
		Terrell's Dairy (Fredericks Hall)	13	5.60	SSW	205°	Monthly	
<b>Fish</b>	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Semi-Annually		
	Lake Orange	25	16.5	NW	312°	Semi-Annually	Control	
<b>Food Products</b> (Broadleaf or at harvest Vegetation)	Route 713	14	1.20	NE	43°	Monthly if available		
	Route 614	15	1.37	SE	133°	Monthly if available or at harvest		
	Route 629/522	16	12.60	NW	314°	Monthly if available or at harvest (Control)		
	End of Route 685	21	1.00	WNW	301°	Monthly if available or at harvest		
	Aspen Hills	23	0.93	SSE	158°	Monthly if available or at harvest		

**Legend For The North Anna Power Station  
Environmental Monitoring Stations Overview Maps**

Map Designation	Environmental Station Identification	Map Designation	Environmental Station Identification
1 (a)	01,NE-5/37	7/8	C-7/8
1A	01A,SE-13/45	1/33	N-1/33
2 (a)	02,SSW-20/52	31/63	NNW-31/63
3 (a)	03,C-5/16	29/61	NW-29/61
4 (a)	04	3/35	NNE-3/35
5 (a)	05	7/39	ENE-7/39
5A (a)	05A,N-2/34	9/41	E-9/41
6 (a)	06,ESE-12/44	11/43	ESE-11/43
7 (a)	07,C-1&2	17/49	S-17/49
8	08-Water, Fish Sediment Shoreline Soil (d)	19/51	SSW-19/51
9	09	21/53	SW-21/53
9A	09A-Water sample, sediment	23/55	WSW-23/55
11	11-River Water, Sediment	25/57	W-25/57
12	12-Milk	16/48	SSE-16/48
13	13-Milk	18/50	S-18/50
14	14-Vegetation, NE-6/38	14/46	SE-14/46
15	Vegetation	22/54	SW-22/54
16	Vegetation	26/58	W-26/58
21 (a)	21,WNW-27/59	28/60	WNW-28/60
22 (a)	22,WSW-24/56	32/64	NNW-32/64
23 (a)	23-SSE-15/47	8/40	ENE-8/40
24 (a)(b)	24,C-3&4	4/36	NNE-40/36
25 (c)	25-Fish	10/42	E-10/42

(a) Indicates air sample station, annual and quarterly TLD, Triennial soil.  
 (b) In Orange  
 (c) In Lake Orange  
 (d) Station 09 changed to 08 effective August 1996.



**Figure 1. North Anna Site  
Radiological Monitoring Locations**

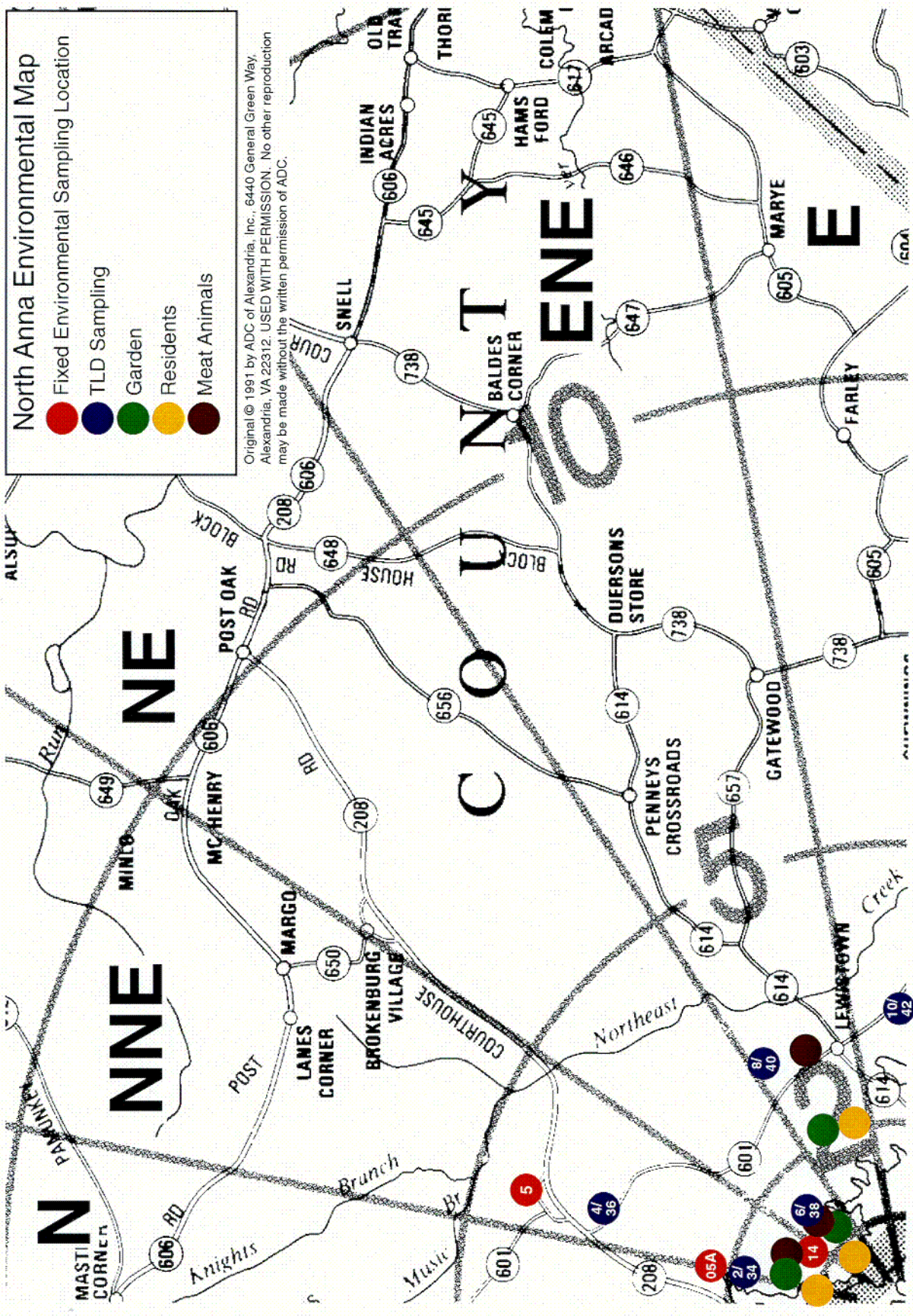
SV644H

C01

### North Anna Environmental Map

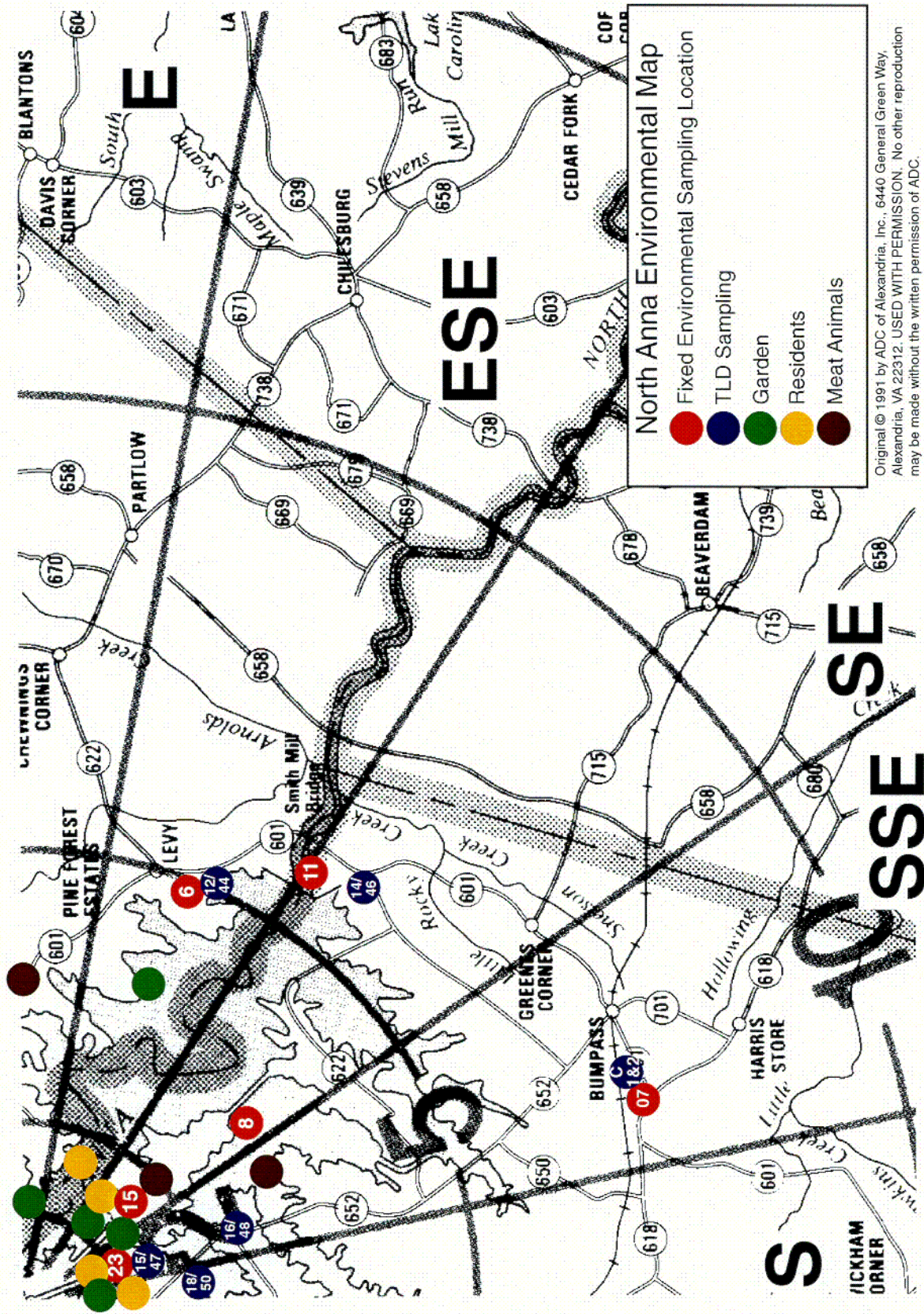
- Fixed Environmental Sampling Location
- TLD Sampling
- Garden
- Residents
- Meat Animals

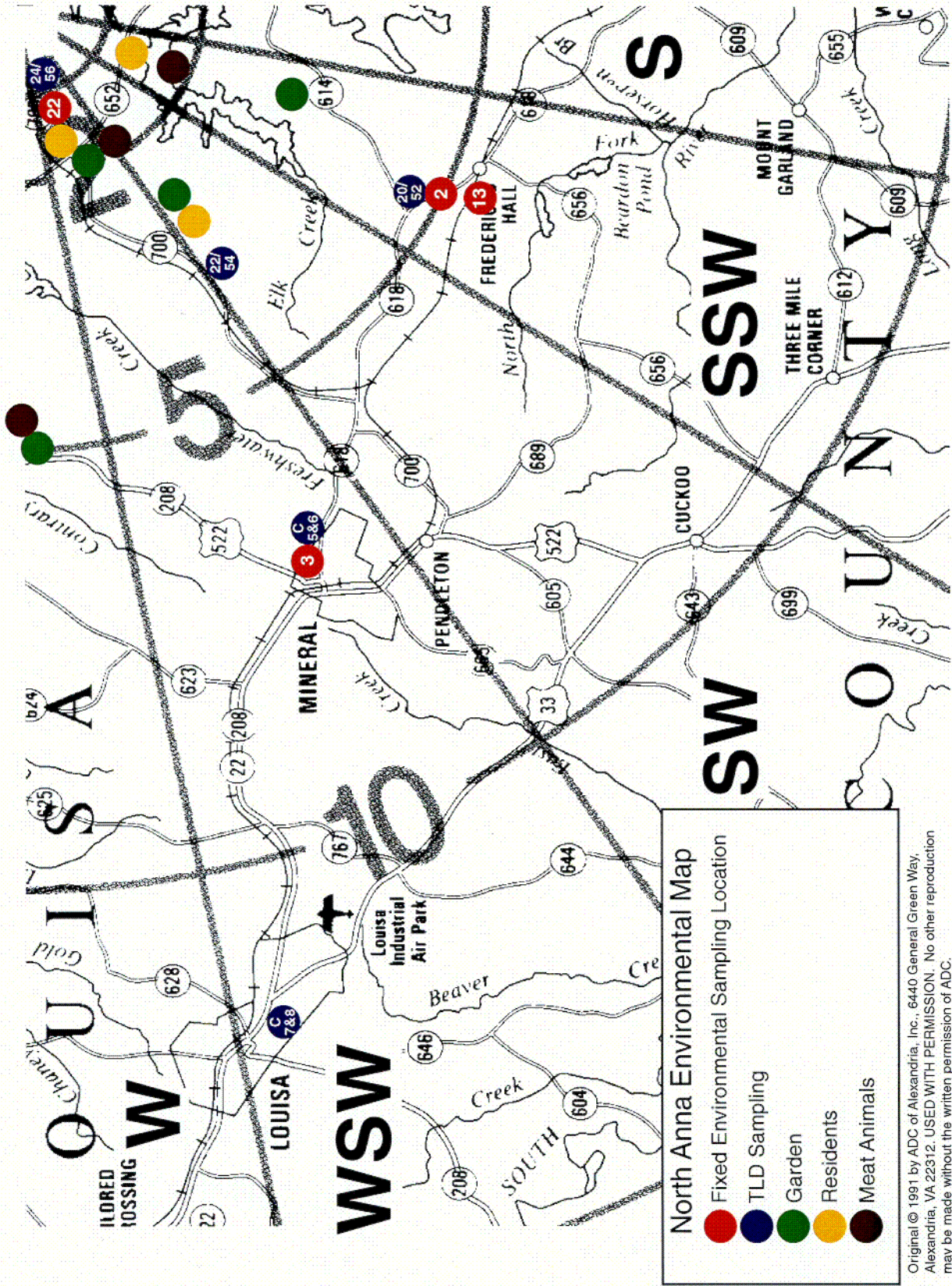
Original © 1991 by ADC of Alexandria, Inc., 6440 General Green Way, Alexandria, VA 22312. USED WITH PERMISSION. No other reproduction may be made without the written permission of ADC.



CB3280C

C02





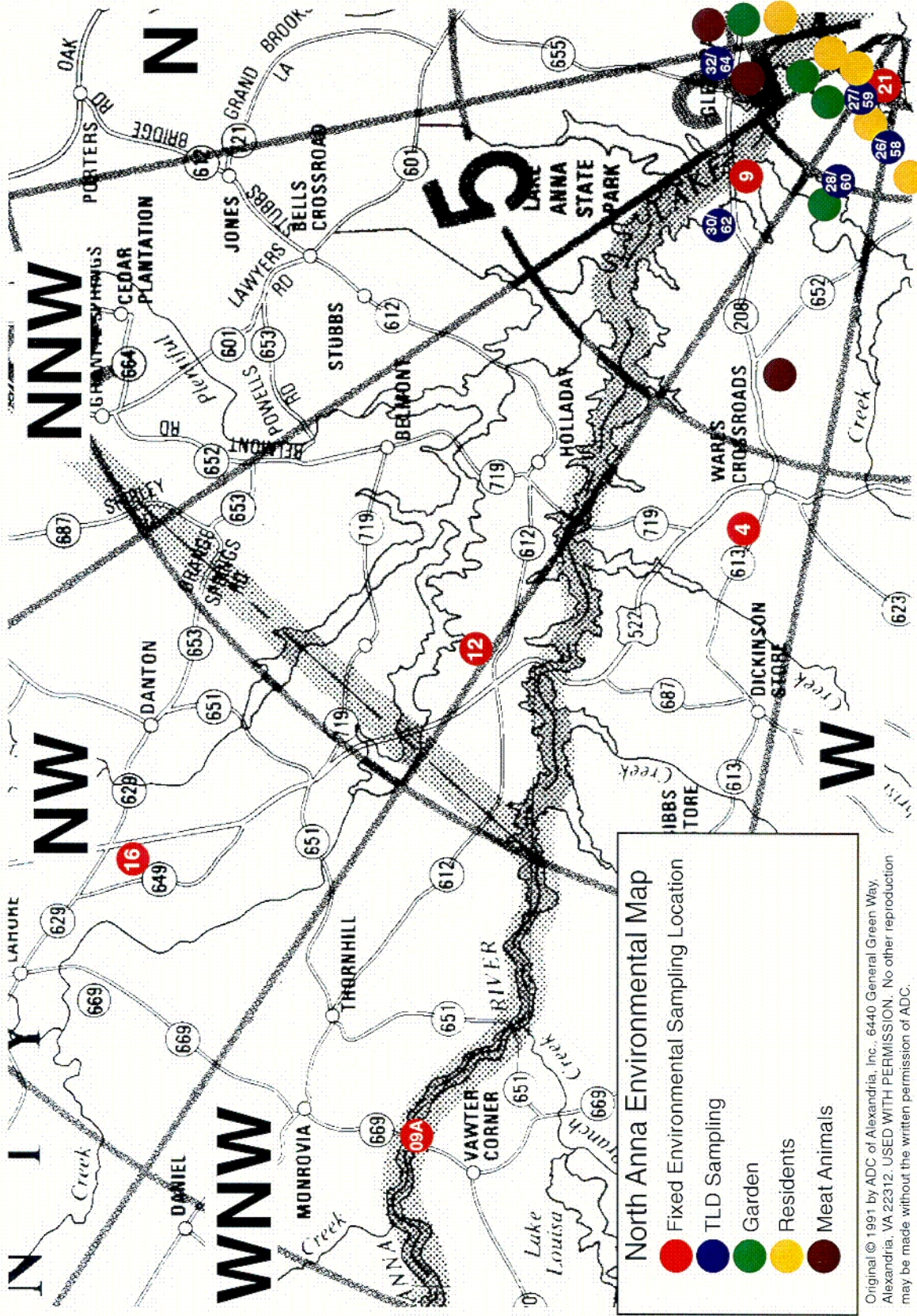
**North Anna Environmental Map**

- Fixed Environmental Sampling Location
- TLD Sampling
- Garden
- Residents
- Meat Animals

Original © 1991 by ADC of Alexandria, Inc., 6440 General Green Way, Alexandria, VA 22312. USED WITH PERMISSION. No other reproduction may be made without the written permission of ADC.

CB3283A





**North Anna Environmental Map**

- Fixed Environmental Sampling Location
- TLD Sampling
- Garden
- Residents
- Meat Animals

Original © 1991 by ADC of Alexandria, Inc., 6440 General Green Way, Alexandria, VA 22312. USED WITH PERMISSION. No other reproduction may be made without the written permission of ADC.

CB8281C

**B. Analysis Program**

1. Table 2 summarizes the analysis program conducted by Teledyne Brown Engineering Environmental Services for North Anna Power Station during 2000. This table is not a complete listing of nuclides that can be detected and reported. Other peaks that are measurable and identifiable, together with the nuclides listed in Table 2, shall also be identified and reported.

**TABLE 2**

(Page 1 of 3)

**NORTH ANNA POWER STATION**  
**SAMPLE ANALYSIS PROGRAM**

<b>SAMPLE MEDIA</b>	<b>FREQUENCY</b>	<b>ANALYSIS</b>	<b>LLD*</b>	<b>REPORT UNITS</b>
<b>Thermoluminescent Dosimetry (TLD)</b> (84 Routine Station TLD's)	Quarterly	Gamma Dose	2mR±2mR	mR/std. month
12 Station TLD's	Annually	Gamma Dose	2mR±2mR	mR/std. month
<b>Airborne Radioiodine</b>	Weekly	I-131	0.07	pCi/m <sup>3</sup>
<b>Airborne Particulate</b>	Weekly	Gross Beta	0.01	pCi/m <sup>3</sup>
	Quarterly (a)	Gamma Isotopic		pCi/m <sup>3</sup>
		Cs-134	0.05	
		Cs-137	0.06	
	2nd Quarter Composite	Sr-89	(c)	pCi/m <sup>3</sup>
		Sr-90	(c)	
<b>Surface Water</b>	Monthly	I-131	1(b)	pCi/l
		Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
		Quarterly (a)	Tritium (H-3)	2000
	2nd Quarter Composite	Sr-89	(c)	pCi/l
	Sr-90	(c)		

\* LLDs indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Brown Engineering Environmental Services may be lower than those listed.

(a) Quarterly Composites of each location's samples are used for the required analysis.

(b) LLD for non-drinking water is 10 pCi/liter.

(c) There are no required LLDs for strontium-89/90. LLDs are those achieved by Teledyne Brown Engineering Environmental Services.

**TABLE 2**

(Page 2 of 3)

**NORTH ANNA POWER STATION****SAMPLE ANALYSIS PROGRAM**

<b>SAMPLE MEDIA</b>	<b>FREQUENCY</b>	<b>ANALYSIS</b>	<b>LLD*</b>	<b>REPORT UNITS</b>		
<b>River Water</b>	Monthly	I-131	1(b)	pCi/l		
		Gamma Isotopic		pCi/l		
		Mn-54	15			
		Fe-59	30			
		Co-58/Co-60	15			
		Zn-65	30			
		Zr-95	30			
		Nb-95	15			
		Cs-134	15			
		Cs-137	18			
		Ba-140	60			
		La-140	15			
		Quarterly (a)	Tritium (H-3)	2000	pCi/l	
	2nd Quarter	Sr-89	(c)	pCi/l		
	Composite	Sr-90	(c)			
<b>Ground Water (Well Water)</b>	Quarterly	Gamma Isotopic		pCi/l		
		Mn-54	15			
		Fe-59	30			
		Co-58/Co-60	15			
		Zn-65	30			
		Zr-95	30			
		Nb-95	15			
		I-131	1(b)			
		Cs-134	15			
		Cs-137	18			
		Ba-140	60			
		La-140	15			
			Quarterly	Tritium (H-3)	2000	pCi/l
			2nd Quarter	Sr-89	(c)	
			Sr-90	(c)		
<b>Aquatic Sediment</b>	Semi-Annually	Gamma Isotopic		pCi/kg (dry)		
		Cs-134	150			
		Cs-137	180			
	Annually	Sr-89	(c)	pCi/kg (dry)		
		Sr-90	(c)			
<b>Precipitation</b>	Monthly	Gross Beta	10	pCi/l		
	Semi-Annual	Gamma Isotopic	10	pCi/l		
	Composite					

- \* LLDs indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Brown Engineering Environmental Services may be lower than those listed.
- (a) Quarterly Composites of each location's samples are used for the required analysis.
- (b) LLD for non-drinking water is 10 pCi/liter.
- (c) There are no required LLDs for strontium-89/90. LLDs are those achieved by Teledyne Brown Engineering Environmental Services.

**TABLE 2**

(Page 3 of 3)

**NORTH ANNA POWER STATION****SAMPLE ANALYSIS PROGRAM**

<b>SAMPLE MEDIA</b>	<b>FREQUENCY</b>	<b>ANALYSIS</b>	<b>LLD*</b>	<b>REPORT UNITS</b>
<b>Shoreline Soil</b>	Semi-Annual	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	(a)	
		Sr-90	(a)	
<b>Soil</b>	Once per 3 yrs.	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
		Sr-89	(a)	pCi/kg (dry)
		Sr-90	(a)	
<b>Milk</b>	Monthly	I-131	1	pCi/l
	Monthly	Gamma Isotopic		pCi/l
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
	Quarterly	La-140	15	
		Sr-89	(a)	pCi/l
		Sr-90	(a)	
<b>Fish</b>	Semi-Annual	Gamma Isotopic		pCi/kg (wet)
		Mn-54	130	
		Fe-59	260	
		Co-58	130	
		Co-60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
		<b>Food Products (Broadleaf Vegetation)</b>	Monthly if available or at harvest	Gamma Isotopic
Cs-134	60			
Cs-137	80			
I-131	60			pCi/kg (wet)

\* LLDs indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Brown Engineering Environmental Services may be lower than those listed.

(a) Quarterly Composites of each location's samples are used for the required analysis.

(b) LLD for non-drinking water is 10 pCi/liter.

(c) There are no required LLDs for strontium-89/90. LLDs are those achieved by Teledyne Brown Engineering Environmental Services.

### III. PROGRAM EXCEPTIONS

**REMP Exceptions For Scheduled  
Sampling And Analysis During 2000 - North Anna**

<b>Location</b>	<b>Description</b>	<b>Date of Sampling</b>	<b>Reason(s) for Loss/Exception</b>
All Stations	Vegetation	01/19/00 02/16/00 03/15/00	Seasonal unavailability.
Sta 08	Aquatic Sediment	02/21/00	Cross-contamination at lab.
Sta 01, 02, 03, 04, 05.	Charcoal Filter	04/26/00	TBE instrument malfunction. Data lost.
All Stations	Vegetation	06/21/00	Low level Iodine not requested or performed.
Sta 24	Charcoal Filter	07/26/00	TBE lost during laboratory move.
Sta 06	Air Particulate	08/23/00	Low value. No particulates on filter.
Sta 24	Charcoal Filter	08/30/00	TBE lost sample.
Sta 12, 13	Milk	09/20/00	Sr-89 not analyzed due to untimely analysis.
Sta 01A	Ground Water	09/27/00	I-131, Co-58, Fe-59, Zr-95 & Ba-140 failed to meet the LLD.
Sta 14, 15, 16, 22, 23	Vegetation	10/18/00	I-131 LLD not met due to untimely analysis.
All Stations	Air Particulates	11/15/00	Sample not received by laboratory.
Sta 08, 09A	Surface Water	12/18/00	Ba-140 LLD not met due to untimely analysis.
Sta 11	River Water	12/18/00	Ba-140 LLD not met due to untimely analysis.
Sta 01A	Precipitation	12/27/00	Co-58, Fe-59, Zr-95, and Ba-140 LLDs not met due to untimely analysis.
All Stations	Annual Environmental TLDs	01/11/01	Removed annual TLD's 6 months early to reflect true annual dose from June to December with change of vendor.
All Stations	Vegetation	01/11/01	Seasonal unavailability.

In late September of 1999, Teledyne Brown Engineering Environmental Services announced that the laboratory would move from its 35 year home in Westwood, NJ and relocate to Knoxville, TN. Build out of the new laboratory in Knoxville, began in January of 2000 with a two-phase move from Westwood to Knoxville scheduled for June and September. Unfortunately construction delays prevented the June phase one occupancy forcing the laboratory into a one-phase move, a significant delay in NUPIC approval of the Knoxville facility, and the use of NUPIC approved sub-contract laboratories to analyze REMP samples. This change resulted in significant delays in analytical turnaround times, in obtaining necessary regulatory compliance approvals, and caused extraordinary difficulties for the laboratory and all of its customers. The most important consequences of this delay was the need to utilize two sub-contractor laboratories, Allegheny Environmental Services in Northbrook, IL and the Duke Engineering Laboratory in Marlborough, MA, to perform REMP analyses between October, 2000 and January, 2001

The Westwood laboratory ceased analytical operations in October and was closed on November 15; the Knoxville laboratory was ready to analyze samples by the middle of December, but was not scheduled for NUPIC audit until the end of January, 2001. During the period October 15 through December 15, 2000, the Knoxville laboratory underwent several customer surveillances allowing it to perform some limited customer analyses. The Knoxville laboratory is now in full production and is NUPIC approved.



#### IV. SUMMARY AND DISCUSSION OF 2000 ANALYTICAL RESULTS

#### ***IV. Summary And Discussion of 2000 Analytical Results***

Data from the radiological analyses of environmental media collected during 2000 are tabulated and discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in the Teledyne Brown Engineering Environmental Services Quality Assurance manual and are explained in the Teledyne Brown Engineering Environmental Services Analytical Procedures. A synopsis of analytical procedures used for the environmental samples is provided in Appendix D. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Interlaboratory Comparison program. The results of the Interlaboratory Comparison Program are provided in Appendix E.

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. The "less than" values in the data tables were calculated for each specific analysis and are dependent on sample size, detector efficiency, length of counting time, chemical yield when appropriate, and the radioactive decay factor from time of counting to time of collection. Teledyne Brown Engineering Environmental Services's analytical methods meet the Lower Limit of Detection (LLD) requirements give in table 2 of the USNRC Branch Technical Position, Radiological Monitoring Acceptable Program (November 1979, Revision 1) and the ODCM.

The following is a discussion and summary of the results of the environmental measurements taken during the 2000 reporting period.

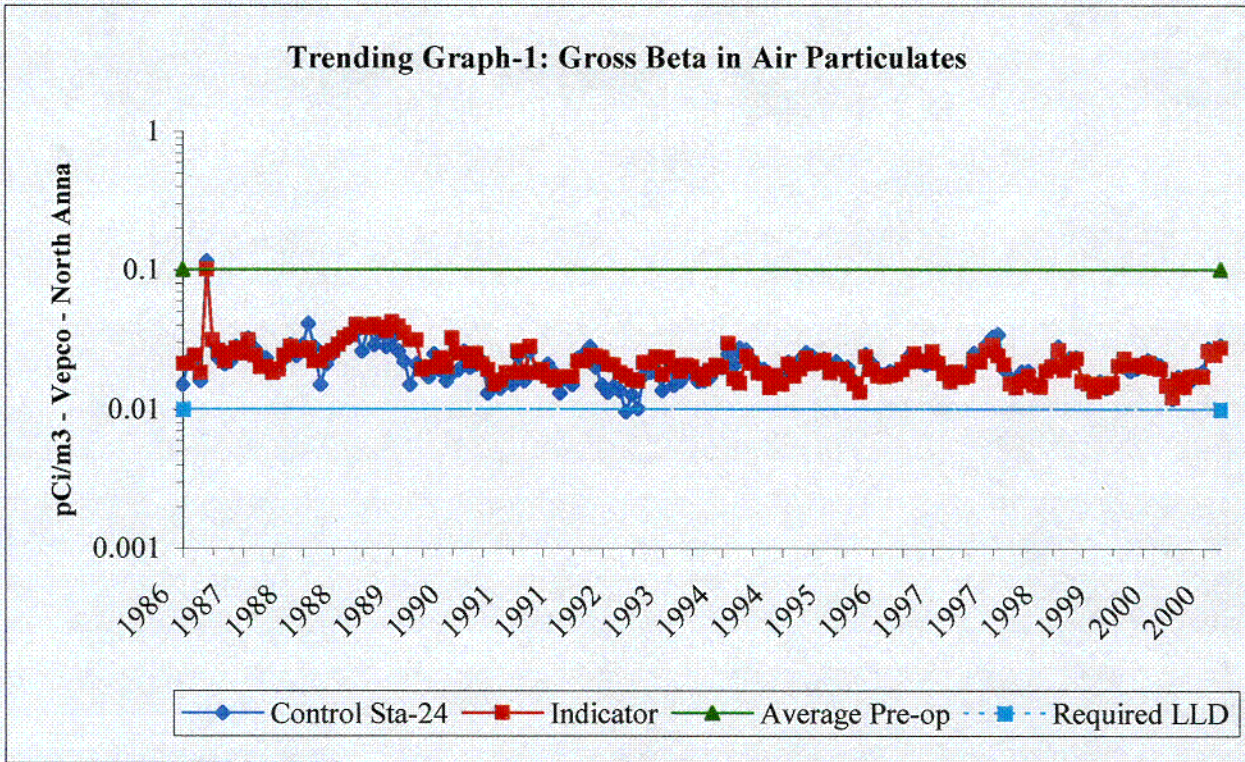
##### ***A. Airborne Exposure Pathway***

###### ***1. Air Iodine/Particulates***

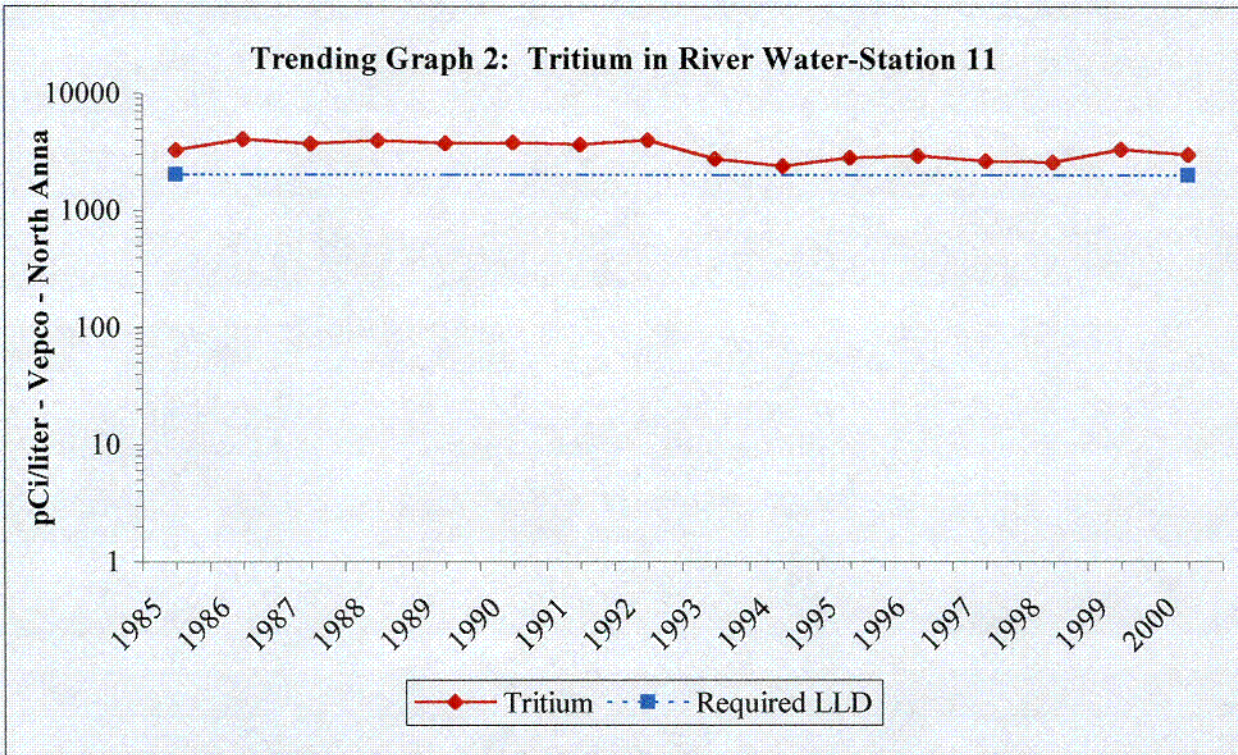
Charcoal cartridges used to collect airborne iodine were collected weekly and analyzed by gamma spectrometry for iodine-131. The results are presented in Table B-1. All results were below the required lower limit of detection. For air particulates, gross beta activity was observed in all fifty-one control samples with an average concentration of 0.019 pCi/m<sup>3</sup> and a range of 0.007 to 0.041 pCi/m<sup>3</sup>. The average measurement for the indicator locations was 0.019 pCi/m<sup>3</sup> with a range of 0.006 to 0.070 pCi/m<sup>3</sup>. The results of the gross beta activities are presented in Table B-2. The gross beta activities for 2000 were comparable to levels measured in the 1982-1999 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing performed in other countries. During the preoperational period of July 1, 1974 through March 31, 1978 gross beta activities ranged from a low of 0.005 pCi/m<sup>3</sup> to a high of 0.75 pCi/m<sup>3</sup>.

Air particulate filters were composited by locations on a quarterly basis and were analyzed by gamma ray spectroscopy. The results are listed in Table B-3. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation, was measured in 47 of the 48 composite samples. The average measurement for the control location was 0.071 pCi/m<sup>3</sup> with a range of 0.066 to 0.080 pCi/m<sup>3</sup>. The indicator locations had an average concentration of 0.064 pCi/m<sup>3</sup> and a range of 0.029 to 0.092 pCi/m<sup>3</sup>. During the preoperational period, beryllium-7 was measured at comparable levels, as would be

Trending Graph-1: Gross Beta in Air Particulates



Trending Graph 2: Tritium in River Water-Station 11



During the operational period, tritium was not detected in the sample analyzed.

expected. Naturally occurring potassium-40 was not detected in any control samples. Potassium-40 was detected in two indicator samples with an average concentration of 0.005 pCi/m<sup>3</sup> and a range of 0.005 to 0.006 pCi/m<sup>3</sup>. All other gamma emitters were below the detection limits. During the preoperational period gamma ray spectroscopy measured several fission products in numerous air particulate filters. All isotopes were attributed to atmospheric nuclear weapons testing conducted before the preoperational period. Among the isotopes measured were zirconium-95, ruthenium-103, ruthenium-106, cesium-137, cerium-141 and cerium-144.

The second quarter composites of air particulate filters from all twelve stations were analyzed for strontium-89 and 90. There was no detection of these fission products at any of the ten indicator stations nor at the control station.

## 2. Precipitation

A sample of rain water was collected monthly at station 01A, on site, 0.75 miles, 138 degrees SE and analyzed for gross beta activity. The results are presented in Table B-4. The average gross beta activity for 2000 in ten of the twelve samples was 3.9 pCi/liter with a range from 1.8 to 10 pCi/liter. Semi-annual composites were prepared and analyzed for gamma emitting isotopes and tritium. Beryllium-7 was not detected in the semi-annual composite samples for 2000. All other gamma emitters were below their detection limits. Tritium was not detected in the semi-annual composite samples. These results were comparable to or lower than those measured in 1986 through 1999. During the preoperational period gross beta activity in rain water was expressed in nCi per square meter of the collector surface, thus a direct comparison can not be made to the 2000 period. During the preoperational period, tritium was measured in over half of the few quarterly composites made. The tritium activity ranged from 100 to 330 pCi/liter.

## 3. Soil

Soil samples are collected every three years. Since they were collected in 1998, they were not collected during 2000.

### ***B. Waterborne Exposure Pathway***

#### 1. Ground/Well Water

Water was sampled quarterly from the on site well at the metrology laboratory. These samples were analyzed for gamma radiation and for tritium. The results are presented in Table B-6. No gamma emitting isotopes were detected during 2000. The second quarter sample was analyzed for strontium-89 and strontium-90. There was no measured activity of these isotopes above the detection level. Tritium was not measured above the detection level. No gamma emitting isotopes were detected during the preoperational period

## 2. River Water

A sample of water from the North Anna River was collected monthly at station 11, 5.8 miles downstream from the discharge lagoon, 128 degrees SE. The results are presented in Table B-7. The samples were analyzed by gamma spectroscopy monthly. The samples were analyzed for tritium quarterly on a composite sample. The second quarter samples were analyzed in addition for strontium-89 and strontium-90.

Potassium-40 was detected in three of the twelve samples with an average concentration of 148 pCi/liter and a range of 7.7 to 385 pCi/liter<sup>3</sup>. All other gamma emitters were below their detection level. There was no measured activity of strontium-89 or strontium-90 above the detection limit. Tritium was measured in all four samples with an average level of 3025 pCi/liter and a range of 1500 to 4700 pCi/liter. This is lower than the average level measured in 1999 of 3350 pCi/liter and a range of 3000 to 3800 pCi/liter. No river water samples were collected during the preoperational period.

## 3. Surface Water

Samples of surface water were collected monthly from two stations. Station 08 is at the discharge lagoon, 1.1 miles, 148 degrees SSE on Lake Anna. Station 09A is located 12.9 miles WNW. The samples were analyzed for iodine-131 by radiochemical separation. No iodine was detected in the 24 samples analyzed. The results are presented in Table B-8. The samples were also analyzed by gamma ray spectrometry. Naturally occurring potassium-40 was detected in one of the 24 samples with a concentration of 39.8 pCi/liter. All other gamma emitters were below their detection level.

A quarterly composite from each station was prepared and analyzed for tritium. The tritium activity at station 08 for the quarterly composites was at an average level of 2850 pCi/liter with a range of 1500 to 4500 pCi/liter. The tritium level had been increasing since the middle of 1978 when the average level was below 300 pCi/liter. However, during 2000 the results were within the same range as those measured in 1986 through 1999. During the preoperational period tritium was measured in several samples with concentrations between 90 and 250 pCi/liter. Tritium was detected in one sample at station 09A with an activity of 110 pCi/liter.

### *C. Aquatic Exposure Pathway*

#### 1. Sediment/Silt

Sediment samples were collected during February and August from each of three locations and were analyzed by gamma spectrometry. The results are presented in Table B-9. Two man-made and a number of naturally occurring radioisotopes were detected in these samples. Cesium-137 was detected in three of the six samples with an average activity of 126 pCi/kg (dry weight) and a range from 58.8 to 205 pCi/kg (dry weight). Europium-152 was detected in one sample at a concentration of 2550 pCi/kg (dry weight), possibly from contamination in the laboratory. The highest reading for cesium-137 was obtained from station 8 located 1.10 miles SSE.

Naturally occurring potassium-40 was observed in all of the six samples with an average activity of 10502 pCi/kg (dry weight) and a range from 3040 to 14700 pCi/kg (dry weight). Naturally occurring, thorium-228 was observed in all six samples with an average concentration of 899 pCi/kg (dry weight) and a range of 474 to 1530 pCi/kg (dry weight). Radium-226 was measured in all six samples with an average concentration of 1217 pCi/kg (dry weight) and a range of 399 to 1870 pCi/kg (dry weight). The August samples were analyzed for strontium-89 and strontium-90. There was no measurable amount of strontium-89 in aquatic sediment/silt. Strontium-90 was measured in the one control sample with a concentration of 290 pCi/kg (dry weight). Strontium-90 was measured in the two indicator samples with an average concentration of 135 pCi/kg (dry weight) and a range of 130-140 pCi/kg (dry weight).

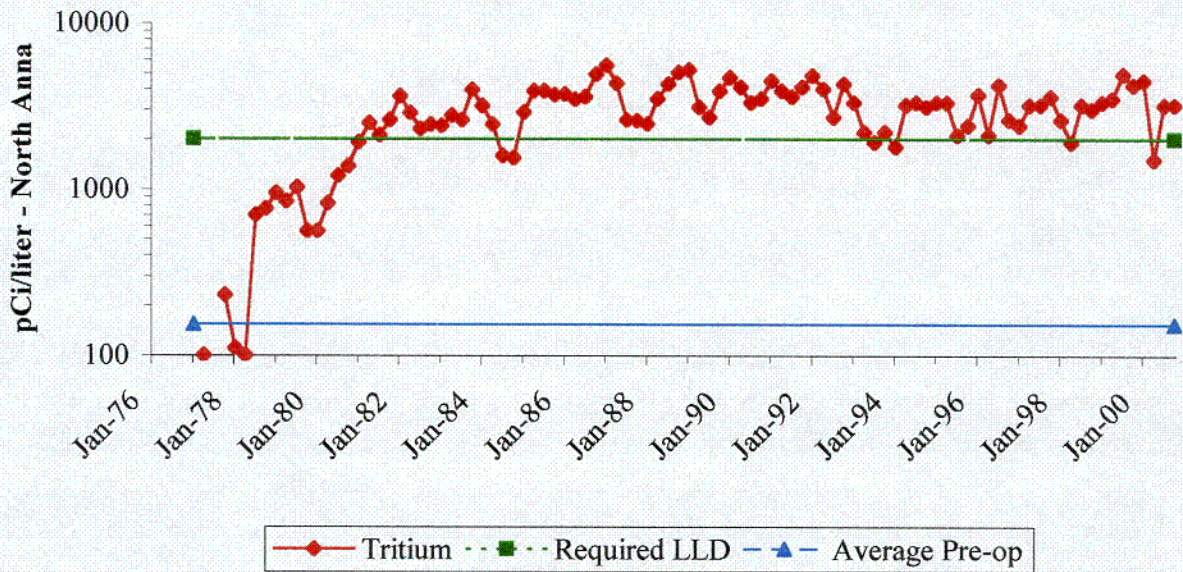
During the preoperational period sediment samples were analyzed by gamma ray spectroscopy. Cesium-137 was measured in most of the samples with concentrations between 33 and 1210 pCi/kg (dry weight). Strontium-90 was measured in most of the samples with concentrations between 60 and 540 pCi/kg (dry weight). Strontium-89 was not measured. Potassium-40, radium-226, and thorium-228, all naturally occurring, were measured at background levels.

## 2. Shoreline Soil

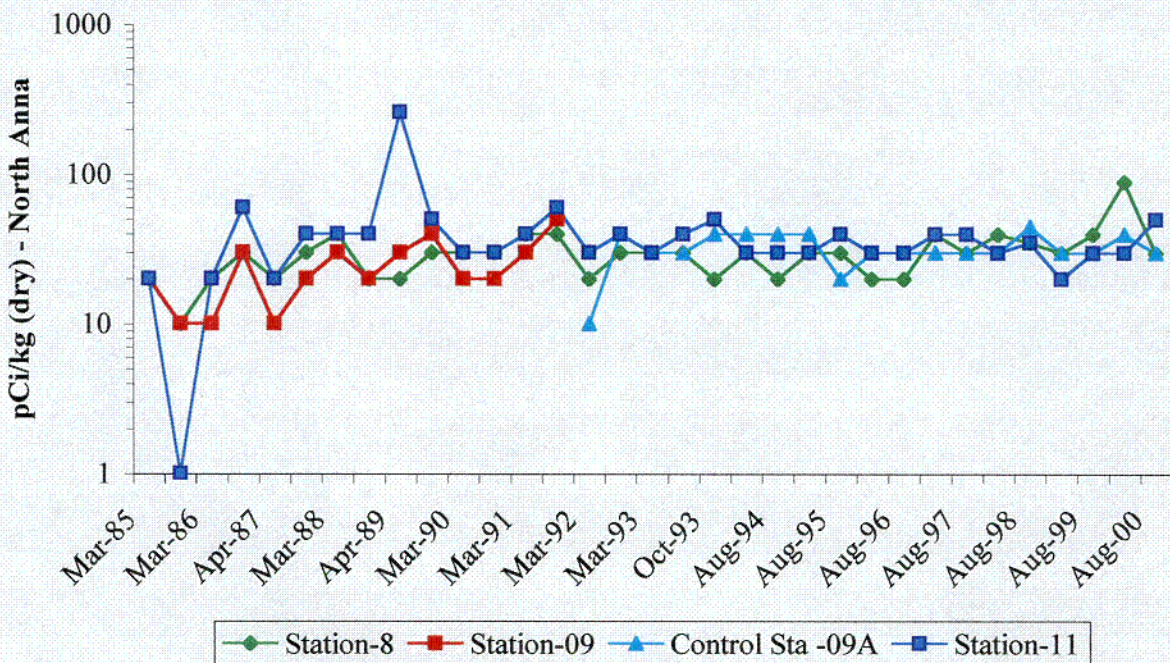
A sample of shoreline sediment was collected in February and August from station 08. The samples were analyzed by gamma ray spectrometry. The results are presented in Table B-10. The naturally occurring nuclide potassium-40 was measured in both samples with an average activity of 1345 pCi/kg (dry weight) and a range of 1280 to 1410 pCi/kg (dry weight). Cosmogenic beryllium-7 was not measured during 2000. Thorium-228 was measured in both samples at an average of 251 pCi/kg (dry weight) and a range of 203 to 298 pCi/kg (dry weight). Radium-226 was measured in both samples with a concentration of 464 pCi/kg (dry weight) and a range of 313 to 615 pCi/kg (dry weight). Cesium-137, a fission product, was measured in one sample with a concentration of 167 pCi/kg (dry weight).

The August sample was analyzed for strontium-89 and strontium-90. There was no measured amount of strontium-89. Strontium-90 was measured at a concentration of 100 pCi/kg (dry weight).

**Trending Graph-3: Tritium in Surface Water  
Station 08**

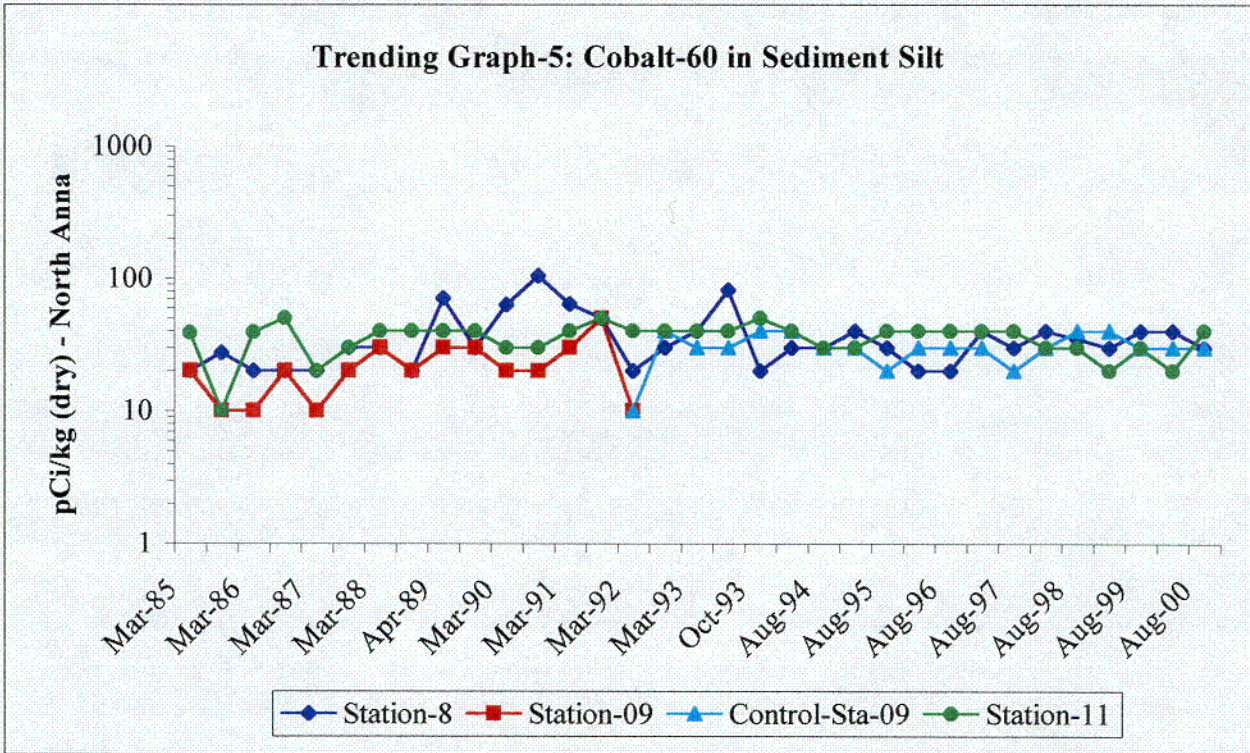


**Trending Graph-4: Cobalt-58 in Sediment Silt**



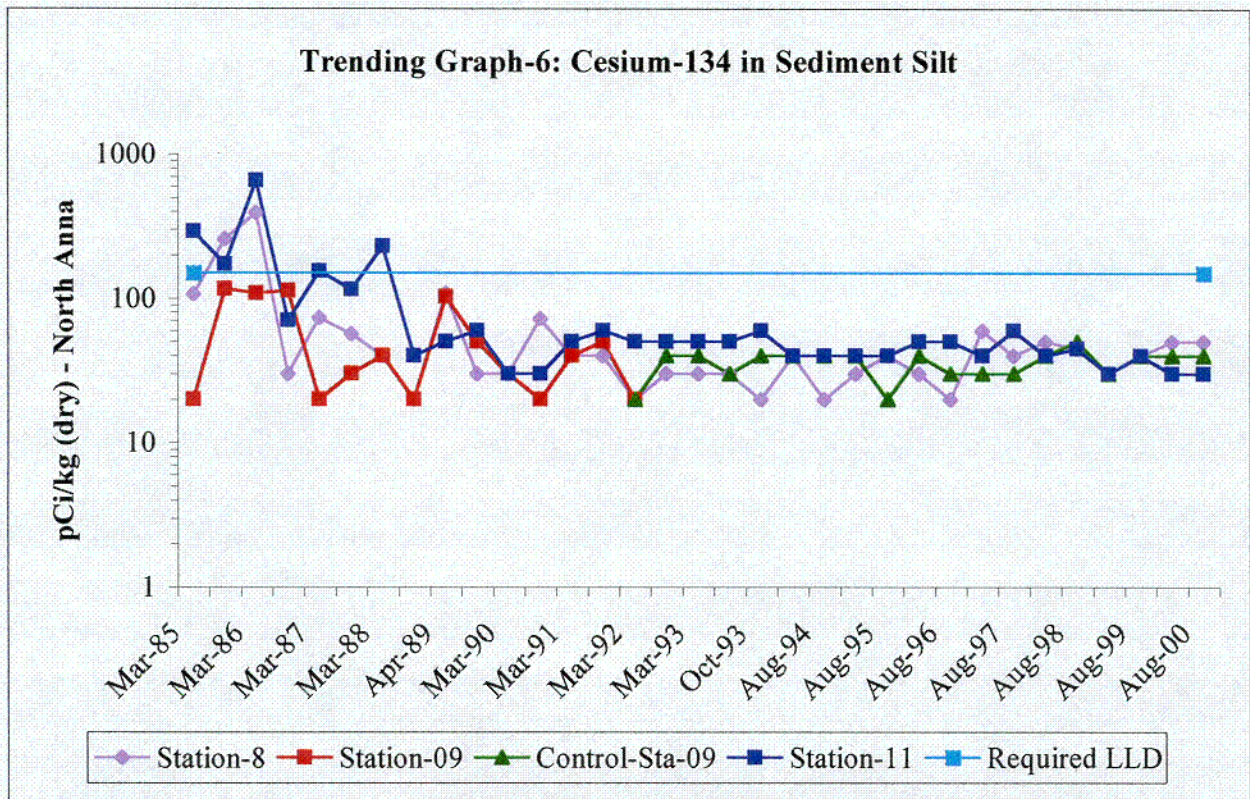
During the properational period, cobalt-58 was not detected in the samples analyzed.

**Trending Graph-5: Cobalt-60 in Sediment Silt**



During the operational period, cobalt-60 was not detected in the sample analyzed.

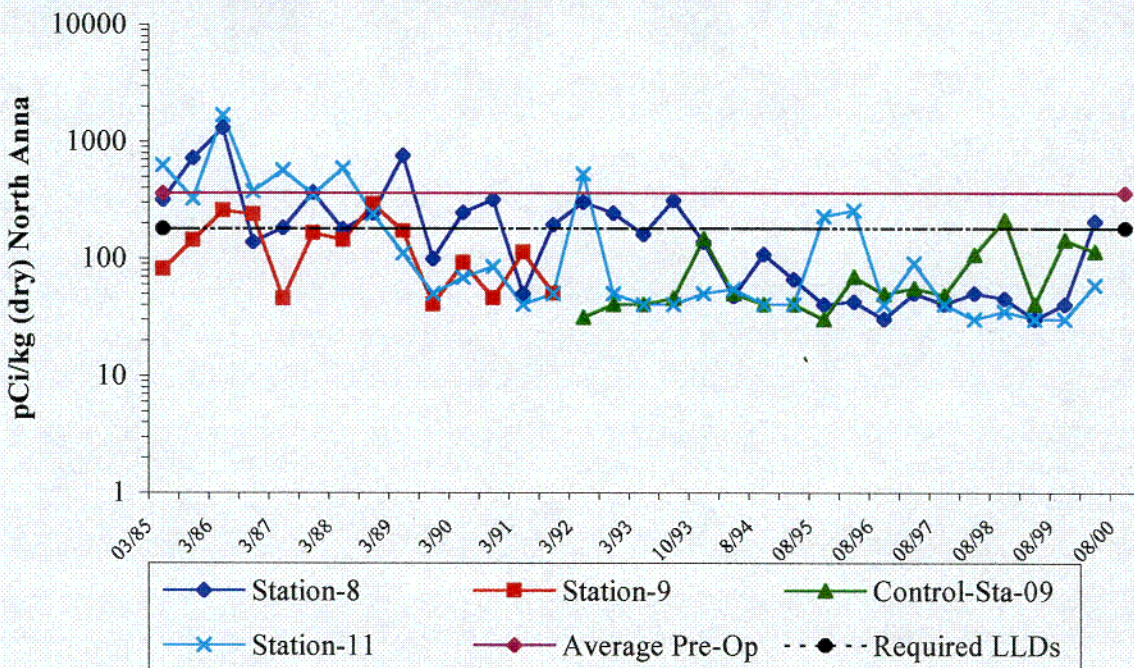
**Trending Graph-6: Cesium-134 in Sediment Silt**



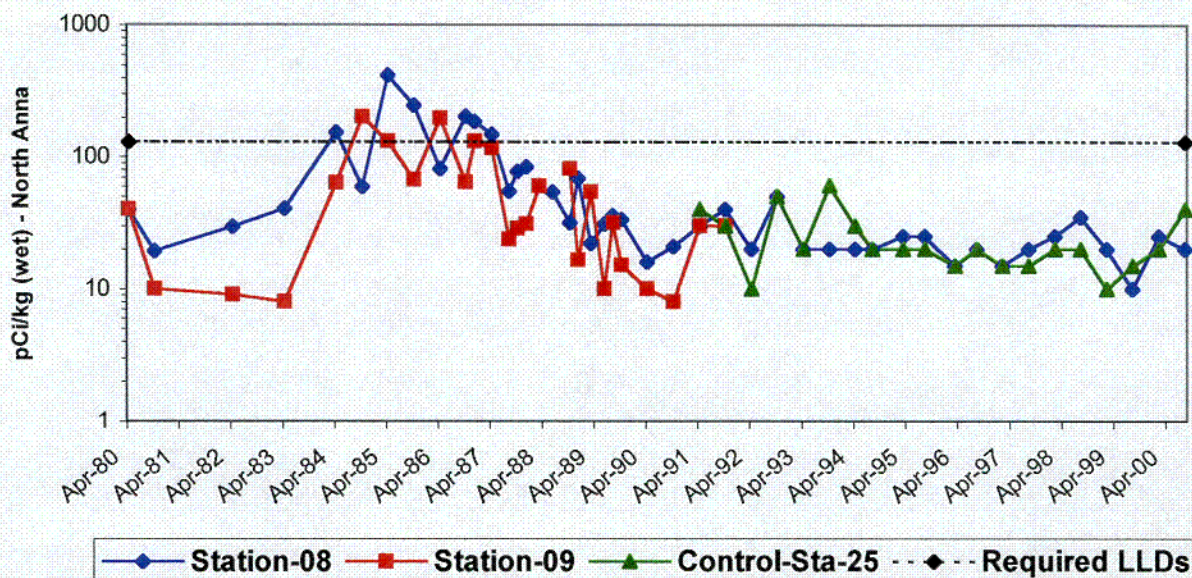
During the operational period, Cesium-134 was not detected in the samples analyzed.



Trending Graph - 7: Cesium-137 in Sediment Silt



TRENDING GRAPH-8: CESIUM-134 IN FISH



During the preoperational period, cesium-134 was not detected in the samples analyzed. Station 25 replaced station 09.

## ***D. Ingestion Exposure Pathway***

### **1. Milk**

The results of the iodine-131 analysis of milk samples are presented in Table B-11. A sample was collected monthly from two stations. A total of 24 samples were analyzed during 2000. There were no measurements of iodine-131 above the detection limits. The milk samples were also analyzed by gamma ray spectroscopy and the results are also presented in Table B-11. A total of 24 samples were analyzed. Naturally occurring potassium-40 was measured in all samples with an average of 1340 pCi/liter and a range of 1010 to 1590 pCi/liter. The fission product cesium-137 has been detected sporadically in recent years and the activity has been attributed to global fallout from past atmospheric weapons testing. However, cesium-137 was not detected at levels above LLD in any milk samples during 2000. All other gamma emitters were below their detection levels. A quarterly composite was prepared from each of the two collection stations and analyzed for strontium-89 and strontium-90. Strontium-89 was not detected at levels above LLD in any of the samples monitored. Strontium-90 was detected in the four samples monitored with an average level of 1.09 pCi/liter and a range of 0.67 to 2.6 pCi/liter. This is similar to activities determined in previous years and lower than the preoperational levels of 2.2 to 5.4 pCi/liter.

### **2. Fish**

Aquatic biota can be sensitive indicators of radionuclide accumulation in the environment because of their ability to concentrate certain chemical elements which have radioactive isotopes. The results are presented in Table B-12. Eight samples of fish were collected during 2000. These samples were analyzed by gamma ray spectroscopy and the naturally occurring isotope potassium-40 was found in all samples at an average of 1699 pCi/kg (wet weight) with a range of 1120 to 2380 pCi/kg (wet weight). The fission product cesium-137 was measured in two of the eight samples with an average activity of 42.6 pCi/kg (wet weight) with a range of 34.1 to 51.1 pCi/kg (wet weight). During the preoperational period cesium-137 was measured in one-fourth of the fish samples collected with concentrations between 31 and 66 pCi/kg (wet weight). All other gamma emitters were below their detection levels.

### **3. Food/Vegetation**

Thirty-five food samples were collected from five locations and analyzed by gamma spectrometry. The results are presented in Table B-13. Naturally occurring potassium-40 was monitored in 34 of 35 samples with an average activity level of 11116 pCi/kg (wet weight) and a range of 5930 to 21300 pCi/kg (wet weight). Cosmogenic beryllium-7 was detected in 23 of the 35 samples with an average concentration of 966 pCi/kg (wet weight) and a range of 221 to 3540 pCi/kg (wet weight).

Cesium-134, a fission product, was not detected at levels above LLD during 2000. Cesium-137 has been detected in some samples at low-levels in previous years and was detected in two samples at an average concentration of 98.6 pCi/kg (wet weight). Cesium-137 was

measured in broadleaf garden vegetation during the preoperational period with concentrations between 53 and 98 pCi/kg (wet weight).

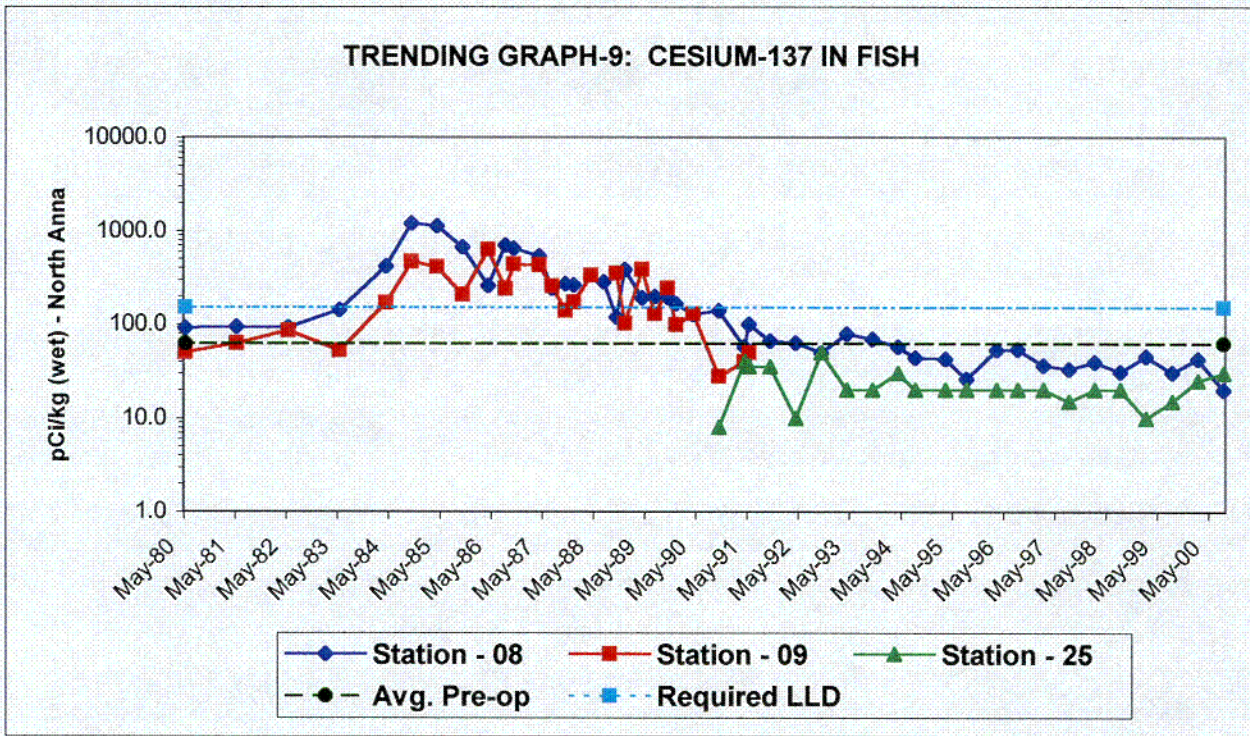
### ***E. Direct Radiation Exposure Pathway***

#### **1. TLD Dosimeters**

Thermoluminescent dosimeters (TLDs) determine environmental radiation doses and the results are presented in Table B-14. Individual measurements of external radiation levels in the environs of the North Anna site had an average dose of 5.5 mR/standard month with a range of 4.3 to 7.1 mR/standard month. This is comparable to the preoperational range. Station, No. 1, had an average reading of 8.2 mR/standard month with a range of 7.5 to 8.7 mR/standard month.

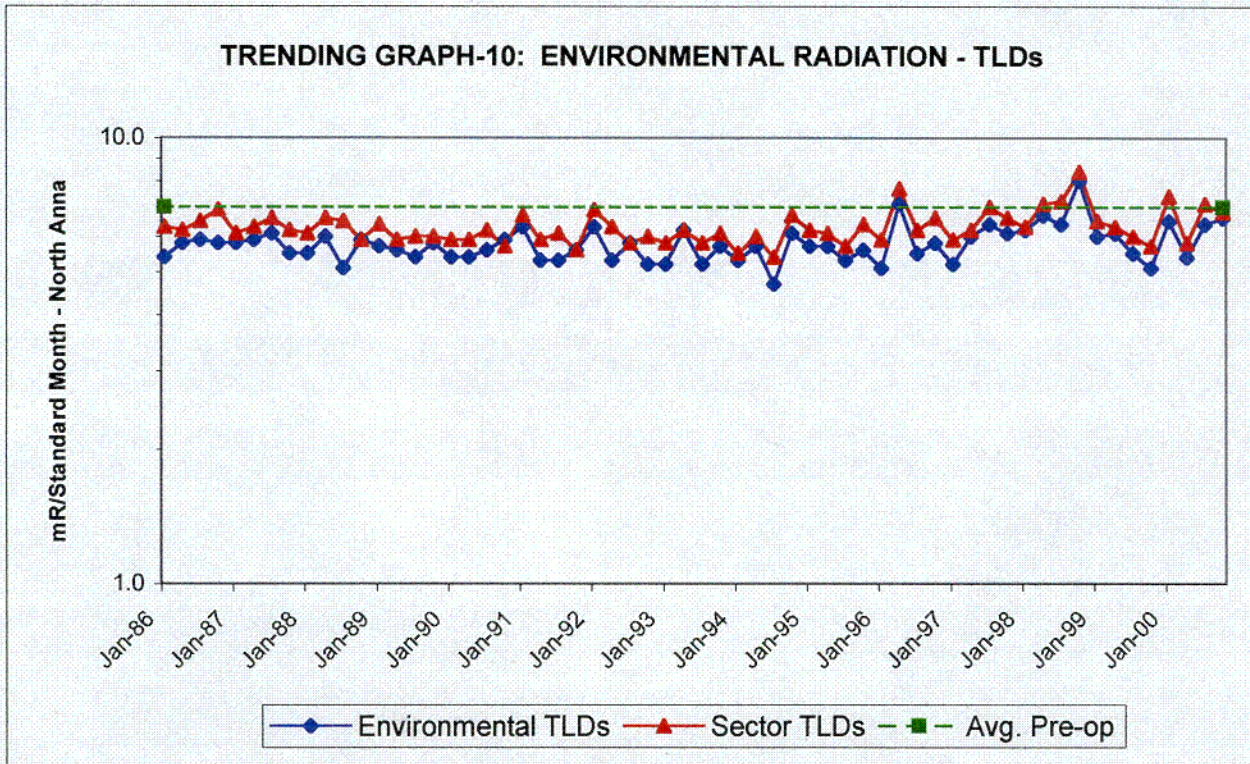
Sector TLDs are deployed quarterly at thirty-two locations in the environs of the North Anna site. Two badges are placed at each location. The results are presented in Table B-15. The average level of the 32 locations (two badges at each location) was 6.9 mR/standard month with a range of 3.9 to 11.1 mR/standard month. The eight control TLDs, collected quarterly from four locations, showed an average reading of 5.9 mR/standard month with a range of 3.9 to 7.9 mR/standard month. During the preoperational period (starting in 1977), when the calculation of the TLD dose included a correction for the in-transit dose, the doses were measured between 4.3 and 8.8 mR/standard month.

TRENDING GRAPH-9: CESIUM-137 IN FISH



Station 25 replaced station 09.

TRENDING GRAPH-10: ENVIRONMENTAL RADIATION - TLDs



## V. CONCLUSIONS

## *V. Conclusions*

The results of the 2000 Radiological Environmental Monitoring Program for the North Anna Nuclear Power Station and ISFSI have been presented. The following sections discuss each pathway individually followed by a program summary.

### *Airborne Exposure Pathway*

Air particulate gross beta concentrations of all the indicator locations for 2000 followed the gross beta concentrations at the control location. The gross beta concentrations were comparable to levels observed since 1982 except for a five week period in 1987 which was influenced by the Chernobyl accident. Gross beta concentrations in the preoperational period were highly variable, ranging from 0.0043 to 0.75 pCi/CuM, due to occasional atmospheric nuclear weapons tests. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). There was no detection above the LLD for fission products nor other man-made isotopes in the particulate media during 2000. Iodine-131 was not detected in the charcoal filters analyzed during 2000.

A precipitation sample was collected monthly during 2000 and analyzed for gross beta activity. All the gross beta activities were comparable to those measured in previous years. During the preoperational period the average gross beta activity was 0.92 pCi/liter. Semi-annual composites were analyzed for gamma emitting isotopes and tritium. All gamma emitters were below their detection limits. Tritium was not observed above the LLD during this reporting period in 1998. During the preoperational period the average tritium activity was 165 pCi/liter.

### *Waterborne Exposure Pathway*

One naturally occurring isotope, potassium-40 and no man-made isotopes were monitored in the surface water of Lake Anna except tritium. The average tritium activity during 2000 at the waste heat treatment facility was 2850 pCi/liter which is 14.25% of the reporting level for a water sample. In 1999 the tritium level was 3975 pCi/liter. The preoperational level was 150 pCi/liter and has risen since 1977, though it has remained relatively consistent since 1986.

River water collected from the North Anna River, 5.8 miles downstream of the site had an average tritium level of 3025 pCi/liter. The average tritium in 1999 had been 3350 pCi/liter. Naturally occurring potassium-40 was measured in 3 out of 12 samples at an average concentration of 148 pCi/liter. No other gamma emitters were detected.

Ground water from the environmental well on site contained no gamma emitters. There was no detection of tritium in ground/well water during 2000.

### *Aquatic Pathway*

Sediment/silt samples provide a sensitive indicator of discharges from nuclear power stations. The sediment from North Anna environmental samples indicated that one man-made isotope was present. Cesium-137 was detected in two samples at the indicator location and in one sample at the

control location. Europium-152 was detected in one indicator location. The europium-152 activity was attributed to possible cross-contamination in the laboratory. During the preoperational period, cesium-137 was measured in samples of aquatic sediment. Strontium-90 was detected in two samples at the indicator location and in one sample at the control location. Sediment contamination does not provide a direct dose pathway to man.

The samples of shoreline soil monitored downstream of the site contained no measurement of cesium-134. Cesium-137 was measured in one of the two samples at a level of 167 pCi/kg. Cesium-137 was not detected during 1999.

### ***Ingestion Pathway***

Iodine-131 was not detected in any of the twenty-four milk samples using the radiochemical separation method. Although cesium-137 has been detected occasionally in previous years and attributed to past atmospheric nuclear weapons testing there was no detection during 2000. Strontium-90 was measured in all four quarterly composite milk samples. Strontium-90 is attributed to past atmospheric nuclear weapons testing. No strontium-89 was detected in any of the milk samples. Naturally occurring potassium-40 was measured in all the milk samples at normal environmental levels.

Activity in fish and vegetation samples along with milk does present a direct dose pathway to man. Fish samples during 2000 showed the presence of one man-made isotope, cesium-137. This isotope was at an activity level somewhat higher than preoperational levels but statistically similar to levels in 1987 through 1999. Only cesium-137 was measured in preoperational environmental fish samples. Due to primary and secondary steam generator problems experienced at North Anna during 1984/1985, a build up in activity levels both in effluents and fish did occur. Repairs to the steam generators and better liquid waste processing have reduced these activity levels in effluents and thus decreased activity levels are now being observed in the fish. The average level of activity during 2000 of cesium-137 was 2.1% of the reporting level.

Two vegetation samples contained cesium-137 at an average level of 98.6 pCi/kg. Cesium-137 has been measured in the past and in preoperational samples.

### ***Direct Exposure Pathway***

The direct exposure pathway as measured in the environment of the North Anna site by thermoluminescent dosimetry has remained essentially the same since the preoperational period in 1977 at 6 milliroentgens per month or 0.2 milliroentgens per day. The average dose levels monitored have shown a normal fluctuation about these levels which are less than the estimated whole body dose due to natural terrestrial and cosmic radiation and the internal dose from natural radionuclides.

### ***Program Conclusions***

The results were as expected for normal environmental samples. Naturally occurring activity was observed in sample media in the expected activity ranges. Occasional samples of nearly all media showed the presence of man-made isotopes. These have been discussed individually in the text. Observed activities were at very low concentrations and had no significant dose consequence.

As a method of referencing the measured radionuclide concentrations in sample media to the dose consequence, the data may be compared to the Reporting Level Concentrations listed in the Offsite Dose Calculation Manual. These concentrations are based upon 25% of the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion "As Low as is Reasonably Achievable". Based upon the evidence of the environmental monitoring program the station is operating within regulatory limits. Thus, no unusual radiological characteristics were observed in the environs of the North Anna Nuclear Power Station during 2000.



## VI. REFERENCES

## *VI. References*

1. Virginia Electric and Power Company, North Anna Power Station Technical Specifications, Units 1 and 2.
2. Virginia Electric and Power Company, Station Administrative Procedure, VPAP-2103N, "Offsite Dose Calculation Manual".
3. Title 10 Code of Federal Regulation, Part 50 (10CFR50), "Domestic Licensing of Production and Utilization Facilities".
4. United States Nuclear Regulatory Commission Regulatory Guide 1.109, Rev. 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I", October, 1977.
5. United States Nuclear Regulatory Commission, Regulatory Guide 4.8 "Environmental Technical Specifications for Nuclear Power Plants", December, 1975.
6. USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program", Rev. 1, November 1979.
7. NUREG 0472, "Radiological Effluent Technical Specifications for PWRs", Rev. 3, March 1982.
8. "Technical Specifications for North Anna Independent Spent Fuel Storage Installation (ISFSI)"

## VII. APPENDICES

**APPENDIX A**  
**RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**  
**ANNUAL SUMMARY TABLES – 2000**

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 1 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
<b>Air Iodine</b> (pCi/m <sup>3</sup> )	I-131	624	0.04	(0/561)(a,b)	N/A		N/A	(0/49)(a,b)	0
<b>Airborne Particulates</b> (1E-03 pCi/m <sup>3</sup> )	Gross	624	5	18.7(560-572)(a)	23	0.93 mi	20.0(52/52)	19.4(51/52)(a)	0
	Beta			(6.0-70)		SSE	(7.6-70)	(7.1-41)	
	Gamma	48							
	Be-7	48	10	63.9(43/44) (29.2-92.1)	24	22.0 mi NW	70.9(4/4) (66.0-79.7)	70.9(4/4) (66.0-79.7)	0
	K-40	48	10	5.43(2/44) (4.95-5.91)	07	7.30 mi SSE	5.91(1/4) (5.91)	(0/4) -	0
	Sr-89	12	3	(0/10) -		N/A	N/A	(0/2) -	0
	Sr-90	12	0.4	(0/10) -		N/A	N/A	(0/2) -	0
<b>Ground Well Water</b>	Gamma	4							
	K-40	4	60	(0/4) -		N/A	N/A	(0/0) -	0
	Tritium	4	2000	(0/4) -		N/A	N/A	(0/0) -	0
	Sr-89	1	3	(0/1) -		N/A	N/A	(0/0) -	0
	Sr-90	1	0.4	(0/1) -		N/A	N/A	(0/0) -	0

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

a) Sample was lost.  
b) Samples not analyzed.

**RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 2 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
<b>River Water</b> (pCi/liter)	Gamma	12							
	K-40	12	200	148(3/12) (7.7-385)	11 5.8 mi SSE	148(3/12) (7.7-385)	(0/0) -	0	
	Tritium	4	2000	3025(4/4) (1500-4700)	11 5.8 mi. SSE	3025(4/4) (1500-4700)	(0/0) -	0	
	Sr-89	1	3	(0/1) -	N/A	N/A	(0/0) -	0	
	Sr-90	1	0.4	(0/1) -	N/A	N/A	(0/0) -	0	
<b>Precipitation</b> (pCi/liter)	Monthly								
	Gross	12	4	3.89(10/12) (1.8-10)	01A 0.2 mi. NE	3.89(10/12) (1.8-10)	(0/0) -	0	
	Beta								
	Gamma (Semi-Annually)	2		(0/2) -	N/A	N/A	(0/0) -	0	
	Tritium	2	2000	(0/2) -	N/A	N/A	(0/0) -	0	
<b>Surface Water</b> (pCi/liter) Regular Monthlies	I-131	24	0.5	(0/12) -	N/A	N/A	(0/12) -	0	
	Gamma	24							
	K-40	24	200	39.8(1/12) (39.8)	08 1.10 mi SSE	39.8(1/12) (39.8)	(0/12) -	0	
	Tritium	4	2000	2850(2/2) (1500-4500)	08 1.10 mi SSE	2850(2/2) (1500-4500)	(0/2) -	0	

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.

# RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 3 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Surface Water (pCi/liter) Regular Monthlies	Sr-89	1		(0/1) -	N/A		N/A	(0/1) -	0
	Sr-90	1		(0/1) -	N/A		N/A	(0/1) -	0
Surface Water (pCi/liter) State Splits	Gamma	N/A							
	K-40	N/A							
	Tritium	N/A							
Sediment Silt (pCi/kg (dry))	Gamma	6							
	Be-7	6		(0/4) -	N/A		N/A	227(1/2) (227)	0
	K-40	6	200	10460(4/4) (3040-14700)	11 SSE	5.8 mi	13800(2/2) (12900-14700)	12800(1/2) (12800)	0
	Cs-137	6	194	132(2/4) (58.8-205)	08 SSE	1.10 mi	205(1/2) (205)	1720(1/2) (1720)	0
	Ra-226	6	100	1320(3/4) (399-1870)	08 SSE	1.10 mi	1870(1/2) (1870)	1720(1/2) (1720)	0
	Th-228	6	30	975(2/4) (849-1100)	08 SSE	1.10 mi.	1100(1/2) (1100)	846(1/2) (846)	0
	Eu-152	6		2550(1/4) (2550)	08 SSE	1.10 mi.	2550(1/4) (2550)	(0/2) -	0
	Sr-89 (Annually)	3	4.0	(0/0) -	N/A		N/A	(0/0) -	0

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.

**RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 4 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Sediment	Sr-90	3	0.8	135(2/2)	09A	12.9 mi.	290(1/1)	290(1/1)	0
	(Annually)			(130-140)			WNW		
(pCi/kg (dry))									
Soil (pCi/kg (dry))	Gamma	0							
	Be-7	0							
	K-40	0							
	Cs-134	0	100						
	Cs-137	0	180						
	Ra-226	0	100						
	Th-228	0	30						
	Sr-89 (Annually)	0	200						
Sr-90 (Annually)	0	40							

Soil samples are collected every three years. Since they were collected in 1998, they were not collected during 2000.

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.



## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 5 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Shoreline Soil (pCi/kg (dry))	Gamma	2							
	Be-7	2		(0/2) -	N/A		N/A	(0/0) -	0
	K-40	2	200	1345(2/2) (1280-1410)	08 1.10 mi SSE		1345(2/2) (1280-1410)	(0/0) -	0
	Cs-137	2	40	167(1/2) (167)	08 1.10 mi SSE		167(1/2) (167)	(0/0) -	0
	Ra-226	2	100	464(2/2) (313-615)	08 1.10 mi SSE		464(2/2) (313-615)	(0/0) -	0
	Th-228	2	30	251(2/2) (203-298)	08 1.10 mi SSE		251(2/2) (203-298)	(0/0) -	0
	Sr-89 (Annually)	1	4.0	(0/1) -	N/A		N/A	(0/0) -	0
	Sr-90 (Annually)	1	0.8	100(1/1) (100)	08 1.10 mi SSE		100(1/1) (100)	(0/0) -	0
Milk (pCi/liter)	I-131	24	0.5	(0/24) -	N/A		N/A	(0/0) -	0
	Gamma	24							
	K-40	24	100	1342(24/24) (1010-1590)	12 8.3 mi. NW		1402(12/12) (1220-1590)	(0/0) -	0
	Sr-89 (Quarterly)	8	5	(0/4) -	N/A		N/A	(0/0) -	0
Sr-90 (Quarterly)	8	0.8	1.09(8/8) (0.67-2.6)	12 8.3 mi NW		1.31(4/4) (0.65-2.6)	(0/0) -	0	

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.

# RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 6 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
<b>Fish</b>	Gamma	8							
(pCi/kg (wet))									
	K-40	8	200	1699(4/4) (1120-1730)	08	1.10 mi SSE	1860(4/4) (1120-2380)	1860(4/4) (1120-2380)	0)
	Cs-137	8	40	42.6(2/4) (34.1-51.1)	08	1.10 mi. SSE	42.6(2/4) (34.1-51.1)	(0/4) -	0
<b>Food</b>	Gamma	35							
<b>Vegetation</b>	Dose								
(pCi/kg (wet))									
	Be-7	35		1064(18/28) (221-3540)	21	1.00 mi WNW	1236(4/7) (506-2210)	614(5/7) (351-972)	0
	K-40	35		10796(27/28) (5390-21300)	23	0.93 mi SSE	12723(7/7) (7270-21300)	12350(7/7) (9750-17100)	0
	Cs-137	35	80	186(1/28) (186)	15	1.20 mi NE	186(1/7) (186)	11.2(1/7) (11.2)	0
	Th-228	35		(0/28) -			(0/7) -	(0/7) -	0

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.

**RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

North Anna Nuclear Power Station, Louisa County, Virginia – 2000

Docket No. 50-338/339

Page 7 of 7

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non- routine
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	Reported Measure- ments
<b>Direct Radiation</b> (mR/std. month) (Regular TLDs)	Gamma Dose	48	0.2	6.24(44/44) (4.1-8.77)	01	0.2 mi. NE	8.20(4/4) (7.5-8.7)	5.8(4/4) (5.0-6.4)	0
<b>Direct Radiation</b> (mR/std. Month) (Annual TLDs)	Gamma Dose	12	0.2	5.47(11/11) (4.3-7.1)	01 23	0.2 mi. NE 0.93 mi. SSE	7.1(2/12) (7.1)	5.3(1/1) (5.3)	0
<b>Direct Radiation</b> (mR/std. Month) (Sector TLDs)	Gamma Dose	288	0.2	6.89(256/256) (4.9-11.1)	17/49	0.22 mi. S	9.9(8/8) (8.4-11.1)	5.86(32/32) (3.9-7.9)	0

\* LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

- a) Sample was lost.
- b) Samples not analyzed.

**APPENDIX B**  
**DATA TABLES**

**TABLE B-1: IODINE-131 CONCENTRATIONS IN FILTERED AIR**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/m<sup>3</sup> ± 2 Sigma

Page 1 of 2

Collection Date	STATIONS											
	01	02	03	04	05	05A	06	07	21	22	23	24
<b>JANUARY</b>												
12/29-01/06	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .007	< .006	< .005
01/06-01/12	< .009	< .009	< .009	< .009	< .006	< .008	< .009	< .008	< .008	< .006	< .01	< .01
01/12-01/19	< .008	< .008	< .008	< .008	< .006	< .008	< .008	< .008	< .008	< .006	< .01	< .01
01/19-01/27	< .01	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .008	< .02	< .02
01/27-02/02	< .02	< .02	< .02	< .02	< .009	< .009	< .009	< .009	< .01	< .01	< .01	< .01
<b>FEBRUARY</b>												
02/02-02/09	< .01	< .01	< .01	< .01	< .008	< .007	< .007	< .007	< .007	< .006	< .01	< .01
02/09-02/16	< .008	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
02/16-02/23	< .008	< .008	< .008	< .008	< .006	< .008	< .008	< .008	< .008	< .005	< .01	< .01
02/23-03/01	< .008	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
<b>MARCH</b>												
03/01-03/08	< .008	< .008	< .009	< .008	< .006	< .008	< .008	< .009	< .008	< .006	< .01	< .01
03/08-03/15	< .007	< .008	< .007	< .006	< .008	< .01	< .01	< .01	< .01	< .008	< .009	< .006
03/15-03/22	< .008	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .007
03/22-03/29	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
<b>APRIL</b>												
03/29-04/05	< .008	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .009	< .007	< .006
04/05-04/12	< .008	< .008	< .008	< .008	< .006	< .01	< .01	< .01	< .01	< .008	< .01	< .01
04/12-04/19	< .009	< .009	< .008	< .009	< .007	< .008	< .008	< .008	< .007	< .006	< .01	< .01
04/19-04/26	(a)	(a)	(a)	(a)	(a)	< .008	< .008	< .008	< .008	< .006	< .02	< .02
04/26-05/03	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .006	< .02	< .02
<b>MAY</b>												
05/03-05/10	< .007	< .007	< .007	< .007	< .005	< .007	< .007	< .008	< .007	< .004	< .006	< .01
05/10-05/17	< .009	< .009	< .009	< .009	< .006	< .02	< .02	< .02	< .02	< .01	< .005	< .007
05/17-05/23	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
05/23-05/31	< .009	< .009	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .008	< .01	< .01
<b>JUNE</b>												
05/31-06/07	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
06/07-06/14	< .007	< .008	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
06/14-06/21	< .009	< .009	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .009	< .009	< .007
06/21-06/28	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .01	< .01

(a) The gamma spectral data was transcribed to magnetic tape. Due to a malfunction of this magnetic tape device, the data was irretrievable and the gamma data not reportable.  
 (b) The sample was not analyzed.

**TABLE B-1: IODINE-131 CONCENTRATIONS IN FILTERED AIR**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/m<sup>3</sup> ± 2 Sigma

Page 2 of 2

Collection Date	STATIONS											
	01	02	03	04	05	05A	06	07	21	22	23	24
<b>JULY</b>												
06/28-07/05	< .008	< .008	< .008	< .008	< .006	< .01	< .01	< .01	< .01	< .009	< .01	< .01
07/05-07/12	< .02	< .02	< .02	< .02	< .02	< .01	< .01	< .01	< .01	< .008	< .007	< .006
07/12-07/19	< .009	< .009	< .009	< .009	< .007	< .01	< .01	< .01	< .01	< .009	< .01	< .01
07/19-07/25	< .009	< .01	< .01	< .01	< .007	< .02	< .01	< .01	< .02	< .01	< .01	< (b)
07/25-08/02	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .007	< .02	< .01
<b>AUGUST</b>												
08/02-08/09	< .011	< .011	< .011	< .011	< .007	< .014	< .014	< .014	< .014	< 0.01	< .009	< .01
08/09-08/16	< .01	< .01	< .01	< .01	< .009	< .02	< .02	< .02	< .02	< .01	< .01	< .009
08/16-08/23	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .01	< .02	< .02
08/23-08/30	< .006	< .006	< .006	< .006	< .006	< .007	< .007	< .007	< .007	< .008	< .01	< (b)
<b>SEPTEMBER</b>												
08/30-09/06	< .01	< .01	< .01	< .01	< .01	< .02	< .02	< .02	< .02	< .01	< .01	< .01
09/06-09/14	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .008	< .01	< .008
09/14-09/20	< .03	< .03	< .03	< .03	< .02	< .02	< .02	< .02	< .02	< .01	< .01	< .02
09/20-9/27	< .009	< .008	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .009	< .009	< .009
<b>OCTOBER</b>												
09/27-10/04	< .007	< .007	< .007	< .007	< .005	< .008	< .008	< .008	< .008	< .005	< .006	< .005
10/04-10/11	< .008	< .008	< .008	< .008	< .004	< .006	< .006	< .006	< .006	< .004	< .004	< .005
10/11-10/18	< .006	< .006	< .007	< .006	< .004	< .006	< .006	< .006	< .006	< .004	< .003	< .005
10/18-10/25	< .007	< .007	< .008	< .008	< .006	< .009	< .009	< .009	< .009	< .006	< .01	< .005
10/25-11/01	< .004	< .005	< .007	< .007	< .007	< .006	< .004	< .007	< .007	< .007	< .007	< .005
<b>NOVEMBER</b>												
11/01-11/08	< .008	< .008	< .008	< .009	< .005	< .008	< .008	< .008	< .008	< .006	< .02	< .01
11/08-11/15	< .01	< .01	< .01	< .01	< .007	< .01	< .01	< .01	< .01	< .007	< .01	< .01
11/15-11/22	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
11/22-11/29	< .006	< .006	< .006	< .006	< .004	< .006	< .006	< .006	< .006	< .004	< .008	< .008
<b>DECEMBER</b>												
11/29-12/6	< .01	< .01	< .01	< .01	< .006	< .01	< .01	< .01	< .01	< .008	< .01	< .01
12/6-12/13	< .004	< .007	< .007	< .007	< .007	< .005	< .006	< .006	< .006	< .006	< .004	< .007
12/13-12/19	< .02	< .02	< .02	< .02	< .01	< .02	< .02	< .02	< .02	< .01	< .02	< .02
12/19-12/27	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01

(a) The gamma spectral data was transcribed to magnetic tape. Due to a malfunction of this magnetic tape device, the data was irretrievable and the gamma data not reportable.  
 (b) The sample was not analyzed.

**TABLE B-2: CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES**

North Anna Power Station, Louisa County, Virginia – 2000

1.0E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 1 of 4

<b>COLLECTION DATE</b>	<b>01</b>	<b>02</b>	<b>03</b>	<b>04</b>	<b>05</b>	<b>05A</b>	<b>06</b>	<b>07</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>AVERAGE ± 2 s.d.</b>
<b>JANUARY</b>													
12/29-01/06	26 ± 2	25 ± 2	27 ± 2	29 ± 2	20 ± 2	27 ± 2	22 ± 2	29 ± 2	28 ± 2	24 ± 2	22 ± 2	26 ± 2	25 ± 6
01/06-01/12	18 ± 2	16 ± 2	19 ± 2	18 ± 2	19 ± 2	19 ± 2	18 ± 2	19 ± 2	19 ± 2	17 ± 2	18 ± 2	21 ± 2	18 ± 2
01/12-01/19	10 ± 1	15 ± 2	14 ± 2	16 ± 2	12 ± 1	13 ± 2	12 ± 1	15 ± 2	14 ± 2	10 ± 1	14 ± 2	14 ± 2	13 ± 4
01/19-01/27	21 ± 2	21 ± 2	25 ± 2	26 ± 2	26 ± 2	26 ± 2	20 ± 2	21 ± 2	27 ± 2	25 ± 2	25 ± 2	29 ± 2	24 ± 6
01/27-02/02	14 ± 2	17 ± 2	16 ± 2	21 ± 2	18 ± 2	19 ± 2	18 ± 2	17 ± 2	19 ± 2	16 ± 2	17 ± 2	17 ± 2	17 ± 4
<b>FEBRUARY</b>													
02/02-02/09	19 ± 2	20 ± 2	20 ± 2	23 ± 2	22 ± 2	22 ± 2	20 ± 2	24 ± 2	21 ± 2	21 ± 2	20 ± 2	24 ± 2	21 ± 3
02/09-02/16	21 ± 2	24 ± 2	23 ± 2	26 ± 2	24 ± 2	23 ± 2	23 ± 2	27 ± 2	29 ± 2	22 ± 2	25 ± 2	26 ± 2	24 ± 5
02/16-02/23	16 ± 2	17 ± 2	17 ± 2	18 ± 2	17 ± 2	18 ± 2	15 ± 2	20 ± 2	21 ± 2	18 ± 2	20 ± 2	17 ± 2	18 ± 3
02/23-03/01	13 ± 2	14 ± 2	15 ± 2	14 ± 2	14 ± 2	14 ± 2	13 ± 2	16 ± 2	15 ± 2	14 ± 2	14 ± 2	15 ± 2	14 ± 2
<b>MARCH</b>													
03/01-03/08	16 ± 2	15 ± 2	18 ± 2	19 ± 2	21 ± 2	18 ± 2	17 ± 2	22 ± 2	18 ± 2	14 ± 2	19 ± 2	19 ± 2	18 ± 5
03/08-03/15	18 ± 2	19 ± 2	17 ± 2	20 ± 2	21 ± 2	19 ± 2	17 ± 2	22 ± 2	18 ± 2	16 ± 2	18 ± 2	17 ± 2	19 ± 4
03/15-03/22	10 ± 2	11 ± 1	10 ± 1	10 ± 1	10 ± 1	12 ± 2	10 ± 1	11 ± 1	13 ± 2	9 ± 1	10 ± 1	11 ± 1	11 ± 2
03/22-03/29	11 ± 2	12 ± 2	10 ± 1	12 ± 2	11 ± 2	13 ± 2	10 ± 1	13 ± 2	12 ± 2	10 ± 1	12 ± 2	11 ± 1	11 ± 2
<b>Quarter Avg. ± 2 s.d.</b>	<b>16 ± 10</b>	<b>17 ± 9</b>	<b>18 ± 11</b>	<b>19 ± 11</b>	<b>18 ± 10</b>	<b>19 ± 10</b>	<b>17 ± 9</b>	<b>20 ± 11</b>	<b>20 ± 11</b>	<b>17 ± 10</b>	<b>18 ± 9</b>	<b>19 ± 12</b>	<b>18 ± 10</b>

(a) Sample not analyzed.

**TABLE B-2: CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES**

North Anna Power Station, Louisa County, Virginia -- 2000

1.0E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 2 of 4

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
<b>APRIL</b>													
03/29-04/05	14 ± 2	15 ± 2	15 ± 2	15 ± 2	15 ± 2	13 ± 2	14 ± 2	16 ± 2	14 ± 2	13 ± 2	13 ± 2	12 ± 2	14 ± 2
04/05-04/12	16 ± 2	17 ± 2	17 ± 2	17 ± 2	14 ± 2	15 ± 2	14 ± 2	16 ± 2	14 ± 2	13 ± 2	15 ± 2	16 ± 2	15 ± 3
04/12-04/19	8 ± 1	8 ± 1	9 ± 1	9 ± 1	9 ± 1	9 ± 1	8 ± 1	10 ± 1	10 ± 1	9 ± 1	8 ± 1	9 ± 1	9 ± 1
04/19-04/26	7 ± 1	8 ± 1	8 ± 1	7 ± 1	7 ± 1	8 ± 1	7 ± 1	9 ± 1	7 ± 1	6 ± 1	8 ± 1	7 ± 1	7 ± 2
04/26-05/03	14 ± 2	15 ± 2	15 ± 2	15 ± 2	13 ± 2	15 ± 2	14 ± 2	17 ± 2	15 ± 2	13 ± 2	14 ± 2	15 ± 2	15 ± 2
<b>MAY</b>													
05/03-05/10	21 ± 2	21 ± 2	20 ± 2	20 ± 2	19 ± 2	20 ± 2	18 ± 2	21 ± 2	22 ± 2	19 ± 2	19 ± 2	21 ± 2	20 ± 2
05/10-05/17	16 ± 2	17 ± 2	16 ± 2	15 ± 2	18 ± 2	18 ± 2	14 ± 2	21 ± 2	18 ± 2	16 ± 2	16 ± 2	18 ± 2	17 ± 4
05/17-05/23	15 ± 2	15 ± 2	13 ± 2	15 ± 2	13 ± 2	14 ± 2	12 ± 2	10 ± 2	12 ± 2	14 ± 2	14 ± 2	14 ± 2	13 ± 3
05/23-05/31	14 ± 2	14 ± 2	14 ± 2	14 ± 2	14 ± 2	13 ± 1	15 ± 2	13 ± 1	14 ± 2	15 ± 2	13 ± 1	12 ± 1	14 ± 2
<b>JUNE</b>													
05/31-06/07	11 ± 1	14 ± 2	12 ± 1	13 ± 2	13 ± 2	14 ± 2	12 ± 1	13 ± 2	11 ± 1	13 ± 2	13 ± 2	14 ± 2	13 ± 2
06/07-06/14	21 ± 2	21 ± 2	23 ± 2	21 ± 2	21 ± 2	24 ± 2	18 ± 2	19 ± 2	21 ± 2	21 ± 2	20 ± 2	23 ± 2	21 ± 3
06/14-06/21	10 ± 1	9 ± 1	11 ± 1	10 ± 1	10 ± 1	11 ± 1	9 ± 1	10 ± 1	9 ± 1	10 ± 1	11 ± 1	11 ± 1	10 ± 2
06/21-06/28	22 ± 2	21 ± 2	20 ± 2	21 ± 2	17 ± 2	21 ± 2	19 ± 2	21 ± 2	17 ± 2	20 ± 2	20 ± 2	20 ± 2	20 ± 3
<b>Quarter Avg. ± 2 s.d.</b>	<b>15 ± 10</b>	<b>15 ± 9</b>	<b>15 ± 9</b>	<b>15 ± 9</b>	<b>14 ± 8</b>	<b>15 ± 9</b>	<b>13 ± 8</b>	<b>15 ± 9</b>	<b>14 ± 9</b>	<b>14 ± 9</b>	<b>14 ± 8</b>	<b>15 ± 9</b>	<b>14 ± 9</b>

(a) Sample not analyzed.



**TABLE B-2: CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES**

North Anna Nuclear Power Station, Louisa County, Virginia- 2000

1.0E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 3 of 4

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
<b>JULY</b>													
06/28-07/05	18 ± 2	17 ± 2	16 ± 2	17 ± 2	15 ± 2	18 ± 2	17 ± 2	16 ± 2	16 ± 2	17 ± 2	15 ± 2	15 ± 2	16 ± 2
07/05-07/12	19 ± 2	18 ± 2	16 ± 2	18 ± 2	16 ± 2	17 ± 2	14 ± 2	15 ± 2	15 ± 2	16 ± 2	15 ± 2	15 ± 2	16 ± 3
07/12-07/19	15 ± 2	15 ± 2	17 ± 2	18 ± 2	15 ± 2	14 ± 2	14 ± 2	16 ± 2	14 ± 2	13 ± 2	15 ± 2	14 ± 2	15 ± 3
07/19-07/25	18 ± 2	18 ± 2	19 ± 2	19 ± 2	17 ± 2	18 ± 2	18 ± 2	15 ± 2	18 ± 2	16 ± 2	16 ± 2	16 ± 2	17 ± 3
07/25-08/02	13 ± 1	11 ± 1	14 ± 1	14 ± 1	11 ± 1	12 ± 1	10 ± 1	11 ± 1	13 ± 1	12 ± 1	12 ± 1	12 ± 1	12 ± 2
<b>AUGUST</b>													
08/02-08/09	22 ± 2	22 ± 2	23 ± 2	23 ± 2	18 ± 2	22 ± 2	19 ± 2	23 ± 2	21 ± 2	22 ± 2	24 ± 2	23 ± 2	22 ± 4
08/09-08/16	19 ± 2	18 ± 2	19 ± 2	20 ± 2	17 ± 2	18 ± 2	15 ± 2	16 ± 2	20 ± 2	18 ± 2	19 ± 2	19 ± 2	18 ± 3
08/16-08/23	14 ± 2	16 ± 2	18 ± 2	17 ± 2	15 ± 2	16 ± 2	< 1.0(a)	15 ± 2	19 ± 2	17 ± 2	16 ± 2	18 ± 2	16 ± 3
08/23-08/30	28 ± 2	25 ± 2	24 ± 2	26 ± 2	23 ± 2	22 ± 2	22 ± 2	23 ± 2	24 ± 2	24 ± 2	23 ± 2	31 ± 2	25 ± 5
<b>SEPTEMBER</b>													
08/30-09/06	13 ± 2	12 ± 2	12 ± 2	13 ± 2	12 ± 2	13 ± 2	12 ± 2	11 ± 2	9 ± 2	13 ± 2	14 ± 2	12 ± 2	12 ± 3
09/06-09/14	19 ± 2	17 ± 2	19 ± 2	17 ± 2	17 ± 2	19 ± 2	15 ± 1	18 ± 2	17 ± 2	19 ± 2	18 ± 2	18 ± 2	18 ± 2
09/14-09/20	16 ± 2	13 ± 2	16 ± 2	13 ± 2	14 ± 2	14 ± 2	13 ± 2	13 ± 2	14 ± 2	15 ± 2	16 ± 2	13 ± 2	14 ± 3
09/20-09/27	14 ± 2	13 ± 2	12 ± 2	13 ± 2	12 ± 2	11 ± 1	11 ± 1	10 ± 1	13 ± 2	12 ± 2	13 ± 2	12 ± 2	12 ± 2
<b>Quarter Avg. ± 2 s.d.</b>	<b>18 ± 9</b>	<b>16 ± 8</b>	<b>17 ± 7</b>	<b>17 ± 8</b>	<b>16 ± 6</b>	<b>16 ± 7</b>	<b>15 ± 7</b>	<b>16 ± 8</b>	<b>16 ± 8</b>	<b>16 ± 7</b>	<b>17 ± 7</b>	<b>17 ± 11</b>	<b>16 ± 8</b>

(a) Sample not analyzed.

**TABLE B-2: CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES**

North Anna Nuclear Power Station, Louisa County, Virginia- 2000

1.0E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 4 of 4

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
<b>OCTOBER</b>													
09/27-10/04	20 ± 2	21 ± 2	20 ± 2	20 ± 2	19 ± 2	19 ± 2	22 ± 2	19 ± 2	19 ± 2	20 ± 2	22 ± 2	19 ± 2	20 ± 2
10/04-10/11	22 ± 2	20 ± 2	22 ± 2	21 ± 2	21 ± 2	21 ± 2	20 ± 2	25 ± 2	18 ± 2	18 ± 2	23 ± 2	24 ± 2	21 ± 4
10/11-10/18	39 ± 3	38 ± 3	41 ± 3	38 ± 3	41 ± 3	37 ± 2	36 ± 2	34 ± 2	34 ± 2	39 ± 2	42 ± 3	40 ± 3	38 ± 5
10/18-10/25	42 ± 3	39 ± 3	41 ± 3	42 ± 3	41 ± 3	37 ± 2	31 ± 2	31 ± 2	39 ± 3	41 ± 3	44 ± 3	41 ± 3	39 ± 8
10/25-11/01	28 ± 2	27 ± 2	27 ± 2	27 ± 2	28 ± 2	26 ± 2	19 ± 2	21 ± 2	26 ± 2	25 ± 2	28 ± 2	28 ± 2	26 ± 6
<b>NOVEMBER</b>													
11/01-11/08	29 ± 2	25 ± 2	29 ± 2	32 ± 3	30 ± 2	27 ± 2	27 ± 2	26 ± 2	24 ± 2	29 ± 2	70 ± 5	29 ± 3	31 ± 25
11/08-11/15	23 ± 2	23 ± 2	23 ± 2	25 ± 2	22 ± 2	25 ± 2	19 ± 2	20 ± 2	22 ± 2	20 ± 2	22 ± 2	24 ± 2	22 ± 4
11/15-11/22	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
11/22-11/29	19 ± 2	20 ± 2	20 ± 2	21 ± 2	20 ± 2	20 ± 2	18 ± 2	18 ± 2	19 ± 2	20 ± 2	21 ± 2	21 ± 2	20 ± 2
<b>DECEMBER</b>													
11/29-12/06	18 ± 2	16 ± 2	20 ± 2	19 ± 2	18 ± 2	19 ± 2	17 ± 2	17 ± 2	18 ± 2	17 ± 2	19 ± 2	19 ± 2	18 ± 3
12/06-12/13	32 ± 2	28 ± 2	33 ± 2	30 ± 2	27 ± 2	28 ± 2	27 ± 2	27 ± 2	30 ± 2	27 ± 2	29 ± 2	27 ± 2	29 ± 4
12/13-12/19	23 ± 2	23 ± 2	27 ± 2	29 ± 2	22 ± 2	25 ± 2	24 ± 2	21 ± 2	23 ± 2	25 ± 2	28 ± 2	28 ± 2	25 ± 5
12/19-12/27	31 ± 2	28 ± 2	36 ± 2	31 ± 2	28 ± 2	30 ± 2	33 ± 2	30 ± 2	28 ± 2	30 ± 2	37 ± 2	31 ± 2	31 ± 6
<b>Quarter Avg. ± 2 s.d.</b>	<b>27 ± 16</b>	<b>26 ± 14</b>	<b>28 ± 16</b>	<b>28 ± 15</b>	<b>26 ± 16</b>	<b>26 ± 12</b>	<b>24 ± 13</b>	<b>24 ± 11</b>	<b>25 ± 13</b>	<b>26 ± 16</b>	<b>32 ± 29</b>	<b>28 ± 14</b>	<b>27 ± 16</b>
<b>Annual Avg. ± 2 s.d.</b>	<b>19 ± 14</b>	<b>19 ± 13</b>	<b>19 ± 15</b>	<b>20 ± 14</b>	<b>18 ± 14</b>	<b>19 ± 13</b>	<b>17 ± 12</b>	<b>18 ± 12</b>	<b>19 ± 13</b>	<b>18 ± 14</b>	<b>20 ± 21</b>	<b>19 ± 15</b>	<b>19 ± 14</b>

(a) Sample not analyzed.

**TABLE B-3: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN AIR PARTICULATES**

North Anna Power Station, Louisa County, Virginia – 2000

1.0 E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 1 of 3

Station	Nuclide*	First Quarter 12/29-03/29	Second Quarter 03/29-06/28	Third Quarter 06/28-09/27	Fourth Quarter 09/27-12/27	Average
STA-01	Sr-89	(a)	< 4	(a)	(a)	
	Sr-90	(a)	< 0.5	(a)	(a)	
	Be-7	58.8 ± 5.9	68.6 ± 6.9	64.3 ± 8.56	88.2 ± 5.88	70.0 ± 25.6
	K-40	< 8	< 4	< 5	< 5	
	Co-60	< 0.3	< 0.3	< 0.2	< 0.1	
	Ru-103	< 0.4	< 0.4	< 5	< 2.0	
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.1	
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.1	
	Th-228	< 0.4	< 0.4	< 0.3	< 0.2	
	STA-02	Sr-89	(a)	< 4	(a)	(a)
Sr-90		(a)	< 0.4	(a)	(a)	
Be-7		61.5 ± 6.1	58.9 ± 5.9	61.4 ± 7.15	76.7 ± 5.08	64.6 ± 16.3
K-40		< 10	< 4	< 3	< 3	
Co-60		< 0.4	< 0.2	< 0.3	< 0.3	
Ru-103		< 0.5	< 0.3	< 4	< 1	
Cs-134		< 0.3	< 0.2	< 0.2	< 0.1	
Cs-137		< 0.3	< 0.2	< 0.2	< 0.1	
Th-228		< 0.4	< 0.4	< 0.2	< 0.2	
STA-03		Sr-89	(a)	< 4	(a)	(a)
	Sr-90	(a)	< 0.5	(a)	(a)	
	Be-7	69.5 ± 6.9	56.4 ± 5.6	66.9 ± 8.28	92.1 ± 6.18	71.2 ± 30.1
	K-40	< 4	< 10	< 4	< 4	
	Co-60	< 0.2	< 0.3	< 0.2	< 0.1	
	Ru-103	< 0.4	< 0.4	< 5	< 2	
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.1	
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.1	
	Th-228	< 0.4	< 0.4	< 0.4	< 0.2	
	STA-04	Sr-89	(a)	< 2	(a)	(a)
Sr-90		(a)	< 0.3	(a)	(a)	
Be-7		64.9 ± 6.5	61.5 ± 6.2	69.1 ± 9.0	88.9 ± 6.45	71.1 ± 24.5
K-40		4.95 ± 2.14	< 5	< 5	< 4	
Co-60		< 0.3	< 0.3	< 0.2	< 0.1	
Ru-103		< 0.4	< 0.4	< 4	< 2	
Cs-134		< 0.2	< 0.2	< 0.2	< 0.1	
Cs-137		< 0.2	< 0.3	< 0.2	< 0.2	
Th-228		< 0.4	< 0.4	< 0.4	< 0.3	

\* All gamma emitters other than those listed were <LLD.

(a) Strontium-89/90 analyses performed only on second quarter samples.

**TABLE B-3: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN AIR PARTICULATES**

North Anna Power Station, Louisa County, Virginia – 2000

1.0 E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 2 of 3

Station	Nuclide*	First Quarter 12/29-03/29	Second Quarter 03/29-06/28	Third Quarter 06/28-09/27	Fourth Quarter 09/27-12/27	Average
STA-05	Sr-89	(a)	< 6	(a)	(a)	
	Sr-90	(a)	< 0.8	(a)	(a)	
	Be-7	68.5 ± 6.9	58.2 ± 5.8	56.0 ± 7.16	90.1 ± 5.76	68.2 ± 31.2
	K-40	< 5	< 5	< 3	< 3	
	Co-60	< 0.3	< 0.2	< 0.2	< 0.1	
	Ru-103	< 0.4	< 0.3	< 4	< 1	
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.1	
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.1	
	Th-228	< 0.4	< 0.3	< 0.3	< 0.2	
STA-05A	Sr-89	(a)	< 3	(a)	(a)	
	Sr-90	(a)	< 0.5	(a)	(a)	
	Be-7	65.6 ± 6.6	51.2 ± 5.1	70.4 ± 11.5	82.2 ± 7.25	67.4 ± 25.7
	K-40	< 4	< 7	< 5	< 4	
	Co-60	< 0.2	< 0.2	< 0.2	< 0.2	
	Ru-103	< 0.4	< 0.4	< 5	< 2	
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.1	
	Th-228	< 0.5	< 0.3	< 0.3	< 0.3	
STA-06	Sr-89	(a)	< 3	(a)	(a)	
	Sr-90	(a)	< 0.4	(a)	(a)	
	Be-7	57.3 ± 5.7	29.2 ± 3.7	53.1 ± 7.07	47.6 ± 2.95	46.8 ± 24.8
	K-40	< 5	< 9	< 3	< 3	
	Co-60	< 0.3	< 0.4	< 0.2	< 0.2	
	Ru-103	< 0.4	< 0.5	< 5	< 0.8	
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.2	
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.2	
	Th-228	< 0.4	< 0.4	< 0.3	< 0.2	
STA-07	Sr-89	(a)	< 2	(a)	(a)	
	Sr-90	(a)	< 0.4	(a)	(a)	
	Be-7	74.6 ± 7.5	56.4 ± 5.6	70.9 ± 9.07	52.1 ± 3.4	63.5 ± 21.9
	K-40	< 6	5.91 ± 1.69	< 4	< 3	
	Co-60	< 0.3	< 0.3	< 0.2	< 0.2	
	Ru-103	< 0.4	< 0.4	< 6	< 0.9	
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.2	
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.2	
	Th-228	< 0.3	< 0.3	< 0.4	< 0.2	

\* All gamma emitters other than those listed were <LLD.  
(a) Strontium-89/90 analyses performed only on second quarter samples.

**TABLE B-3: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN AIR PARTICULATES**

North Anna Power Station, Louisa County, Virginia – 2000

1.0 E-03 pCi/m<sup>3</sup> ± 2 Sigma

Page 3 of 3

Station	Nuclide*	First Quarter 12/29-03/29	Second Quarter 03/29-06/28	Third Quarter 06/28-09/27	Fourth Quarter 09/27-12/27	Average
STA-21	Sr-89	(a)	< 10	(a)	(a)	
	Sr-90	(a)	< 0.8	(a)	(a)	
	Be-7	75.6 ± 7.6	56.8 ± 4.17	61.0 ± 8.69	37.0 ± 2.84	57.6 ± 31.8
	K-40	< 10	< 3	< 4	< 3	
	Co-60	< 0.4	< 0.2	< 0.3	< 0.2	
	Ru-103	< 0.6	< 0.3	< 6	< 0.9	
	Cs-134	< 0.4	< 0.2	< 0.3	< 0.2	
	Cs-137	< 0.4	< 0.2	< 0.2	< 0.2	
	Th-228	< 0.5	< 0.3	< 0.3	< 0.2	
STA-22	Sr-89	(a)	< 20	(a)	(a)	
	Sr-90	(a)	< 4	(a)	(a)	
	Be-7	64.0 ± 6.4	49.0 ± 3.92	58.8 ± 9.84	51.9 ± 3.8	55.9 ± 13.6
	K-40	< 5	< 9	< 6	< 5	
	Co-60	< 0.3	< 0.3	< 0.3	< 0.2	
	Ru-103	< 0.5	< 0.4	< 8	< 1	
	Cs-134	< 0.4	< 0.3	< 0.4	< 0.3	
	Cs-137	< 0.4	< 0.3	< 0.3	< 0.2	
	Th-228	< 0.5	< 0.4	< 0.5	< 0.3	
STA-23	Sr-89	(a)	< 6	(a)	(a)	
	Sr-90	(a)	< 1	(a)	(a)	
	Be-7	74.2 ± 7.4	< 2	61.0 ± 9.02	64.6 ± 4.05	66.6 ± 13.7
	K-40	< 6	< 1	< 5	< 4	
	Co-60	< 0.3	< 0.1	< 0.3	< 0.2	
	Ru-103	< 0.4	< 0.3	< 7	< 1	
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.3	
	Cs-137	< 0.3	< 0.1	< 0.3	< 0.3	
	Th-228	< 0.5	< 0.5	< 0.4	< 0.2	
STA-24	Sr-89	(a)	< 2	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	67.4 ± 6.7	66.0 ± 4.66	79.7 ± 13.7	70.6 ± 5.54	70.9 ± 12.3
	K-40	< 8	< 8	< 6	< 6	
	Co-60	< 0.3	< 0.3	< 0.4	< 0.3	
	Ru-103	< 0.4	< 0.4	< 11	< 2	
	Cs-134	< 0.3	< 0.3	< 0.5	< 0.3	
	Cs-137	< 0.3	< 0.3	< 0.4	< 0.3	
	Th-228	< 0.4	< 0.4	< 0.5	< 0.4	

\* All gamma emitters other than those listed were <LLD.

(a) Strontium-89/90 analyses performed only on second quarter samples.

**TABLE B-4: GROSS BETA, TRITIUM AND GAMMA EMITTER\* CONCENTRATIONS IN PRECIPITATION**

**Station 01A -- (On Site)**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 1 of 1

Collection Dates	Gross Beta	Rainfall (inches)
12/29/99-01/27/00	5.0 ± 0.8	2.10
01/27/00-02/23/00	2.2 ± 0.5	2.15
02/23/00-03/29/00	4.0 ± 0.7	3.67
03/29/00-04/26/00	1.8 ± 0.6	5.45
04/26/00-05/31/00	2.7 ± 0.7	3.71
05/31/00-06/28/00	3.1 ± 0.7	3.17
06/28/00-07/25/00	10.0 ± 1.0	2.35
07/25/00-08/30/00	4.5 ± 1.1	3.74
08/30/00-09/27/00	5.2 ± 0.8	4.6
09/27/00-10/25/00	(a)	(a)
10/25/00-11/29/00	< 3	1.61
11/29/00-12/27/00	4.3 ± 1.7	2.13
<b>Average ± 2 s.d.</b>	<b>3.9 ± 5.1</b>	

**SEMI-ANNUAL PRECIPITATION COMPOSITES**

12/29/99 – 06/28/00	06/28/00 – 12/27/00
Be-7 = < 10	Be-7 = < 300
H-3 = < 200	H-3 = < 100

\* All gamma emitters other than those listed were <LLD.  
 (a) No precipitation in October.

**TABLE B-5 CONCENTRATIONS OF GAMMA EMITTERS\* AND STRONTIUM IN SOIL**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/kg  $\pm$  2 Sigma

STATION	COLL DATES	Sr-89	Sr-90	Be-7	K-40	Cs-134	Cs-137	Ra-226	Th-228
---------	---------------	-------	-------	------	------	--------	--------	--------	--------

Soil samples are collected every three years. Since they were collected in 1998, they were not collected during 2000.

\* All gamma emitters other than those listed were <LLD.

**TABLE B-6: GAMMA EMITTER\*, STRONTIUM AND TRITIUM CONCENTRATIONS  
IN GROUND AND WELL WATER**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Ba-140	Th-228
------------------	-------	-------	-----	------	------	-------	--------	--------

**STATION 01A**

03/29/00	(a)	(a)	< 100	< 30	< 50	< 7 (b)	< 5	< 6
06/28/00	< 0.9	< 0.8	< 100	< 30	< 50	< 10 (b)	< 9	< 6
09/27/00	(a)	(a)	< 300	< 200	< 75	< 900000 (c)	< 30000 (c)	< 8
12/28/00	(a)	(a)	< 100	< 40	< 80	< 40	< 50	< 7

**Average ± 2 sd.**

- \* All gamma emitters other than those listed were <LLD.  
 (a) Strontium-89/90 analyses performed only on second quarter sample.  
 (b) I-131 results by Gamma. More sensitive method by radiochemistry not requested.  
 (c) Due to delay in analysis, the LLD was missed.

**TABLE B-7: GAMMA EMITTER\*, STRONTIUM, TRITIUM, AND IODINE CONCENTRATIONS  
IN RIVER WATER**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
------------------	-------	-------	-----	------	------	-------	--------	--------	--------	--------

**STATION - 11**

01/13/00	(a)	(a)	4700 ± 200	< 30	< 60	< 0.5	< 3	< 7	< 50	< 5
02/15/00	(a)	(a)	(b)	< 30	< 60	< 0.2	< 3	< 5	< 50	< 5
03/15/00	(a)	(a)	(b)	< 30	< 50	< 0.3	< 4	< 6	< 70	< 6
04/17/00	< 4	0.6	1500 ± 100	< 30	< 60	< 0.4	< 2	< 10	< 40	< 4
05/11/00	(a)	(a)	(b)	< 20	52.3 ± 13.7	< 0.3	< 2	< 10	< 40	< 3
06/15/00	(a)	(a)	(b)	< 30	< 30	< 0.6	< 2	< 9	< 50	< 4
07/12/00	(a)	(a)	2800 ± 200	< 40	385 ± 38	< 0.8	< 3	< 10	< 60	< 5
08/15/00	(a)	(a)	(b)	< 30	< 80	< 0.4	< 3	< 9	< 60	< 6
09/15/00	(a)	(a)	(b)	< 40	< 80	< 0.8	< 3	< 10	< 60	< 5
10/16/00	(a)	(a)	3100 ± 100	< 40	< 60	< 0.1	< 3	< 40	< 100	< 300
11/16/00	(a)	(a)	(b)	< 20	< 40	< 1.0	< 3	< 8	< 80	< 10
12/18/00	(a)	(a)	(b)	< 50	7.71 ± 31.5	< 1.0	< 4	< 200	< 9	< 8

**Average ± 2 sd**

**3025 ± 2630**

**148 ± 412**

- \* All gamma emitters other than those listed were <LLD.  
 (a) Strontium-89/90 analyses performed only on second quarter sample.  
 (b) Tritium analysis performed on quarterly composite.



**TABLE B-8: GAMMA EMITTER\*, STRONTIUM AND TRITIUM CONCENTRATIONS IN SURFACE WATER**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131**	Cs-137	Ba-140	Ra-226	Th-228
------------------	-------	-------	-----	------	------	---------	--------	--------	--------	--------

**STATION - 08**

01/13	(a)	(a)	4500 ± 200	< 30	< 50	< 0.4	< 3	< 7	< 70	< 6
02/15	(a)	(a)	(b)	< 30	< 50	< 0.2	< 3	< 5	< 80	< 6
03/15	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 3	< 70	< 6
04/17	< 4	< 0.6	1500 ± 100	< 30	< 30	< 0.3	< 2	< 10	< 40	< 4
05/11	(a)	(a)	(b)	< 20	< 20	< 0.6	< 1	< 10	< 30	< 3
06/15	(a)	(a)	(b)	< 30	39.8 ± 21.9	< 0.6	< 3	< 10	< 60	< 5
07/12	(a)	(a)	3200 ± 200	< 30	< 30	< 0.6	< 3	< 7	< 70	< 6
08/15	(a)	(a)	(b)	< 30	< 40	< 0.4	< 3	< 8	< 70	< 6
09/15	(a)	(a)	(b)	< 40	< 80	< 0.6	< 3	< 10	< 60	< 5
10/16	(a)	(a)	2200 ± 100	< 60	< 100	< 0.8	< 5	< 60	< 120	< 600
11/16	(a)	(a)	(b)	< 30	< 50	< 0.8	< 3	< 10	< 90	< 10
12/18	(a)	(a)	(b)	< 40	< 50	< 0.8	< 5	< 100	< 6	< 100

**Average ± 2 sd**

**2850 ± 2605**

**STATION - 09A**

01/13	(a)	(a)	< 200	< 20	< 40	< 0.3	< 3	< 6	< 60	< 6
02/15	(a)	(a)	(b)	< 20	< 40	< 0.2	< 3	< 5	< 60	< 5
03/15	(a)	(a)	(b)	< 30	< 60	< 0.3	< 4	< 5	< 60	< 5
04/17	< 2	< 0.9	< 200	< 30	< 30	< 0.3	< 2	< 10	< 50	< 4
05/11	(a)	(a)	(b)	< 20	< 40	< 0.3	< 1	< 10	< 30	< 2
06/15	(a)	(a)	(b)	< 40	< 100	< 0.6	< 4	< 10	< 70	< 6
07/12	(a)	(a)	< 300	< 40	< 90	< 0.6	< 4	< 9	< 70	< 5
08/15	(a)	(a)	(b)	< 30	< 40	< 0.4	< 2	< 6	< 60	< 5
09/15	(a)	(a)	(b)	< 40	< 80	< 0.7	< 3	< 10	< 60	< 5
10/16	(a)	(a)	110 ± 40	< 40	< 80	< 0.9	< 4	< 60	< 100	< 300
11/16	(a)	(a)	(b)	< 30	< 50	< 1	< 3	< 10	< 100	< 10
12/18	(a)	(a)	(b)	< 50	< 50	< 0.9	< 3	< 100	11.4 ± 2.6	< 8

**Average ± 2 sd**

\* All gamma emitters other than those listed were <LLD.

\*\* I-131 by radiochemistry.

(a) Strontium 89/90 analyses performed annually.

(b) H-3 analyses performed quarterly.

**TABLE B-9: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN SEDIMENT SILT**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/kg ± 2 Sigma

Page 1 of 1

Nuclide	STA-08 02/21 (b)	STA-09A 02/21	STA-11 02/21	STA-08 08/07	STA-09A 08/07	STA-11 08/07	Average ± 2 s.d.
Sr-89	(a)	(a)	(a)	< 3000	< 2000	< 3000	
Sr-90	(a)	(a)	(a)	130 ± 70	290 ± 60	140 ± 70	187 ± 179
Be-7	< 1000	< 400	< 300	< 250	< 400	< 460	
K-40	11200 ± 1100	12800 ± 1300	12900 ± 1300	3040 ± 362	8370 ± 544	14700 ± 950	10502 ± 8455
Mn-54	< 40	< 30	< 20	< 30	< 30	< 50	
Co-58	< 90	< 40	< 30	< 30	< 30	< 50	
Co-60	< 40	< 30	< 20	< 30	< 30	< 40	
Cs-134	< 50	< 40	< 30	< 20	< 30	< 40	
Cs-137	205 ± 39	114 ± 38	58.8 ± 15.3	< 30	< 40	< 50	126 ± 148
Ra-226	1870 ± 530	1720 ± 570	1690 ± 370	399 ± 28.2	521 ± 30	1100 ± 52	1217 ± 1287
Th-228	1100 ± 110	846 ± 85	849 ± 85	596 ± 34.2	474 ± 34.1	1530 ± 81	899 ± 757

\* All gamma emitters other than those listed were <LLD.

(a) Strontium 89/90 analyses performed annually.

(b) Europium-152 was measured at 2550 ± 260 pCi/kg in Station 08 on 02/21/00.

**TABLE B-10: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS  
IN SHORELINE SOIL**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/kg ± 2 Sigma

Page 1 of 1

<b>Nuclide</b>	<b>Station-08 02/21/00</b>	<b>Station-08 08/07/00</b>	<b>Average ± 2 Sigma</b>
Sr-89	(a)	< 2000	
Sr-90	(a)	100 ± 60	
Be-7	< 200	< 330	
K-40	1280 ± 210	1410 ± 315	1345 ± 185
Mn-54	< 20	< 30.8	
Co-58	< 20	< 33.0	
Co-60	< 20	< 42.9	
Cs-134	< 20	< 32.6	
Cs-137	< 20	167 ± 23.6	
Ra-226	615 ± 256	313 ± 22.7	464 ± 427
Th-228	298 ± 32	203 ± 21.3	251 ± 134

\* All gamma emitters other than those listed were <LLD.  
(a) Strontium 89/90 analyses performed annually.

**TABLE B-11: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN MILK**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 1 of 2

MONTH	NUCLIDE	STATION-12	STATION-13
JANUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1360 ± 140	1420 ± 140
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.2
FEBRUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1580 ± 160	1250 ± 120
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.3
MARCH	Sr-89	< 3	< 2
	Sr-90	1.2 ± 0.3	0.82 ± 0.25
	K-40	1370 ± 140	1250 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.3	< 0.2
APRIL	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1220 ± 120	1400 ± 140
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.3
MAY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1590 ± 160	1310 ± 130
	Cs-137	< 3	< 4
	I-131	< 0.2	< 0.3
JUNE	Sr-89	< 2	< 2
	Sr-90	0.75 ± 0.23	1.1 ± 0.2
	K-40	1370 ± 140	1340 ± 130
	Cs-137	< 4	< 3
	I-131	< 0.5	< 0.4

\* All gamma emitters other than those listed were <LLD.  
 (a) Strontium 89/90 analyses performed quarterly.  
 (b) Due to delay in analysis, Sr-89 was not analyzed.

**TABLE B-11: GAMMA EMITTER\* AND STRONTIUM CONCENTRATIONS IN MILK**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/l ± 2 Sigma

Page 2 of 2

MONTH	NUCLIDE	STATION-12	STATION-13
JULY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1270 ± 130	1260 ± 130
	Cs-137	< 4	< 3
	I-131	< 0.3	< 0.3
AUGUST	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1420 ± 84	1310 ± 93
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.4
SEPTEMBER	Sr-89	(b)	(b)
	Sr-90	2.6 ± 0.5	0.75 ± 0.20
	K-40	1430 ± 127	1010 ± 69
	Cs-137	< 6	< 4
	I-131	< 0.6	< 0.4
OCTOBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1480 ± 120	1240 ± 110
	Cs-137	< 4	< 2
	I-131	< 0.6	< 0.7
NOVEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1390 ± 140	1310 ± 110
	Cs-137	< 5	< 2
	I-131	< 0.6	< 0.5
DECEMBER	Sr-89	< 8	< 7
	Sr-90	0.67 ± 0.25	0.82 ± 0.21
	K-40	1340 ± 53	1280 ± 57
	Cs-137	< 5	< 4
	I-131	< 0.6	< 0.9
Average ± 2 s.d.	Sr-89		
	Sr-90	1.31 ± 1.79	0.87 ± 0.31
	K-40	1402 ± 220	1282 ± 206
	Cs-137		
	I-131		

\* All gamma emitters other than those listed were <LLD.  
 (a) Strontium 89/90 analyses performed quarterly.  
 (b) Due to delay in analysis, Sr-89 was not analyzed.

**TABLE B-12: GAMMA EMITTER\* CONCENTRATIONS IN FISH**

North Anna Power Station, Louisa County, Virginia – 2000

pCi/kg ± 2 Sigma

Page 1 of 1

Collection Date	Station	Sample Type	K-40	Co-58	Cs-134	Cs-137
02/24	08	Fish (a)	1730 ± 270	< 30	< 30	51.1 ± 20.6
02/22	25	Fish (a)	1880 ± 230	< 20	< 20	< 20
02/24	08	Catfish (b)	1630 ± 210	< 20	< 20	34.1 ± 16.8
02/23	25	Catfish (b)	1120 ± 200	< 30	< 20	< 30
08/10	08	Fish (a)	1670 ± 217	< 20	< 20	< 20
08/09	25	Fish (a)	2380 ± 330	< 30	< 20	< 30
08/10	08	Catfish (b)	1120 ± 203	< 20	< 20	< 20
08/09	25	Catfish (b)	2060 ± 306	< 38	< 20	< 30
<b>Avg.</b>	<b>08</b>		<b>1537 ± 563</b>			<b>42.6 ± 24.0</b>
<b>± 2 s.d.</b>	<b>25</b>		<b>1860 ± 1070</b>			<b>-</b>

\* All gamma emitters other than those listed were <LLD.

(a) Non-bottom dwelling species of gamefish.

(b) Bottom dwelling species of fish.

**TABLE B-13: GAMMA EMITTER\* CONCENTRATIONS IN FOOD/VEGETATION**

North Anna Power Station, Louisa County, Virginia –2000

pCi/kg ± 2 Sigma

Page 1 of 2

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
<b>STATION 14</b>								
04/19	1290 ± 130	5930 ± 590	< 50	< 9	< 8	< 8	< 100	< 10
05/17	627 ± 172	7270 ± 730	< 30	< 30	< 20	< 20	< 300	< 30
06/21	584 ± 180	7191 ± 720	< 100 (a)	< 30	< 20	< 20	< 400	< 30
07/25	1270 ± 200	12300 ± 1200	< 50	< 30	< 30	< 20	< 400	< 30
08/16	2170 ± 260	10300 ± 1000	< 60	< 40	< 30	< 30	< 500	< 50
09/20	< 2040	11600 ± 530	< 10	< 590	< 20	< 20	< 550	< 30
10/18(b)	< 300	< 200	< 300	< 30	< 20	< 20	< 400	< 90
<b>STATION 15</b>								
04/19	983 ± 98	6840 ± 680	< 50	< 10	< 10	< 10	< 200	< 10
05/17	337 ± 124	7970 ± 800	< 20	< 20	< 10	< 10	< 200	< 20
06/21	283 ± 120	9420 ± 940	< 400 (a)	< 20	< 10	< 10	< 200	< 20
07/25	933 ± 107	13300 ± 570	< 40	< 27	< 19	186 ± 16.6	< 47	< 30
08/16	3540 ± 540	11100 ± 1100	< 50	< 80	< 60	< 60	< 1000	< 100
09/20	< 700	8140 ± 250	< 9	< 200	< 8	< 7	< 100	< 20
10/18(b)	< 400	13100 ± 800	< 300	< 40	< 30	< 20	< 400	< 100
<b>STATION 16</b>								
04/19	429 ± 52	10300 ± 1000	< 60	< 8	< 7	< 6	< 100	< 10
05/17	907 ± 203	11100 ± 1100	< 20	< 30	< 20	< 20	< 400	< 40
06/21	409 ± 138	9750 ± 980	< 90 (a)	< 20	< 20	< 20	< 200	< 20
07/25	351 ± 66.7	10600 ± 440	< 50	< 18	< 13	11.2 ± 8.5	< 30	< 30
08/16	972 ± 172	17100 ± 1700	< 60	< 20	< 20	< 20	< 300	< 30
09/20	< 3200	12800 ± 600	< 10	< 980	< 40	< 30	< 700	< 60
10/18(b)	< 400	14800 ± 900	< 270	< 40	< 30	< 30	< 500	< 100
<b>STATION 21</b>								
04/19	< 200	7360 ± 740	< 50	< 20	< 10	< 10	< 200	< 20
05/17	506 ± 101	6910 ± 690	< 20	< 20	< 10	< 10	< 200	< 20
06/21	< 80	7690 ± 770	< 5	< 8	< 10	< 10	< 200	< 20
07/25	1590 ± 280	13200 ± 300	< 40	< 40	< 30	< 30	< 500	< 50
08/16	2210 ± 20	18600 ± 1900	< 70	< 30	< 30	< 20	< 400	< 40
09/20	< 2850	13400 ± 570	< 10	< 850	< 40	< 30	< 620	< 40
10/18(b)	637 ± 232	10800 ± 600	< 400	< 40	< 30	< 20	< 500	< 100

\* All gamma emitters other than those listed were <LLD.

(a) More sensitive I-131 method by radiochemistry not requested by customer nor ordered by lab. Specs not met for I-131.

(b) Vegetation samples were not subbed in a timely manner. Some detection levels were not met.

**TABLE B-13: GAMMA EMITTER\* CONCENTRATIONS IN FOOD/VEGETATION**

North Anna Power Station, Louisa County, Virginia –2000

pCi/kg ± 2 Sigma

Page 2 of 2

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
<b>STATION 23</b>								
04/19	857 ± 86	7270 ± 730	< 50	< 10	< 8	< 8	< 100	< 10
05/17	661 ± 111	7800 ± 780	< 30	< 20	< 10	< 10	< 200	< 20
06/21	221 ± 93	9420 ± 940	< 80 (a)	< 20	< 10	< 10	< 200	< 20
07/25	< 500	7470 ± 750	< 50	< 70	< 50	< 50	< 1000	< 90
08/16	< 400	21300 ± 2100	< 50	< 50	< 30	< 40	< 700	< 60
09/20	< 4400	21300 ± 830	< 10	< 1300	< 60	< 40	< 800	< 100
10/18(b)	457 ± 232	14500 ± 800	< 300	< 40	< 30	< 30	< 500	< 100
<b>Average</b>	<b>966±1570</b>	<b>11116±8038</b>				<b>98.6±247</b>		
	<b>± 2 s.d.</b>							

\* All gamma emitters other than those listed were <LLD.

(a) More sensitive I-131 method by radiochemistry not requested by customer nor ordered by lab. Specs not met for I-131.

(b) Vegetation samples were not subbed in a timely manner. Some detection levels were not met.



**TABLE B-14: DIRECT RADIATION MEASUREMENTS -- QUARTERLY AND ANNUAL TLD RESULTS**

North Anna Power Station, Louisa County, Virginia – 2000

mR/Std. Month (30.4 days) ± 2 Sigma

Page 1 of 1

Station Number	First Qtr 01/06/00 03/29/00	Second Qtr 03/29/00 07/05/00	Third Qtr 07/05/00 09/28/00	Fourth Qtr 09/28/00 01/11/01	Quarterly Average	Annual TLD
01	8.7 ± 0.5	7.5 ± 0.4	8.1 ± 0.7	8.5 ± 0.4	8.2 ± 1.1	7.1 ± 0.8
02	5.5 ± 0.2	4.1 ± 0.2	5.3 ± 0.1	5.3 ± 0.1	5.1 ± 1.3	4.3 ± 0.5
03	5.8 ± 0.5	4.1 ± 0.3	4.9 ± 0.2	5.1 ± 0.2	5.0 ± 1.4	4.3 ± 0.3
04	5.2 ± 0.6	4.3 ± 0.5	5.0 ± 0.5	5.1 ± 0.4	4.9 ± 0.8	4.5 ± 0.4
05	6.6 ± 0.4	5.3 ± 0.4	6.6 ± 0.6	6.7 ± 0.2	6.3 ± 1.3	5.7 ± 0.3
05A	6.0 ± 0.1	4.7 ± 0.1	5.2 ± 0.8	5.9 ± 0.3	5.5 ± 1.2	5.1 ± 0.3
06	7.3 ± 0.1	6.8 ± 0.5	7.9 ± 0.8	7.8 ± 0.5	7.5 ± 1.0	6.3 ± 0.7
07	6.3 ± 1.2	4.8 ± 0.4	6.0 ± 0.4	6.2 ± 0.3	5.8 ± 1.4	5.0 ± 0.1
21	6.6 ± 0.9	4.9 ± 0.3	5.9 ± 0.2	6.0 ± 0.3	5.9 ± 1.4	4.7 ± 0.3
22	6.9 ± 0.8	6.3 ± 1.0	7.5 ± 0.6	7.3 ± 0.5	7.0 ± 1.1	6.2 ± 0.4
23	7.1 ± 1.3	6.6 ± 0.3	8.4 ± 1.4	8.4 ± 0.4	7.6 ± 1.8	7.1 ± 0.2
24	6.0 ± 0.4	5.0 ± 0.1	5.8 ± 0.6	6.4 ± 0.4	5.8 ± 1.2	5.3 ± 0.5
<b>Average ± 2 s.d.</b>	<b>6.5 ± 1.9</b>	<b>5.4 ± 2.3</b>	<b>6.4 ± 2.6</b>	<b>6.6 ± 2.4</b>	<b>6.2 ± 2.2</b>	<b>5.5 ± 2.0</b>

**TABLE B-15: DIRECT RADIATION MEASUREMENTS -  
SECTOR QUARTERLY TLD RESULTS**

North Anna Power Station, Louisa County, Virginia – 2000

mR/Std. Month (30.4 days) ± 2 Sigma

Page 1 of 2

<b>Station Number</b>	<b>First Qtr. 01/06-03/29</b>	<b>Second Qtr. 03/29-07/05</b>	<b>Third Qtr. 07/05-09/28</b>	<b>Fourth Qtr. 09/28-01/11/01</b>	<b>Average ± 2 s.d.</b>
N-1	7.6 ± 0.5	5.9 ± 0.6	7.2 ± 0.5	6.7 ± 0.9	6.9 ± 1.5
N-2	5.7 ± 0.3	4.3 ± 0.8	5.2 ± 0.5	5.3 ± 0.3	5.1 ± 1.2
NNE-3	10.1 ± 0.6	7.8 ± 1.2	9.6 ± 0.5	9.5 ± 0.4	9.3 ± 2.0
NNE-4	6.8 ± 0.2	5.3 ± 1.0	6.7 ± 0.7	6.5 ± 0.3	6.3 ± 1.4
NE-5	8.6 ± 1.0	7.0 ± 0.4	8.1 ± 0.3	7.9 ± 0.5	7.9 ± 1.3
NE-6	6.5 ± 0.4	5.0 ± 0.9	6.2 ± 0.6	5.9 ± 0.5	5.9 ± 1.3
ENE-7	7.9 ± 0.6	5.9 ± 0.8	7.3 ± 0.2	7.1 ± 0.4	7.1 ± 1.7
ENE-8	5.4 ± 0.4	4.1 ± 0.2	5.7 ± 0.4	5.5 ± 0.0	5.2 ± 1.5
E-9	7.9 ± 0.4	6.6 ± 0.4	8.1 ± 0.4	7.6 ± 0.3	7.6 ± 1.3
E-10	6.9 ± 0.5	5.5 ± 0.4	7.1 ± 0.7	6.7 ± 0.3	6.6 ± 1.4
ESE-11	7.1 ± 0.6	5.6 ± 0.5	6.6 ± 0.4	6.7 ± 0.5	6.5 ± 1.3
ESE-12	7.9 ± 0.3	6.2 ± 0.4	7.5 ± 0.5	7.2 ± 0.8	7.2 ± 1.5
SE-13	7.1 ± 0.4	5.9 ± 0.4	6.8 ± 0.1	6.5 ± 0.4	6.6 ± 1.0
SE-14	9.6 ± 0.2	7.9 ± 1.3	9.3 ± 0.5	9.0 ± 0.8	9.0 ± 1.5
SSE-15	8.2 ± 0.6	6.4 ± 0.4	8.1 ± 0.4	7.4 ± 0.3	7.5 ± 1.7
SSE-16	6.5 ± 0.3	4.7 ± 0.4	5.9 ± 0.2	5.6 ± 0.4	5.7 ± 1.5
S-17	10.2 ± 0.2	8.5 ± 0.7	10.3 ± 0.2	9.8 ± 0.5	9.7 ± 1.7
S-18	5.9 ± 0.3	4.3 ± 0.3	5.2 ± 0.3	4.7 ± 0.1	5.0 ± 1.4
SSW-19	8.8 ± 0.9	7.8 ± 0.1	9.3 ± 1.1	8.7 ± 0.7	8.7 ± 1.2
SSW-20	5.6 ± 0.7	4.0 ± 0.5	5.0 ± 0.2	4.7 ± 0.2	4.8 ± 1.3
SW-21	6.6 ± 0.5	5.4 ± 0.2	6.7 ± 1.0	5.9 ± 0.5	6.2 ± 1.2
SW-22	7.3 ± 0.2	5.8 ± 1.0	7.1 ± 0.4	6.8 ± 0.4	6.8 ± 1.3
WSW-23	8.7 ± 0.3	7.3 ± 0.4	8.4 ± 0.4	7.6 ± 0.2	8.0 ± 1.3
WSW-24	7.6 ± 0.2	6.1 ± 0.6	7.1 ± 0.5	6.9 ± 0.4	6.9 ± 1.2
W-25	9.6 ± 0.3	8.0 ± 1.3	8.8 ± 0.4	8.1 ± 0.4	8.6 ± 1.5
W-26	6.3 ± 0.3	4.5 ± 0.6	5.7 ± 0.4	5.5 ± 0.2	5.5 ± 1.5
WNW-27	6.1 ± 0.6	4.8 ± 0.5	6.0 ± 0.3	5.6 ± 0.4	5.6 ± 1.2
WNW-28	6.8 ± 1.0	4.9 ± 0.4	6.0 ± 0.2	5.6 ± 0.3	5.8 ± 1.6
NW-29	9.9 ± 0.6	7.8 ± 0.3	9.7 ± 0.5	8.8 ± 0.3	9.1 ± 1.9
NW-30	6.1 ± 0.4	4.6 ± 0.3	5.3 ± 0.3	5.3 ± 0.2	5.3 ± 1.2
NNW-31	6.8 ± 0.2	5.2 ± 0.3	6.2 ± 0.5	6.0 ± 0.1	6.1 ± 1.3
NNW-32	7.6 ± 0.8	5.3 ± 0.4	6.7 ± 0.3	6.3 ± 0.7	6.5 ± 1.9
N-33	8.3 ± 1.1	6.2 ± 0.2	7.0 ± 0.3	7.2 ± 0.4	7.2 ± 1.7
N-34	5.9 ± 0.6	4.3 ± 0.5	5.2 ± 0.2	5.4 ± 0.2	5.2 ± 1.3
NNE-35	10.6 ± 0.7	8.0 ± 0.9	9.4 ± 0.9	9.7 ± 0.9	9.4 ± 2.2
NNE-36	7.5 ± 0.2	5.8 ± 0.3	6.9 ± 0.2	6.7 ± 0.3	6.7 ± 1.4
NE-37	9.0 ± 0.5	7.0 ± 0.5	8.2 ± 0.2	7.9 ± 0.6	8.0 ± 1.7
NE-38	6.7 ± 0.4	5.1 ± 1.2	6.3 ± 0.2	6.0 ± 0.3	6.0 ± 1.4

**TABLE B-15: DIRECT RADIATION MEASUREMENTS -  
SECTOR QUARTERLY TLD RESULTS**

North Anna Power Station, Louisa County, Virginia – 2000

mR/Std. Month (30.4 days) ± 2 Sigma

Page 2 of 2

<b>Station Number</b>	<b>First Qtr 01/06-03/29</b>	<b>Second Qtr 03/29-07/05</b>	<b>Third Qtr 07/05-09/28</b>	<b>Fourth Qtr 09/28-01/11/01</b>	<b>Average ± 2 s.d.</b>
ENE-39	7.7 ± 0.6	6.5 ± 0.7	7.5 ± 1.1	7.5 ± 0.1	7.3 ± 1.1
ENE-40	5.7 ± 0.3	3.9 ± 0.3	5.9 ± 0.2	5.6 ± 0.5	5.3 ± 1.9
E-41	8.0 ± 0.5	6.5 ± 0.3	7.9 ± 0.4	8.0 ± 0.4	7.6 ± 1.5
E-42	7.2 ± 0.4	5.8 ± 0.3	7.0 ± 0.1	7.0 ± 0.6	6.0 ± 2.9
ESE-43	7.4 ± 0.7	5.5 ± 0.7	6.7 ± 0.9	6.8 ± 0.5	6.6 ± 1.6
ESE-44	7.9 ± 0.4	6.1 ± 1.1	7.7 ± 0.3	7.5 ± 0.3	7.3 ± 1.6
SE-45	7.7 ± 0.2	6.2 ± 0.3	6.8 ± 0.5	6.8 ± 0.3	6.9 ± 1.2
SE-46	9.4 ± 0.9	7.5 ± 1.2	9.8 ± 0.6	9.0 ± 0.4	8.9 ± 2.0
SSE-47	8.6 ± 0.7	6.4 ± 0.4	8.3 ± 0.6	7.5 ± 0.4	7.7 ± 2.0
SSE-48	6.6 ± 0.8	5.0 ± 0.4	6.3 ± 0.9	5.9 ± 0.4	6.0 ± 1.4
S-49	10.2 ± 0.3	8.4 ± 1.4	11.1 ± 0.9	9.8 ± 0.9	9.9 ± 2.2
S-50	5.4 ± 0.3	4.2 ± 0.3	5.4 ± 0.5	4.9 ± 0.1	5.0 ± 1.1
SSW-51	9.2 ± 1.4	7.6 ± 0.5	9.6 ± 0.3	9.3 ± 0.5	8.9 ± 1.8
SSW-52	5.8 ± 0.2	4.0 ± 0.5	5.5 ± 0.2	5.0 ± 0.4	5.1 ± 1.6
SW-53	7.1 ± 0.6	5.3 ± 0.4	6.8 ± 0.7	6.1 ± 0.5	6.3 ± 1.6
SW-54	7.4 ± 0.3	6.1 ± 0.6	7.8 ± 0.5	7.2 ± 0.3	7.1 ± 1.5
WSW-55	8.6 ± 0.6	6.9 ± 0.8	8.6 ± 0.7	7.8 ± 0.3	8.0 ± 1.6
WSW-56	8.0 ± 1.4	6.4 ± 0.5	7.9 ± 1.0	7.0 ± 0.2	7.3 ± 1.5
W-57	9.3 ± 0.2	7.6 ± 0.5	9.5 ± 1.2	8.5 ± 0.4	8.7 ± 1.7
W-58	6.7 ± 0.6	4.7 ± 0.4	5.8 ± 0.3	5.2 ± 0.2	5.6 ± 1.7
WNW-59	6.4 ± 0.3	5.0 ± 0.1	5.5 ± 0.7	5.6 ± 0.2	5.6 ± 1.2
WNW-60	6.9 ± 1.2	4.8 ± 0.6	6.3 ± 0.1	5.8 ± 0.2	6.0 ± 1.8
NW-61	9.7 ± 1.1	7.9 ± 0.6	9.2 ± 0.4	8.5 ± 0.7	8.8 ± 1.6
NW-62	5.9 ± 0.4	4.7 ± 0.1	5.6 ± 0.3	5.2 ± 0.3	5.4 ± 1.0
NNW-63	7.0 ± 0.4	5.3 ± 0.3	6.5 ± 0.5	6.2 ± 0.1	6.3 ± 1.4
NNW-64	6.9 ± 0.6	5.4 ± 0.4	6.4 ± 0.8	6.3 ± 0.4	6.3 ± 1.2
C-1	6.4 ± 1.1	4.9 ± 0.5	6.1 ± 0.1	6.2 ± 1.0	5.7 ± 1.4
C-2	5.9 ± 0.7	5.1 ± 0.3	6.0 ± 0.1	5.9 ± 0.1	5.7 ± 0.8
C-3	6.3 ± 0.1	5.1 ± 0.2	6.0 ± 0.2	6.0 ± 0.3	5.9 ± 1.0
C-4	6.8 ± 0.9	5.1 ± 0.2	5.9 ± 0.5	6.0 ± 0.3	6.0 ± 1.4
C-5	5.3 ± 0.1	3.9 ± 0.4	5.1 ± 0.5	5.2 ± 0.5	4.9 ± 1.3
C-6	5.4 ± 0.3	4.0 ± 0.2	5.3 ± 0.5	4.8 ± 0.2	4.9 ± 1.3
C-7	7.4 ± 0.3	5.7 ± 0.5	7.9 ± 0.5	6.9 ± 0.4	7.0 ± 1.9
C-8	7.5 ± 0.5	5.9 ± 0.2	7.7 ± 0.7	6.9 ± 0.6	7.0 ± 1.6
<b>Average</b>	<b>7.4 ± 2.7</b>	<b>5.8 ± 2.5</b>	<b>7.1 ± 3.0</b>	<b>6.8 ± 2.7</b>	<b>6.8 ± 2.7</b>

**APPENDIX C**  
**LAND USE CENSUS - 2000**

**DOMINION VIRGINIA POWER  
NORTH ANNA POWER STATION  
Annual Radiological Environmental Land Use Census Data for 2000  
August 1 - September 8**

<b>Sector</b>	<b>Nearest Resident km</b>	<b>Nearest Site Boundary km</b>	<b>Milch * Cow km</b>	<b>Meat Animal km</b>	<b>Milch * Goat km</b>	<b>Veg. Garden 500 Sq. ft. km</b>
N	2.4	1.4		3.5		2.4
NNE	1.4	1.4		2.3		2.5
NE	1.5	1.3		2.3		1.5
ENE	3.4	1.3		4.0		3.4
E	2.1	1.3		5.7		2.1
ESE	2.7	1.4		NONE		5.6
SE	2.3	1.4		2.3		2.3
SSE	1.6	1.5		4.5		4.1
S	1.7	1.5		NONE		1.5
SSW	1.9	1.6		3.1		4.6
SW	5.0	1.7		NONE		5.0
WSW	2.7	1.8		2.7		2.7
W	2.4	1.7		7.1		8.0
WNW	1.8	1.6		6.5		3.5
NW	1.7	1.6		NONE		1.9
NNW	1.6	1.4		3.2		1.9

**\* Note: No milch cow or goats within a 5 mile radius of North Anna Power Station**

**km = kilometer**

**DOMINION VIRGINIA POWER  
NORTH ANNA POWER STATION  
Annual Radiological Environmental Land Use Census Data for 2000  
August 1 - September 8**

<b>Sector</b>	<b>Nearest Resident M</b>	<b>Nearest Site Boundary M</b>	<b>Milch * Cow M</b>	<b>Meat Animal M</b>	<b>Milch * Goat M</b>	<b>Veg. Garden 500 Sq. Ft. M</b>
N	1.5	0.9		2.2		1.5
NNE	0.9	0.9		1.5		1.5
NE	0.9	0.8		1.4		0.9
ENE	2.1	0.8		2.5		2.1
E	1.3	0.8		3.5		1.3
ESE	1.7	0.9		NONE		3.5
SE	1.4	0.9		1.4		1.4
SSE	1.0	0.9		2.8		2.6
S	1.1	0.9		NONE		1.0
SSW	1.2	1.0		2.0		2.9
SW	3.1	1.1		NONE		3.1
WSW	1.7	1.1		1.7		1.7
W	1.5	1.1		4.4		5.0
WNW	1.1	1.0		4.1		2.2
NW	1.0	1.0		NONE		1.2
NNW	1.0	0.9		2.0		1.2

\* Note: No milch cow or goats within a 5 mile radius of North Anna Power Station

M = mile

**DOMINION VIRGINIA POWER  
NORTH ANNA POWER STATION  
COMPARISON OF THE 2000 TO THE 1999 LAND USE CENSUS**

- I. No changes were observed in the nearest resident.
- II. No changes were observed in the nearest site boundary distances.
- III. No changes were observed in the nearest milk cow/goat status.
- IV. The following change was observed in the nearest vegetable garden as compared to the previous year:
  - a. Sector South      2.1 km to 1.5 km
  - b. Sector N            3.2 km to 2.4 km
  - c. Sector ESE         5.3 km to 5.6 km
  - d. Sector SSE         1.6 km to 4.1 km
- V. The following change was observed in the nearest meat animal status as compared to the previous year:
  - a. Sector South      1.5 miles to deletion of the meat animal.

**APPENDIX D**  
**SYNOPSIS OF ANALYTICAL PROCEDURES**



## ***ANALYTICAL PROCEDURES SYNOPSIS***

Appendix D is a synopsis of the analytical procedures performed on samples collected for the North Anna Power Station's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by Dominion Virginia Power and Teledyne Brown Engineering Environmental Services and include those recommended by the USNRC Branch Technical Position, Rev. 1, November 1979.

<u><b>ANALYSIS TITLE</b></u>	<u><b>PAGE</b></u>
Gross Beta Analysis of Samples.....	88
Airborne Particulates.....	88
Water.....	89
Analysis of Samples for Tritium (Liquid Scintillation).....	90
Analysis of Samples for Strontium-89 and 90.....	91
Water.....	91
Milk.....	91
Soil and Sediment.....	91
Organic Solids.....	91
Air Particulates.....	92
Analysis of Samples for Iodine-131.....	94
Milk and Water.....	94
Gamma Spectrometry of Samples.....	95
Milk or Water.....	95
Dried Solids other than Solids and Sediment.....	95
Fish.....	95
Soils and Sediments.....	95
Charcoal Cartridge (Air Iodine).....	95
Airborne Particulates.....	95
Environmental Dosimetry.....	97

## GROSS BETA ANALYSIS OF SAMPLES

### Air Particulates

After a delay of five or more days, allowing for the radon-222 and radon-220 (thoron) daughter products to decay, the filters are counted in a gas-flow proportional counter. An unused air particulate filter, supplied by the customer, is counted as the blank.

Calculations of the result, the two sigma error and the lower limit of detection (LLD):

$$\text{RESULT (pCi/m}^3\text{)} = ((S/T) - (B/t))/(2.22 V E)$$

$$\text{TWO SIGMA ERROR (pCi/m}^3\text{)} = 2((S/T^2) + (B/t^2))^{1/2}/2.22 V E$$

$$\text{LLD (pCi}^3\text{)} = 4.66 (B^{1/2})/2.22 V E t$$

where:

S	=	Gross counts of sample including blank
B	=	Counts of Blank
E	=	Counting Efficiency
T	=	Number of minutes sample was counted
t	=	Number of minutes blank was counted
V	=	Sample aliquot size (cubic meters)

## ***DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES***

### **Introduction**

The procedures described in this section are used to measure the overall radioactivity of water samples without identifying the radioactive species present. No chemical separation techniques are involved.

One liter of the sample is evaporated on a hot plate. A smaller volume may be used if the sample has a significant salt content as measured by a conductivity meter. If requested by the customer, the sample is filtered through the No. 54 filter paper before evaporation, removing particles greater than 30 microns in size.

After evaporating to a small volume in a beaker, the sample is rinsed into a 2-inch diameter stainless steel planchette which is stamped with a concentric ring pattern to distribute residue evenly. Final evaporation to dryness takes place under heat lamps.

Residue mass is determined by weighing the planchette before and after mounting the sample. The planchette is counted for beta activity on an automatic proportional counter. Results are calculated using empirical self-absorption curves which allow for the change in effective efficiency caused by the residue mass.

### **Detection Capability**

Detection capability depends upon the sample volume actually represented on the planchette, the background and the efficiency of the counting instrument, and upon self-absorption of beta particles by the mounted sample. Because the radioactive species are not identified, no decay corrections are made and the reported activity refers to the counting time.

The minimum detectable level (MDL) for water samples is nominally 1.6 picoCuries per liter for gross beta at the 4.66 sigma level (1.0 pCi/l at the 2.83 sigma level), assuming that 1 liter of sample is used and that ½ gram of sample residue is mounted on the planchette. These figures are based upon counting time of 50 minutes and upon representative values of counting efficiency and background of 0.2 and 1.2 cpm, respectively.

The MDL becomes significantly lower as the mount weight decreases because of reduced self-absorption. At a zero mount weight, the 4.66 sigma MDL for gross beta is 0.9 picoCuries per liter. These values reflect a beta counting efficiency of 0.38.

**ANALYSIS OF SAMPLES FOR TRITIUM**  
*(Liquid Scintillation)*

**Water**

Ten millimeters of water are mixed with 10 ml of a liquid scintillation “cocktail” and then the mixture is counted in an automatic liquid scintillator.

Calculation of the result, the two sigma error and the lower limit detection (LLD) in pCi/l:

RESULT	=	$(N-B)/(2.22 V E)$
TWO SIGMA ERROR	=	$2(N + B)/(\Delta t)^{1/2} / (2.22 V E)$
LLD	=	$4.66 (B/\Delta t)^{1/2} / (2.22 V E)$

where:	N	=	the gross cpm of the sample
	B	=	the background of the detector in cpm
	2.22	=	conversion factor changing dpm to pCi
	V	=	volume of the sample in ml
	E	=	efficiency of the detector
	$\Delta t$	=	counting time for the sample

## **ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90**

### **Water**

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as  $\text{Sr}(\text{NO}_3)_2$  using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a minimum of 5 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating  $\text{SrCO}_3$  from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

### **Milk**

Stable strontium carrier is added to 1 liter of sample and the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved and precipitated as  $\text{Sr}(\text{NO}_3)_2$  using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and then re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating  $\text{SrCO}_3$  from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

### **Soil and Sediment**

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrochloric acid. The mixture is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as  $\text{Sr}(\text{NO}_3)_2$  using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating  $\text{SrCO}_3$  from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

### **Organic Solids**

A wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in hydrochloric acid. The sample is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as  $(\text{SrNO}_3)_2$  using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a minimum of 5 days period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating  $\text{SrCO}_3$  from the sample after yttrium separation. This precipitate is counted on a nylon planchette and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

## Air Particulates

Stable strontium carrier is added to the sample and it is leached in nitric acid to bring deposits into solution. The mixture is then filtered and the filtrate is reduced in volume by evaporation. Strontium is precipitated as  $\text{Sr}(\text{NO}_3)_2$  using fuming (90%) nitric acid. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating  $\text{SrCO}_3$  from the sample after yttrium separation. This precipitate is counted on a nylon planchette and is covered with  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

Calculations of the result, two sigma errors and lower limits of detection (LLD) are expressed in activity of pCi/volume or pCi/mass:

$$\begin{aligned} \text{RESULT Sr-89} &= (N/\Delta t - B_C - B_A) / (2.22 V Y_S DF_{\text{Sr-89}} E_{\text{Sr-89}}) \\ \text{TWO SIGMA ERROR Sr-89} &= 2(N/\Delta t + B_C + B_A) / (\Delta t)^{1/2} / (2.22 V Y_S DF_{\text{Sr-89}} E_{\text{Sr-89}}) \\ \text{LLD Sr-89} &= 4.66(B_C + B_A) / (\Delta t)^{1/2} / (2.22 V Y_S DF_{\text{Sr-89}} E_{\text{Sr-89}}) \\ \text{RESULT Sr-90} &= (N/\Delta t - B) / (2.22 V Y_1 Y_2 DF IF E) \\ \text{TWO SIGMA ERROR Sr-90} &= 2(N/\Delta t + B) / (\Delta t)^{1/2} / (2.22 V Y_1 Y_2 DF E IF) \\ \text{LLD Sr-90} &= 4.66(B_C + B_A) / (\Delta t)^{1/2} / (2.22 V Y_1 Y_2 IF DF E) \end{aligned}$$

Where:

N	=	total counts from sample
$\Delta t$	=	counting time for sample (min)
$B_C$	=	background rate of counter (cpm) using absorber Configuration.
2.22	=	dpm / pCi
V	=	volume or weight of sample analyzed
$B_A$	=	background addition from Sr-90 and ingrowth of Y-90
$B_C$	=	$0.016(K) + ((K) E_{Y/abs})(IG_{Y-90})$
$Y_S$	=	chemical yield of strontium
$DF_{\text{Sr-89}}$	=	decay factor from the mid collection date to the counting date for Sr-89
K	=	$(N\Delta t - B_C)_{Y-90} / (E_{Y-90} IF_{Y-90} DF_{Y-90} Y_1)$
$DF_{Y-90}$	=	the decay factor for Y-90 from the "milk" time to the mid count time
$E_{Y-90}$	=	efficiency of the counter for Y-90
$IF_{Y-90}$	=	ingrowth factor for Y-90 from scavenge to time to milking time
$IG_{Y-90}$	=	the ingrowth factor for Y-90 into the strontium mount from the "milk" time to the mid count time

0.016	=	the efficiency of measuring Sr-90 through a No. 6 absorber
$EY_{abs}$	=	the efficiency of counting Y-90 through a No. 6 absorber
B	=	background rate of counter (cpm)
$Y_1$	=	chemical yield of yttrium
$Y_2$	=	chemical yield of strontium
DF	=	decay factor of yttrium from the radiochemical milking time to the mid count time
E	=	efficiency of the counter for Y-90
IF	=	ingrowth factor for Y-90 from scavenge time to the radiochemical milking time

## ANALYSIS OF SAMPLES FOR IODINE-131

### Milk or Water

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, is reduced with hydroxylamine hydrochloride and is extracted into carbon tetrachloride as free iodine. It is then back-extracted as iodide into sodium bisulfite solution and is precipitated as palladium iodide. The sodium bisulfite solution is precipitated as palladium iodide. The precipitate is weighed for chemical yield and is mounted on a nylon planchette for low level beta counting. The chemical yield is corrected by measuring the stable iodide content of the milk or the water with a specific ion electrode.

Calculations of results, two sigma error and the lower limit of detection (LLD) in pCi/l:

$$\text{RESULT} = (N/\Delta t - B)/(2.22 V Y DF)$$

$$\text{TWO SIGMA ERROR} = 2((N/\Delta t + B) / \Delta t)^{1/2} / (2.22 E V Y DF)$$

$$\text{LLD} = 4.66(B/\Delta t)^{1/2} / (2.22 E V Y DF)$$

Where	N	=	total counts from sample
	$\Delta t$	=	counting time for sample (min)
	B	=	background rate of counter
	2.22	=	dpm/pCi
	V	=	volume or weight of sample analyzed
	Y	=	chemical yield of the mount or sample counted
	DF	=	decay factor from the collection to the counting date
	E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
	E	=	$E_s(\exp(-0.0061M)) / (\exp(-0.0061M_s))$
	$E_s$	=	efficiency of the counter determined from an I-131 standard mount
	$M_s$	=	mass of $\text{PdI}_2$ on the standard mount, mg
	M	=	mass of $\text{PdI}_2$ on the sample mount, mg



## ***GAMMA SPECTROMETRY OF SAMPLES***

### **Milk and Water**

A 1.0 liter Marinelli beaker is filled with a representative aliquot of the sample. The sample is then counted for approximately 1000 minutes with a shielded high purity germanium (HPGe) detector coupled to a personal computer (PC)-based data acquisition system which performs pulse height analysis.

### **Dried Solids Other Than Soil and Sediments**

A large quantity of the sample is dried at a low temperature, less than 100°C. As much as possible (up to the total sample) is loaded into a tared 1-liter Marinelli and weighed. The sample is then counted for approximately 1000 minutes with a shielded HPGe detector coupled to a PC-based data acquisition system which performs pulse height analysis.

### **Fish**

As much as possible (up to the total sample) of the edible portion of the sample is loaded into a tared Marinelli and weighed. The sample is then counted for approximately 100 minutes with a shield HPGe detector coupled to a PC-based data acquisition system which performs pulse height analysis.

### **Soil and Sediments**

Soils and sediments are dried at a low temperature, less than 100°C. The soil or sediment is loaded fully into a tared, standard 300 cc container and weighed. The sample is then counted for approximately six hours with a shielded HPGe detector coupled to a PC-computer-based data acquisition system which performs pulse height and analysis.

### **Charcoal Cartridges (Air Iodine)**

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a HPGe detector and up to four on the side of the HPGe detector. Each HPGe detector is calibrated for both positions. The detection limit for I-131 of each charcoal cartridge can be determined (assuming no positive I-131) uniquely from the volume of air which passed through it. In the event I-131 is observed in the initial counting of a set, each charcoal cartridge is then counted separately, positioned on the face of the detector.

### **Air Particulates**

The thirteen airborne particulate filters for a quarterly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded HPGe detector coupled to a PC-based data acquisition system which performs pulse height analysis.

A PC software program defines peaks by certain changes in the slope of the spectrum. The program also compares the energy of each peak with a library of peaks for isotope identification and then performs the radioactivity calculation using the appropriate fractional gamma ray abundance, half life, detector efficiency, and net counts in the peak region.

Calculation of results, two sigma error and the lower limit of detection (LLD) in pCi/volume of pCi/mass:

RESULT =  $(s-b)/(2.22 T E V F DF)$

TWO SIGMA ERROR =  $2(S+B)^{1/2}/(2.22 t E V F DF)$

LLD =  $4.66 (B)^{1/2}/(2.22 t E V F DF)$

where: S = Area, in counts, of sample peak and background (region of spectrum of interest.)  
B = Background area, in counts, under sample peak, determined by a linear interpolation of the representative backgrounds on peak.  
t = length of time in minutes the sample was counted  
2.22 = dpm/pCi  
E = detector efficiency for energy of interest and geometry of sample  
V = sample aliquot size (liters, cubic meters, kilograms, or grams)  
F = fractional gamma abundance (specific for each emitted gamma)  
DF = decay factor from the mid-collection date to the counting date

## *ENVIRONMENTAL DOSIMETRY*

Teledyne Brown Engineering Environmental Services uses a  $\text{CaSO}_4:\text{Dy}$  thermoluminescent dosimeter (TLD) which the company manufactures. This material has a high light output, negligible thermally induced signal loss (fading), and negligible self dosing. The energy response curve (as well as all other features) satisfies NRC Reg. Guide 4.13. Transit doses are accounted for by use of separate TLDs.

Following the field exposure period TLDs are placed in a Teledyne Brown Engineering Environmental Services Model 8300. One-fourth of the rectangular TLD is heated at a time and the measured light emission (luminescence) is recorded. The TLD is then annealed and exposed to a known Cs-137 dose; each area is then read again. This provides a calibration of each area of each TLD after every field use. The transit controls are read in the same manner.

In June of 2000, clients were notified that TBE would no longer a provider of environmental TLD service.

Calculations of results and the two sigma error in net milliRoentgen (mR):

$$\text{RESULT} = D = (D_1 + D_2 + D_3 + D_4)^{1/4}$$

$$\text{TWO SIGMA ERROR} = 2(D_1 - D)^2 + (D_2 - D)^2 + (D_3 - D)^2 + (D_4 - D)^2 / 3)^{1/2}$$

Where:

$D_1$	=	the net mR of area 1 of the TLD, and similarly for $D_2$ , $D_3$ , and $D_4$
$D_1$	=	$I_1 K / R_1 - A$
$I_1$	=	the instrument reading of the field dose in area 1
$K$	=	the know exposure by the Cs-137 dose on area 1
$R_1$	=	the instrument reading due to the Cs-137 dose on area 1
$A$	=	average dose in mR, calculated in similar manner as above, of the transit control TLDs
$D$	=	the average net mR of all 4 areas of the TLD

**APPENDIX E**  
**INTERLABORATORY COMPARISON PROGRAM**

## **INTERLABORATORY COMPARISION PROGRAM**

The US Environmental Protection Agency (EPA) discontinued their Interlaboratory Comparison Program in December 1998. Since the EPA is no longer involved in the program, there are no "approved" laboratories for Intercomparison Studies; however, Teledyne Brown Engineering Environmental Services participates in the Analytics, Inc. and Environmental Resource Associates (ERA) programs to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability.

The National Institute of Standards and Technology (NIST) is the approval authority for laboratory providers participating in Intercomparison Study Programs; however, at this time, there are no approved laboratories for environmental and/or radiochemical isotope analyses.

Trending graphs are provided in this section for the EPA Program and for Analytics when there were at least two data points to plot.

### **Exceptions 2000**

During 2000, several Interlaboratory Comparison Program (ICP) analyses were not performed as required by the ODCM. These omissions were identified in the audit EVL# 254T-01. Omitted analyses all occurred during the second half of 2000 while TBE facilities were in transition to the new Knoxville, TN facility and include the following.

- Water analysis for gamma
- Water analysis for iodine-131
- Water analysis for strontium-89
- Air particulate filters for gross beta
- Air particulate filters for strontium-90

To prevent recurrence, Dominion has initiated internal commitment tracking by Radiological Protection Department to verify status and compliance by TBE on a quarterly basis. TBE has initiated modifications to management of the ICP. These modifications include the designation of a single point of contact to ensure that all the required samples are ordered, received and reported in a timely fashion. It is apparent, from the 2000 exceptions to the ICP, that after the TBE relocation to the new Knoxville, TN facility, inadequate information was given to new personnel regarding client specific ICP requirements. Newly assigned project managers have been tasked with reviewing their assigned contracts and ODCMs to ensure compliance for the 2001 ICP. TBE is confident that problems with omitted analyses will not be an issue in 2001.

**ANALYTICS CROSS CHECK COMPARISON PROGRAM 2000**

Sample Date	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b,d)
03/20/00	Milk	I-131	18 ± 1	20 ± 1	0.90
		Cr-51	381 ± 38	387 ± 19	0.98
		Cs-134	132 ± 13	143 ± 7	0.92
		Cs-137	128 ± 13	114 ± 6	1.12
		Co-58	89 ± 9	79 ± 4	1.13
		Mn-54	195 ± 20	176 ± 9	1.11
		Fe-59	161 ± 16	144 ± 7	1.12
		Zn-65	171 ± 17	165 ± 8	1.04
		Co-60	179 ± 18	176 ± 9	1.02
03/20/00	Milk	Sr-89	13 ± 3	25 ± 1	0.52(c)
		Sr-90	16 ± 1	19 ± 1	0.84
06/19/00	Air Filter	Ce-141	143 ± 8	132 ± 7	1.08
		Cr-51	229 ± 17	198 ± 10	1.16
		Cs-134	74 ± 4	81 ± 4	0.91
		Cs-137	143 ± 8	115 ± 6	1.24(e)
		Co-58	89 ± 5	77 ± 4	1.16
		Mn-54	102 ± 6	84 ± 4	1.21(e)
		Fe-59	98 ± 6	75 ± 4	1.31(e)
		Zn-65	188 ± 11	139 ± 7	1.35(e)
		Co-60	113 ± 7	104 ± 5	1.09
06/19/00	Cartridge	I-131	106 ± 6	88 ± 4	1.20
06/19/00	Air Filter	Sr-90	88 ± 5	96 ± 5	0.92
06/19/00	Air Filter	Gross Alpha	103 ± 6	93 ± 5	1.11
		Gross Beta	210 ± 6	193 ± 10	1.09
09/18/00	Milk	I-131	97 ± 10	87 ± 4	1.11
		Ce-141	83 ± 8	77 ± 4	1.08
		Cr-51	323 ± 40	304 ± 15	1.06
		Cs-134	98 ± 10	102 ± 5	0.96
		Cs-137	117 ± 12	107 ± 5	1.09
		Co-58	64 ± 6	60 ± 3	1.07
		Mn-54	99 ± 10	88 ± 4	1.13
		Fe-59	132 ± 13	119 ± 6	1.11
		Zn-65	218 ± 22	196 ± 10	1.11
		Co-60	209 ± 21	197 ± 10	1.06

**ANALYTICS CROSS CHECK COMPARISON PROGRAM 2000 (cont.)**

Sample Date	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b,d)
09/18/00	Milk	Sr-89	14 ± 1	15 ± 1	0.93
		Sr-90	18 ± 1	14 ± 1	1.29
09/18/00	Milk	Sr-89	77 ± 8	90 ± 5	0.86
		Sr-90	58 ± 1	59 ± 3	0.98
09/18/00	Milk	I-131	83 ± 8	84 ± 4	0.99
		Ce-141	470 ± 47	460 ± 23	1.02
		Cr-51	266 ± 35	256 ± 13	1.04
		Cs-134	150 ± 15	150 ± 8	1.00
		Cs-137	155 ± 15	138 ± 7	1.12
		Co-58	53 ± 5	47 ± 2	1.12
		Mn-54	191 ± 19	171 ± 9	1.12
		Fe-59	115 ± 12	99 ± 5	1.16
		Zn-65	237 ± 24	208 ± 10	1.14
		Co-60	133 ± 13	125 ± 6	1.06
09/18/00	Milk	Fe-55	140 ± 60	99 ± 5	1.41(e)
		Sr-89	65 ± 7	74 ± 4	0.88
		Sr-90	35 ± 1	37 ± 2	0.90
09/18/00	Air Filter	Ce-141	90 ± 9	110 ± 6	0.82
		Cr-51	92 ± 25	133 ± 7	0.69(e)
		Cs-134	48 ± 5	74 ± 4	0.64(e)
		Cs-137	107 ± 11	126 ± 6	0.85
		Co58	27 ± 4	34 ± 2	0.80
		Mn-54	42 ± 4	52 ± 3	0.80
		Fe-59	24 ± 8	31 ± 2	0.77(e)
		Zn-65	65 ± 9	77 ± 4	0.84
		Co-60	112 ± 11	142 ± 7	0.79

**Footnotes:**

- (a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters.
- (b) Ratio of Teledyne Brown Engineering Environmental Services to Analytics results.
- (c) Caused by incorrect rinsing of the strontium extraction column. Additional training was conducted and was documented in the analyst's training file. Subsequent tests on two milk samples spiked with Sr-89 produced correct results.
- (d) Ratio control limits - 0.80-1.20.
- (e) For Westwood, NJ results outside control limits, an investigation was not instituted. After the relocation to Knoxville, TN, it was determined that the vast majority of outlying results were caused by analyst error or equipment failure. These possibilities were eliminated by the relocation.

**ERA\* STATISTICAL SUMMARY**  
**PROFICIENCY TESTING (PT) PROGRAM – 2000**

DATE	NUCLIDE	ERA Known Value (pCi/l)(a)	TBE Result (b) (pCi/l)	Expected Dev. Known (c) (pCi/l)	Control Limits (d) (pCi/l)	Warning Limits (e) (pCi/l)	Performance Evaluation (f)
2/10/00	Gr-A	58.4	83.6	14.6	33.3-83.5	41.5-75.3	NA (g)
2/10/00	Gr-B	16.8	15.4	5.00	8.10-25.5	11.0-22.6	A
2/24/00	U(NAT)	6.07	5.77	3.00	0.870-11.3	2.61-9.53	A
2/24/00	Ra-226	8.26	7.20	1.24	6.11-10.4	6.83-9.69	A
2/24/00	Ra-228	2.25	2.37	0.56	1.28-3.22	1.60-2.90	A
2/24/00	Gr-A	25.4	14.0	6.35	14.5-36.3	18.1-32.7	NA (g)
2/24/00	Gr-B	42.1	34.0	5.00	33.4-50.8	36.3-47.9	CE (g)
2/25/00	Ba-133	98.2	91.7	9.82	81.5-115	86.9-110	A
2/25/00	Co-60	99.6	101	5.00	90.9-108	93.8-105	A
2/25/00	Cs-134	49.2	48.0	5.00	40.5-57.9	43.3-55.0	A
2/25/00	Cs-137	209	76.3	10.4	191-227	197-221	NA (g)
2/26/00	Sr-89	16.4	15.7	5.00	7.70-25.1	10.6-22.2	A
2/26/00	Sr-90	28.9	29.0	5.00	20.2-37.6	23.1-34.7	A
2/26/00	Co-60	64.4	68.3	5.00	55.7-73.1	58.6-70.2	A
2/26/00	Cs-134	12.3	12.0	5.00	3.60-21.0	6.53-18.1	A
2/26/00	Cs-137	72.2	76.3	5.00	63.5-80.9	66.4-78.0	A
3/01/00	H-3	23800	22300	12380	19800-27800	21000-26500	A



**ERA\* STATISTICAL SUMMARY  
PROFICIENCY TESTING (PT) PROGRAM - 2000**

DATE	NUCLIDE	ERA Known Value (pCi/l)(a)	TBE Result (b) (pCi/l)	Expected Dev. Known (c) (pCi/l)	Control Limits (d) (pCi/l)	Warning Limits (e) (pCi/l)	Performance Evaluation (f)
5/18/00	Sr-89	22.5	18.3	5.00	13.8-31.2	16.7-28.3	A
5/18/00	Sr-90	9.6	8.33	5.00	0.9-18.3	3.83-15.4	A
5/23/00	I-131	19.9	2.03	3.00	14.7-25.1	16.4-23.4	NA (g)
9/1/00	Ra-226	13.0	9.70	1.15	7.41-18.6	9.25-16.8	A
9/1/00	U (NAT)	63.4	57.0	4.44	52.6-74.2	56.1-70.7	A
9/1/00	Ra-228	2.83	2.99	6.34	2.21-3.77	2.47-3.51	A
9/1/00	Ra-228	13.0	10.0	3.25	7.41-18.6	9.25-16.8	A
9/1/00	Sr-90	26.2	28.6	1.40	17.5-34.9	20.4-32.0	A
9/1/00	Gr-A	7.17	6.90	1.11	1.12-15.9	1.40-12.9	A
9/1/00	Gr-B	87.5	88.8	9.76	70.2-105	76.0-99.0	A
9/1/00	H-3	8320	8740	174	6910-9730	7360-9280	A

**Footnotes:**

- \* All ERA samples are water.
- (a) The ERA Known Value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.
- (b) Average  $\pm$  1 sigma.
- (c) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
- (d) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
- (e) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
- (f) A= Acceptable. Reported Result falls within the Warning Limits.  
NA = Not Acceptable. Reported Result falls outside of the Control Limits.  
CE = Check for Error. Reported Result falls within the Control Limits and outside of the Warning Limit.
- (g) For Westwood, NJ results outside control limits, an investigation was not instituted. After the relocation to Knoxville, TN, it has been determined that the vast majority of outlying results were caused by analyst error or equipment failure. These possibilities were eliminated by the relocation.

**ERA \* STATISTICAL SUMMARY**  
**ENVIRONMENTAL, INC.**  
**PROFICIENCY TESTING (PT) PROGRAM**  
**YEAR 2000**

DATE	NUCLIDE	ERA Known Value (pCi/l)(a)	ENV Result (b) (pCi/l)	Control Limits (pCi/l)	Performance Evaluation (c)
Jan, 2000	Gr-A	25.4	39.3	14.5-36.3	NA (d)
Jan, 2000	Gr-B	42.1	40.7	33.4-50.8	A
Jan, 2000	Sr-89	22.5	17.1	13.8-31.2	A
Jan, 2000	Sr-90	9.6	8.1	0.9-18.3	A
Feb, 2000	Ra-266	8.3	7.6	6.1-10.4	A
Feb, 2000	Ra-228	2.3	5.6	1.3-3.2	NA (e)
Feb, 2000	Uranium	6.1	5.4	0.9-11.3	A
Mar, 2000	H-3	23,800	23,500	19,800-27,800	A
Mar, 2000	Gr-A	58.4	83.6	33.3-83.5	NA (f)
Mar, 2000	Gr-B	16.8	15.4	8.1-25.5	A
Mar, 2000	I-131	19.9	18.7	14.7-25.1	A
Apr, 2000	Gr-A	54.0	52.3	30.8-77.2	A
Apr, 2000	Ra-226	18.6	17.5	13.8-23.4	A
Apr, 2000	Ra-228	3.6	3.7	2.0-5.1	A
Apr, 2000	Co-60	16.9	19.2	8.2-25.6	A
Apr, 2000	Cs-134	86.4	81.0	77.7-95.1	A
Apr, 2000	Cs-137	123.0	119.0	112.0-134.0	A
Apr, 2000	Gr-B	289.0	276.0	214.0-364.0	A
Apr, 2000	Sr-89	50.7	32.3	42.0-59.4	A (g)
Apr, 2000	Sr-90	32.8	11.3	24.1-41.5	A (g)
Jun, 2000	Ba-133	25.5	22.4	16.8-34.2	A
Jun, 2000	Co-60	65.6	69.9	56.9-74.3	A
Jun, 2000	Cs-134	13.8	13.5	5.1-22.5	A
Jun, 2000	Cs-137	238.0	232.0	217.0-259.0	A
Jun, 2000	Zn-65	54.6	50.9	45.3-63.9	A
Jun, 2000	Ra-226	3.0	2.8	2.2-3.8	A

*Footnotes are on the last page.*

**ERA\* STATISTICAL SUMMARY**  
**ENVIRONMENTAL, INC.**  
**PROFICIENCY TESTING (PT) PROGRAM**  
**YEAR 2000 (cont'd)**

DATE	NUCLIDE	ERA Known Value (pCi/l)(a)	ENV Result (b) (pCi/l)	Control Limits (pCi/l)	Performance Evaluation (c)
Jun, 2000	Ra-228	13.0	10.0	7.4-18.6	A
Jun, 2000	Uranium	63.4	57.0	52.6-74.2	A
Jul, 2000	Gr-A	7.2	6.9	0.0-15.9	A
Jul, 2000	Gr-B	87.5	88.8	70.2-105.0	A
Aug, 2000	H-3	8320.0	8740.0	6910.0-9730.0	A
Sep, 2000	Ra-226	18.9	17.9	14.0-23.8	A
Sep, 2000	Ra-228	6.2	5.7	3.5-8.8	A
Sep, 2000	Uranium	11.9	10.3	6.7-17.1	A
Oct, 2000	I-131	15.9	16.9	10.7-21.1	A
Oct, 2000	I-131(g)	15.9	17.1	10.7-21.1	A
Oct, 2000	Gr-A	74.4	66.3	42.2-107.0	A
Oct, 2000	Ra-226	10.5	10.1	7.8-13.2	A
Oct, 2000	Ra-228	19.4	21.2	11.0-27.8	A
Oct, 2000	Uranium	44.5	41.4	36.8-52.2	A
Oct, 2000	Co-60	91.1	93.4	82.4-99.8	A
Oct, 2000	Cs-134	59.8	54.8	51.1-68.5	A
Oct, 2000	Cs-137	45.0	45.5	36.3-53.7	A
Oct, 2000	Gr-B	256	209	189-323	A
Oct, 2000	Sr-89	41.3	32.8	32.6-50.0	A
Oct, 2000	Sr-90	18.0	16.0	9.3-26.7	A
Nov, 2000	Gr-A	60.3	50.3	34.4-86.2	A
Nov, 2000	Gr-B	25.5	28.6	16.8-34.2	A
Nov, 2000	Ba-133	82.2	78.0	68.0-96.4	A
Nov, 2000	Co-60	27.8	30.8	19.1-36.5	A
Nov, 2000	Cs-134	76.0	67.2	67.3-84.7	NA (h)
Nov, 2000	Cs-137	106.0	109.0	96.8-115.0	A
Nov, 2000	Zn-65	79.0	81.5	65.3-92.7	A

Footnotes are on the last page.

**ERA \* STATISTICAL SUMMARY**  
**ENVIRONMENTAL, INC.**  
**PROFICIENCY TESTING (PT) PROGRAM**  
**YEAR 2000 (cont'd)**

\* All ERA samples are water.

(a) Results are presented as the known values and control limits as provided by ERA.

(b) Unless otherwise, indicated, the laboratory results are given as the mean for three determinations.

(c) A= Acceptable. Reported Result falls within the Warning Limits.

NA = Not Acceptable. Reported Result falls outside of the Control Limits.

(d) The analysis was repeated and recalculated with A-241 efficiency: result of reanalysis 28.32 pCi/L. Internal spike program results do not indicate a problem.

(e) Result of reanalysis: 6.34 pCi/L. Activity confirmed by gamma spectroscopy: 6.00 pCi/L

(f) Results were recalculated with Am-241 efficiency; 57.8 pCi/L. Refer to Jan, 2000 Gr-B.

(g) An error was found in calculation. Result of recalculation: Sr-89, 55.5 pCi/L / Sr-90, 30.7 pCi/L. Results of reanalysis: Sr-89, 47.4 pCi/L / Sr-90, 33.0 pCi/L. Both results are within limits.

(h) The mean value for Cs-134 of all participating laboratories was 70.7 pCi/L. Other gamma emitters are within limits, the counting efficiency is not suspect, Library values were reviewed and found to be correct.

**DUKE ANALYTICS CROSS CHECK COMPARISON PROGRAM  
YEAR 2000**

<b>Quarter/ Year</b>	<b>Matrix</b>	<b>Nuclide</b>	<b>Reported Value pCi/L (a)</b>	<b>Known Value pCi/L (a)</b>	<b>Ratio DUKE/ Analytics</b>	<b>Evaluation</b>
1st/00	Water	I-131LL	76.63	74	1.04	A
1st/00	Water	I-131	70	74	0.95	A
1st/00	Water	Ce-141	426	427	1.00	A
1st/00	Water	Cr-51	205	238	0.86	A
1st/00	Water	Cs-134	135	139	0.97	A
1st/00	Water	Cs-137	126	128	0.98	A
1st/00	Water	Co-58	46	44	1.05	A
1st/00	Water	Mn-54	165	159	1.04	A
1st/00	Water	Fe-59	94	92	1.02	A
1st/00	Water	Zn-65	191	196	0.97	A
1st/00	Water	Co-60	117	116	1.01	A
1st/00	Water	Gr-A	60	82	0.73	NA (b)
1st/00	Water	Gr-B	223	210	1.06	A
1st/00	Water	U-234	62	57	1.09	A
1st/00	Water	U-235	2.5	2.7	0.93	A
1st/00	Water	U-238	64	59	1.08	A
1st/00	Water	Pu-238	80	73	1.10	A
1st/00	Water	Pu-239	69	62	1.11	A
1st/00	Water	Ra-226	87	89	0.98	A
1st/00	Water	Ra-228	77	66	1.17	NA (b)
1st/00	Milk	I-131LL	86	84	1.02	A
1st/00	Milk	I-131	84	84	1.00	A
1st/00	Milk	Ce-141	483	460	1.05	A
1st/00	Milk	Cr-51	279	256	1.09	A
1st/00	Milk	Cs-134	145	150	0.97	A
1st/00	Milk	Cs-137	138	138	1.00	A
1st/00	Milk	Co-58	43	47	0.91	A
1st/00	Milk	Mn-54	166	171	0.97	A
1st/00	Milk	Fe-59	103	99	1.04	A
1st/00	Milk	Zn-65	197	208	0.95	A
1st/00	Milk	Co-60	124	125	0.99	A
1st/00	Milk	Sr-89	90	90	1.00	A
1st/00	Milk	Sr-90	57	59	0.97	A

Footnotes on last page.

**DUKE ANALYTICS CROSS CHECK COMPARISON PROGRAM**  
**YEAR 2000 (cont.)**

Quarter/ Year	Matrix	Nuclide	Reported Value pCi/L (a)	Known Value pCi/L (a)	Ratio DUKE/ Analytics	Evaluation
2nd/00	Filter	Ce-141	75	80	0.94	A
2nd/00	Filter	Cr-51	242	243	1.00	A
2nd/00	Filter	Cs-134	89	105	0.85	A
2nd/00	Filter	Cs-137	230	219	1.05	A
2nd/00	Filter	Co-58	119	120	0.99	A
2nd/00	Filter	Mn-54	143	136	1.05	A
2nd/00	Filter	Fe-59	63	58	1.09	A
2nd/00	Filter	Zn-65	182	170	1.07	A
2nd/00	Filter	Co-60	159	163	0.98	A
2nd/00	Filter	Sr-89	87	109	0.80	A
2nd/00	Filter	Sr-90	62	66	0.94	A
2nd/00	Filter	Gr-A	25	24	1.04	A
2nd/00	Filter	Gr-B	97	93	1.04	A
2nd/00	Water	H-3	10627	11400	0.93	A
2nd/00	Milk	I-131LL	81	81	1.00	A
2nd/00	Milk	I-131	86	81	1.06	A
2nd/00	Milk	Ce-141	75	69	1.09	A
2nd/00	Milk	Cr-51	236	211	1.12	A
2nd/00	Milk	Cs-134	85	91	0.93	A
2nd/00	Milk	Cs-137	199	190	1.05	A
2nd/00	Milk	Co-58	98	104	0.94	A
2nd/00	Milk	Mn-54	122	118	1.03	A
2nd/00	Milk	Fe-59	52	50	1.04	A
2nd/00	Milk	Zn-65	136	148	0.92	A
2nd/00	Milk	Co-60	151	142	1.06	A
3rd/00	Water	I-131LL	72	75	0.95	A
3rd/00	Water	I-131	79	75	1.05	A
3rd/00	Water	Ce-141	192	191	1.00	A
3rd/00	Water	Cr-51	219	230	0.95	A
3rd/00	Water	Cs-134	121	128	0.95	A
3rd/00	Water	Cs-137	225	218	1.03	A
3rd/00	Water	Co-58	58	60	0.97	A
3rd/00	Water	Mn-54	92	89	1.04	A

Footnotes on last page

**DUKE ANALYTICS CROSS CHECK COMPARISON PROGRAM**  
**YEAR 2000 (cont.)**

<b>Quarter/ Year</b>	<b>Matrix</b>	<b>Nuclide</b>	<b>Reported Value pCi/L (a)</b>	<b>Known Value pCi/L (a)</b>	<b>Ratio DUKE/ Analytics</b>	<b>Evaluation</b>
3rd/00	Water	Fe-59	56	54	1.03	A
3rd/00	Water	Zn-65	129	134	0.97	A
3rd/00	Water	Co-60	247	246	1.01	A
3rd/00	Water	Sr-89	90	85	1.06	A
3rd/00	Water	Sr-90	52	54	0.97	A
3rd/00	Water	Gr-A	55	50	1.10	A
3rd/00	Water	Gr-B	228	205	1.11	A
3rd/00	Milk	Sr-89	65	74	0.88	A
3rd/00	Milk	Sr-90	41	39	1.06	A
3rd/00	Milk	I-131LL	66	58	1.14	A
3rd/00	Milk	I-131	69	58	1.20	NA (c)
3rd/00	Milk	Ce-141	176	164	1.07	A
3rd/00	Milk	Cr-51	195	198	0.99	A
3rd/00	Milk	Cs-134	108	110	0.98	A
3rd/00	Milk	Cs-137	193	188	1.02	A
3rd/00	Milk	Co-58	50	51	0.99	A
3rd/00	Milk	Mn-54	81	77	1.05	A
3rd/00	Milk	Fe-59	50	47	1.06	A
3rd/00	Milk	Zn-65	117	115	1.02	A
3rd/00	Milk	Co-60	212	212	1.00	A
4th/00	Milk	I-131	86	85	1.01	A
4th/00	Milk	Ce-141	362	356	1.02	A
4th/00	Milk	Cr-51	521	503	1.04	A
4th/00	Milk	Cs-134	84	85	0.99	A
4th/00	Milk	Cs-137	204	199	1.02	A
4th/00	Milk	Co-58	79	76	1.04	A
4th/00	Milk	Mn-54	162	152	1.06	A
4th/00	Milk	Fe-59	93	82	1.13	A
4th/00	Milk	Zn-65	148	148	1.00	A
4th/00	Milk	Co-60	185	184	1.00	A
4th/00	Filter	Sr-89	60	85	0.70	A
4th/00	Filter	Sr-90	42	41	1.03	A
4th/00	Filter	Gr-A	20	21	0.97	A
4th/00	Filter	Gr-B	136	114	1.19	A
4th/00	Water	H-3	9657	10082	0.96	A

Footnotes on last page

***DUKE ANALYTICS CROSS CHECK COMPARISON PROGRAM  
YEAR 2000 (cont.)***

- (a) Results for filters in pCi.
- (b) CR 00-26 issued. Gross alpha disagreement: Suspect incomplete rinsing of nuclide from laboratory glassware. Laboratory procedure revised to increase the strength of the acid wash. Ra-228 disagreement: Root cause not determined. Laboratory procedure revised to include new separation techniques obtained from EPA procedures.
- (c) CR 01-07 issued. Disagreement resulted from excessive decay time between sample preparation and analysis.