

VIRGINIA POWER COMPANY

NORTH ANNA POWER STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR 1987

Prepared by

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and

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ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

NORTH ANNA POWER STATION

JANUARY 1, 1987 to DECEMBER 31, 1987

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This report is submitted as required by Technical Specification 6.9.1.8, Annual Radiological Environmental Operating Report for North Anna Power Stations Units 1 and 2, Virginia Electric and Power Company Docket Nos. 50-338 and 50-339.

I. INTRODUCTION

VIRGINIA ELECTRIC AND POWER COMPANY

NORTH ANNA POWER STATION

RADIOLOGICAL ENVIRONMENTAL OPERATING PROGRAM

I. INTRODUCTION

The operational radiological environmental monitoring program conducted for the year 1987 for the North Anna Power Station is provided in this report. The results of measurements and analyses of data obtained from samples collected from January 1, 1987 through December 31, 1987 is summarized.

- A. The North Anna Power Station of Virginia Electric and Power Company is located on Lake Anna in Mineral, Virginia, approximately 35 miles west of Fredericksburg, Virginia. The site consists of two units, each with pressurized water reactor (PWR) nuclear steam supply systems and turbine generator furnished by Westinghouse Electric Corporation. Each unit is designed with a gross electrical output of 970 megawatts electric (MWe). Unit 1 achieved commercial operation on June 6, 1978, and Unit 2 on December 14, 1980.
- B. The United States Nuclear Regulatory Commission (USNRC) regulations (10CFR50.34a) require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). To ensure these criteria are met, the operating license for North Anna Power Station includes Technical Specifications which govern the release of radioactive effluents. Inplant monitoring is used to determine that these predetermined 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 Technical Specifications.

- C. Virginia Electric and Power Company is responsible for collecting the various indicator and control (background) environmental samples. Teledyne Isotopes is responsible for sample analysis and the submission of reports of radioanalyses. The results are used to determine if changes in radioactivity levels could be attributable to station operations. Measured values are compared with background 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 environmental 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 may be compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8 and Table 4.12-2 of North Anna's Technical Specifications. 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 1987 and satisfies the following objectives of the program:

1. To provide 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. To supplement the radiological effluent monitoring program by verifying that radioactive releases are within allowable limits.
3. To identify changes of radioactivity in the environment.
4. To verify 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 North Anna Power Station during 1987. Figure 1 indicates the locations of the environmental monitoring stations.
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. These are indicated as "co-location" samples.
3. In addition to the Radiological Environmental Monitoring Program required by North Anna Technical Specifications, Virginia Electric and Power Company splits samples with the Commonwealth of Virginia. All samples listed in Table 1 are collected by Veeco personnel except for those labeled state split. All samples are shipped to Teledyne Isotopes in Westwood, New Jersey.
4. All samples listed in Table 1 are taken at indicator locations except those labeled "control".

B. Analysis Program

1. Table 2 summarizes the analysis program conducted by Teledyne Isotopes for North Anna Power Station during 1987.

TABLE 1

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North Anna Power Station - 1937

## RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	COMPASS DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Environmental Thermoluminescent Dosimetry (TLD)	NAPS Sewage Treatment Plant	01	0.20	NE	42	Quarterly & Annually	On-Site, State Split
	Fredericks Hall	02	5.30	SSW	225	Quarterly & Annually	State Split
	Mineral, Va.	03	7.10	WSW	243	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	287	Quarterly & Annually	State Split
	Route 752	05	4.20	NNE	20	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	3.20	NNE	11	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	115	Quarterly & Annually	State Split, Co-Location
	Bumpass, VA	07	7.30	SSE	167	Quarterly & Annually	State Split
	End of Route 685	21	1.00	WNW	301	Quarterly & Annually	Exclusion Boundary
	Route 700	22	1.00	WSW	242	Quarterly & Annually	State Split, Co-Location
	"Aspen Hills"	23	0.93	SSE	158	Quarterly & Annually	Exclusion Boundary
	Orange, VA	24	22.00	NW	325	Quarterly & Annually	State Split, Co-Location Control
	Bearing Cooling tow.	N-1/33	0.06	N	10	Quarterly	On-Site
	Sturgeon's Creek Marina	N-2/34	3.20	N	11	Quarterly	
	Parking Lot "C" (on-site)	NNE-3/35	0.25	NNE	32	Quarterly	On-Site
	Good Hope Church	NNE-4/36	4.96	NNE	25	Quarterly	State Split
	Parking Lot "B"	NE-5/37	0.20	NE	42	Quarterly	On-Site
	Lake Anna Marina	NE-6/38	1.49	NE	34	Quarterly	
	Weather tower fence	ENE-7/39	0.36	ENE	74	Quarterly	On-Site
	Route 689	ENE-8/40	2.43	ENE	65	Quarterly	
	Near Training Facility	E-9/41	0.30	E	91	Quarterly	On-Site

TABLE 1

(Page 2 of 5)

North Anna Power Station - 1987

## RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	COMPASS DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Environmental Thermoluminescent Dosimetry (TLD)	"Morning Glory Hill"	E-10/42	2.85	E	93	Quarterly	
	Island Dike	ESE-11/43	0.12	ESE	103	Quarterly	On-Site
	Route 622	ESE-12/44	4.70	ESE	115	Quarterly	
	VEPCO Biology Lab	SE-13/45	0.75	SE	138	Quarterly	On-site
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	137	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	158	Quarterly	Exclusion Boundary
	Elk Creek	SSE-16/48	2.33	SSE	165	Quarterly	
	Warehouse Compound Gate	S-17/49	0.22	S	173	Quarterly	On-Site
	Elk Creek Church	S-18/50	1.55	S	178	Quarterly	
	NAPS Access Road	SSW-19/51	0.36	SSW	197	Quarterly	On-Site
	Route 618	SSW-20/52	5.30	SSW	205	Quarterly	
	NAPS Access Road	SW-21/53	0.30	SW	218	Quarterly	On-Site
	Route 700	SW-22/54	4.36	SW	232	Quarterly	
	500 kv Tower	WSW-23/55	0.40	WSW	237	Quarterly	On-Site
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242	Quarterly	Exclusion Boundary
	NAPS Radio Tower	W-25/57	0.31	W	279	Quarterly	On-Site
	Route 685	W-26/58	1.55	W	274	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301	Quarterly	Exclusion Boundary
	H. Purcell's Private Road	WNW-28/60	1.52	WNW	303	Quarterly	Co-Location
	End of #1/#2 Intake	NW-29/61	0.15	NW	321	Quarterly	On-Site
	Lake Anna Campground	NW-30/62	2.54	NW	319	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349	Quarterly	On-Site
	Route 208	NNW-32/64	3.45	NNW	344	Quarterly	
	Bumpass Post Office	C-1/2	7.90	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

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North Anna Power Station - 1987

## RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	COMPASS DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Airborne Particulate and Radioiodine	NAPS Sewage Treatment Plant	01	0.20	NE	42	Weekly	On-Site, State Split
	Fredericks Hall Mineral, VA	02	5.30	SSW	205	Weekly	
	Wares Crossroads	03	7.10	WSW	243	Weekly	
	Route 752	04	5.10	WNW	287	Weekly	
	Sturgeon's Creek Marina	05	4.20	NNE	20	Weekly	
	Levy, VA	05A	3.20	N	11	Weekly	
	Pumpass, VA	06	4.70	ESE	115	Weekly	
	End of Route 685	07	7.30	SSE	167	Weekly	
	Route 700	21	1.00	WNW	301	Weekly	Exclusion Boundary
	"Aspen Hills"	22	1.00	WSW	242	Weekly	Exclusion Boundary
	Orange, VA	23	0.93	SSE	158	Weekly	State Split
		24	22.00	NW	325	Weekly	Exclusion Boundary Control
Surface Water	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148	Monthly	State Split
	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320	Monthly	Control, State Split
River Water	North Anna River (downstream)	11	5.80	SE	120	Quarterly	
Ground Water (well water)	Biology Lab	01A	0.75	SE	138	Quarterly	State Split
Aquatic Sediment	Waste Heat Treatment Facility (Discharge Lagoon)	08	1.10	SSE	148	Semi-Annually	State Split
	Lake Anna (upstream)	09	2.20	NW	320	Semi-Annually	Control, State Split
	North Anna River (Downstream)	11	5.80	SSE	128	Semi-Annually	

TABLE 1

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North Anna Power Station - 1987

## RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Shoreline Soil	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320	Semi-Annually	State Split
Soil	NAPS Sewage Treatment Plant	01	0.20	NE	42	Once/3 years	On-Site
	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/5 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	Exclusion Boundary
	Route 700	22	1.00	WSW	242	Once/3 years	Exclusion Boundary
	(Exclusion Boundary) "Aupen Hills"	23	0.93	SSE	158	Once/3 years	Exclusion Boundary
	Orange, VA	24	22.00	NW	325	Once/3 years	Control
Milk	Holladay Dairy (R.C. Goodwin)	12	8.30	NW	310	Monthly	State Split
	Terrell's Dairy (Fredericks Hall)	13	5.60	SSW	205	Monthly	State Split
Fish	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148	Quarterly	State Split
	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320	Quarterly	Control, State Split
Food Products (Broadleaf vegetation)	Route 713	14	1.20	NE	43	Monthly if available or at harvest	
	Route 614	15	1.70	SE	133	Monthly if available or at harvest	



TABLE 1

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North Anna Power Station - 1987

## RADIOLOGICAL SAMPLING STATIONS

## DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Food Products (Broadleaf Vegetation)	Route 629/522	16	12.60	NW	314	Monthly if available or at harvest	
	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	

TABLE 2

(Page 1 of 3)

## NORTH ANNA POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Thermoluminescent Dosimetry (TLD) (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
Airborne Radioiodine	Weekly	I-131	0.07	pCi/m <sup>3</sup>
Airborne Particulate	Weekly	Gross Beta	0.01	pCi/m <sup>3</sup>
	Quarterly (1)	Gamma Isotopic		pCi/m <sup>3</sup>
		Cs-134	0.05	
	Annually	Cs-137	0.06	
		Sr-89/90	0.005/0.0002	pCi/m <sup>3</sup>
Surface Water	Monthly	Gamma Isotopic		pCi/ℓ
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		I-131	10	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
		Quarterly (1)	Tritium (H-3)	2000
2nd quarterly Composite	Sr-89/90	5/1	pCi/ℓ	

(1) Quarterly Composites of each location's samples will be used for the required analysis.

\* LLD's 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 Isotopes may be lower than those listed.

TABLE 2

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## NORTH ANNA POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
River Water	Quarterly	Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		I-131	10	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
	Quarterly 2nd Quarterly Sample	Tritium (H-3)	2000	pCi/l
Sr-89/90	5/1	pCi/l		
Ground Water (Well Water)	Quarterly	Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		I-131	1	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
Quarterly	Tritium (H-3)	2000	pCi/l	
Aquatic Sediment	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
	Cs-137	180		
Annually	Sr-89/90	200/40	pCi/kg (dry)	
Shoreline Soil	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
Soil	Once per 3 yrs.	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
	Cs-137	180		
Once per 3 yrs.	Sr-89/90	200/40	pCi/l.g (dry)	

\* LLD's 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 Isotopes may be lower than those listed.

TABLE 2 (Cont.)

(Page 3 of 3)

## NORTH ANNA POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Milk	Monthly	I-131	1.0	pCi/l
	Monthly	Gamma Isotopic		pCi/l
		Cs-134	15	
		Cs-137	18	
Quarterly	Ba-La-140	15		
		Sr-89/90	5/1	pCi/l
Fish	Semi-Annually (Quarterly - interim period)	Gamma Isotopic		pCi/kg (wet)
		Mn-54	130	
		Fe-59	260	
		Co-58,60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
Food Products (Broadleaf Vegetation)	Monthly if available or at harvest	Gamma Isotopic		pCi/kg (wet)
		Cs-134	60	
		Cs-137	80	
		I-131	60	pCi/kg (wet)

NOTE: This table is not a complete listing of nuclides which can be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

\* LLD's 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 Isotopes may be lower than those listed.

LEGEND FOR THE NORTH ANNA POWER STATION

ENVIRONMENTAL MONITORING STATIONS OVERVIEW MAPS

(FIGURES 1, 2, 3)

MAP DESIGNATION	ENVIRONMENTAL STATION IDENTIFICATION	MAP DESIGNATION	ENVIRONMENTAL STATION IDENTIFICATION
1	N-1/33	23	WSW-23/55
2	N-2/34,05A	24	WSW-24/56,22
3	NNE-3/35	25	W-25/57
4	NNE-4/36	26	W-26/58
5	NE-5/37,01	27	WNW-27/59,21
6	NE-6/38,14	28	WNW-28/60
7	ENE-7/39	29	NW-29/61
8	ENE-8/40	30	NW-30/62,09
9	E-9/41	31	NNW-31/63
10	E-10/42	32	NNW-32/64
11	ESE-11/43	33	03, C-5&6
12	ESE-12/44,06	34	04
13	SE-13/45,01A	35	05
14	SE-14/46	36	07, C-1&2
15	SSE-15/47,23	37	08
16	SSE-16/48	38	11
17	S-17/49	39	12
18	S-18/50	40	13
19	SSW-19/51	41	15
20	SSW-20/52,02	42	16
21	SW-21/53	43	24, C-3&4
22	SW-22/54	44	C-7&8

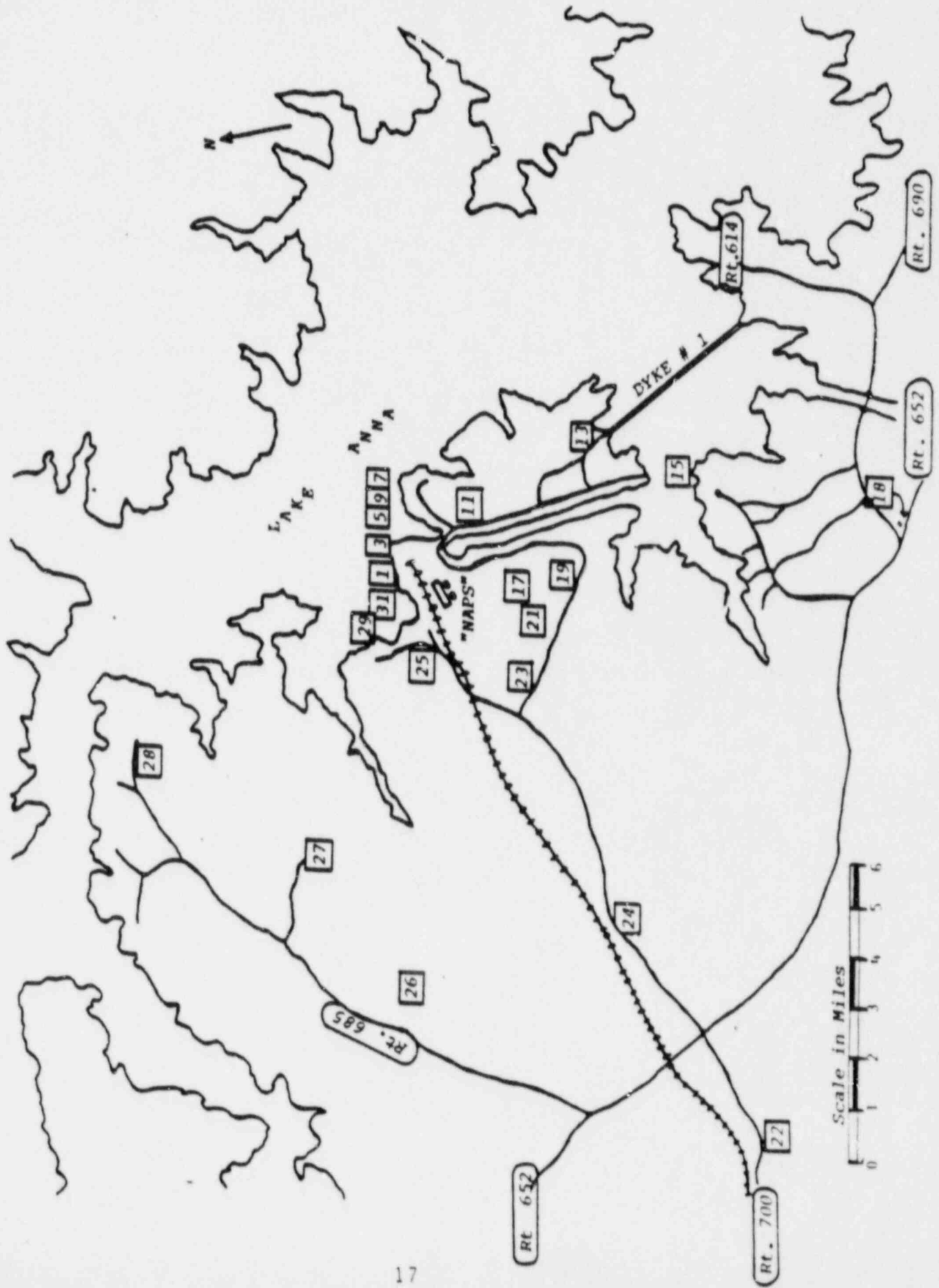


Map Designation #



Road Numbers

NORTH ANNA POWER STATION  
ENVIRONMENTAL MONITORING STATIONS OVERVIEW MAP



NORTH ANNA POWER STATION  
ENVIRONMENTAL MONITORING STATIONS OVERVIEW MAP

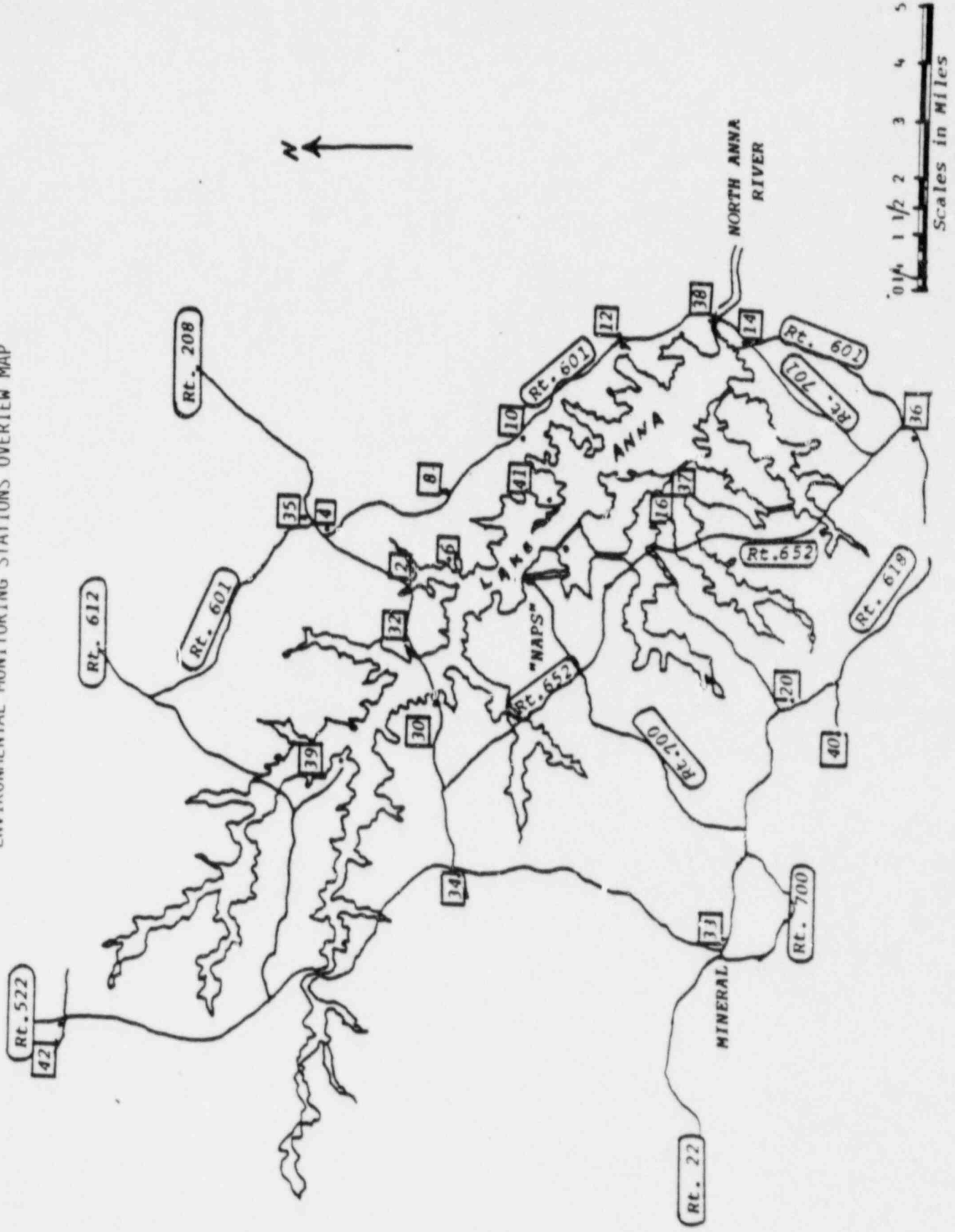
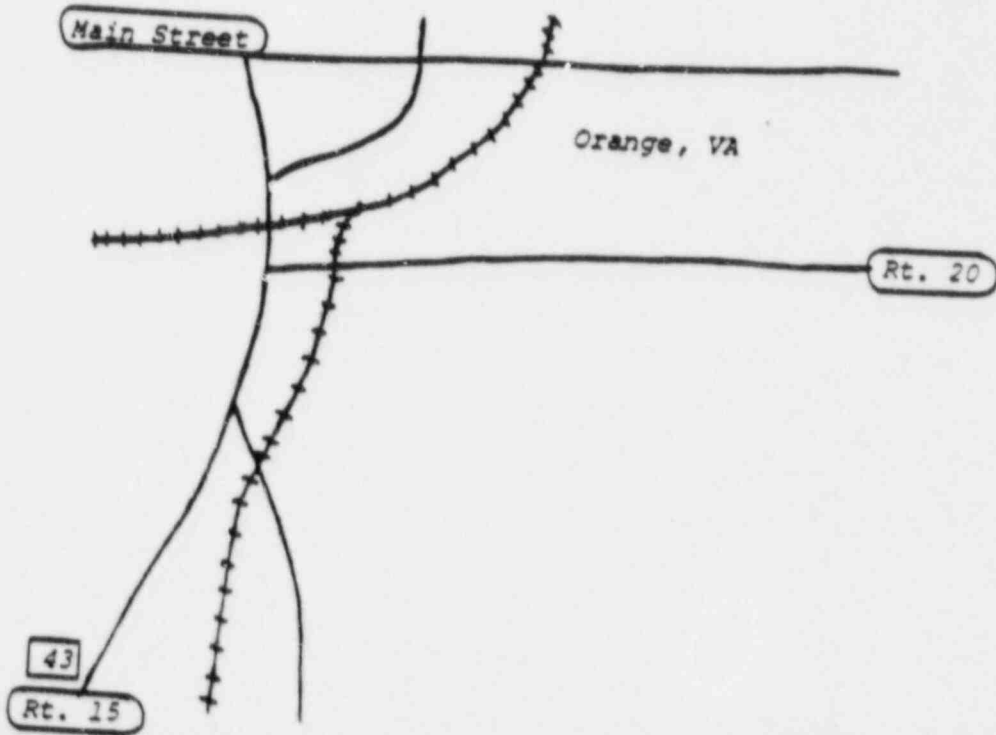
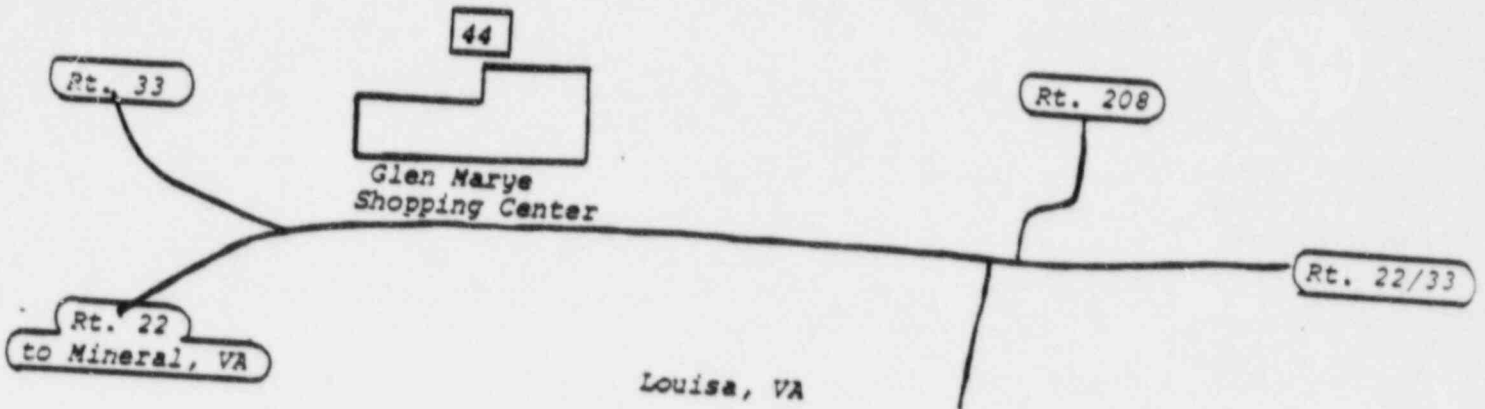


FIGURE 1

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NORTH ANNA POWER STATION

ENVIRONMENTAL MONITORING STATIONS OVERVIEW MAP





### III. PROGRAM EXCEPTIONS

### III. PROGRAM EXCEPTIONS

During the 1987 environmental reporting period, several samples were not available. There were also some analyses of samples that did not meet the required sensitivity (LLD). The following is a discussion of the exceptions and actions taken to limit re-occurrence.

Several air iodine/particulate samples were lost. In some cases the sampler malfunctioned and no sample was available. Due to inclement weather in late January all samples ran for a two week period. In one case the sample was lost during chemical analysis and the analyst was unable to chemically recover it.

One precipitation sample was not collected due to an oversight in the field. In addition, for a precipitation sample the LLD for I-131 could not be met due to long lapse of time from collection to receipt at TI.

One food/vegetation sample did not meet the required LLD for Cs-134 and Cs-137 due to small sample size.

A ground/well water sample did not meet the LLD for I-131 due to an oversight at TI. This has been corrected by the installation of an automatic flagging system which will improve the review of LLD requirements.

Four direct radiations TLD's were vandalized; two during the second quarter and two during the fourth quarter.

Surface water samples are collected by the Commonwealth of Virginia on a monthly basis from two stations. The analyses for barium/lanthanum-140, and I-131 failed to meet the required Lower Limit of Detection (LLD) in several cases due to delay in receipt of samples from the State of Virginia.

The fourth quarter river water sample was not collected due to oversight in the field. Additional weekly supervisory control has been established to insure compliance with the sampling schedule.

REMP EXCEPTIONS FOR SCHEDULED  
SAMPLING AND ANALYSIS DURING 1987 - NORTH ANNA

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
All Stations	Air Particulate/ Air Iodine	01/20/87-02/03/87	All samples ran for two weeks due to inclement weather.
01	Air Particulate/ Air Iodine	03/10/87-03/17/87	Sampler malfunction; no sample available.
22	Air Iodine	03/10/87-03/17/87	No power at time of collection; sample lost in analysis.
05	Air Iodine	03/24/87-03/31/87	Sample lost during chemical analysis. Tried unsuccessfully to chemically recover sample.
01/22	Air Particulate/ Air Iodine	04/07/87-04/14/87	Insufficient volume. No sample collected.
05A	Air Particulate/ Air Iodine	04/07/87-04/14/87	Insufficient volume. No sample collected.
04	Air Particulate/ Air Iodine	05/19/87-05/26/87	Power outage; no sample available.
02	Air Particulate/ Air Iodine	07/07/87-07/21/87	Results in total pCi.
02/07/23	Air Particulate/ Air Iodine	07/07/87-07/21/87	All samples ran for two weeks.
24	Air Particulate/ Air Iodine	07/21/87-07/28/87	Equipment malfunction. No sample available.
05A	Air Particulate/ Air Iodine	08/04/87-08/11/87	LLD not met due to low air volume.
03	Air Particulate/ Air Iodine	08/11/87-08/18/87	Insufficient volume. No sample available.
02/21	Air Particulate/ Air Iodine	09/22/87-09/29/87	Insufficient volume. No sample available.
02	Air Particulate/ Air Iodine	10/13/87-10/20/87	Equipment malfunction. No sample available.

REMP EXCEPTIONS FOR SCHEDULED  
SAMPLING AND ANALYSIS DURING 1987 - NORTH ANNA (Cont.)

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
03/22	Air Particulate/ Air Iodine	11/03/87-11/10/87	Insufficient volume. No sample available.
24	Air Particulate/ Air Iodine	11/17/87-11/24/87	Results in total pCi.
05A/21	Air Particulate/ Air Iodine	12/15/87-12/22/87	Equipment malfunction; no sample available.
01	Precipitation	09/29/87-10/27/87	Sample not collected due to oversight in the field.
01	Precipitation	12/31/86-06/30/87	LLD for I-131 could not be met due to long lapse of time from collection to receipt at TI.
14/15/16/ 21/23	Food/Vegetation	11/03/87	LLD for I-131 not met due to small sample size.
21	Food/Vegetation	11/03/87	LLD for Cs-134 and Cs-137 not met due to small sample size.
SW-22/54	Direct Radiation (TLD's)	Second Quarter	TLD Vandalized.
SE-14/16	Direct Radiation (TLD's)	Fourth Quarter	TLD Vandalized.
01A	Gamma in Ground/Well Water	03/31/87	LLD For I-131 not met due to an oversight at TI.
W-27/ W-33	Gamma in Surface Water	01/15/87 02/15/87 03/15/87 04/15/87 05/15/87 06/15/87 08/15/87 11/15/87 12/15/87	LLD could not be met for Ba/La-140 due to long lapse of time from collection to receipt at TI.

REMP EXCEPTIONS FOR SCHEDULED  
SAMPLING AND ANALYSIS DURING 1987 - NORTH ANNA (Cont.)

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
W-27/ W-33	Gamma in Surface Water	01/15/87 02/15/87 03/15/87 04/15/87	LLD for I-131 could not be met due to long lapse of time from collection to receipt at TI.
11	Gamma in River Water	12/29/87	Sample not collected due to oversight in field. Additional weekly supervisory control has been established to insure compliance with sampling schedule.

#### IV. SUMMARY AND DISCUSSION OF 1987 ANALYTICAL RESULTS

Data from the radiological analyses of environmental media collected during the report period are tabulated and discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in the Teledyne Isotopes Quality Assurance Manual and are explained in the Teledyne Isotopes Analytical Procedures. A synopsis of analytical procedures used for the environmental samples is provided in Section VII. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Section VIII.

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. Teledyne Isotopes analytical methods meet the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring (November 1979, Revision 1).

The following is a discussion and summary of the results of the environmental measurements taken during the 1987 reporting period.

##### A. Airborne Exposure Pathway

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

Gross beta activity was observed in all fifty control samples with an average concentration of  $0.025 \text{ pCi/m}^3$  and a range of  $0.012$  to  $0.063 \text{ pCi/m}^3$ . The average measurement for the indicator locations was  $0.024$

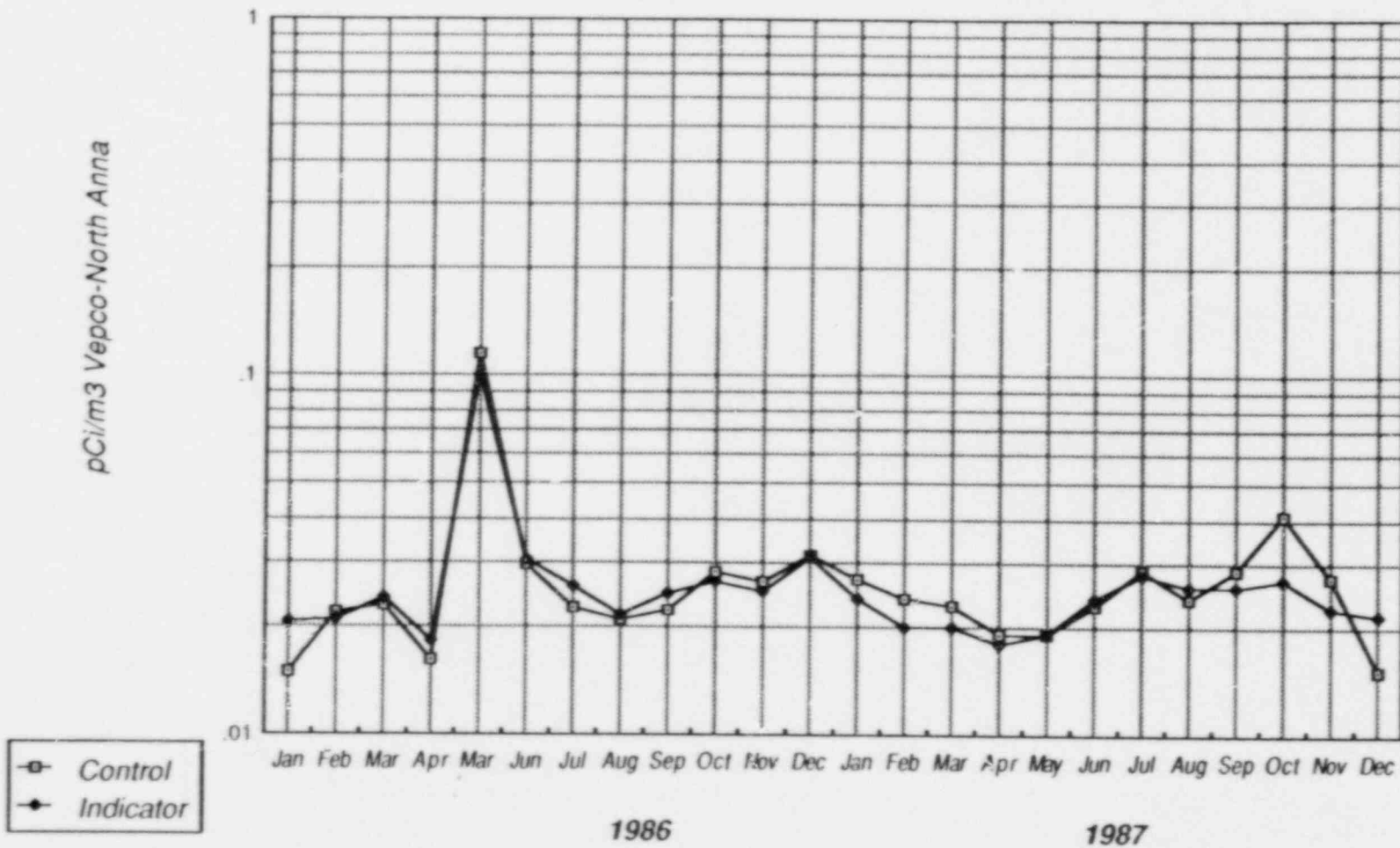
pCi/m<sup>3</sup> with a range of 0.006 to 0.048 pCi/m<sup>3</sup>. The results of the gross beta activities are presented in Table 5. The monthly averages of the gross beta concentrations for the eleven indicator locations and the control location are plotted from 1977 through 1987. With the exception of the five week period in 1986 influenced by the Chernobyl accident, the gross beta activities were comparable to levels in the 1982-1986 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing by other countries.

Air particulate filters were composited by locations on a quarterly basis and were analyzed by gamma ray spectroscopy. The results are listed in Table 6. Cosmogenically produced beryllium-7 was measured in all 48 composite samples. The average measurement for the control location was 0.082 pCi/m<sup>3</sup> with a range of 0.055 to 0.096 pCi/m<sup>3</sup>. The indicator locations had an average concentration of 0.071 pCi/m<sup>3</sup> and a range of 0.020 to 0.125 pCi/m<sup>3</sup>. Naturally occurring potassium-40 was detected in one control sample with an activity of 0.015 pCi/m<sup>3</sup> and in five indicator samples with an average measurement of 0.017 pCi/m<sup>3</sup> and a range of 0.010 to 0.021 pCi/m<sup>3</sup>. All other gamma emitters were below the detection limits.

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

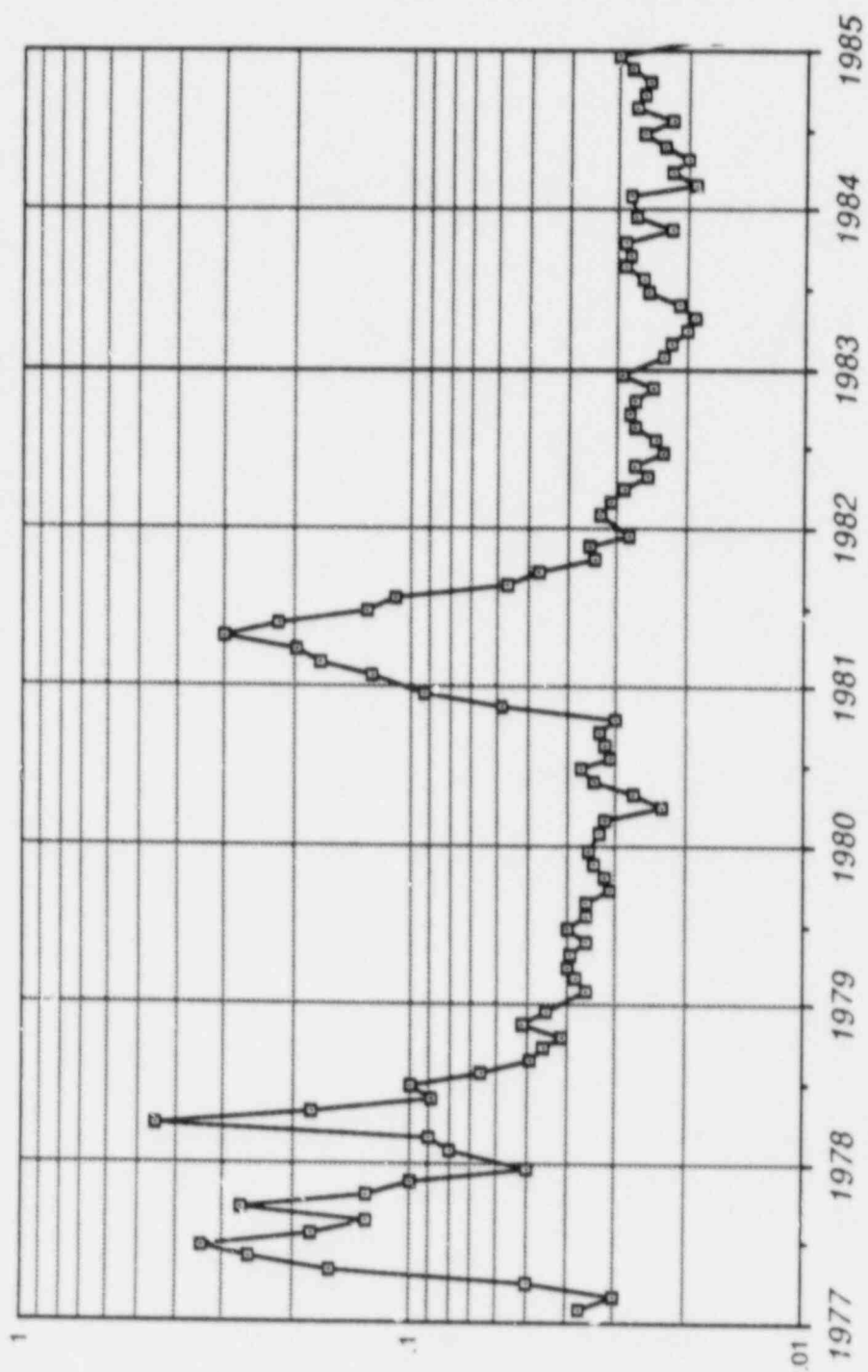
# GROSS BETA - AIR PARTICULATES

pCi/m<sup>3</sup> Vepco-North Anna





# GROSS BETA - AIR PARTICULATES



pC/m3 Vepco - North Anna

TABLE 3

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO. 50-339/339

LOUISA COUNTY, VIRGINIA

JANUARY 1 to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST MEAN		CONTROL LOCATION		NUMBER OF NONROUTINE REPORTED MEASUREMENTS
			MEAN RANGE FRACTION		NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION	MEAN RANGE FRACTION		
Air Iodine (pCi/m <sup>3</sup> )	I-131	588	0.04	-(0/538)	N/A	N/A	-(0/50)	0	
Airborne Particulates (1E-03 pCi/m <sup>3</sup> )	Gross Beta	585	5	22.9(535/535) (6.1-48)	05 4.2 mi NNE	26.7(51/51) (12-45)	24.9(50/50) (12-63)	0	
	Gamma Spec Quarterly	48							
	Be-7	48		70.6(44/44) (20.2-125)	05 4.2 mi NNE	84.4(4/4) (55.7-104)	81.6(4/4) (55.4-95.9)	0	
	K-40	48		16.7(5/44) (10.4-21.1)	01 0.2 mi NE	21.1(1/4)	15.4(1/4)	0	
	Sr-89	12		-(0/11)	NA	NA	-(0/1)	0	
	SR-90	12		-(0/11)	NA	NA	-(0/1)	0	

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 4

(Page 1 of 4)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF IODINE-131 IN FILTERED AIR  
 pCi/m<sup>3</sup> ± 2 Sigma

COLLECTION DATE	STATIONS											
	01	02	03	04	05	05A	06	07	21	22	23	24
<b>JANUARY</b>												
12/30-01/06	<.007	<.01	<.006	<.008	<.006	<.008	<.005	<.005	<.006	<.008	<.007	<.006
01/06-01/13	<.01	<.006	<.008	<.02	<.009	<.01	<.02	<.01	<.02	<.01	<.007	<.01
01/13-01/20	<.007	<.01	<.009	<.009	<.008	<.007	<.006	<.009	<.009	<.008	<.01	<.005
01/20-02/03 (a)	<.009	<.008	<.02	<.01	<.009	<.008	<.008	<.006	<.008	<.005	<.004	<.005
<b>FEBRUARY</b>												
02/03-02/10	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
02/10-02/18	<.02	<.009	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.01
02/18-02/24	<.02	<.02	<.02	<.02	<.02	<.01	<.02	<.02	<.01	<.02	<.02	<.02
02/24-03/03	<.02	<.01	<.01	<.01	<.02	<.009	<.01	<.02	<.008	<.007	<.008	<.02
<b>MARCH</b>												
03/03-03/10	<.01	<.01	<.02	<.02	<.02	<.02	<.01	<.02	<.009	<.01	<.01	<.02
03/10-03/17	(b)	<.01	<.02	<.01	<.01	<.01	<.01	<.01	<.01	(c)	<.007	<.02
03/17-03/24	<.007	<.008	<.006	<.005	<.008	<.006	<.005	<.006	<.005	<.008	<.01	<.006
03/24-03/31	<.009	<.007	<.008	<.007	(d)	<.01	<.02	<.005	<.01	<.005	<.008	<.006

(a) All samples ran for two weeks due to inclement weather.

(b) Equipment Malfunction; no sample available.

(c) No power at time of collection; sample lost in analysis.

(d) Lost during chemical analysis. Tried unsuccessfully to chemically recover sample.

TABLE 4

(Page 2 of 4)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF IODINE-131 IN FILTERED AIR  
 pCi/m<sup>3</sup> ± 2 Sigma

1987 COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24
<b>APRIL</b>												
03/31-04/07	<.006 (a)	<.006	<.009	<.006	<.009	<.008	<.006	<.006	<.008	<.007	<.009	<.008
04/07-04/14	<.02 (b)	<.02	<.02	<.007	<.007	<.009	<.007	<.007	<.006	(b)	<.005	<.006
04/14-04/21	<.02	<.02	<.01	<.01	<.02	<.009	<.02	<.005	<.005	<.01	<.01	<.008
04/21-04/28	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.02	<.01	<.009	<.01	<.01
<b>MAY</b>												
04/28-05/05	<.01	<.006	<.007	<.008	<.008	<.008	<.007	<.007	<.009	<.01	<.007	<.01
05/05-05/12	<.02	<.02	<.02	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.02	<.02
05/12-05/19	<.01	<.009	<.01	<.01	<.007	<.01	<.006	<.01	<.01	<.01	<.01	<.01
05/19-05/26	<.02	<.02	<.009	(c)	<.02	<.01	<.01	<.02	<.02	<.02	<.02	<.02
05/26-06/02	<.008	<.01	<.008	<.005	<.02	<.01	<.009	<.01	<.009	<.008	<.01	<.006
<b>JUNE</b>												
06/02-06/09	<.02	<.02	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.02	<.02	<.01
06/09-06/16	<.01	<.01	<.01	<.01	<.01	<.009	<.01	<.008	<.01	<.01	<.008	<.01
06/16-06/23	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
06/23-06/30	<.02	<.01	<.02	<.01	<.02	<.02	<.02	<.01	<.02	<.02	<.01	<.02

(a) Collection dates 03/31/87-04/08/87.

(b) Insufficient volume; no sample available.

(c) Power outage; no sample available.

TABLE 4

(Page 3 of 4)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF IODINE-131 IN FILTERED AIR  
 pCi/m<sup>3</sup> ± 2 Sigma

COLLECTION DATE	STATIONS											
	01	02	03	04	05	05A	06	07	21	22	23	24
<b>JULY</b>												
06/30-07/07	<.02	<.01	<.02	<.01	<.01	<.02	<.02	<.01	<.02	<.01	<.02	<.01
07/07-07/21 (a)	<.01	<.02 (b)	<.01	<.01	<.01	<.01	<.01	<.02 (c)	<.01	<.01	<.02 (c)	<.01
07/21-07/28	<.01	<.01	<.02	<.01	<.02	<.02	<.01	<.02	<.01	<.01	<.02	<.01
07/28-08/04	<.01	<.01	<.01	<.01	<.009	<.01	<.01	<.01	<.01	<.01	<.006	<.007
<b>AUGUST</b>												
08/04-08/11	<.01	<.009	<.02	<.01	<.01	<.6 (e)	<.01	<.02	<.01	<.01	<.02	<.01
08/11-08/18	<.01	<.01	(f)	<.008	<.008	<.01	<.008	<.008	<.009	<.01	<.008	<.01
08/18-08/25	<.008	<.007	<.01	<.007	<.006	<.007	<.007	<.007	<.009	<.006	<.02	<.005
08/25-09/01	<.01	<.009	<.02	<.009	<.008	<.01	<.008	<.01	<.008	<.01	<.009	<.006
<b>SEPTEMBER</b>												
09/01-09/08	<.01	<.01	<.01	<.009	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
09/08-09/15	<.01	<.02	<.02	<.01	<.01	<.02	<.01	<.01	<.01	<.02	<.02	<.01
09/15-09/22	<.01	<.009	<.01	<.01	<.007	<.007	<.009	<.009	<.01	<.01	<.01	<.009
09/22-09/29	<.01	(f)	<.008	<.006	<.009	<.01	<.009	<.01	(f)	<.008	<.007	<.01

- (a) Samples ran for two weeks due to inclement weather.  
 (b) Result in total pCi; collection dates 07/16 to 07/21.  
 (c) Collection dates 07/16-07/21.  
 (d) Equipment malfunction; no sample available.  
 (e) LLD could not be met due to low air volume.  
 (f) Insufficient volume; no sample available.

TABLE 4

(Page 4 of 4)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

pCi/m<sup>3</sup> ± 2 Sigma

1987	STATIONS											
COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24
<b>OCTOBER</b>												
09/29-10/06	<.007	<.008	<.01	<.01	<.008	<.008	<.008	<.007	<.01	<.01	<.008	<.006
10/06-10/13	<.01	<.008	<.008	<.007	<.01	<.005	<.005	<.008	<.01	<.007	<.007	<.009
10/13-10/20	<.008	(a)	<.007	<.007	<.006	<.006	<.004	<.006	<.008	<.01	<.006	<.008
10/20-10/27	<.01	<.01	<.01	<.01	<.01	<.009	<.007	<.008	<.009	<.01	<.01	<.01
10/27-11/03	<.005	<.009	<.007	<.006	<.007	<.006	<.004	<.005	<.005	<.005	<.007	<.008
<b>NOVEMBER</b>												
11/03-11/10	<.01	<.01	(b)	<.008	<.009	<.01	<.007	<.008	<.008	(b)	<.008	<.01
11/10-11/17	<.005	<.007	<.004	<.006	<.005	<.005	<.005	<.006	<.006	<.006	<.005	<.001
11/17-11/24	<.02	<.02	<.02	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.02 (c)
11/24-12/01	<.004	<.006	<.004	<.006	<.005	<.005	<.004	<.006	<.006	<.006	<.006	<.004
<b>DECEMBER</b>												
12/01-12/08	<.01	<.009	<.007	<.009	<.01	<.01	<.006	<.01	<.007	<.008	<.01	<.009
12/08-12/15	<.006	<.007	<.006	<.008	<.007	<.006	<.006	<.01	<.009	<.01	<.01	<.004
12/15-12/22	<.004	<.005	<.004	<.005	<.004	(a)	<.004	<.004	(a)	<.005	<.005	<.003
12/22-12/29	<.006	<.01	<.007	<.01	<.01	<.02	<.01	<.01	<.01	<.01	<.009	<.006

(a) Equipment malfunction; no sample available.

(b) Insufficient volume; no sample available.

(c) Results in total pCi.

TABLE 5

(Page 1 of 4)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 Sigma

1987 COLL. DATE	STA-01	STA-02	STA-03	STA-04	STA-05	STATIONS							AVERAGE $\pm$ 2 s.d.
						STA-05A	STA-06	STA-07	STA-21	STA-22	STA-23	STA-24	
<u>JANUARY</u>													
12/30-01/06	32 $\pm$ 7	33 $\pm$ 7	29 $\pm$ 7	23 $\pm$ 6	35 $\pm$ 6	31 $\pm$ 7	35 $\pm$ 6	15 $\pm$ 5	31 $\pm$ 7	28 $\pm$ 6	18 $\pm$ 6	32 $\pm$ 6	28.5 $\pm$ 13.0
01/06-01/13	30 $\pm$ 6	31 $\pm$ 6	29 $\pm$ 6	30 $\pm$ 6	26 $\pm$ 6	28 $\pm$ 6	29 $\pm$ 6	18 $\pm$ 5	32 $\pm$ 6	24 $\pm$ 5	27 $\pm$ 5	25 $\pm$ 5	27.4 $\pm$ 7.6
01/13-01/20	20 $\pm$ 6	21 $\pm$ 6	21 $\pm$ 6	19 $\pm$ 6	22 $\pm$ 6	21 $\pm$ 6	19 $\pm$ 5	8.4 $\pm$ 4.9	26 $\pm$ 7	16 $\pm$ 6	17 $\pm$ 5	27 $\pm$ 6	19.8 $\pm$ 9.6
01/20-02/03(a)	26 $\pm$ 3	27 $\pm$ 3	19 $\pm$ 3	18 $\pm$ 3	22 $\pm$ 3	16 $\pm$ 3	17 $\pm$ 3	14 $\pm$ 3	27 $\pm$ 3	24 $\pm$ 4	21 $\pm$ 3	25 $\pm$ 3	21.3 $\pm$ 9.0
<u>FEBRUARY</u>													
02/03-02/10	25 $\pm$ 6	30 $\pm$ 6	16 $\pm$ 5	13 $\pm$ 5	25 $\pm$ 6	23 $\pm$ 6	20 $\pm$ 5	26 $\pm$ 6	31 $\pm$ 6	21 $\pm$ 6	27 $\pm$ 6	28 $\pm$ 6	23.8 $\pm$ 10.9
02/10-02/18	26 $\pm$ 5	30 $\pm$ 5	24 $\pm$ 5	16 $\pm$ 4	22 $\pm$ 5	22 $\pm$ 5	22 $\pm$ 5	10 $\pm$ 4	27 $\pm$ 5	22 $\pm$ 5	22 $\pm$ 5	28 $\pm$ 5	22.6 $\pm$ 10.8
02/18-02/24	21 $\pm$ 6	21 $\pm$ 6	24 $\pm$ 6	16 $\pm$ 5	25 $\pm$ 6	21 $\pm$ 6	20 $\pm$ 6	13 $\pm$ 5	22 $\pm$ 6	16 $\pm$ 5	15 $\pm$ 5	22 $\pm$ 6	19.7 $\pm$ 7.5
02/24-03/03	8.5 $\pm$ 5.2	19 $\pm$ 7	17 $\pm$ 6	17 $\pm$ 6	19 $\pm$ 6	17 $\pm$ 6	16 $\pm$ 6	16 $\pm$ 6	21 $\pm$ 6	12 $\pm$ 5	16 $\pm$ 5	17 $\pm$ 6	16.3 $\pm$ 6.6
<u>MARCH</u>													
03/03-03/10	18 $\pm$ 6	35 $\pm$ 6	19 $\pm$ 6	22 $\pm$ 5	18 $\pm$ 5	26 $\pm$ 6	31 $\pm$ 6	24 $\pm$ 7	29 $\pm$ 6	12 $\pm$ 5	18 $\pm$ 5	28 $\pm$ 6	23.3 $\pm$ 13.4
03/10-03/17	(b)	27 $\pm$ 5	23 $\pm$ 5	18 $\pm$ 5	25 $\pm$ 5	24 $\pm$ 5	23 $\pm$ 5	21 $\pm$ 5	31 $\pm$ 5	18 $\pm$ 5	25 $\pm$ 5	28 $\pm$ 5	23.9 $\pm$ 8.0
03/17-03/24	17 $\pm$ 5	20 $\pm$ 5	18 $\pm$ 5	22 $\pm$ 5	15 $\pm$ 4	15 $\pm$ 5	16 $\pm$ 4	17 $\pm$ 5	22 $\pm$ 5	7.1 $\pm$ 4.0	19 $\pm$ 5	16 $\pm$ 4	17.0 $\pm$ 7.9
03/24-03/31	13 $\pm$ 5	12 $\pm$ 5	15 $\pm$ 5	22 $\pm$ 5	14 $\pm$ 5	15 $\pm$ 5	22 $\pm$ 8	19 $\pm$ 5	24 $\pm$ 6	23 $\pm$ 5	17 $\pm$ 5	20 $\pm$ 5	18.0 $\pm$ 8.4
Average $\pm$ 2 s.d.	22 $\pm$ 14	26 $\pm$ 14	21 $\pm$ 9	20 $\pm$ 9	22 $\pm$ 11	22 $\pm$ 10	23 $\pm$ 12	17 $\pm$ 11	27 $\pm$ 8	19 $\pm$ 12	20 $\pm$ 8	25 $\pm$ 10	22.0 $\pm$ 5.9

(a) All samples ran for 2 weeks due to inclement weather.

(b) Equipment malfunction; no sample collected.

TABLE 5

(Page 2 of 4)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 Sigma

1987 COLL. DATE	STA-01	STA-02	STA-03	STA-04	STA-05	STATIONS		STA-07	STA-21	STA-22	STA-23	STA-24	AVERAGE $\pm$ 2 s.d.
						STA-05A	STA-06						
<u>APRIL</u>													
03/31-04/07	16 $\pm$ 4	17 $\pm$ 5	15 $\pm$ 5	18 $\pm$ 5	12 $\pm$ 5	16 $\pm$ 5	16 $\pm$ 5	15 $\pm$ 5	20 $\pm$ 5	28 $\pm$ 6	13 $\pm$ 5	17 $\pm$ 5	16.9 $\pm$ 8.2
04/07-04/14	(a)	20 $\pm$ 5	18 $\pm$ 5	21 $\pm$ 5	15 $\pm$ 4	16 $\pm$ 5	21 $\pm$ 5	18 $\pm$ 5	22 $\pm$ 5	(a)	16 $\pm$ 4	17 $\pm$ 5	18.4 $\pm$ 4.9
04/14-04/21	32 $\pm$ 6	25 $\pm$ 6	31 $\pm$ 6	16 $\pm$ 3	21 $\pm$ 5	25 $\pm$ 6	27 $\pm$ 6	12 $\pm$ 3	15 $\pm$ 3	23 $\pm$ 5	17 $\pm$ 5	23 $\pm$ 6	22.3 $\pm$ 12.6
04/21-04/28	17 $\pm$ 5	10 $\pm$ 5	14 $\pm$ 5	13 $\pm$ 5	13 $\pm$ 5	16 $\pm$ 5	16 $\pm$ 5	20 $\pm$ 5	18 $\pm$ 5	14 $\pm$ 5	11 $\pm$ 5	18 $\pm$ 5	15.0 $\pm$ 6.0
<u>MAY</u>													
04/28-05/05	13 $\pm$ 4	12 $\pm$ 4	16 $\pm$ 5	12 $\pm$ 4	18 $\pm$ 5	15 $\pm$ 5	8.8 $\pm$ 4.1	17 $\pm$ 5	16 $\pm$ 5	17 $\pm$ 5	8.8 $\pm$ 0.1	15 $\pm$ 4	14.1 $\pm$ 6.2
05/05-05/12	28 $\pm$ 6	20 $\pm$ 5	25 $\pm$ 6	29 $\pm$ 6	26 $\pm$ 5	30 $\pm$ 6	30 $\pm$ 6	19 $\pm$ 4	31 $\pm$ 6	32 $\pm$ 6	20 $\pm$ 5	28 $\pm$ 5	26.5 $\pm$ 9.1
05/12-05/19	30 $\pm$ 5	14 $\pm$ 4	20 $\pm$ 5	16 $\pm$ 5	26 $\pm$ 5	26 $\pm$ 5	19 $\pm$ 4	9.8 $\pm$ 3.8	23 $\pm$ 5	21 $\pm$ 5	18 $\pm$ 4	17 $\pm$ 5	20.0 $\pm$ 11.3
05/19-05/26	20 $\pm$ 5	11 $\pm$ 5	12 $\pm$ 4	(b)	13 $\pm$ 5	18 $\pm$ 5	17 $\pm$ 5	6.1 $\pm$ 4.0	15 $\pm$ 6	15 $\pm$ 5	9.5 $\pm$ 4.3	15 $\pm$ 5	13.8 $\pm$ 8.0
05/26-06/02	27 $\pm$ 6	9.7 $\pm$ 4.3	26 $\pm$ 6	23 $\pm$ 4	40 $\pm$ 10(c)	18 $\pm$ 5	24 $\pm$ 5	14 $\pm$ 4	22 $\pm$ 5	24 $\pm$ 5	16 $\pm$ 5	22 $\pm$ 5	22.1 $\pm$ 15.3
<u>JUNE</u>													
06/02-06/09	27 $\pm$ 5	9.6 $\pm$ 4.1	24 $\pm$ 6	21 $\pm$ 4	30 $\pm$ 5	22 $\pm$ 6	25 $\pm$ 5	11 $\pm$ 4	23 $\pm$ 5	25 $\pm$ 5	25 $\pm$ 6	24 $\pm$ 5	22.2 $\pm$ 12.1
06/09-06/16	24 $\pm$ 5	19 $\pm$ 5	26 $\pm$ 5	27 $\pm$ 5	30 $\pm$ 5	24 $\pm$ 5	23 $\pm$ 5	18 $\pm$ 4	19 $\pm$ 5	24 $\pm$ 5	30 $\pm$ 5	26 $\pm$ 5	24.2 $\pm$ 8.0
06/16-06/23	25 $\pm$ 5	25 $\pm$ 5	30 $\pm$ 5	20 $\pm$ 5	29 $\pm$ 5	20 $\pm$ 5	23 $\pm$ 5	25 $\pm$ 5	19 $\pm$ 5	21 $\pm$ 5	18 $\pm$ 5	18 $\pm$ 5	22.8 $\pm$ 8.2
06/23-06/30	30 $\pm$ 5	18 $\pm$ 5	26 $\pm$ 5	22 $\pm$ 5	28 $\pm$ 5	30 $\pm$ 6	24 $\pm$ 5	24 $\pm$ 5	23 $\pm$ 5	30 $\pm$ 5	24 $\pm$ 5	22 $\pm$ 5	25.1 $\pm$ 7.6
Average $\pm$ 2 s.d.	24 $\pm$ 12	16 $\pm$ 11	22 $\pm$ 13	20 $\pm$ 10	23 $\pm$ 17	21 $\pm$ 11	21 $\pm$ 11	16 $\pm$ 11	21 $\pm$ 9	23 $\pm$ 11	17 $\pm$ 13	20 $\pm$ 9	20 $\pm$ 5

(a) Insufficient volume; no sample collected.

(b) Power outage; no sample collected.

(c) Counted twice to confirm result.



TABLE 5

(Page 3 of 4)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm 2$  Sigma

1987 COLL. DATE	STATIONS												AVERAGE $\pm 2$ s.d.
	STA-01	STA-02	STA-03	STA-04	STA-05	STA-05A	STA-06	STA-07	STA-21	STA-22	STA-23	STA-24	
<u>JULY</u>													
06/30-07/07	35 $\pm$ 6	21 $\pm$ 5	30 $\pm$ 6	21 $\pm$ 5	30 $\pm$ 6	28 $\pm$ 6	25 $\pm$ 6	19 $\pm$ 5	24 $\pm$ 6	27 $\pm$ 6	26 $\pm$ 6	24 $\pm$ 5	25.8 $\pm$ 9.1
07/07-07/21	25 $\pm$ 3	(a)	25 $\pm$ 3	23 $\pm$ 3	25 $\pm$ 3	27 $\pm$ 3	22 $\pm$ 3	27 $\pm$ 6(f)	19 $\pm$ 3	22 $\pm$ 3	36 $\pm$ 7(f)	29 $\pm$ 3	25.8 $\pm$ 9.2
07/21-07/28	46 $\pm$ 6	19 $\pm$ 5(b)	37 $\pm$ 6	35 $\pm$ 6	39 $\pm$ 6	37 $\pm$ 6	33 $\pm$ 5	24 $\pm$ 5	29 $\pm$ 5	32 $\pm$ 5	18 $\pm$ 5	(c)	31.7 $\pm$ 17.2
07/28-08/04	40 $\pm$ 6	26 $\pm$ 6	35 $\pm$ 6	33 $\pm$ 6	33 $\pm$ 6	34 $\pm$ 6	25 $\pm$ 5	29 $\pm$ 6	26 $\pm$ 6	23 $\pm$ 5	29 $\pm$ 6	35 $\pm$ 6	30.7 $\pm$ 10.2
<u>AUGUST</u>													
08/04-08/11	39 $\pm$ 6	15 $\pm$ 4	53 $\pm$ 12(d)	31 $\pm$ 6	30 $\pm$ 6	440 $\pm$ 240(d)	30 $\pm$ 6	30 $\pm$ 6	26 $\pm$ 6	31 $\pm$ 6	32 $\pm$ 6	32 $\pm$ 6	29.6 $\pm$ 12.1
08/11-08/18	39 $\pm$ 7	12 $\pm$ 5	(e)	26 $\pm$ 6	35 $\pm$ 6	23 $\pm$ 6	19 $\pm$ 5	24 $\pm$ 5	19 $\pm$ 6	23 $\pm$ 6	20 $\pm$ 5	19 $\pm$ 4	23.5 $\pm$ 15.3
08/18-08/25	34 $\pm$ 6	12 $\pm$ 4(e)	30 $\pm$ 6	22 $\pm$ 5	27 $\pm$ 5	26 $\pm$ 5	23 $\pm$ 5	22 $\pm$ 5	30 $\pm$ 7	23 $\pm$ 5	14 $\pm$ 4(b)	21 $\pm$ 4	23.7 $\pm$ 12.7
08/25-09/01	33 $\pm$ 6	12 $\pm$ 4	80 $\pm$ 28(d)	29 $\pm$ 5	31 $\pm$ 5	31 $\pm$ 6	28 $\pm$ 5	22 $\pm$ 5	16 $\pm$ 5	23 $\pm$ 5	33 $\pm$ 6	22 $\pm$ 4	25.5 $\pm$ 14.1
<u>SEPTEMBER</u>													
09/01-09/08	28 $\pm$ 5	20 $\pm$ 5	28 $\pm$ 6	22 $\pm$ 5	29 $\pm$ 5	21 $\pm$ 5	24 $\pm$ 5	22 $\pm$ 5	20 $\pm$ 5	26 $\pm$ 5	25 $\pm$ 5	23 $\pm$ 5	24.0 $\pm$ 6.4
09/08-09/15	24 $\pm$ 5	12 $\pm$ 4	39 $\pm$ 6	24 $\pm$ 5	29 $\pm$ 5	30 $\pm$ 6	28 $\pm$ 5	29 $\pm$ 5	18 $\pm$ 5	27 $\pm$ 8	19 $\pm$ 5	23 $\pm$ 4	25.2 $\pm$ 13.8
09/15-09/22	24 $\pm$ 5	18 $\pm$ 5	32 $\pm$ 6	30 $\pm$ 6	27 $\pm$ 5	23 $\pm$ 5	39 $\pm$ 6	29 $\pm$ 5	16 $\pm$ 5	22 $\pm$ 5	27 $\pm$ 5	32 $\pm$ 6	26.6 $\pm$ 12.9
09/22-09/29	20 $\pm$ 5	(e)	34 $\pm$ 6	31 $\pm$ 5	35 $\pm$ 6	21 $\pm$ 5	33 $\pm$ 5	24 $\pm$ 5	(e)	33 $\pm$ 5	31 $\pm$ 5	37 $\pm$ 6	29.9 $\pm$ 12.1
Average $\pm 2$ s.d.	32 $\pm$ 16	17 $\pm$ 10	33 $\pm$ 8	27 $\pm$ 10	31 $\pm$ 8	27 $\pm$ 11	27 $\pm$ 11	25 $\pm$ 7	22 $\pm$ 10	26 $\pm$ 8	26 $\pm$ 14	27 $\pm$ 12	27 $\pm$ 9

(a) Result of 1100  $\pm$  500 total pCi; omitted from average. Collection dates 07/16-07/21.

(b) Filter light in color indicating low deposition of particulate matter.

(c) Equipment malfunction; no sample available.

(d) Elevated results due to low sample volume; omitted from average.

(e) Low volume; no sample available.

(f) Collection dates 07/16/87-07/21/87.

TABLE 5

(Page 4 of 4)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 Sigma

1987 COLL. DATE	STA-01	STA-02	STA-03	STA-04	STA-05	STATIONS		STA-07	STA-21	STA-22	STA-23	STA-24	AVERAGE $\pm$ 2 s.d.
						STA-05A	STA-06						
<u>OCTOBER</u>													
09/29-10/06	17 $\pm$ 5	22 $\pm$ 5	24 $\pm$ 5	24 $\pm$ 5	30 $\pm$ 5	23 $\pm$ 5	24 $\pm$ 5	24 $\pm$ 5	19 $\pm$ 5	22 $\pm$ 5	19 $\pm$ 5	20 $\pm$ 4	22.3 $\pm$ 6.8
10/06-10/13	14 $\pm$ 5	18 $\pm$ 4	20 $\pm$ 5	18 $\pm$ 5	28 $\pm$ 6	23 $\pm$ 5	16 $\pm$ 3	25 $\pm$ 5	21 $\pm$ 5	19 $\pm$ 5	13 $\pm$ 4	17 $\pm$ 3	19.3 $\pm$ 8.8
10/13-10/20	19 $\pm$ 5	(a)	33 $\pm$ 6	34 $\pm$ 6	45 $\pm$ 6	48 $\pm$ 7	33 $\pm$ 5	37 $\pm$ 6	37 $\pm$ 6	43 $\pm$ 6	25 $\pm$ 5	50 $\pm$ 7	36.7 $\pm$ 19.0
10/20-10/27	15 $\pm$ 5	24 $\pm$ 5	19 $\pm$ 5	24 $\pm$ 5	29 $\pm$ 5	36 $\pm$ 6	16 $\pm$ 3	32 $\pm$ 5	17 $\pm$ 5	33 $\pm$ 8	14 $\pm$ 4	54 $\pm$ 8	26.1 $\pm$ 23.2
10/27-11/03	15 $\pm$ 5	22 $\pm$ 5	16 $\pm$ 5	39 $\pm$ 6	45 $\pm$ 6	25 $\pm$ 5	22 $\pm$ 4	40 $\pm$ 6	19 $\pm$ 5	29 $\pm$ 5	20 $\pm$ 5	63 $\pm$ 8	29.6 $\pm$ 28.9
<u>NOVEMBER</u>													
11/03-11/10	17 $\pm$ 5	24 $\pm$ 5	(b)	28 $\pm$ 5	45 $\pm$ 6	48 $\pm$ 7	21 $\pm$ 4	38 $\pm$ 6	17 $\pm$ 4	(b)	14 $\pm$ 4	33 $\pm$ 6	28.5 $\pm$ 24.2
11/10-11/17	16 $\pm$ 4	17 $\pm$ 5	20 $\pm$ 4	27 $\pm$ 5	38 $\pm$ 6	31 $\pm$ 6	33 $\pm$ 4	33 $\pm$ 5	30 $\pm$ 6	33 $\pm$ 6	27 $\pm$ 6	34 $\pm$ 9	28.3 $\pm$ 14.2
11/17-11/24	12 $\pm$ 3	12 $\pm$ 4	12 $\pm$ 3	22 $\pm$ 5	25 $\pm$ 5	36 $\pm$ 7	22 $\pm$ 4	26 $\pm$ 5	19 $\pm$ 5	29 $\pm$ 5	10 $\pm$ 4	(c)	20.5 $\pm$ 16.7
11/24-12/01	8.8 $\pm$ 3.4	20 $\pm$ 5	8.8 $\pm$ 3.2	12 $\pm$ 5	14 $\pm$ 5	18 $\pm$ 5	10 $\pm$ 3	20 $\pm$ 5	20 $\pm$ 5	18 $\pm$ 5	11 $\pm$ 4	16 $\pm$ 4	14.7 $\pm$ 9.0
<u>DECEMBER</u>													
12/01-12/08	18 $\pm$ 5	15 $\pm$ 5	10 $\pm$ 3	22 $\pm$ 6	16 $\pm$ 5	25 $\pm$ 6	9.0 $\pm$ 3.2	16 $\pm$ 5	24 $\pm$ 5	24 $\pm$ 5	22 $\pm$ 5	12 $\pm$ 3	17.8 $\pm$ 11.3
12/08-12/15	19 $\pm$ 4	29 $\pm$ 5	11 $\pm$ 3	28 $\pm$ 5	17 $\pm$ 5	31 $\pm$ 6	16 $\pm$ 4	24 $\pm$ 5	17 $\pm$ 5	28 $\pm$ 5	12 $\pm$ 4	14 $\pm$ 3	20.5 $\pm$ 14.3
12/15-12/22	21 $\pm$ 4	27 $\pm$ 5	16 $\pm$ 5	25 $\pm$ 5	25 $\pm$ 5	(a)	20 $\pm$ 5	27 $\pm$ 5	(a)	26 $\pm$ 6	22 $\pm$ 5	16 $\pm$ 4	22.5 $\pm$ 8.4
12/22-12/29	13 $\pm$ 3	39 $\pm$ 8	11 $\pm$ 3	18 $\pm$ 5	37 $\pm$ 6	35 $\pm$ 6	15 $\pm$ 4	29 $\pm$ 6	31 $\pm$ 6	31 $\pm$ 6	11 $\pm$ 4	19 $\pm$ 4	24.1 $\pm$ 21.2
Quarterly Average $\pm$ 2 s.d.	16 $\pm$ 7	22 $\pm$ 4	17 $\pm$ 4	25 $\pm$ 4	30 $\pm$ 22	32 $\pm$ 19	20 $\pm$ 15	29 $\pm$ 14	23 $\pm$ 13	28 $\pm$ 14	17 $\pm$ 12	29 $\pm$ 35	23.9 $\pm$ 11.3
Annual Average $\pm$ 2 s.d.	23 $\pm$ 17	20 $\pm$ 14	22 $\pm$ 16	23 $\pm$ 13	27 $\pm$ 17	25 $\pm$ 16	23 $\pm$ 13	27 $\pm$ 15	23 $\pm$ 11	31 $\pm$ 22	20 $\pm$ 13	25 $\pm$ 21	23.7 $\pm$ 6.1

(a) Equipment malfunction; no sample available.

(b) Insufficient volume; no sample available.

(c) Result of 3900 $\pm$ 700 total pCi not included in averages. Volume not provided.

TABLE 6

(Page 1 of 3)

## VIRGINIA POWER - NORTH ANNA - 1987

## CONCENTRATIONS OF STRONTIUM 89/90 AND GAMMA EMITTERS\* IN QUARTERLY AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 sigma

STATION	NUCLIDE	FIRST QUARTER 12/30-03/31	SECOND QUARTER 03/31-06/30	THIRD QUARTER 06/30-09/29	FOURTH QUARTER 09/29-12/29	AVERAGE $\pm$ 2 s.d.
STA-01	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.4	(a)	(a)	(a)
	Be-7	59.9 $\pm$ 18.8	105 $\pm$ 13	84.6 $\pm$ 13.8	20.2 $\pm$ 8.0	67.4 $\pm$ 73.0
	K-40	<20	<20	21.1 $\pm$ 8.4	<20	21.1 $\pm$ 8.4
	Co-60	<1	<1	<1	<1	-
	Ru-103	<2	<1	<2	<1	-
	Cs-134	<1	<1	<0.9	<0.8	-
	Cs-137	<1	<1	<1	<0.9	-
	Th-228	<3	<2	<2	<1	-
STA-02	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	104 $\pm$ 18	51.5 $\pm$ 13.7	46.0 $\pm$ 14.9	44.9 $\pm$ 10.5	61.6 $\pm$ 56.8
	K-40	<20	<60	<20	<20	-
	Co-60	<1	<2	<1	<1	-
	Ru-103	<2	<3	<2	<1	-
	Cs-134	<1	<2	<1	<0.9	-
	Cs-137	<1	<2	<1	<0.8	-
	Th-228	<2	<3	<2	<1	-
STA-03	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.4	(a)	(a)	(a)
	Be-7	81.2 $\pm$ 30.4	79.1 $\pm$ 15.6	108 $\pm$ 18	25.4 $\pm$ 7.7	73.4 $\pm$ 69.2
	K-40	<60	<20	<30	<20	-
	Co-60	<2	<1	<2	<1	-
	Ru-103	<5	<2	<2	<1	-
	Cs-134	<2	<1	<2	<1	-
	Cs-137	<3	<1	<2	<0.9	-
	Th-228	<5	<2	<3	<2	-
STA-04	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	73.4 $\pm$ 22.9	85.9 $\pm$ 13.5	69.1 $\pm$ 13.3	44.1 $\pm$ 10.0	68.1 $\pm$ 35.1
	K-40	<40	<20	<40	<40	-
	Co-60	<2	<1	<2	<1	-
	Ru-103	<3	<2	<2	<1	-
	Cs-134	<2	<1	<1	<1	-
	Cs-137	<2	<1	<1	<1	-
	Th-228	<4	<2	<2	<2	-

\* All other gamma emitters were <LID.  
(a) Strontium-89/90 performed annually.

TABLE 6

(Page 2 of 3)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF STRONTIUM 89/90 AND GAMMA EMITTERS\* IN QUARTERLY AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 sigma

STATION	NUCLIDE	FIRST QUARTER 12/30-03/31	SECOND QUARTER 03/31-06/30	THIRD QUARTER 06/30-09/29	FOURTH QUARTER 09/29-12/29	AVERAGE $\pm$ 2 s.d.
STA-05	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	75.2 $\pm$ 15.0	104 $\pm$ 12	103 $\pm$ 12	55.7 $\pm$ 3.3	84.4 $\pm$ 46.7
	K-40	<20	17.8 $\pm$ 8.0	<20	<20	-
	Co-60	<1	<1	<1	<1	-
	Ru-103	<2	<1	<1	<0.8	-
	Cs-134	<1	<0.8	<0.9	<0.8	-
	Cs-137	<2	<0.9	<0.8	<0.9	-
	Th-228	<2	<2	<2	<1	-
STA-05A	Sr-89	(a)	<4	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	73.7 $\pm$ 26.7	90.8 $\pm$ 23.5	90.2 $\pm$ 22.8	57.6 $\pm$ 16.4	78.1 $\pm$ 31.6
	K-40	<70	<60	<70	<60	-
	Co-60	<2	<2	<2	<2	-
	Ru-103	<4	<2	<3	<2	-
	Cs-134	<2	<2	<2	<2	-
	Cs-137	<2	<2	<2	<2	-
	Th-228	<3	<3	<3	<2	-
STA-06	Sr-89	(a)	<2	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	62.4 $\pm$ 16.2	96.2 $\pm$ 12.7	95.8 $\pm$ 12.7	46.7 $\pm$ 6.1	76.8 $\pm$ 47.8
	K-40	<60	17.8 $\pm$ 8.7	<20	<10	17.8 $\pm$ 8.7
	Co-60	<2	<1	<1	<0.6	-
	Ru-103	<2	<1	<1	<0.7	-
	Cs-134	<2	<1	<1	<0.5	-
	Cs-137	<2	<1	<1	<0.5	-
	Th-228	<2	<2	<2	<0.9	-
STA-07	Sr-89	(a)	<2	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	40.6 $\pm$ 18.4	52.0 $\pm$ 12.2	83.7 $\pm$ 13.2	50.7 $\pm$ 10.0	56.8 $\pm$ 37.4
	K-40	<20	<20	<20	10.4 $\pm$ 5.6	10.4 $\pm$ 5.6
	Co-60	<1	<0.7	<0.8	<0.9	-
	Ru-103	<2	<1	<1	<0.7	-
	Cs-134	<1	<1	<1	<0.7	-
	Cs-137	<1	<1	<1	<0.7	-
	Th-228	<2	<2	<2	<1	-

\* All other gamma emitters were <LLD.  
(a) Sr-89/90 analysis performed annually.

TABLE 6

(Page 3 of 3)

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF STRONTIUM 89/90 AND GAMMA EMITTERS\* IN QUARTERLY AIR PARTICULATES

 $10^{-3}$  pCi/m<sup>3</sup>  $\pm$  2 sigma

STATION	NUCLIDE	FIRST QUARTER 12/30-03/31	SECOND QUARTER 03/31-06/30	THIRD QUARTER 06/30-09/29	FOURTH QUARTER 09/29-12/29	AVERAGE $\pm$ 2 s.d.
STA-21	Sr-89	(a)	<2	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	125 $\pm$ 20	74.0 $\pm$ 13.9	38.5 $\pm$ 7.6 (b)	35.5 $\pm$ 12.3	68.3 $\pm$ 83.4
	K-40	<20	<20	<20	<50	-
	Co-60	<1	<1	<1	<2	-
	Ku-103	<2	<1	<0.8	<2	-
	Cs-134	<1	<1	<0.9	<2	-
	Cs-137	<1	<1	<0.9	<1	-
	Th-228	<2	<2	<1	<2	-
STA-22	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.3	(a)	(a)	(a)
	Be-7	49.8 $\pm$ 19.2	108 $\pm$ 19	97.7 $\pm$ 23.5	61.0 $\pm$ 11.6	79.1 $\pm$ 56.2
	K-40	16.4 $\pm$ 9.5	<30	<50	<20	16.4 $\pm$ 9.5
	Co-60	<1	<2	<1	<1	-
	Ru-103	<3	<2	<3	<1	-
	Cs-134	<2	<2	<2	<0.9	-
	Cs-137	<2	<2	<2	<1	-
	Th-228	<3	<3	<4	<1	-
STA-23	Sr-89	(a)	<3	(a)	(a)	(a)
	Sr-90	(a)	<0.5	(a)	(a)	(a)
	Be-7	67.8 $\pm$ 21.3	73.5 $\pm$ 14.6	72.2 $\pm$ 17.5	34.8 $\pm$ 11.0	62.1 $\pm$ 16.7
	K-40	<40	<40	<20	<40	-
	Co-60	<2	<2	<2	<1	-
	Ru-103	<3	<2	<2	<1	-
	Cs-134	<2	<2	<2	<1	-
	Cs-137	<2	<2	<2	<1	-
	Th-228	<3	<3	<2	<2	-
STA-24	Sr-89	(a)	<2	(a)	(a)	(a)
	Sr-90	(a)	<0.4	(a)	(a)	(a)
	Be-7	95.9 $\pm$ 18.6	81.7 $\pm$ 12.8	93.4 $\pm$ 12.3	55.4 $\pm$ 10.7	81.6 $\pm$ 37.1
	K-40	<20	15.4 $\pm$ 7.5	<20	<40	15.4 $\pm$ 7.5
	Co-60	<1	<1	<1	<1	-
	Ru-103	<2	<1	<1	<1	-
	Cs-134	<1	<0.7	<0.8	<1	-
	Cs-137	<2	<1	<1	<1	-
	Th-228	<2	<2	<1	<2	-

\* All other gamma emitters were <LLD.  
(a) Strontium-89/90 performed annually.  
(b) Collection Dates 06/30/87-09/22/87

## 2. Precipitation

A sample of rain water was collected monthly at station 01, on site, 0.2 miles, 42 degrees NE and analyzed for gross beta activity. The results are presented in Tables 7 and 8. The average gross beta activity for eleven months was 3.9 pCi/l with a range from 1.6 to 9.1 pCi/l. (There was no sample available for the month of October due to an oversight in the field). A semi-annual composite was prepared and analyzed for gamma emitting isotopes and tritium. All gamma emitters were below their detection limits. In addition, the tritium results were below the normal level of detection of 100 pCi/l. These results were lower than those measured in 1986.

TABLE 7

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE FRACTION	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION	CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF ROUTINE REPORTED MEASUREMENTS
Precipitation (pCi/L)	Monthly Gross Beta	11 4	3.9(11/11) (1.6-9.1)	01 0.2 mi NE	3.9(11/11) (1.6-9.1)	NONE	0
	Gamma (Semi-Annually)	2					
	Be-7	2 -	-(0/2)	N/A	N/A	NONE	0
	Tritium	2 2000	-(0/2)	N/A	N/A	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 8

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GROSS BETA, TRITIUM AND GAMMA EMITTERS\* IN PRECIPITATION

pCi/L  $\pm$  2 Sigma

STATION 01 - (on site)

COLLECTION DATES	GROSS BETA pCi/L	RAINFALL Inches
12/31/86-01/28/87	2.1 $\pm$ 0.6	2.9
01/28/87-03/02/87	3.1 $\pm$ 0.7	2.5
03/02/87-03/31/87	3.4 $\pm$ 0.7	5.1
03/31/87-04/28/87	2.8 $\pm$ 0.7	5.7
04/28/87-05/26/87	2.9 $\pm$ 0.8	5.1
06/01/87-06/30/87	4.1 $\pm$ 0.8	3.3
06/30/87-08/04/87	9.1 $\pm$ 1.1	1.9
08/04/87-09/01/87	7.0 $\pm$ 1.0	0.9
08/25/87-09/29/87	1.6 $\pm$ 0.6	7.6
09/29/87-10/27/87 (a)		
10/27/87-11/24/87	4.7 $\pm$ 0.8	4.4
11/24/87-12/29/87	2.3 $\pm$ 0.8	1.8
Average $\pm$ 2 s.d.	3.9 $\pm$ 4.5	

## SEMI-ANNUAL COMPOSITES OF PRECIPITATION

12/31/86-06/30/87Gamma Spec  
I-131 - <30 (b)  
H-3 - <12006/30/87-12/31/87Gamma Spec  
I-131 <10  
H-3 <100

- \* All gamma emitters were <LLD.  
 (a) Sample not collected due to oversight in field.  
 (b) LLD for I-131 not met due to long lapse of time from collection to receipt at TI.



### 3. Soil

Soil samples are collected every three years from twelve stations. Since the samples were collected in 1986 Tables 9 and 10 will not be included in the 1987 report.

## B. Waterborne Exposure Pathway

### 1. Ground/Well Water

Water was sampled quarterly from the on site well at the biology laboratory. These samples were analyzed by gamma ray spectroscopy and for tritium. The results are presented in Tables 11 and 12. No gamma emitting isotopes were detected. Tritium was detected in the first and second quarterly samples at an average level of 160 pCi/l with a range from 150 to 170 pCi/l. These are normal environmental levels. The second quarter sample was analyzed for strontium-89 and 90. There were no detections of these isotopes above the detection level.

TABLE II

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST MEAN		CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
			MEAN RANGE FRACTION		NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION		
Ground/Well water (pCi/l)	Gamma	4						
	K-40	4	60	-(0/4)	N/A	-(0/4)	NONE	0
	Tritium	4	2000	160(2/4) (150-170)	01A 0.75 mi SE	160(2/4) (150-170)	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 12  
 VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF STRONTIUM, TRITIUM AND GAMMA EMITTERS\* IN GROUND/WELL WATER  
 pCi/l ± 2 Sigma

COLLECTION DATES	H-3	Sr-89	Sr-90	Be-7	K-40	I-131	Ba-140	Th-228
<u>STATION 01A</u>								
03/31/87	170 ± 90	(a)	(a)	<30	<40	<40 (b)	<10	<6
04/01/87-06/30/87	150 ± 100	<4	<0.6	<30	<50	<0.4 (c)	<6	<7
06/30/87-09/29/87	<130	(a)	(a)	<50	<100	<0.5 (c)	<7	<10
09/29/87-12/29/87	<100	(a)	(a)	<30	<60	<0.5 (c)	<7	<7
Average ± 2. s.d.	160 ± 28							

- \* All other gamma emitters were <LLD.  
 (a) Strontium-89/90 analyses performed only on second quarter sample.  
 (b) LLD not met due to an oversight at TI.  
 (c) I-131 by radiochemistry

## 2. River Water

A sample of water from the North Anna River was collected quarterly at station 11, 5.8 miles downstream from the discharge lagoon, 128 degrees SSE. The results are presented in Tables 13 and 14. No sample was collected for the fourth quarter due to an oversight in the field. The samples were analyzed by gamma spectroscopy, and for tritium. The second quarter sample was analyzed in addition for strontium-89 and strontium-90.

All gamma emitters were below the detection level. No detections of strontium-89 or strontium-90 occurred. Tritium was analyzed by proportional gas counting and was measured with an average level of 3680 pCi/l with a range from 2600 to 5170 pCi/l. This is comparable with the average tritium activity level for 1986. It was measured in 1986 with an average concentration of 4020 pCi/l with a range of 3400 to 5000 pCi/l.

TABLE 13

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS	LOCATION WITH HIGHEST MEAN	CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS	
			MEAN RANGE FRACTION	NAME MEAN RANGE FRACTION DISTANCE AND DIRECTION			
River Water (pCi/l)	Gamma	3					
	K-40	3 -	-(0/3)	N/A	N/A	NONE	0
	Tritium	3 2000	3680(3/3) (2600-5170)	11 5.8 mi SE	3680(3/3) (2600-5170)	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 14  
 VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF STRONTIUM, TRITIUM AND GAMMA EMITTERS\* IN RIVER WATER  
 pCi/l ± 2 Sigma

COLLECTION DATES	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - 11										
03/12/87	(a)	(a)	5170 ± 260	<60	<100	<10	<6	<6	<100	<10
06/16/87	<2	<0.6	3270 ± 110	<50	<60	<10	<5	<9	<100	<8
09/09/87	(a)	(a)	2600 ± 100	<40	<50	<0.6 (c)	<4	<7	<70	<7
12/29/87	(b)									
Average ± 2 s.d.			3680 ± 2666							

- \* All other gamma emitters were <LLD.
- (a) Analysis only performed on second quarter sample.
- (b) Sample not received.
- (c) Analyzed for I-131 by radiochemistry.

50

### 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 09 is 2.2 miles upstream on Lake Anna, 320 degrees NW. The samples were analyzed for iodine-131 by radiochemical separation. No iodine was detected in the 24 samples analyzed. The results are presented in Tables 15 and 16. The samples were also analyzed by gamma ray spectrometry. Naturally occurring potassium-40 was observed in one sample from station 08 at a level of 51.0 pCi/l. All other gamma emitters were below the detection levels at either station.

The second quarter composite from each station was analyzed for the fission products strontium-89 and strontium-90. The activity of these isotopes were below the limit of detection.

A quarterly composite from each station was prepared and analyzed for tritium. The tritium activity at station 08 was at an average level of 3763 pCi/l with a range of 2590 to 5550 pCi/l. The trend of the tritium activity at station 08 has been plotted. The tritium level had been increasing since the middle of 1978 when the average level was below 300 pCi/l. However, in 1987 the results were within the same range as those measured in 1986.

The tritium activity in the four quarterly composites from station 09 was at a level of 2665 pCi/l with a range of 1850 to 3690 pCi/l. This is particularly significant since this level is found upstream of the plant. The level of tritium for 1987 for station 09 is also within the same range as those measured in 1986.

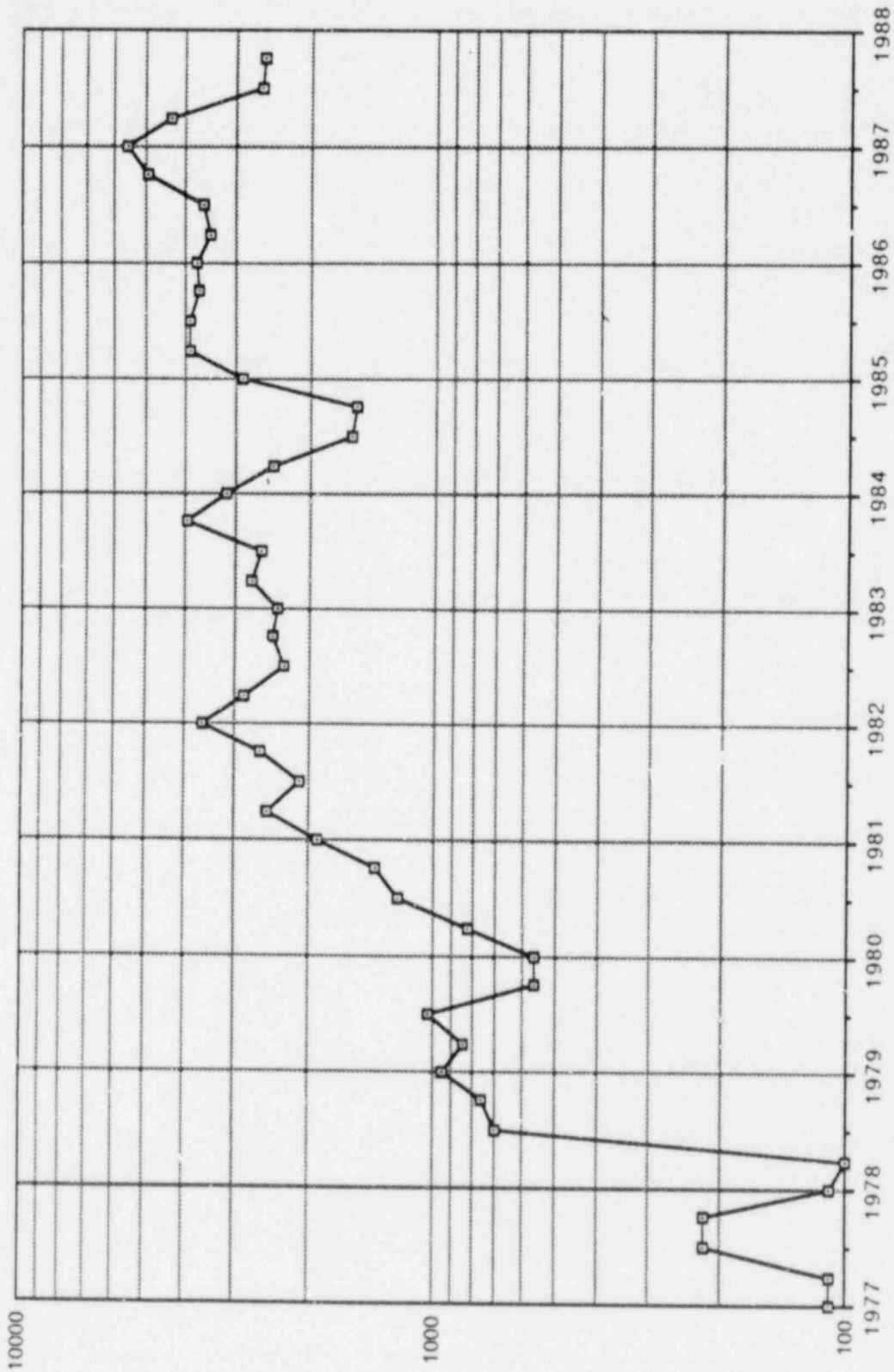
Samples of surface water were collected by the Commonwealth of Virginia from two stations. Station W-33 is located at the discharge lagoon and station W-27 is located on the North Anna River at the RT. 208 Bridge, which



is upstream of the site. Ten grab samples and two composite samples were collected and analyzed by gamma ray spectroscopy, for gross beta and for tritium. The results are shown in Table 15 and 17. The gross beta results at station W-33 were at an average level of 5.0 pCi/l with a range of 3.1 to 9.5 pCi/l. The results at station W-27 were at an average level of 3.7 with a range of 2.0 to 5.0 pCi/l. This is an expected level for surface waters. Gamma ray spectrometry detected the natural nuclide potassium-40 two times at station W-27 with an average concentration of 49.8 pCi/l and a range of 49.2 to 50.3 pCi/l. All other gamma emitters were below their detection levels.

Two samples from each station were analyzed for tritium. The average level at station W-33 was 3510 pCi/l with a range from 2520 to 4500 pCi/l. This is similar to the average result of 3763 pCi/l detected at station 08, the discharge lagoon. The average level of tritium at station W-27 was 825 pCi/l with a range of 210 to 1440 pCi/l.

# TRITIUM IN SURFACE WATER



pCi/liter - North Anna

Quarterly Average - Discharge Cooling Station-08

TABLE 15

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS	
Surface Water (pCi/l) (State Splits)	Gross Beta	24	4					
	Gamma	24						
	K-40	24	-	49.8(2/24) (49.2-50.3)	W-27	49.8(2/12) (49.2-50.3)	NONE	0
	Tritium	24	2000	2168(4/24) (210-4500)	W-33	3519(2/12) (2520-4500)	NONE	0
Surface Water (pCi/l) Regular Monthlies	I-131	24		-(0/12)	NA	NA	-(0/12)	0
	Gamma	24						
	K-40	24		51.0(1/12)	08 1.1 mi SSE	51.0(1/12)	-(0/12)	0
	Tritium	8	2000	3763(4/4) (2590-5550)	08 1.1 mi SSE	3763(4/4) (2590-5550)	2665(4/4) (1850-3690)	0

(1) LLD is Lower Limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 16

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF TRITIUM, STRONTIUM AND GAMMA EMITTERS\* IN SURFACE WATER

pCi/l  $\pm$  2 Sigma

COLLECTION DATES	H-3	I-131(a)	Sr-89	Sr-90	Be-7	K-40	Cs-137	Ba-140	Ra-226	Th-228
<u>STATION - 08</u>										
01/28/87	5550 $\pm$ 280	<0.3	(c)	(c)	<30	<50	<3	<5	<100	<8
02/15/87	(b)	<0.5			<30	<50	<4	<8	<90	<7
03/12/87		<0.3			<40	<60	<4	<6	<80	<8
04/09/87	4310 $\pm$ 130	<0.2	<3	<0.6	<30	<60	<4	<5	<90	<8
05/14/87		<0.4			<60	<90	<5	<10	<100	<10
06/16/87		<0.3			<50	51.0 $\pm$ 22.4	<5	<10	<100	<10
07/10/87	2600 $\pm$ 300	<0.5			<40	<50	<3	<7	<80	<7
08/11/87		<0.5			<40	<50	<4	<6	<100	<8
09/09/87		<0.5			<60	<100	<5	<9	<100	<10
10/16/87	2590 $\pm$ 100	<0.5			<40	<50	<4	<7	<80	<7
11/12/87		<0.3			<30	<40	<3	<5	<70	<6
12/11/87		<0.4			<30	<50	<3	<10	<60	<5
Average $\pm$ 2 s.d.	3763 $\pm$ 2880					51.0 $\pm$ 22.4				
<u>STATION - 09</u>										
01/28/87	2520 $\pm$ 130	<0.4	(c)	(c)	<30	<60	<4	<5	<100	<8
02/15/87	(b)	<0.5			<40	<50	<4	<7	<90	<8
03/12/87		<0.5			<40	<60	<4	<6	<100	<8
04/09/87	3690 $\pm$ 130	<0.4	<3	<0.5	<30	<40	<4	<6	<80	<7
05/14/87		<0.5			<60	<200	<6	<10	<100	<10
06/16/87		<0.3			<50	<60	<5	<8	<100	<9
07/10/87	2600 $\pm$ 300	<0.4			<40	<40	<3	<8	<60	<6
08/11/87		<0.2			<30	<40	<4	<6	<70	<7
09/09/87		<0.5			<30	<40	<3	<8	<80	<6
10/16/87	1850 $\pm$ 100	<0.3			<40	<60	<4	<8	<100	<8
11/12/87		<0.4			<30	<50	<3	<6	<70	<7
12/11/87		<0.4			<30	<50	<3	<10	<70	<6
Average $\pm$ 2 s.d.	2655 $\pm$ 1523									

\* All other gamma emitters were &lt;LLD.

(a) I-131 by radiochemistry

(b) Analysis performed quarterly.

(c) Analysis performed only with second quarter.

TABLE 17  
 VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\*, TRITIUM AND GR-BETA IN SURFACE WATER  
 pCi/l ± 2 Sigma - STATE SPLIT

COLLECTION DATES	GR-BETA	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
<u>STATION - W-27</u>									
01/15/87	4.2 ± 1.0	210 ± 90	<50	49.2 ± 24.7	<200 (b)	<3	<30 (c)	<80	<7
02/15/87	2.9 ± 0.8	(a)	<50	<50	<70 (b)	<4	<20 (c)	<100	<9
03/15/87	2.9 ± 0.8	(a)	<50	<50	<200 (b)	<3	<40 (c)	<80	<7
04/15/87	4.1 ± 0.8	(a)	<50	<40	<300 (b)	<3	<50 (c)	<80	<7
05/15/87	3.3 ± 0.8	(a)	<60	<40	<200 (b)	<3	<30 (c)	<90	<8
06/15/87	4.7 ± 0.7	(a)	<50	<40	<0.9	<3	<30 (c)	<90	<8
07/15-08/15	3.7 ± 0.8	(a)	<40	<50	<0.5	<4	<5	<100	<8
08/15/87	3.4 ± 0.8	1440 ± 120	<50	<50	<100 (b)	<3	<30 (c)	<80	<7
09/15-10/16	3.8 ± 0.8	(a)	<60	<90	<1	<5	<9	<100	<10
10/16-11/15	4.2 ± 1.1	(a)	<30	<50	<0.4	<3	<4	<70	<6
11/15/87	2.0 ± 0.9	(a)	<60	50.3 ± 24.0	<10	<4	<70 (c)	<90	<7
12/15/87	5.0 ± 1.0	(a)	<50	<50	<5	<3	<30 (c)	<70	<6
Average ± 2 s.d.	3.7 ± 1.7	825 ± 1739		49.8 ± 1.6					
<u>STATION - W-33</u>									
01/15/87	4.1 ± 1.0	4500 ± 200	<60	<50	<200 (b)	<3	<40 (c)	<100	<9
02/15/87	3.3 ± 0.8	(a)	<50	<50	<70 (b)	<4	<20 (c)	<70	<7
03/15/87	3.1 ± 0.7	(a)	<50	<50	<200 (b)	<3	<40 (c)	<80	<7
04/15/87	3.2 ± 0.7	(a)	<50	<40	<300 (b)	<3	<50 (c)	<60	<6
05/15/87	4.7 ± 0.9	(a)	<50	<40	<100 (b)	<3	<40 (c)	<70	<6
06/15/87	9.5 ± 1.3	(a)	<100	<200	<0.7	<6	<60 (c)	<200	<10
07/15-08/15	5.1 ± 0.9	(a)	<40	<50	<0.5	<3	<7	<70	<7
08/15/87	7.6 ± 1.0	2520 ± 130	<60	<100	<200 (b)	<4	<40 (c)	<90	<8
09/15-10/16	4.6 ± 0.8	(a)	<60	<100	<1	<6	<9	<100	<10
10/16-11/15	5.9 ± 1.2	(a)	<50	<200	<1	<5	<8	<100	<10
11/15/87	4.1 ± 1.0	(a)	<80	<100	<10	<5	<100(c)	<90	<9
12/15/87	4.4 ± 0.9	(a)	<50	<50	<6	<4	<30 (c)	<80	<7
Average ± 2 s.d.	5.0 ± 3.8	3510 ± 2800							

\* All other gamma emitters were <LLD.  
 (a) Analysis not required.  
 (b) LLD for I-131 could not be met due to delay in receipt of sample from the State of Virginia.  
 (c) LLD for Ba-140 could not be met due to delay in receipt of sample from the State of Virginia.

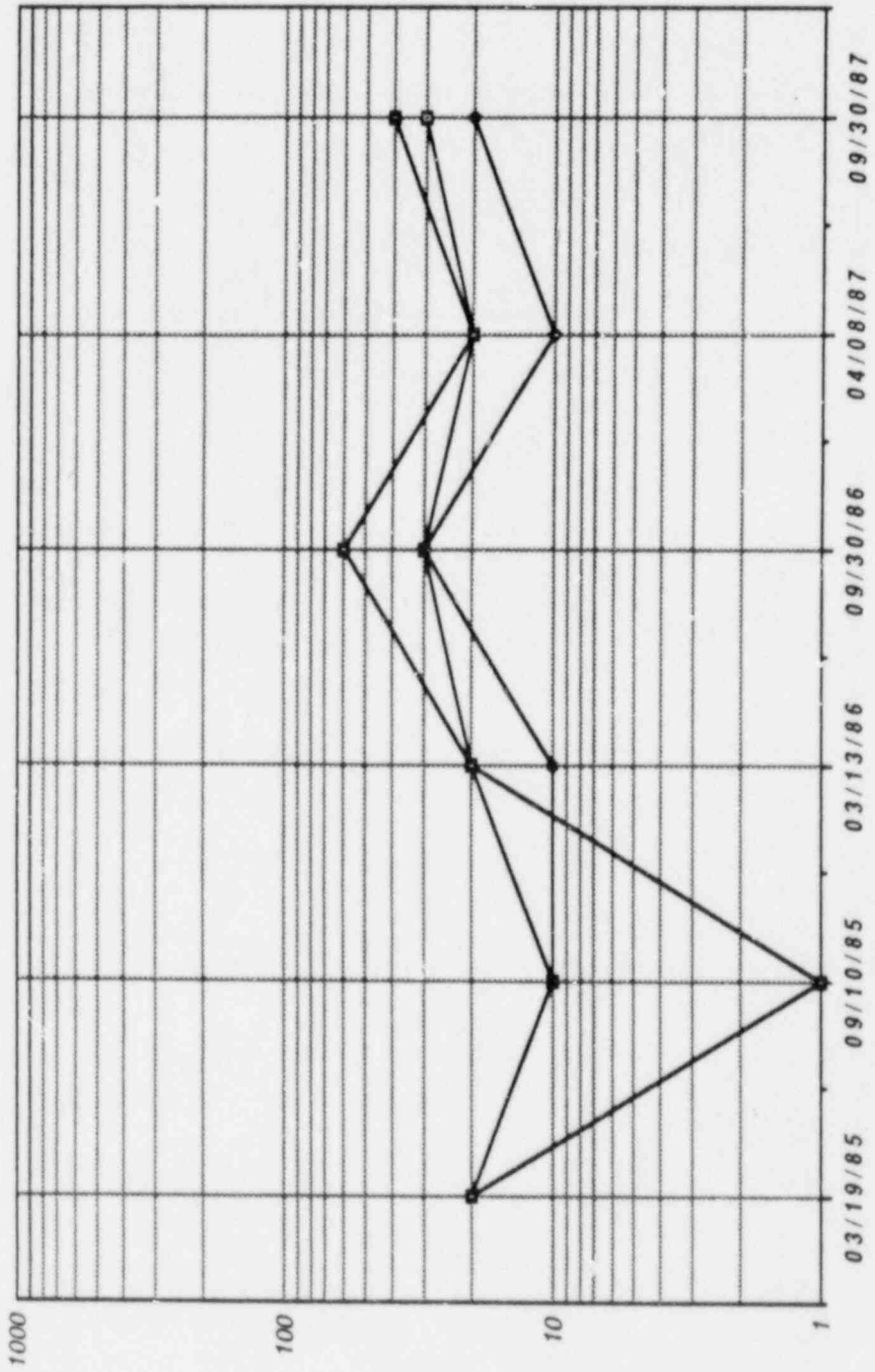
## C. AQUATIC EXPOSURE PATHWAY

### 1. Sediment/Silt

Sediment samples were collected in April and in September from each of three locations and were analyzed by gamma spectrometry. The results are presented in Tables 18 and 19. A number of man-made and naturally occurring radioisotopes were detected in these samples. Cesium-137 was detected in all samples with an average activity of 278 pCi/kg (dry weight) and a range from 44.8 to 569 pCi/kg (dry weight). Cesium-134 was measured in 4 of the 6 samples with an average activity of 100 pCi/kg (dry weight) and a range of 57 to 155 pCi/kg (dry weight). The highest readings for cesium-134 and cesium-137 were obtained at station 11, 5.8 miles downstream in the North Anna River, 128 degrees SSE.

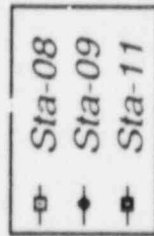
Naturally occurring potassium-40 was observed in all samples with an average activity of 9425 pCi/kg (dry weight) and a range from 1710 to 21500 pCi/kg (dry weight). Radium-226 was also measured in all six samples with an average concentration of 1376 pCi/kg (dry weight) and a range of 627 to 1930 pCi/kg (dry weight). Also naturally occurring, thorium-228 was observed in all six samples with an average concentration of 829 pCi/kg (dry weight) and a range of 284 to 1510 pCi/kg (dry weight). A composite was prepared of the semi-annual samples and analyzed for strontium-89 and strontium-90. There were no detections of these fission products in aquatic sediment/silt. In the accompanying figures the isotopes cobalt-58, cobalt-60, cesium-134, and cesium-137 are plotted for the sediment samples collected during 1987 at stations 08, 09, and 11. All results are consistent with previous years.

# SEDIMENT SILT - COBALT-58

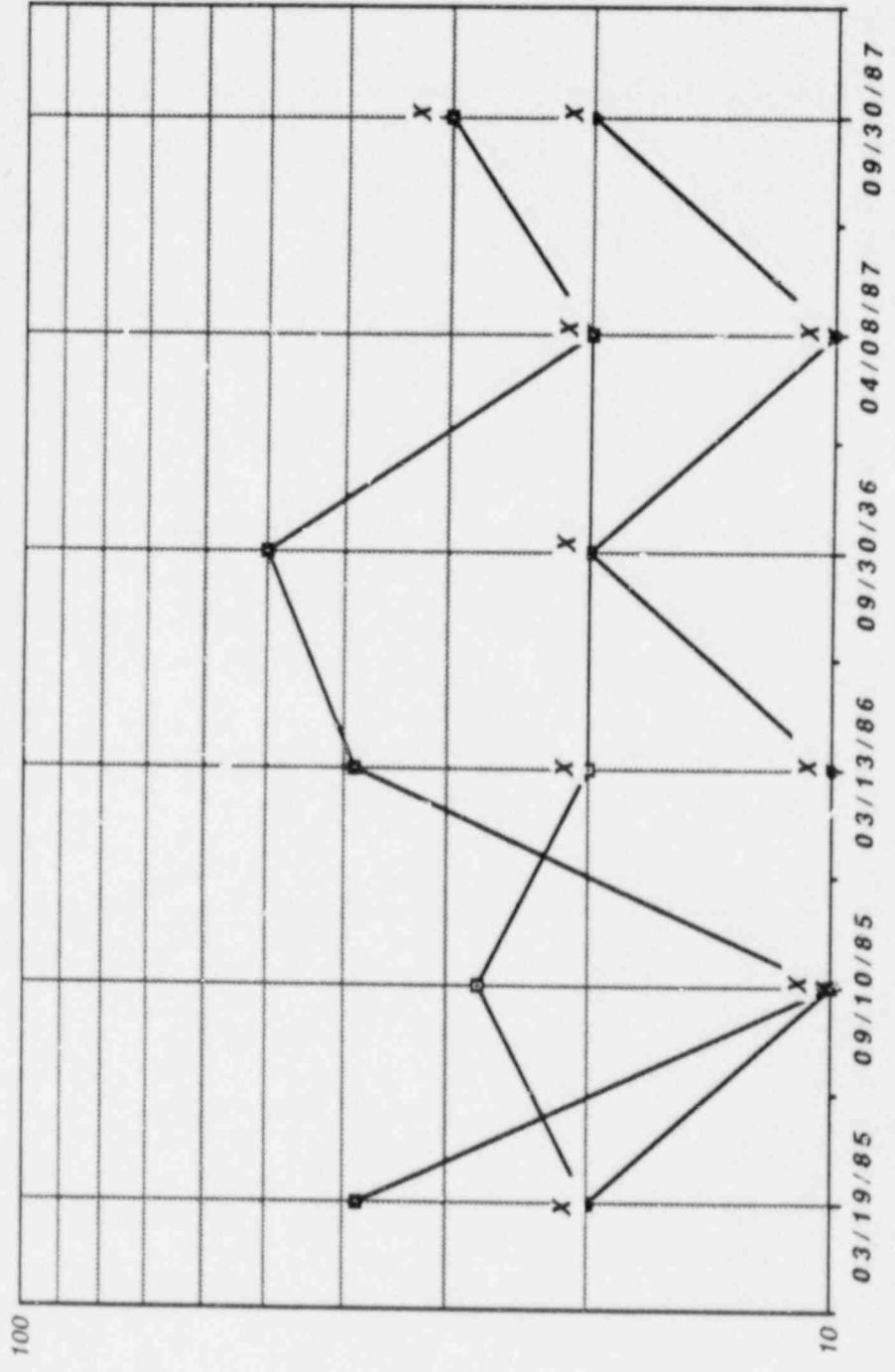


All samples reported less than LLD.

pCi/Kg Dry - Vepco North Anna



# SEDIMENT SILT - COBALT-60



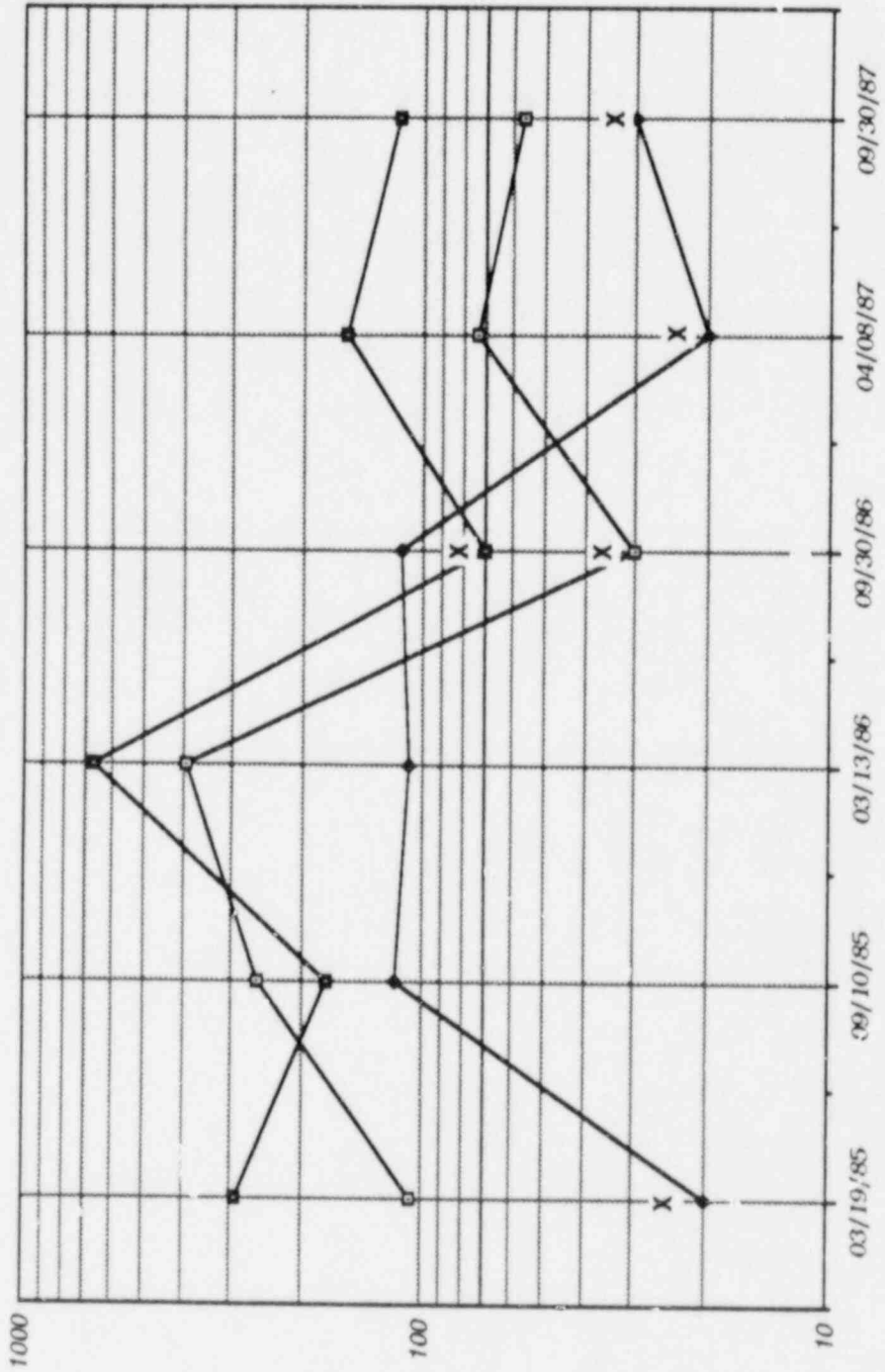
X - <LLD

- Sta-08
- Sta-09
- Sta-11

pCi/Kg Dry - Vepco North Anna



# SEDIMENT SILT - CESIUM-134

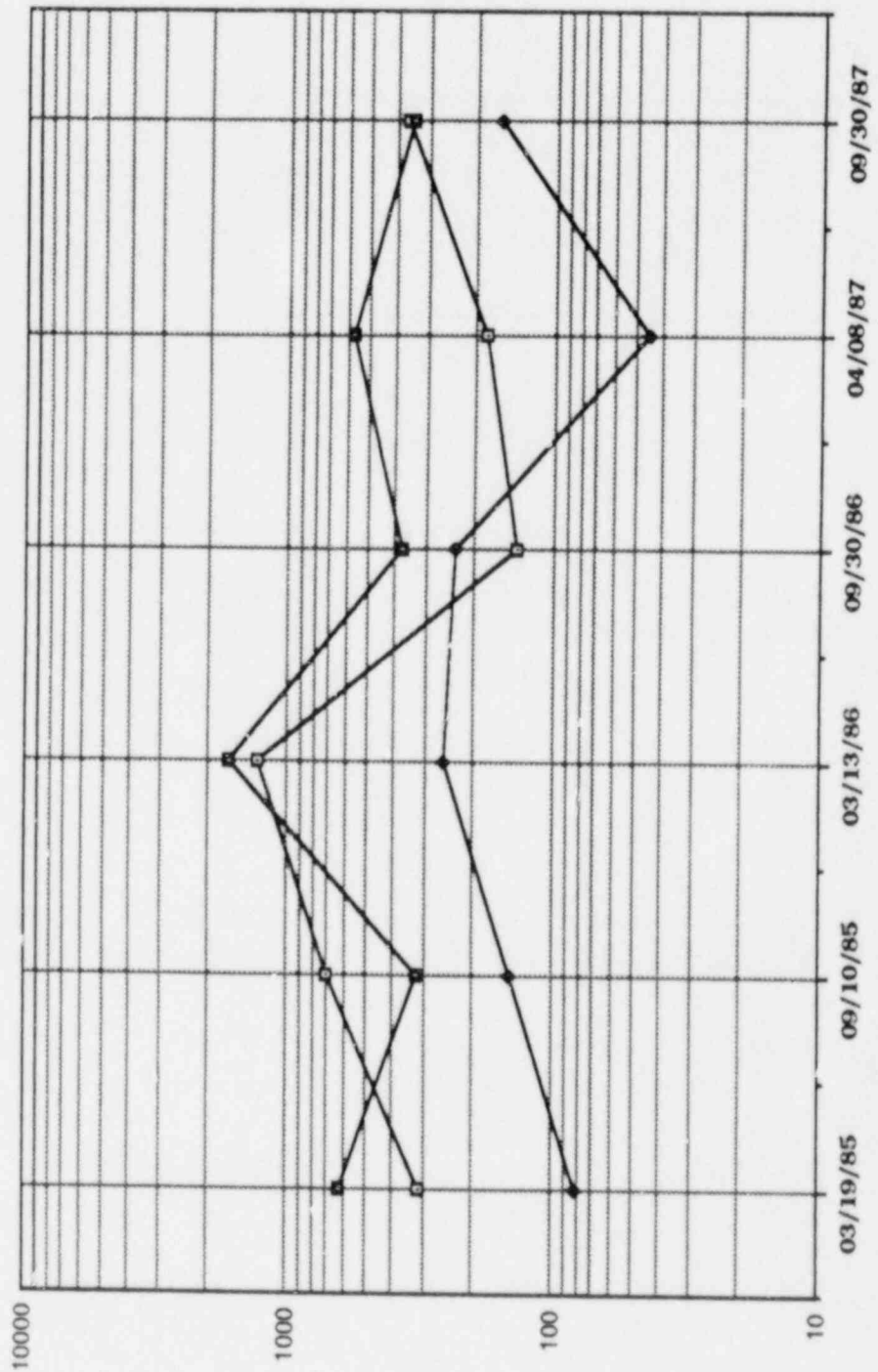


X - <LLD

- Sta-08
- Sta-09
- Sta-11

pCi/Kg Dry - Vepco North Anna

# SEDIMENT SILT - CESIUM-137



pCi/Kg Dry - Vepco North Anna

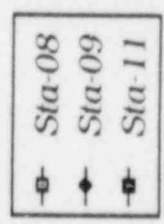


TABLE 18

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST MEAN		CONTROL LOCATION		NUMBER OF NONROUTINE REPORTED MEASUREMENTS
			MEAN RANGE FRACTION		NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION	MEAN RANGE FRACTION		
Sediment/Silt pCi/kg (dry)	Gamma	6							
	K-40	6	-	12635(4/4) (2650-21500)	11 5.8 mi SSE	20900(2/2) (20300-21500)	3005(2/2) (1710-4300)		0
	Cs-134	6	150	100(4/4) (57.0-155)	11 5.8 mi SSE	135(2/2) (115-155)	-(0/2) -		0
	Cs-137	6	180	365(4/4) (181-569)	11 5.8 mi SSE	459(2/2) (348-569)	104(2/2) (44.8-163)		0
	Ra-226	6		1553(4/4) (1050-1930)	11 5.8 mi SSE	1615(2/2) (1440-1790)	1024(2/2) (627-1420)		0
	Th-228	6	-	794(4/4) (519-1040)	11 5.8 mi SSE	1001(2/2) (961-1040)	897(2/2) (284-1510)		0
	Sr-89 (Annually)	3	-	-(0/2) -	NA	NA	-(0/1) -		0
	Sr-90 (annually)	3	0.8	-(0/2) -	NA	NA	-(0/1) -		0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 19  
 VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\* IN SEDIMENT/SILT  
 pCi/kg  $\pm$  2 Sigma

NUCLIDE	STA-08 04/08/87	STA-09 04/08/87	STA-11 04/08/87	STA-08 09/30/87	STA-09 09/16-09/29	STA-11 09/30/87	AVERAGE $\pm$ 2 s.d.
Sr-89	<100	<800	<600	(a)	(a)	(a)	-
Sr-90	<50	<50	<40	(a)	(a)	(a)	-
Be-7	<200	<100	<200	<300	<300	<300	-
K-40	2650 $\pm$ 270	4300 $\pm$ 430	21500 $\pm$ 2200	6090 $\pm$ 610	1710 $\pm$ 200	20300 $\pm$ 2000	9425 $\pm$ 18042
Mn-54	<20	<10	<20	<20	<20	<30	-
Co-58	<20	<10	<20	<30	<20	<40	-
Co-60	<20	<10	<20	<30	<20	<30	-
Cs-134	73.6 $\pm$ 19.7	<20	155 $\pm$ 22	57.0 $\pm$ 20.8	<30	115 $\pm$ 30	100 $\pm$ 88
Cs-137	181 $\pm$ 23	44.8 $\pm$ 14.6	569 $\pm$ 57	362 $\pm$ 36	163 $\pm$ 21	348 $\pm$ 35	278 $\pm$ 373
Ra-226	1050 $\pm$ 330	627 $\pm$ 238	1790 $\pm$ 360	1930 $\pm$ 400	1420 $\pm$ 280	1440 $\pm$ 430	1376 $\pm$ 960
Th-228	519 $\pm$ 52	284 $\pm$ 28	961 $\pm$ 96	657 $\pm$ 66	1510 $\pm$ 150	1040 $\pm$ 100	829 $\pm$ 871

\* All other gamma emitters were <LLD.  
 (a) Sr-89/90 analyses performed annually.

## 2. Shoreline Soil

A sample of shoreline sediment was collected in March and September from station 09, 2.2 miles upstream of the North Anna Power Station. The samples were analyzed by gamma ray spectrometry. The results are presented in Tables 20 and 21. The naturally occurring nuclide potassium-40 was measured in both samples at an average of 2595 pCi/kg (dry weight) and a range of 600 to 4590 pCi/kg (dry weight). Thorium-228 was measured at an average of 156 pCi/kg (dry weight) and a range of 94.6 to 218 pCi/kg (dry weight). Radium-226 was detected in one sample at a level of 424 pCi/kg (dry weight). Cesium-137, also a fission product was monitored at an average level of 21.8 pCi/kg (dry weight) with a range of 19.9 to 23.6 pCi/kg (dry weight).

The two quarterly samples were composited and analyzed for strontium-89 and 90. There were no detections of either of these fission products in shoreline soil.

TABLE 20

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO. 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE FRACTION	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION	CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF ROUTINE REPORTED MEASUREMENTS	
Shoreline Soil pCi/g (dry)	Gamma	2						
	K-40	2	-	2595(2/2) (600-4590)	09 2.2 mi NW	2595(2/2) (600-4590)	NONE	0
	Cs-137	2	180	21.8(2/2) (19.9-23.6)	09 2.2 mi NW	21.8(2/2) (19.9-23.6)	NONE	0
	Ra-226	2	-	424(1/2)	09 2.2 mi NW	424(1/2)	NONE	0
	Th-228	2	-	156(2/2) (94.6-218)	09 2.2 mi NW	156(2/2) (94.6-218)	NONE	0
	Sr-89	1	-	-(0/1)	NA	NA	NONE	0
	Sr-90	1	0.8	-(0/1)	NA	NA	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 21

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF SR-89, SR-90 AND GAMMA EMITTERS\* IN SHORELINE SOIL  
 pCi/kg  $\pm$  2 Sigma

NUCLIDE	STA-09 03/17/87	STA-09 09/16/87-09/29/87
Sr-89	<800	(a)
Sr-90	<40	(a)
Be-7	<100	<200
K-40	4590 $\pm$ 460	600 $\pm$ 60
Mn-54	<10	<10
Co-58	<10	<20
Co-60	<10	<20
Cs-134	<10	<20
Ci-137	19.9 $\pm$ 9.3	23.6 $\pm$ 12.0
Ra-226	424 $\pm$ 159	<300
Th-228	218 $\pm$ 22	94.6 $\pm$ 34.9

\* All other gamma emitters were <L.D.  
 (a) Analysis performed annually.

#### D. INGESTION EXPOSURE PATHWAY

##### 1. Milk

The results of the iodine-131 analysis of milk samples are presented in Tables 22 and 23. A sample was collected monthly from two stations. A total of 24 samples were analyzed. 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 Tables 22 and 23. A total of 24 samples were analyzed. Naturally occurring potassium-40 was measured in all of the samples with an average of 1240 pCi/l and a range of 980 to 1390 pCi/l. Cesium-137, which is a fission product, has been detected sporadically in recent years. The activity has been attributed to global fallout from past atmospheric weapons testing. Cesium-137 was detected in the two February samples with an average activity of 7.33 pCi/l and a range of 5.71 to 8.94 pCi/l. After February there were no additional detections of cesium-137. 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 in any of the samples monitored. Strontium-90 was detected in the eight samples monitored with an average level of 1.4 pCi/l and a range of 0.57 to 2.4 pCi/l. This is similar to activities determined in previous years and lower than the preoperation levels of 2.2 to 5.4 pCi/l.



TABLE 22

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST MEAN		CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
			MEAN RANGE FRACTION		NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION		
Milk (pCi/l)	I-131	24	0.5	-(0/24)	NA	NA	NONE	0
	Gamma	24	-	-	-	-	-	-
	K-40	24	-	1240(24/24) (980-1390)	12 8.3 mi NW	1263(12/12) (980-1390)	NONE	0
	Cs-137	24	3.00	7.33(2/24) (5.71-8.94)	13 5.6 mi SSW	8.94(1/12)	NONE	0
	Sr-89 (Quarterly)	8	-	-(0/8)	NA	NA	NONE	0
	Sr-90 (Quarterly)	8	0.8	1.44(8/8) (0.57-2.4)	13 5.6 mi SSW	1.52(4/4) (0.57-2.4)	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 23

(Page 1 of 3)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\* IN MILK  
 pCi/l  $\pm$  2 Sigma

MONTH	NUCLIDE	STA-12	STA-13
JANUARY	Sr-89	<2	<2
	Sr-90	1.6 $\pm$ 0.8	1.5 $\pm$ 0.9
	K-40	1380 $\pm$ 140	1260 $\pm$ 130
	Cs-137	<5	<6
	I-131	<0.3	<0.5
FEBRUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1270 $\pm$ 130	1300 $\pm$ 130
	Cs-137	5.71 $\pm$ 3.2	8.94 $\pm$ 4.13
	I-131	<0.4	<0.5
MARCH	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1190 $\pm$ 120	1040 $\pm$ 100
	Cs-137	<6	<7
	I-131	<0.3	<0.4
APRIL	Sr-89	<2	<2
	Sr-90	1.6 $\pm$ 0.3	1.6 $\pm$ 0.3
	K-40	1230 $\pm$ 120	1240 $\pm$ 120
	Cs-137	<5	<5
	I-131	<0.3	<0.3

\* All other gamma emitters were <LLD.  
 (a) Strontium-89/90 analyses performed quarterly.

TABLE 23

(Page 2 of 3)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\* IN MILK  
 pCi/l  $\pm$  2 Sigma

MONTH	NUCLIDE	STA-12	STA-13
MAY	Sr-89	{a}	{a}
	Sr-90	{a}	{a}
	K-40	1230 $\pm$ 120	1310 $\pm$ 130
	Cs-137	<4	<5
	I-131	<0.4	<0.5
JUNE	Sr-89	{a}	{a}
	Sr-90	{a}	{a}
	K-40	1260 $\pm$ 130	1080 $\pm$ 110
	Cs-137	<6	<7
	I-131	<0.3	<0.3
JULY	Sr-89	<2	<2
	Sr-90	1.4 $\pm$ 0.5	2.4 $\pm$ 0.7
	K-40	1330 $\pm$ 130	1350 $\pm$ 140
	Cs-137	<4	<5
	I-131	<0.5	<0.5
AUGUST	Sr-89	{a}	{a}
	Sr-90	{a}	{a}
	K-40	980 $\pm$ 98	1350 $\pm$ 140
	Cs-137	<7	<4
	I-131	<0.3	<0.3

\* All other gamma emitters were <LLD.

TABLE 23

(Page 3 of 3)

VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\* IN MILK  
 pCi/L  $\pm$  2 Sigma

MONTH	NUCLIDE	STA-12	STA-13
SEPTEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1280 $\pm$ 130	1230 $\pm$ 120
	Cs-137	<4	<4
	I-131	<0.2	<0.2
OCTOBER	Sr-89	<2	<2
	Sr-90	0.87 $\pm$ 0.37	0.57 $\pm$ 0.40
	K-40	1240 $\pm$ 120	1020 $\pm$ 100
	Cs-137	<6	<7
	I-131	<0.3	<0.2
NOVEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1380 $\pm$ 140	1220 $\pm$ 120
	Cs-137	<6	<7
	I-131	<0.2	<0.3
DECEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1390 $\pm$ 140	1190 $\pm$ 120
	Cs-137	<4	<4
	I-131	<0.4	<0.3

\* All other gamma emitters were <LLD.  
 (a) Strontium 89/90 analyses performed quarterly.

## 2. Fish

Marine 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 Tables 24 and 25. Four samples of fish were collected from station 08, the discharge lagoon. These samples were analyzed by gamma ray spectroscopy and the naturally occurring isotope potassium-40 was found in all four samples at an average of 1853 pCi/kg (wet weight) with a range of 1490 to 2040 pCi/kg (wet weight). Cesium-134, a fission product, was found at an average of 91.0 pCi/kg (wet weight) in all four samples with a range of 54.7 to 148 pCi/kg (wet weight). The fission product cesium-137 was found at an average of 330 pCi/kg (wet weight) in all four samples with a range of 244 to 537 pCi/kg (wet weight).

Five samples were collected from station 09, the control location 2.2 miles upstream on Lake Anna. The same nuclides were detected by gamma ray spectroscopy. Naturally occurring potassium-40 was monitored in all five samples at an average of 1968 pCi/kg (wet weight) with a range of 1750 to 2180 pCi/kg (wet weight). Cesium-134 was detected in all five samples at an average of 50.6 pCi/kg (wet weight) with a range of 23.7 to 116 pCi/kg (wet weight). Cesium-137 was found in all five samples at an average of 221 pCi/kg (wet weight) with a range of 113 to 427 pCi/kg (wet weight).

The levels of the fission products cesium-134 and cesium-137 were somewhat higher at the discharge lagoon than at the control station upstream of the discharge point. The results in 1986 for cesium-134 were 112 pCi/kg (wet weight) at station 09 and 157 pCi/kg (wet weight) at the discharge lagoon. The results in 1986 for cesium-137 were 309 pCi/kg (wet weight) at station 09 and 537 pCi/kg (wet weight) at the discharge lagoon.

TABLE 24

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE FRACTION	LOCATION WITH HIGHEST MEAN		CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
				NAME	MEAN RANGE FRACTION		
Fish pCi/kg (wet)	Gamma	9					
	K-40	9 -	1853(4/4) (1490-2040)	09 2.2 mi NW	1968(5/5) (1750-2180)	1968(5/5) (1750-2180)	0
	Cs-134	9 -	91.0(4/4) (54.7-148)	08 1.1 mi SSE	91(4/4) (54.7-148)	50.6(5/5) (23.7-116)	0
	Cs-137	9 -	330(4/4) (244-537)	08 1.1 mi SSE	330(4/4) (244-537)	221(5/5) (113-427)	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 25  
 VIRGINIA POWER - NORTH ANNA - 1987  
 CONCENTRATIONS OF GAMMA EMITTERS\* IN FISH  
 pCi/kg (wet)  $\pm$  2 Sigma

COLLECTION DATE	STATION	SAMPLE TYPE	K-40	Co-58	Cs-134	Cs-137
03/02/87	08		2040 $\pm$ 200	<6	148 $\pm$ 15	537 $\pm$ 54
07/01/87	08		1850 $\pm$ 180	<6	54.7 $\pm$ 8.9	244 $\pm$ 24
09/09/87	08		1490 $\pm$ 150	<6	77.5 $\pm$ 9.2	273 $\pm$ 27
11/12/87	08		2030 $\pm$ 200	<7	83.8 $\pm$ 8.4	264 $\pm$ 26
03/02/87	09		2020 $\pm$ 200	<7	116 $\pm$ 12	427 $\pm$ 43
03/02/87 (a)	09		2180 $\pm$ 220	<6	23.7 $\pm$ 6.4	113 $\pm$ 11
06/29/87	09		1890 $\pm$ 190	<10	54.0 $\pm$ 6.2	253 $\pm$ 25
09/09/87	09		1750 $\pm$ 180	<7	28.5 $\pm$ 8.1	140 $\pm$ 14
11/18/87	09		2000 $\pm$ 200	<6	31.0 $\pm$ 5.8	171 $\pm$ 17
Average $\pm$ 2 s.d.			1917 $\pm$ 406		68.6 $\pm$ 84.6	269 $\pm$ 272

\* All other gamma emitters were <LLD.  
 (a) Control Sample

### 3. Food Products/Vegetation

Seventeen food samples were collected from seven locations and analyzed by gamma spectrometry. The samples consisted of green leafy vegetables such as cabbage and lettuce. The results are presented in Tables 26 and 27. Naturally occurring potassium-40 was monitored in all of the samples with an average activity level of 13312 pCi/kg (wet weight) and a range of 5270 to 22100 pCi/kg (wet weight). Cosmogenic beryllium-7 was detected in twelve of the seventeen samples with an average concentration of 3398 pCi/kg (wet weight) and a range of 329 to 6110 pCi/kg (wet weight). The terrestrial nuclide thorium-228 occurred in five of the samples at an average activity of 382 pCi/kg (wet weight) and a range of 294 to 509 pCi/kg (wet weight). Radium-226 was detected in three samples with an average activity of 900 pCi/kg (wet weight) and a range of 609 to 1070 pCi/kg (wet weight).

The fission product cesium-137 was detected in eight of the seventeen samples with an average activity of 106 pCi/Kg (wet weight) and a range of 51.5 to 181 pCi/Kg (wet weight). In recent years cesium-137 has been detected sporadically and has been attributed to global fallout from past atmospheric weapons testing.



TABLE 26

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE FRACTION	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE FRACTION	CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS	
Food/Vegetation pCi/kg (wet)	Gamma	17						
	Be-7	17	-	3398(12/17) (329-6110)	21 1.0 mi WNW	4537(3/3) (4030-5050)	NONE	0
	K-40	17	-	13312(17/17) (5270-22100)	15 1.7 mi SE	15600(3/3) (11000-22100)	NONE	0
	Cs-137	17	80	106(8/17) (51.5-181)	15 1.7 mi SE	130(1/3) -	NONE	0
	Ra-226	17	-	900(3/17) (609-1070)	23 0.93 mi SSE	1070(1/3) -	NONE	0
	Th-228	17	-	382(5/17) (294-509)	23 0.93 mi SSE	509(1/3) -	NONE	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE 27

VIRGINIA POWER - NORTH ANNA - 1987

CONCENTRATIONS OF GAMMA EMITTERS\* IN FOOD/VEGETATION

pCi/kg (wet)  $\pm$  2 Sigma

STATION	COLLECTION DATE	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Th-228	Ra-226
14	05/26/87	3970 $\pm$ 400	12200 $\pm$ 1200	<60	<20	<20	97.1 $\pm$ 14.9	294 $\pm$ 29	609 $\pm$ 250
	09/29/87	1580 $\pm$ 220	16100 $\pm$ 1600	<60	<30	<20	51.5 $\pm$ 20.5	<40	<400
	11/03/87	<600	16500 $\pm$ 1600	<200 (a)	<70	<60	<70	<100	<1000
15	05/26/87	4040 $\pm$ 400	13700 $\pm$ 1400	<60	<20	<20	130 $\pm$ 18	372 $\pm$ 37	<400
	09/29/87	2800 $\pm$ 280	11000 $\pm$ 1100	<40	<20	<20	<20	<40	<400
	11/03/87	<500	22100 $\pm$ 2200	<100 (a)	<60	<50	<50	<100	<1000
16	05/26/87	2120 $\pm$ 210	16000 $\pm$ 1600	<60	<20	<20	57.3 $\pm$ 16.8	299 $\pm$ 30	<400
	09/29/87	6110 $\pm$ 620	10900 $\pm$ 1100	<50	<80	<60	<60	<100	<1000
	11/03/87	<600	16800 $\pm$ 1700	<200 (a)	<70	<60	<60	<100	<1000
21	05/26/87	4030 $\pm$ 400	19000 $\pm$ 1900	<60	<20	<20	181 $\pm$ 21	437 $\pm$ 44	1020 $\pm$ 330
	09/29/87	4530 $\pm$ 460	6100 $\pm$ 610	<60	<60	<40	75.0 $\pm$ 34.4	<100	<1000
	11/03/87	5050 $\pm$ 2040	10000 $\pm$ 2200	<700 (a)	<300	<300 (a)	<300 (a)	<500	<5000
23	05/26/87	3530 $\pm$ 370	19400 $\pm$ 1900	<30	<40	<40	116 $\pm$ 30	509 $\pm$ 57	1070 $\pm$ 530
	09/29/87	2690 $\pm$ 370	8550 $\pm$ 860	<40	<40	<40	137 $\pm$ 30	<70	<800
	11/03/87	<600	17300 $\pm$ 1700	<200 (a)	<70	<70 (a)	<70	<200	<2000
92	06/12/87 (b)	329 $\pm$ 118	5380 $\pm$ 540	<60	<20	<10	<10	<30	<300
98	06/12/87 (b)	<100	5270 $\pm$ 530	<50	<10	<10	<10	<20	<200
Average $\pm$ 2 s.d.		3398 $\pm$ 3176	13312 $\pm$ 10316				106 $\pm$ 88	382 $\pm$ 184	900 $\pm$ 506

\* All other gamma emitters were <LLD.  
(a) LLD not met due to small sample size.  
(b) State Split

## E. DIRECT RADIATION EXPOSURE PATHWAY

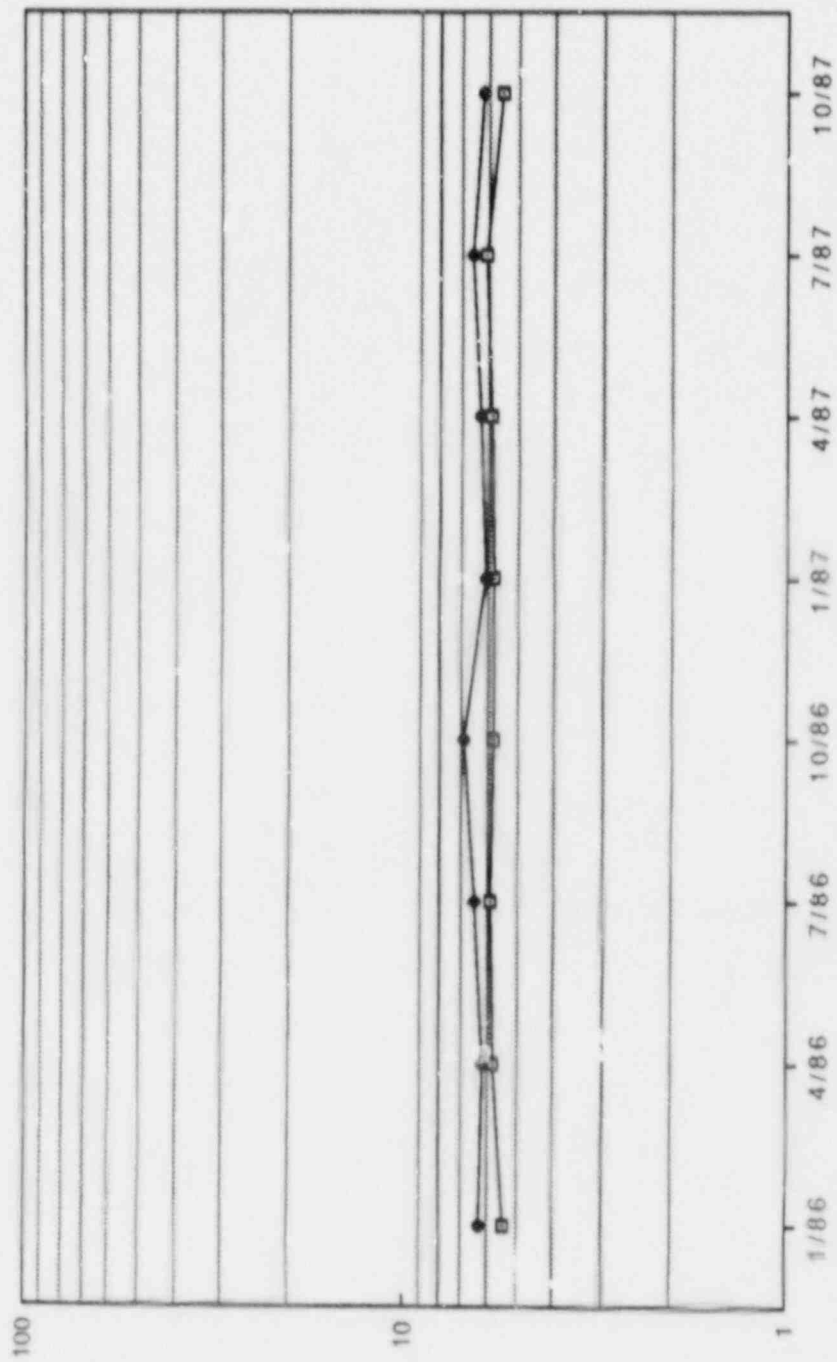
### 1. TLD Dosimeters

Thermoluminescent dosimeters (TLDs) determined environmental radiation dose rates and the results are contained in Tables 28 and 29. A TLD badge of four readout areas each was deployed quarterly at 12 locations around the periphery of the plant. The mean values of four readings (calibrated individually for response to a known dose and for intransit dose) are reported in this table. Individual measurements of external radiation levels in the environs of the North Anna site had an average dose of 6.0 mR/standard month with a range of 4.1 to 8.8 mR/standard month. The control station, No 24 had an average reading of 4.3 mR/standard month with a range of 3.7 to 5.0 mR/standard month. The highest dose was at station 01, NAPS Sewage Treatment Plant, 0.2 miles, 42 degrees NE, with a reading of 8.2 mR/standard month and a range of 7.4 to 8.8 mR/standard month.

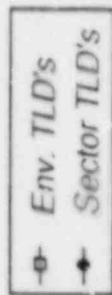
Sector TLDs are deployed quarterly at thirty-two locations in the environs of the North Anna site. Two badges are placed at each location. The results are presented in Tables 28 and 30. The average level of the 32 locations (two badges at each location) was 6.5 mR/standard month with a range of 2.3 to 11.3 mR/standard month. The six control TLDs showed an average reading of 5.2 mR/standard month with a range of 3.8 to 6.8 mR/standard month. Four of the badges were vandalized; two during the second quarter and two during the fourth quarter. The highest dose levels were at station SW-53 with an average level of 9.1 mR/standard month and a range of 8.5 to 10.2 mR/standard month.

On one figure the results of the environmental TLDs are plotted from 1977 through 1985 in mR/day. For 1986 and 1987 the results were plotted in mR/standard month on a second figure. For the period 1985 through 1987, the external radiation levels have remained constant at approximately 0.2 mR/day (or 6 mR/standard month). The sector TLDs have been in use since 1984 and the results for 1984 through 1985 are plotted on the same two figures discussed above. The results of the sector TLDs are comparable to the results of the environmental TLDs.

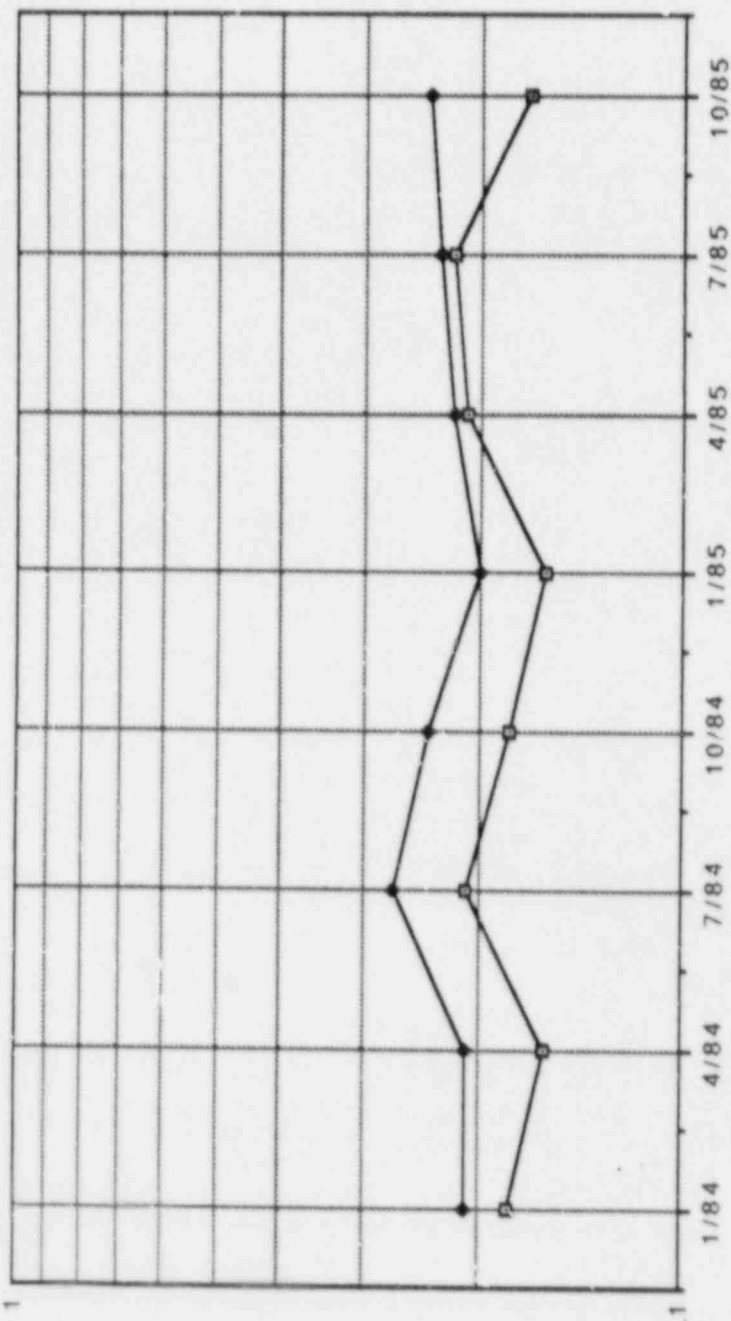
# ENVIRONMENTAL RADIATION - TLD'S



mR/Standard Month - North Anna



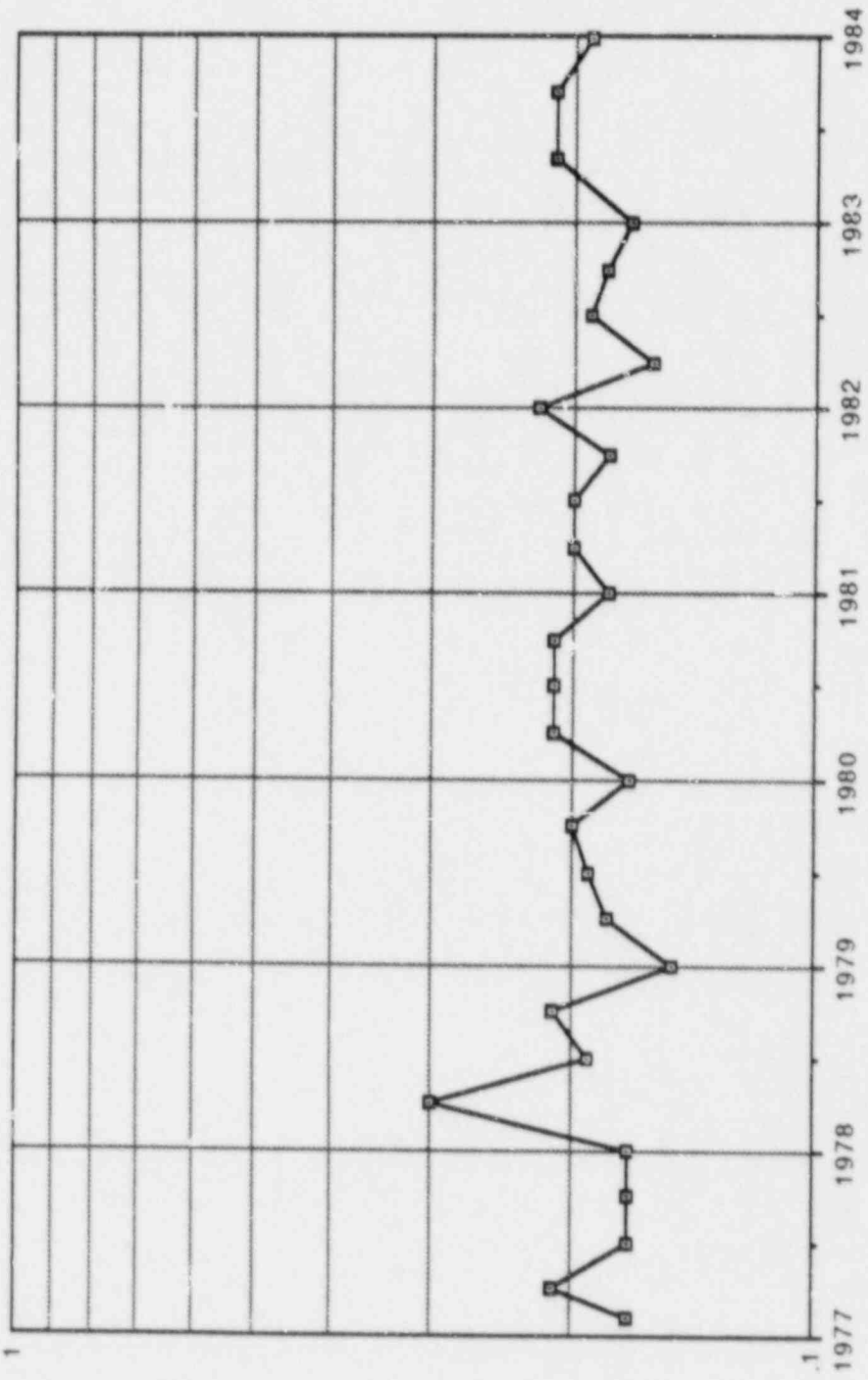
# ENVIRONMENTAL RADIATION - TLD'S



nR/Day - Vepco - North Anna



# ENVIRONMENTAL RADIATION - TLD'S



mR/Day - Vepco - North Anna

TABLE 28

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

NORTH ANNA NUCLEAR POWER STATION

DOCKET NO 50-338/339

LOUISA COUNTY, VIRGINIA

JANUARY 1, to DECEMBER 31, 1987

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE FRACTION	LOCATION WITH HIGHEST MEAN		CONTROL LOCATION MEAN RANGE FRACTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
				NAME	MEAN RANGE FRACTION		
Direct Radiation (mR/std. month) (Regular TLDs )	Gamma Dose 48		6.0(44/44) (4.1-8.8)	01	0.2 mi NE 8.2(4/4) (7.4-8.8)	4.3(4/4) (3.7-5.0)	0
Sector TLDs	Gamma Dose 284		6.5(252-252) (2.3-11.3)	21/53	0.3 mi SW 9.1(8/8) (8.5-10.2)	5.2(32/32) (3.8-6.8)	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision I, November 1979



TABLE 29  
 VIRGINIA POWER - NORTH ANNA - 1987  
 DIRECT RADIATION MEASUREMENTS - QUARTERLY TID RESULTS  
 mR/standard month\*  $\pm$  2 Sigma

STATION NUMBER	FIRST QUARTER 12/31/86-04/01/87	SECOND QUARTER 04/01/87-06/30/87	THIRD QUARTER 06/30/87-09/30/87	FOURTH QUARTER 09/30/87-01/05/88	AVERAGE $\pm$ 2 s.d.
01	7.4 $\pm$ 0.2	8.4 $\pm$ 0.3	8.8 $\pm$ 0.4	8.0 $\pm$ 0.4	8.2 $\pm$ 1.2
02	4.8 $\pm$ 0.2	4.8 $\pm$ 0.4	4.6 $\pm$ 0.1	4.5 $\pm$ 0.2	4.7 $\pm$ 0.3
03	4.8 $\pm$ 0.2	4.3 $\pm$ 0.2	4.6 $\pm$ 0.6	4.7 $\pm$ 0.3	4.6 $\pm$ 0.4
04	5.1 $\pm$ 0.07	4.1 $\pm$ 0.03	5.0 $\pm$ 0.1	4.4 $\pm$ 0.5	4.7 $\pm$ 1.0
05	5.5 $\pm$ 0.1	6.3 $\pm$ 0.5	6.3 $\pm$ 0.3	5.6 $\pm$ 0.4	5.9 $\pm$ 0.9
05A	5.8 $\pm$ 0.1	6.2 $\pm$ 0.5	6.0 $\pm$ 0.2	5.2 $\pm$ 0.1	5.8 $\pm$ 0.9
06	6.8 $\pm$ 0.2	7.1 $\pm$ 0.4	7.4 $\pm$ 0.2	6.5 $\pm$ 0.1	7.0 $\pm$ 0.8
07	5.6 $\pm$ 0.2	5.9 $\pm$ 0.3	6.0 $\pm$ 0.2	4.8 $\pm$ 0.3	5.6 $\pm$ 1.1
21	5.2 $\pm$ 0.07	6.0 $\pm$ 0.07	5.4 $\pm$ 0.4	5.6 $\pm$ 0.2	5.6 $\pm$ 0.7
22	6.4 $\pm$ 0.1	6.6 $\pm$ 0.4	7.5 $\pm$ 0.4	6.5 $\pm$ 0.2	6.8 $\pm$ 1.0
23	6.7 $\pm$ 0.1	6.4 $\pm$ 0.1	7.6 $\pm$ 0.3	6.5 $\pm$ 0.5	6.8 $\pm$ 1.1
24	5.0 $\pm$ 0.3	4.1 $\pm$ 0.1	4.4 $\pm$ 0.1	3.7 $\pm$ 0.1	4.3 $\pm$ 1.1
AVERAGE $\pm$ 2 s.d.	5.8 $\pm$ 1.7	5.9 $\pm$ 2.6	6.1 $\pm$ 2.8	5.5 $\pm$ 2.4	5.8 $\pm$ 0.5

\* Standard month = 30.4 days.

TABLE 30

(Page 1 of 2)

## VIRGINIA POWER - NORTH ANNA - 1987

## DIRECT RADIATION MEASUREMENTS - SECTOR QUARTERLY TLD RESULTS

mR/standard month\*  $\pm$  2 Sigma

STATION NUMBER	FIRST QUARTER 12/31/86-04/01/87	SECOND QUARTER 04/01/87-06/30/87	THIRD QUARTER 06/30/87-09/30/87	FOURTH QUARTER 09/30/87-01/05/88(b)	AVERAGE $\pm$ 2 s.d
N-1	6.1 $\pm$ 0.3	5.0 $\pm$ 0.3	5.8 $\pm$ 0.5	5.4 $\pm$ 0.4	5.6 $\pm$ 1.0
N-2	5.6 $\pm$ 0.2	6.0 $\pm$ 0.2	6.0 $\pm$ 0.1	4.3 $\pm$ 0.8	5.5 $\pm$ 1.6
NNE-3	6.0 $\pm$ 0.1	5.9 $\pm$ 0.5	5.9 $\pm$ 0.2	7.2 $\pm$ 0.5	6.3 $\pm$ 1.3
NNE-4	5.2 $\pm$ 0.07	6.6 $\pm$ 1.0	5.8 $\pm$ 0.3	5.4 $\pm$ 0.5	5.8 $\pm$ 1.2
NE-5	7.4 $\pm$ 0.1	8.8 $\pm$ 0.2	7.8 $\pm$ 0.5	7.3 $\pm$ 0.3	7.8 $\pm$ 1.4
NE-6	4.7 $\pm$ 0.1	3.7 $\pm$ 0.3	4.8 $\pm$ 0.5	3.8 $\pm$ 0.2	4.3 $\pm$ 1.2
ENE-7	6.6 $\pm$ 0.7	6.4 $\pm$ 0.2	7.0 $\pm$ 0.3	6.5 $\pm$ 0.8	6.6 $\pm$ 0.5
ENE-8	5.2 $\pm$ 0.07	5.1 $\pm$ 0.07	5.5 $\pm$ 0.3	4.4 $\pm$ 0.2	5.1 $\pm$ 0.9
E-9	7.2 $\pm$ 0.07	6.8 $\pm$ 0.1	7.8 $\pm$ 0.4	6.9 $\pm$ 0.5	7.2 $\pm$ 0.9
E-10	6.1 $\pm$ 0.2	5.6 $\pm$ 0.03	6.0 $\pm$ 0.5	6.7 $\pm$ 0.3	6.1 $\pm$ 0.9
ESE-11	6.5 $\pm$ 0.2	7.3 $\pm$ 0.3	7.0 $\pm$ 0.3	6.7 $\pm$ 0.6	6.9 $\pm$ 0.7
ESE-12	7.5 $\pm$ 0.5	7.3 $\pm$ 0.07	8.1 $\pm$ 0.4	6.2 $\pm$ 0.5	7.3 $\pm$ 1.6
SE-13	5.8 $\pm$ 0.1	6.4 $\pm$ 0.07	7.5 $\pm$ 0.3	5.8 $\pm$ 0.1	6.4 $\pm$ 1.6
SE-14	5.4 $\pm$ 0.1	5.6 $\pm$ 0.07	6.6 $\pm$ 0.3	(a)	5.9 $\pm$ 1.3
SSE-15	7.2 $\pm$ 0.2	7.1 $\pm$ 0.3	6.9 $\pm$ 0.3	7.2 $\pm$ 0.5	7.1 $\pm$ 0.3
SSE-16	5.2 $\pm$ 0.07	5.0 $\pm$ 0.1	5.7 $\pm$ 0.2	5.4 $\pm$ 0.3	5.3 $\pm$ 0.6
S-17	7.5 $\pm$ 0.07	7.2 $\pm$ 0.1	7.5 $\pm$ 0.4	7.5 $\pm$ 0.3	7.4 $\pm$ 0.3
S-18	4.0 $\pm$ 0.1	4.2 $\pm$ 0.07	4.3 $\pm$ 0.3	4.5 $\pm$ 0.1	4.3 $\pm$ 0.4
SSW-19	8.5 $\pm$ 0.1	9.3 $\pm$ 0.5	8.8 $\pm$ 0.3	8.5 $\pm$ 0.5	8.8 $\pm$ 0.8
SSW-20	4.4 $\pm$ 0.1	5.1 $\pm$ 0.1	4.6 $\pm$ 0.2	4.8 $\pm$ 0.3	4.7 $\pm$ 0.6
SW-21	8.6 $\pm$ 0.1	8.5 $\pm$ 0.03	9.6 $\pm$ 0.7	8.7 $\pm$ 0.7	8.9 $\pm$ 1.0
SW-22	6.0 $\pm$ 0.3	(a)	6.4 $\pm$ 0.1	11.3 $\pm$ 1.2	7.9 $\pm$ 5.9
WSW-23	5.6 $\pm$ 0.1	6.1 $\pm$ 0.07	6.8 $\pm$ 0.2	5.7 $\pm$ 0.6	6.1 $\pm$ 1.1
WSW-24	6.8 $\pm$ 0.3	6.5 $\pm$ 0.2	7.1 $\pm$ 0.2	6.2 $\pm$ 0.1	6.7 $\pm$ 0.8
W-25	5.8 $\pm$ 0.3	7.8 $\pm$ 0.2	7.9 $\pm$ 0.4	7.1 $\pm$ 0.4	7.2 $\pm$ 1.9
W-26	6.0 $\pm$ 0.2	5.3 $\pm$ 0.2	5.2 $\pm$ 0.4	4.2 $\pm$ 0.2	5.2 $\pm$ 1.5
WNW-27	5.2 $\pm$ 0.1	5.9 $\pm$ 0.2	5.5 $\pm$ 0.4	5.2 $\pm$ 0.3	5.5 $\pm$ 0.7
WNW-28	5.5 $\pm$ 0.1	6.0 $\pm$ 0.3	6.0 $\pm$ 0.2	5.4 $\pm$ 0.2	5.7 $\pm$ 0.6
NW-29	8.1 $\pm$ 0.03	8.0 $\pm$ 0.03	8.6 $\pm$ 0.2	7.9 $\pm$ 0.4	8.2 $\pm$ 0.6
NW-30	5.5 $\pm$ 0.1	5.8 $\pm$ 0.07	5.9 $\pm$ 0.3	4.9 $\pm$ 0.4	5.5 $\pm$ 0.9
NNW-31	6.0 $\pm$ 0.03	5.9 $\pm$ 0.07	6.5 $\pm$ 0.1	7.2 $\pm$ 0.4	6.4 $\pm$ 1.2
NNW-32	5.6 $\pm$ 0.1	5.4 $\pm$ 0.1	6.4 $\pm$ 0.4	5.8 $\pm$ 0.5	5.8 $\pm$ 0.9
N-33	6.4 $\pm$ 0.3	5.2 $\pm$ 0.1	5.6 $\pm$ 0.0	5.5 $\pm$ 0.3	5.7 $\pm$ 1.0
N-34	5.5 $\pm$ 0.2	5.3 $\pm$ 0.1	5.7 $\pm$ 0.2	5.4 $\pm$ 0.1	5.5 $\pm$ 0.3
NNE-35	6.1 $\pm$ 0.2	6.4 $\pm$ 0.07	6.9 $\pm$ 0.1	7.5 $\pm$ 0.4	6.7 $\pm$ 1.2
NNE-36	6.8 $\pm$ 0.07	6.4 $\pm$ 0.1	6.2 $\pm$ 0.1	5.5 $\pm$ 0.8	6.2 $\pm$ 1.1
NE-37	8.2 $\pm$ 0.2	7.7 $\pm$ 0.1	8.7 $\pm$ 0.3	7.5 $\pm$ 0.7	8.0 $\pm$ 1.1

\* Standard month = 30.4 days

(a) TLD Vandalized

(b) Several of the TLD's had collection dates 09/30/87-01/06/88.

TABLE 30

(Page 2 of 2)

## VIRGINIA POWER - NORTH ANNA - 1987

## DIRECT RADIATION MEASUREMENTS - SECTOR QUARTERLY TLD RESULTS

mR/standard month\*  $\pm 2$  Sigma

STATION NUMBER	FIRST QUARTER 12/31/86-04/01/87	SECOND QUARTER 04/01/87-06/30/87	THIRD QUARTER 06/30/87-09/30/87	FOURTH QUARTER 09/30/87-01/05/88(b)	AVERAGE $\pm 2$ s.d
NE-38	4.4 $\pm$ 0.1	4.8 $\pm$ 0.2	4.7 $\pm$ 0.2	4.5 $\pm$ 0.1	4.6 $\pm$ 0.4
ENE-39	6.8 $\pm$ 0.1	6.4 $\pm$ 0.07	7.3 $\pm$ 0.4	6.8 $\pm$ 0.5	6.8 $\pm$ 0.7
ENE-40	5.3 $\pm$ 0.1	4.7 $\pm$ 0.1	5.3 $\pm$ 0.2	4.9 $\pm$ 0.3	5.1 $\pm$ 0.6
E-41	7.9 $\pm$ 0.2	7.4 $\pm$ 0.2	7.5 $\pm$ 0.2	6.9 $\pm$ 0.2	7.4 $\pm$ 0.8
E-42	6.1 $\pm$ 0.1	6.8 $\pm$ 0.2	6.1 $\pm$ 0.4	6.5 $\pm$ 0.4	6.4 $\pm$ 0.7
ESE-43	6.0 $\pm$ 0.1	7.1 $\pm$ 0.5	7.3 $\pm$ 0.4	6.3 $\pm$ 0.7	6.7 $\pm$ 1.2
ESE-44	6.8 $\pm$ 0.2	6.0 $\pm$ 0.2	7.8 $\pm$ 0.4	6.5 $\pm$ 0.1	6.8 $\pm$ 1.5
SE-45	6.3 $\pm$ 0.1	6.3 $\pm$ 0.1	2.3 $\pm$ 0.2	6.5 $\pm$ 0.5	5.4 $\pm$ 4.1
SE-46	6.0 $\pm$ 0.07	6.5 $\pm$ 0.2	7.3 $\pm$ 0.4	(a)	6.6 $\pm$ 1.3
SSE-47	7.4 $\pm$ 0.4	6.7 $\pm$ 0.2	7.9 $\pm$ 0.4	8.1 $\pm$ 5.8	7.5 $\pm$ 1.2
SSE-48	5.6 $\pm$ 0.1	5.9 $\pm$ 0.07	6.7 $\pm$ 0.3	5.5 $\pm$ 0.2	5.9 $\pm$ 1.1
S-49	8.1 $\pm$ 1.0	7.2 $\pm$ 0.2	9.1 $\pm$ 0.4	7.3 $\pm$ 0.1	7.9 $\pm$ 1.8
S-50	4.1 $\pm$ 0.07	4.1 $\pm$ 0.07	5.6 $\pm$ 0.2	4.3 $\pm$ 0.5	4.5 $\pm$ 1.4
SSW-51	8.5 $\pm$ 0.1	10.0 $\pm$ 0.5	9.9 $\pm$ 0.3	8.4 $\pm$ 0.7	9.1 $\pm$ 1.5
SSW-52	4.4 $\pm$ 0.1	5.4 $\pm$ 0.1	5.3 $\pm$ 0.4	5.1 $\pm$ 0.3	5.1 $\pm$ 0.9
SW-53	8.5 $\pm$ 0.1	9.1 $\pm$ 0.3	10.2 $\pm$ 0.5	9.4 $\pm$ 0.8	9.3 $\pm$ 1.4
SW-54	5.8 $\pm$ 0.3	(a)	7.5 $\pm$ 0.1	7.7 $\pm$ 0.4	7.0 $\pm$ 2.1
WSW-55	6.3 $\pm$ 0.1	6.0 $\pm$ 0.1	6.4 $\pm$ 0.3	6.1 $\pm$ 0.5	6.2 $\pm$ 0.4
WSW-56	7.1 $\pm$ 0.03	6.8 $\pm$ 0.1	7.0 $\pm$ 0.9	5.6 $\pm$ 0.2	6.6 $\pm$ 1.4
W-57	7.5 $\pm$ 0.2	7.8 $\pm$ 0.3	8.7 $\pm$ 0.6	7.8 $\pm$ 0.2	8.0 $\pm$ 1.0
W-58	5.1 $\pm$ 0.03	5.9 $\pm$ 0.1	5.2 $\pm$ 0.2	5.9 $\pm$ 0.2	5.5 $\pm$ 0.9
WNW-59	5.1 $\pm$ 0.07	6.1 $\pm$ 0.3	5.9 $\pm$ 0.2	5.8 $\pm$ 0.3	5.7 $\pm$ 0.9
WNW-60	5.5 $\pm$ 0.1	6.0 $\pm$ 0.07	6.9 $\pm$ 0.3	6.4 $\pm$ 0.1	6.2 $\pm$ 1.2
NW-61	8.4 $\pm$ 0.1	9.1 $\pm$ 0.4	9.0 $\pm$ 0.4	9.2 $\pm$ 0.5	8.9 $\pm$ 0.7
NW-62	5.1 $\pm$ 0.07	5.5 $\pm$ 0.2	5.9 $\pm$ 0.1	5.0 $\pm$ 0.1	5.4 $\pm$ 0.8
NNW-63	7.0 $\pm$ 0.5	7.0 $\pm$ 0.1	7.5 $\pm$ 1.1	7.1 $\pm$ 0.2	7.2 $\pm$ 0.5
NNW-64	6.3 $\pm$ 0.2	6.1 $\pm$ 0.1	6.3 $\pm$ 0.2	5.4 $\pm$ 0.4	6.0 $\pm$ 0.9
C-1	5.2 $\pm$ 0.1	5.3 $\pm$ 0.07	6.4 $\pm$ 0.2	5.2 $\pm$ 0.5	5.5 $\pm$ 1.2
C-2	5.2 $\pm$ 0.07	6.1 $\pm$ 0.3	5.6 $\pm$ 0.2	5.3 $\pm$ 0.2	5.6 $\pm$ 0.8
C-3	4.9 $\pm$ 0.07	4.6 $\pm$ 0.4	5.2 $\pm$ 0.3	4.3 $\pm$ 0.9	4.8 $\pm$ 0.8
C-4	4.2 $\pm$ 0.03	4.3 $\pm$ 0.5	4.8 $\pm$ 0.1	3.8 $\pm$ 0.1	4.3 $\pm$ 0.8
C-5	4.4 $\pm$ 0.07	4.2 $\pm$ 0.1	4.6 $\pm$ 0.2	4.0 $\pm$ 0.3	4.3 $\pm$ 0.5
C-6	5.1 $\pm$ 0.1	5.1 $\pm$ 0.4	5.0 $\pm$ 0.4	4.6 $\pm$ 0.2	5.0 $\pm$ 0.5
C-7	5.8 $\pm$ 0.07	5.8 $\pm$ 0.1	6.8 $\pm$ 0.4	5.9 $\pm$ 0.2	6.1 $\pm$ 1.0
C-8	6.7 $\pm$ 0.1	6.2 $\pm$ 0.4	6.8 $\pm$ 0.3	6.4 $\pm$ 0.1	6.5 $\pm$ 0.6
Average $\pm 2$ s.d.	6.1 $\pm$ 2.4	6.3 $\pm$ 2.6	6.6 $\pm$ 2.9	6.2 $\pm$ 2.9	6.3 $\pm$ 0.4

\* Standard month = 30.4 days

(a) TLD Vandalized

(b) Several of the TLD's had collection dates 09/30/87-01/06/88.

V. CONCLUSIONS

## V. CONCLUSIONS

The results of the 1987 Radiological Environmental Monitoring Program for the North Anna Nuclear Power Station have been presented. 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 NRC Regulatory Guide 4.8. 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." Specific examples of sample media with positive analysis results are discussed below.

### AIRBORNE EXPOSURE PATHWAY

Air particulate gross beta concentrations of all the indicator locations for 1987 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 1986 which was influenced by the Chernobyl accident. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). No man-made activity was found in the particulate media during 1987. No iodine-131 was detected in charcoal filters in 1987.

A precipitation sample was collected monthly and analyzed for gross beta activity. All the gross beta activities were comparable to those measured in previous years. Semi-annual composites were analyzed for gamma emitting isotopes and tritium. All gamma emitters and tritium were below their detection limits.

#### WATERBORNE EXPOSURE PATHWAY

No man-made or natural isotopes were monitored in the surface water of Lake Anna except tritium. The average tritium activity at the waste heat treatment facility was 3763 pCi/l which is 18.8% of the reporting level for a water sample. In 1986 the tritium level was 3918 pCi/l. The preoperational level was 150 pCi/l and has been rising since 1977. The tritium level upstream of the site was 2655 pCi/l as compared with 2883 pCi/l in 1986. This is particularly significant since it is upstream of the site.

The samples of surface water collected by the Commonwealth of Virginia at the waste heat treatment facility had similar tritium results with an average activity of 3510 pCi/l. The upstream location had a lower average activity of 825 pCi/l. Naturally occurring potassium-40 was detected two times at the upstream location. No other gamma emitting isotopes were detected.

River water collected from the North Anna River, 5.8 miles downstream of the site had an average tritium level of 3680 pCi/l. The average tritium in 1986 had been 4020 pCi/l. No gamma emitters were detected.

Ground water from the environmental well on site contained no gamma emitters. The average level of tritium in ground/well water was 160 pCi/l which is a low environmental level.

#### AQUATIC PATHWAY

Sediment/silt samples provide a sensitive indicator of discharges from nuclear power stations. The sediment from North Anna environmental samples indicated that two man-made isotopes were present. Cesium-137 was monitored at all six stations. Cesium-137 was also monitored in preoperational samples of aquatic sediment; however, additional man-made isotopes appear to have accumulated. Cesium-134 was monitored at stations 08 and 11 but not at station 09. Sediment contamination does not provide a direct dose pathway to man.

The samples of shoreline soil monitored downstream of the site contained no cesium-134. Cesium-137 occurred at levels considerably lower than in sediment samples.

#### INGESTION PATHWAY

Iodine-131 was not measured in any of the 24 milk samples using the radiochemical separation method. Cesium-137 was detected in two milk samples in February 1987. Cesium-137 has been detected occasionally in previous years and then was attributed to past atmospheric nuclear weapons testing. Strontium-90 was measured in all of the milk samples. The values were comparable to the levels in 1986 and somewhat lower than preoperational years. Strontium-90 from those years 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 in 1987 showed the presence of the man-made isotopes cesium-134 and cesium-137. These isotopes were at an

activity level somewhat higher than preoperational levels but statistically similar to levels in 1986. Only cesium-137 was measured in preoperational environmental fish samples. The average level of activity in 1987 of cesium-134 was 6.9% of the reporting level and cesium-137 was 13.5% of the reporting level.

Vegetation samples contained the man-made isotope cesium-137. The cesium-137 activity levels in 1986 and in preoperational samples were statistically similar to the 1987 level.

#### 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 dosage from natural radionuclides.

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 in 1987.



VI. LAND USE CENSUS

VI. LAND USE CENSUS

- A. Technical Specification 3.12.2 requires that a Land Use Census be conducted within a distance of 8 km (5 miles) from North Anna on an annual basis. This census identifies the location of the nearest milk cow, the nearest resident and the nearest garden of greater than 50 m<sup>2</sup> (500 ft.<sup>2</sup>) producing broad leaf vegetation in each of the 16 meteorological sectors.
- B. The results of the Land Use Census are used to calculate the principal exposure pathway from gaseous effluents. This pathway analysis is compared to previous analysis to determine the requirements for modification of the Radiological Environmental Monitoring Program and/or the calculational model used for determining dose contributions to the unrestricted area.
- C. The results of the 1987 Land Use Census show no changes to the Radiological Environmental Monitoring Program or to the Offsite Dose Calculation Manual Pathway Models.

VIRGINIA POWER

NORTH ANNA POWER STATION

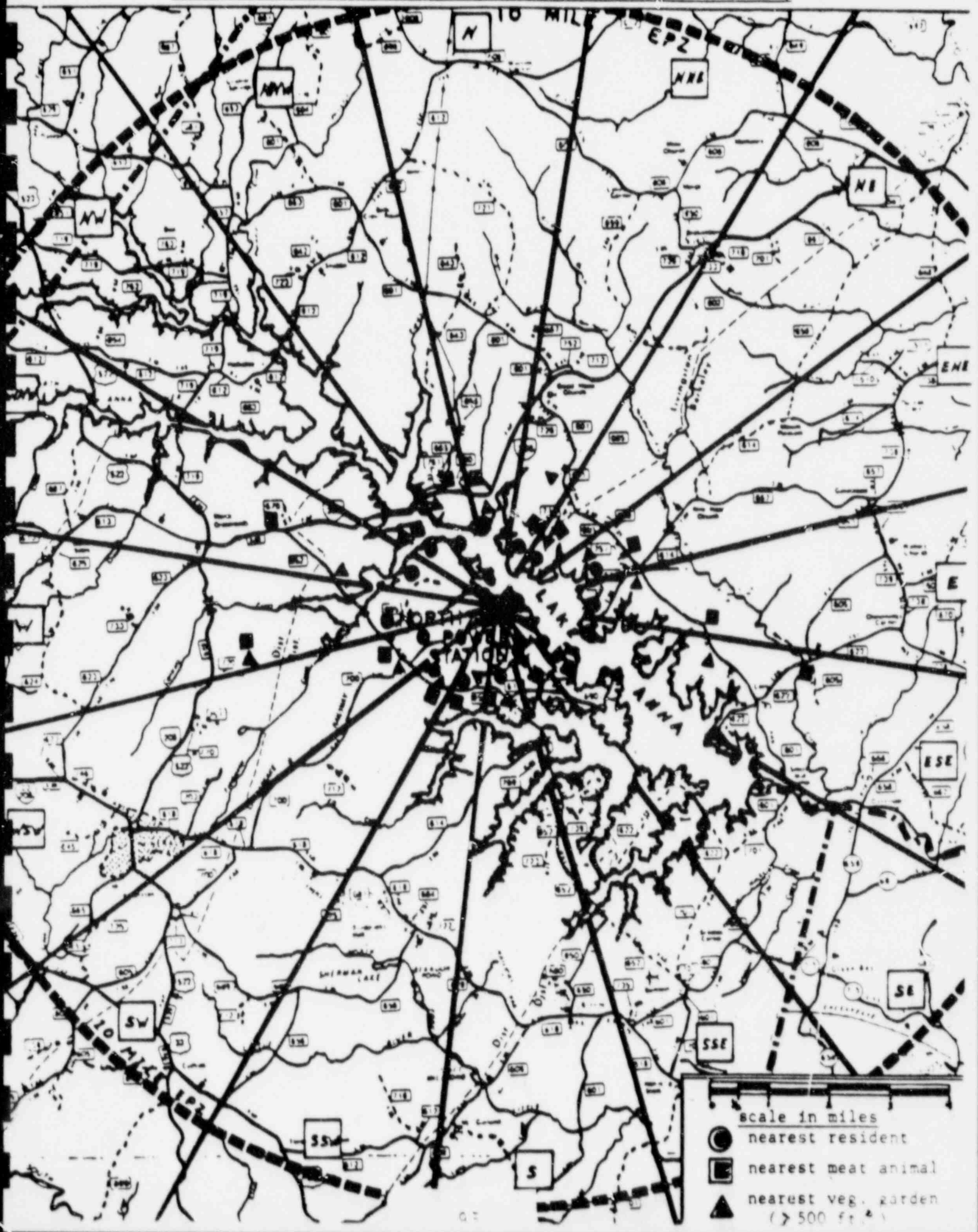
ANNUAL RADIOLOGICAL ENVIRONMENTAL LAND USE CENSUS DATA FOR 1987

(JULY 28-30)

<u>SECTOR</u>	<u>NEAREST RESIDENT</u>	<u>NEAREST SITE BOUNDARY</u>	<u>MILK* COW</u>	<u>MEAT ANIMAL</u>	<u>MILK* GOAT</u>	<u>VEG. GARDEN 500 ft<sup>2</sup></u>
N	2.41 km	1.40 km		3.51 km		2.36 km
NNE	2.17 km	1.36 km		2.36 km		4.0 km
NE	1.93 km	1.32 km		2.55 km		2.49 km
ENE	3.21 km	1.31 km		4.10 km		3.21 km
E	2.01 km	1.33 km		5.95 km		4.26 km
ESE	2.69 km	1.37 km		8.85 km		6.20 km
SE	2.33 km	1.41 km		2.33 km		2.32 km
SSE	1.53 km	1.47 km		2.33 km		1.59 km
S	1.61 km	1.52 km		2.30 km		2.41 km
SSW	2.17 km	1.62 km		2.50 km		2.17 km
SW	2.38 km	1.70 km		2.74 km		2.45 km
WSW	2.25 km	1.75 km		2.90 km		2.90 km
W	2.91 km	1.71 km		6.83 km		6.83 km
WNW	2.34 km	1.64 km		6.20 km		4.18 km
NW	2.39 km	1.56 km		4.35 km		4.35 km
NNW	1.93 km	1.45 km		3.62 km		3.36 km

\* NOTE: No milk cows or milk goats within a five mile radius of North Anna Power Station.

VIRGINIA POWER - NORTH ANNA POWER STATION  
 ANNUAL RADIOLOGICAL ENVIRONMENTAL LAND USE CENSUS MAP FOR 1987



VII. SYNOPSIS OF ANALYTICAL PROCEDURES

## VII. SYNOPSIS OF ANALYTICAL PROCEDURES

Section VII is a synopsis of the analytical procedures performed on samples collected for the North Anna Power Station Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by VEPCO and Teledyne Isotopes and include those requested by the USNRC Regulatory Guide 4.8,BTP, Rev. 1, November 1979.

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GROSS BETA AND GROSS ALPHA ANALYSIS OF AIR PARTICULATE SAMPLES

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. The sample is counted at one operating voltage for gross beta and then changed to a second operating voltage for gross alpha.

Calculation of the results, the two sigma error and the lower limit of detection (LLD).

$$\begin{aligned}\text{RESULT (pCi/m}^3\text{)} &= ((S/T) - (B/t)) / (2.22 V E) \\ \text{TWO SIGMA ERROR (pCi/m}^3\text{)} &= ((S/T^2) + (B/t^2))^{1/2} / (2.22 V E) \\ \text{LLD (pCi/m}^3\text{)} &= 4.66 (B^{1/2}) / (2.22 V E t)\end{aligned}$$

where.

- S = Gross counts of sample
- B = Counts of background (different for alpha and beta)
- E = Counting efficiency (different for alpha and beta)
- T = Number of minutes sample was counted
- t = Number of minutes background was counted
- V = Sample aliquot size (cubic meters)

## GROSS BETA ANALYSIS OF WATER SAMPLES

One liter of sample is evaporated to near dryness and the residue is transferred to a tared, 2" diameter planchet and final evaporation to dryness takes place under heat lamps. The planchet is weighed and then counted in a gas-flow proportional counter.

Calculation of the results, the two sigma error and the lower limit of detection (LLD).

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

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

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

where:

- S = Gross counts of sample
- B = Counts of background
- E = Counting efficiency
- T = Number of minutes sample was counted
- t = Number of minutes background was counted
- V = Sample aliquot size (liter)



## ANALYSIS OF SAMPLES FOR TRITIUM

### Water

Approximately 2 ml of water are converted to hydrogen by passing the water, heated to its vapor state, over a granular zinc conversion column heated to 400° C. The hydrogen is loaded into a one liter proportional detector and the volume is determined by recording the pressure.

The proportional detector is passively shielded by lead and steel and an electronic, anticoincidence system provides additional shielding from cosmic rays.

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

$$\text{RESULT} = 3.234 T_N V_N (C_G - B) / (C_N V_S)$$

$$\text{TWO SIGMA ERROR} = 2((C_G + B)\Delta t)^{1/2} 3.234 T_N V_N / ((C_N V_S)(C_G - B))$$

$$\text{LLD} = 4.66 (3.234) T_N V_N (C_G)^{1/2} / (\Delta t C_N V_S)$$

- where:
- $T_N$  = tritium units of the standard
  - 3.234 = conversion factor changing tritium units to pCi/ℓ
  - $V_N$  = volume of the standard used to calibrate the efficiency of the detector in psia
  - $V_S$  = volume of the sample loaded into the detector in psia
  - $C_N$  = the cpm activity of the standard of volume  $V_N$
  - $C_G$  = the gross activity in cpm of the sample of volume  $V_S$  and the detector volume
  - B = the background of the detector in cpm
  - $\Delta t$  = counting time for the sample

## 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 precipitate is weighed for chemical yield and is mounted on a nylon planchet 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:

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

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

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

where: N = total counts from sample (counts)

Δt = counting time for sample (min)

B = background rate of counter (cpm)

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 mid-collection date 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<sub>s</sub> = efficiency of the counter determined from an I-131 standard mount

M<sub>s</sub> = mass of PdI<sub>2</sub> on the standard mount, mg

M = mass of PdI<sub>2</sub> 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 at least 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

### Dried Solids Other Than Soils 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 at least 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-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 at least 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

### Soils and Sediments

Soils and sediments are dried to 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 at least six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

### Charcoal Cartridges (Air Iodine)

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a Ge(Li) detector and up to four on the side of the Ge(Li) detector. Each Ge(Li) 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 Particulate

The four or five (depending on the calendar month) air particulate filters for a monthly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

A mini-computer 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. The calculation of results, two sigma error and the lower limit of detection (LLD) in pCi/volume or pCi/mass:

$$\text{RESULT} = (S-B)/(2.22 t E V F DF)$$

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

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

- 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 either side of the 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 collection to the counting date

## ENVIRONMENTAL DOSIMETRY

Teledyne Isotopes 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 the TLDs are placed in a Teledyne Isotopes 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.

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

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

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

- 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 known exposure by the Cs-137 source
- $R_1$  = 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

## 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 5 to 7 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet 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 planchet 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 trichloroacetic acid (TCA) is added to produce a curd. The curd is separated by filtration and is discarded. An oxalate precipitation is performed on the filtrate and the precipitate is ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as  $\text{SrNO}_3$  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 7 to 10 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet 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 planchet 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 a 10 gram aliquot is taken. Stable strontium carrier is added and the sample is leached in nitric acid. The mixture is filtered and the liquid portion is reduced in volume by evaporation. 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 7 to 10 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet 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 planchet and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting.

### Organic Solids

A 200g 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 nitric acid. The sample is filtered and the volume is reduced by evaporation. Strontium is precipitated as  $\text{Sr}(\text{NO}_3)_2$  using fuming (90%) nitric acid. 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, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet 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 mounted on a nylon planchet 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. 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, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet 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 mounted on a nylon planchet and is covered with  $80 \text{ mg/cm}^2$  aluminum absorber for level beta counting.

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

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

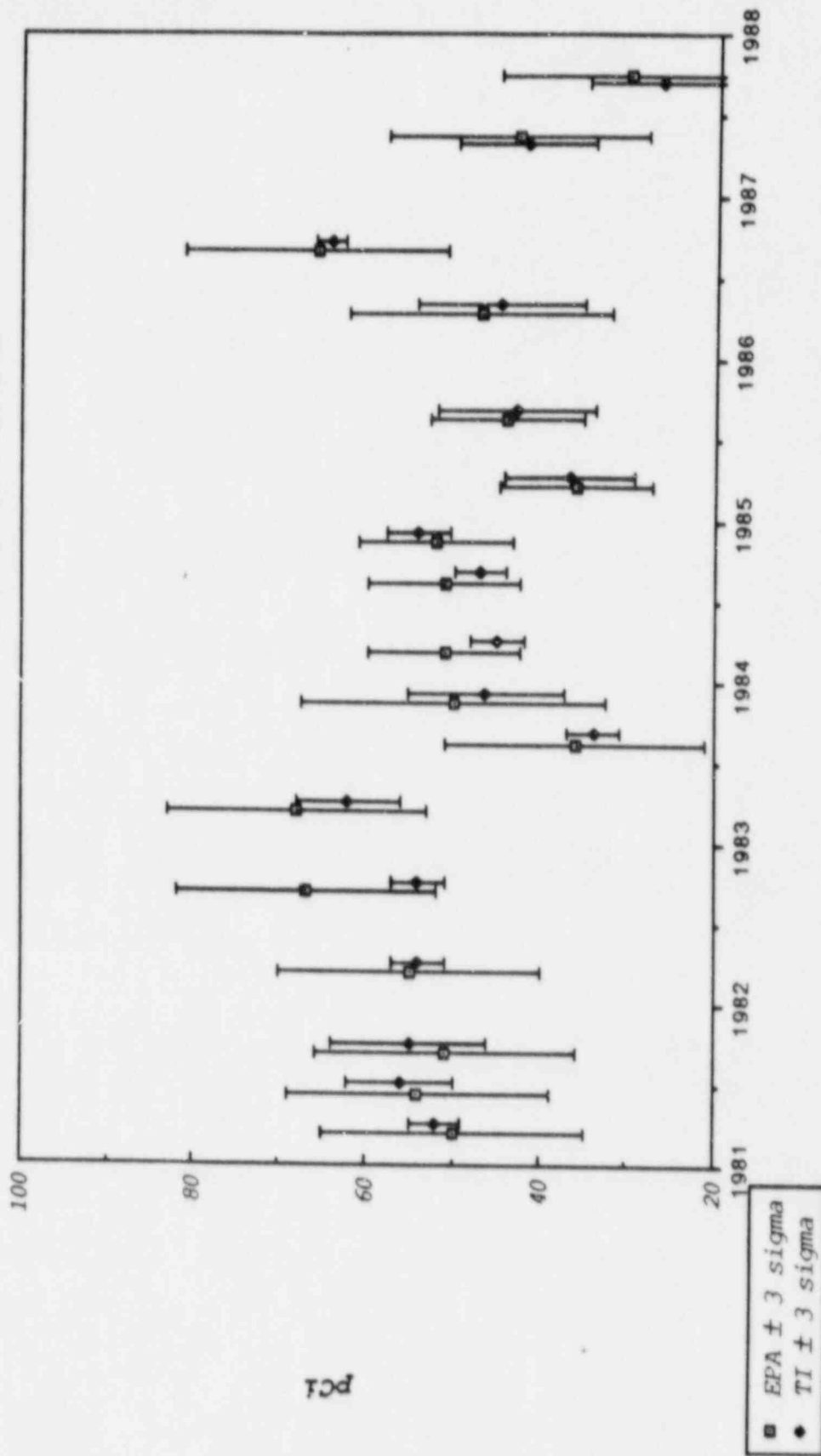
VIII. EPA INTERLABORATORY COMPARISON PROGRAM



#### VIII. EPA INTERLABORATORY COMPARISON PROGRAM

Teledyne Isotopes participates in the US EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1987 data summary tables are presented for isotopes in the various sample media applicable to the North Anna Stations Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases.

**US EPA CROSS CHECK PROGRAM**  
**Gross Beta in Air Particulates**

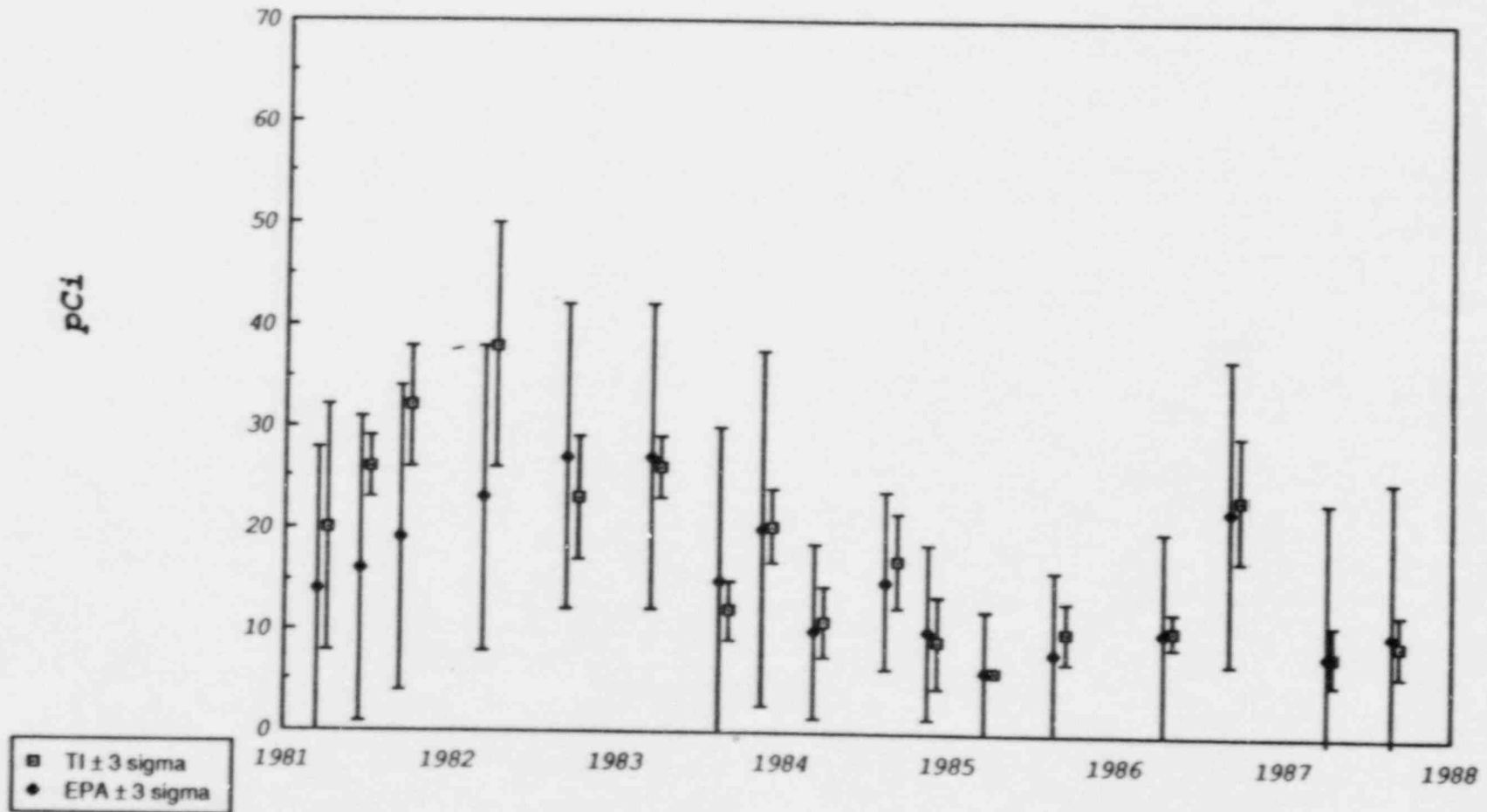


# US EPA CROSS CHECK PROGRAM

## Cs-137 in Air Particulates

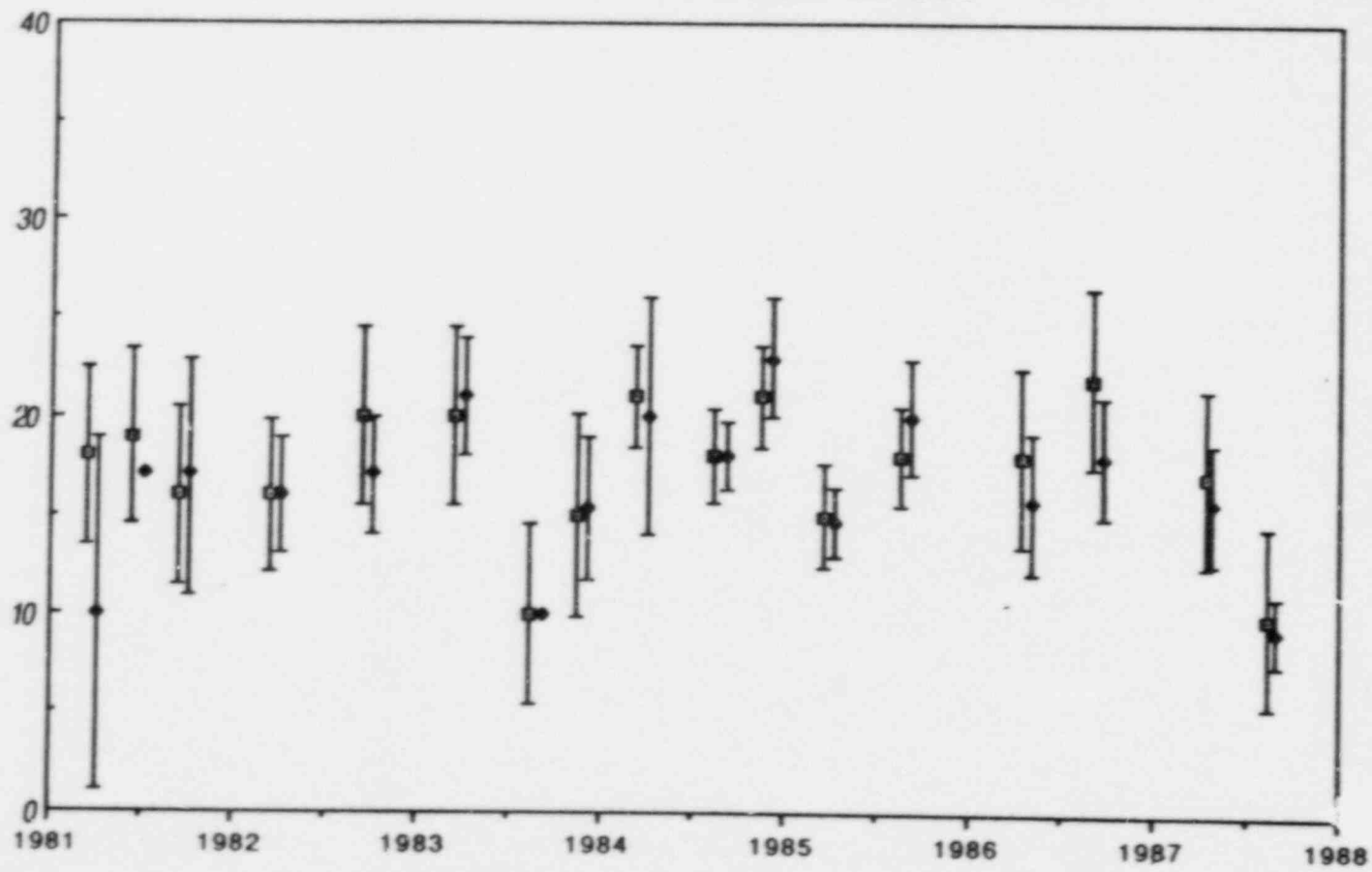
110

pCi



US EPA CROSS CHECK PROGRAM

Sr-90 in Air Particulates



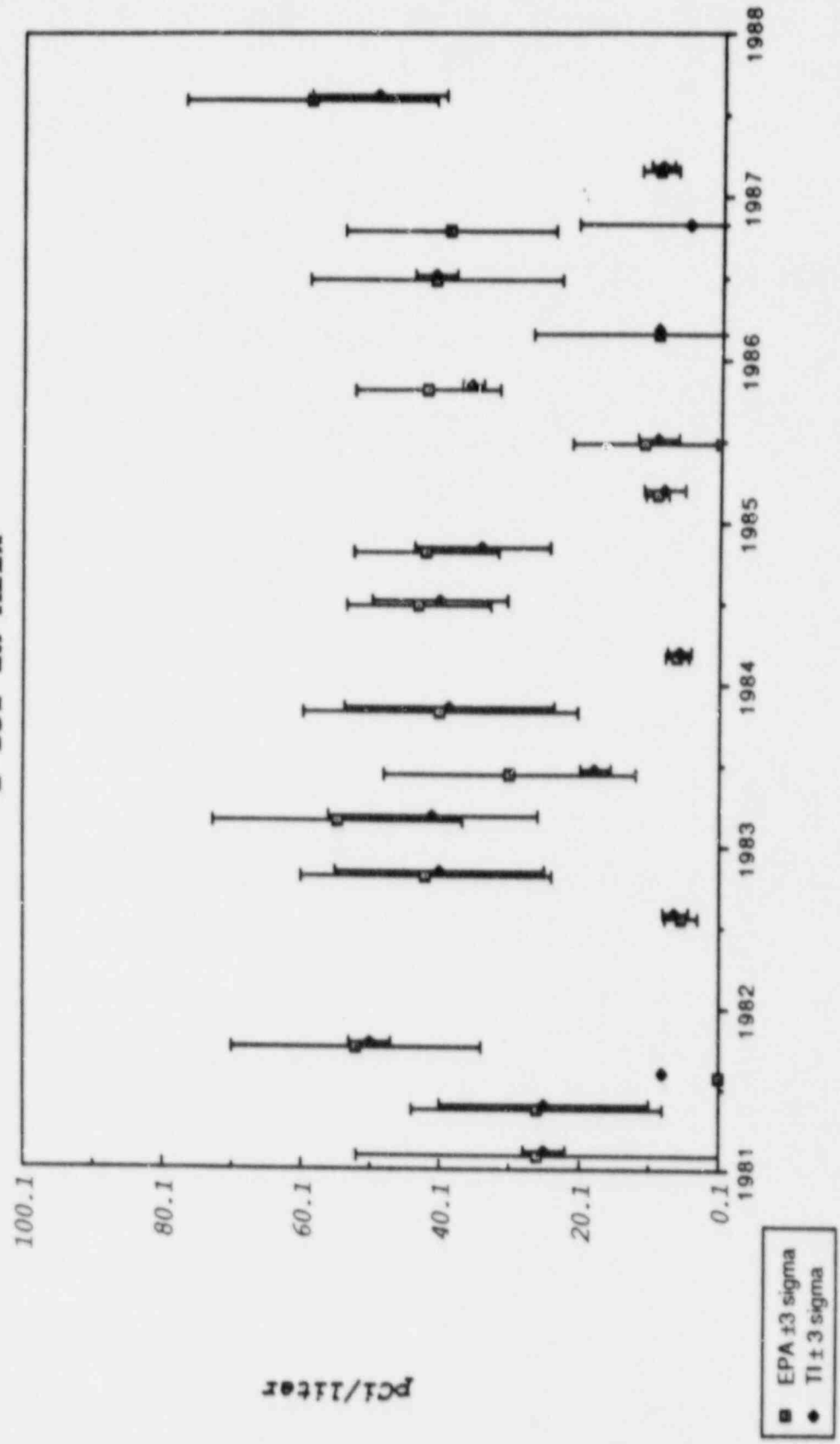
■ EPA ± 3 sigma  
● TI ± 3 sigma

111

PCI

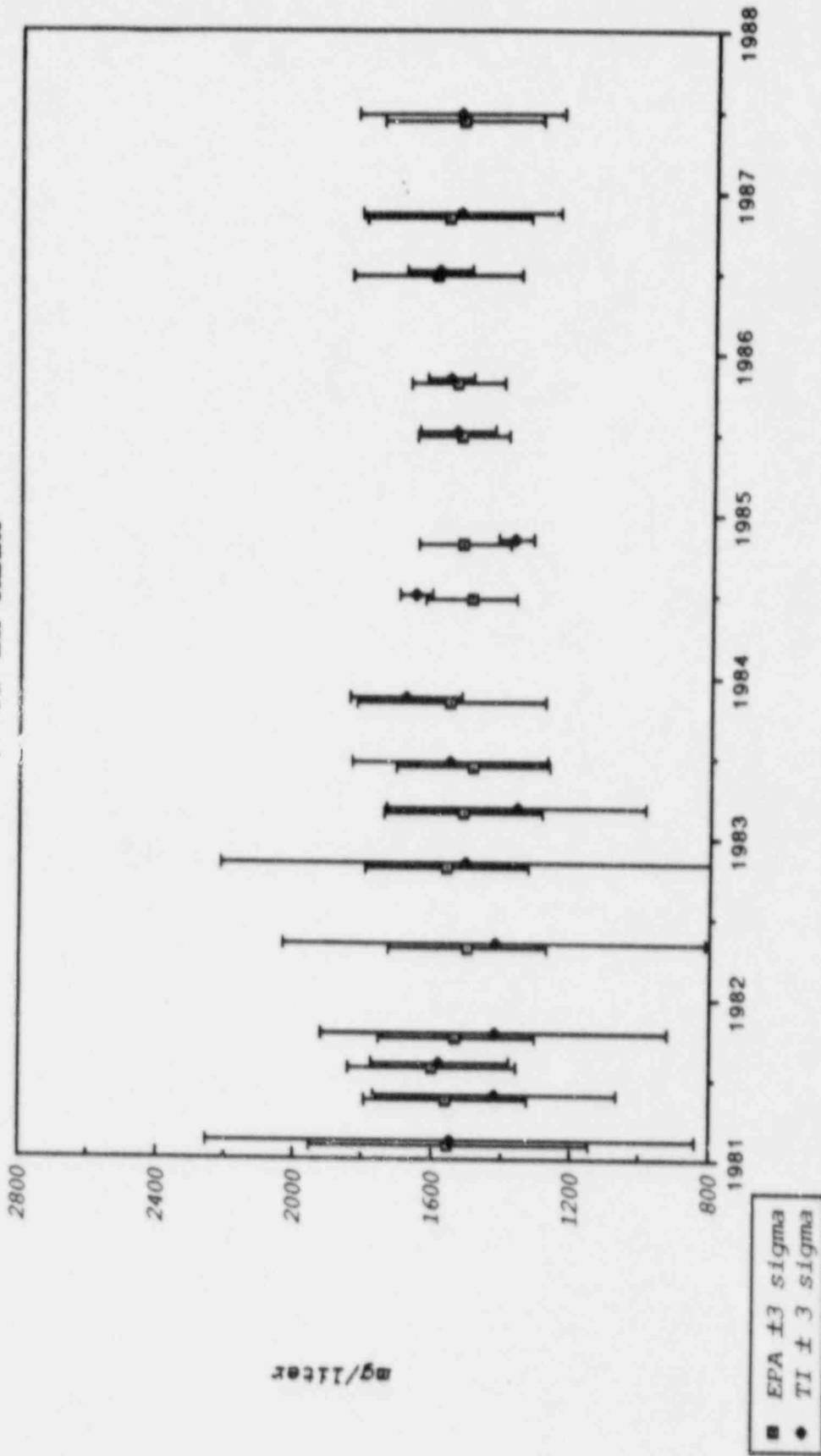
# US EPA CROSS CHECK PROGRAM

## I-131 in Milk



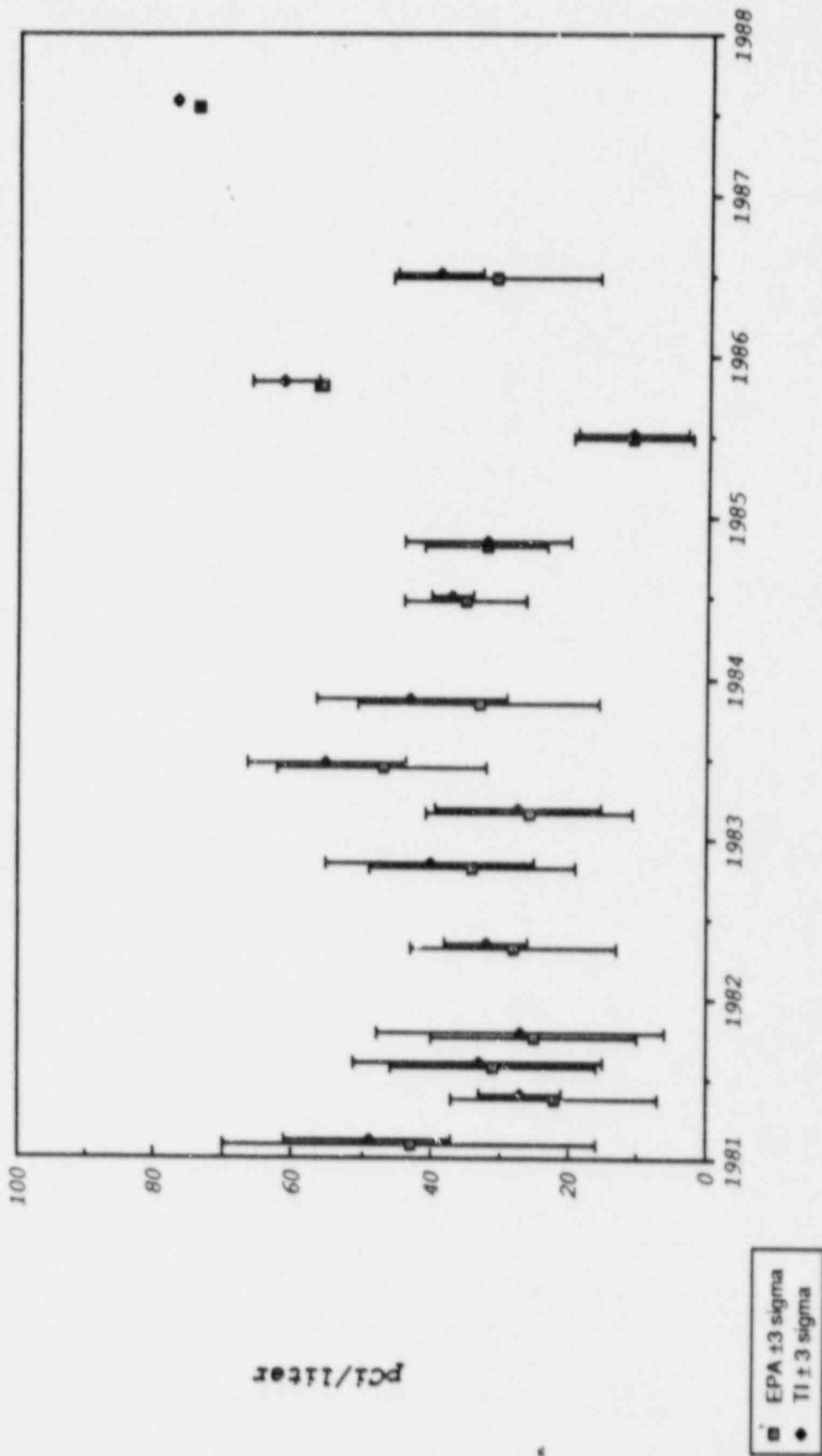
# US EPA CROSS CHECK PROGRAM

PC-40 in Milk

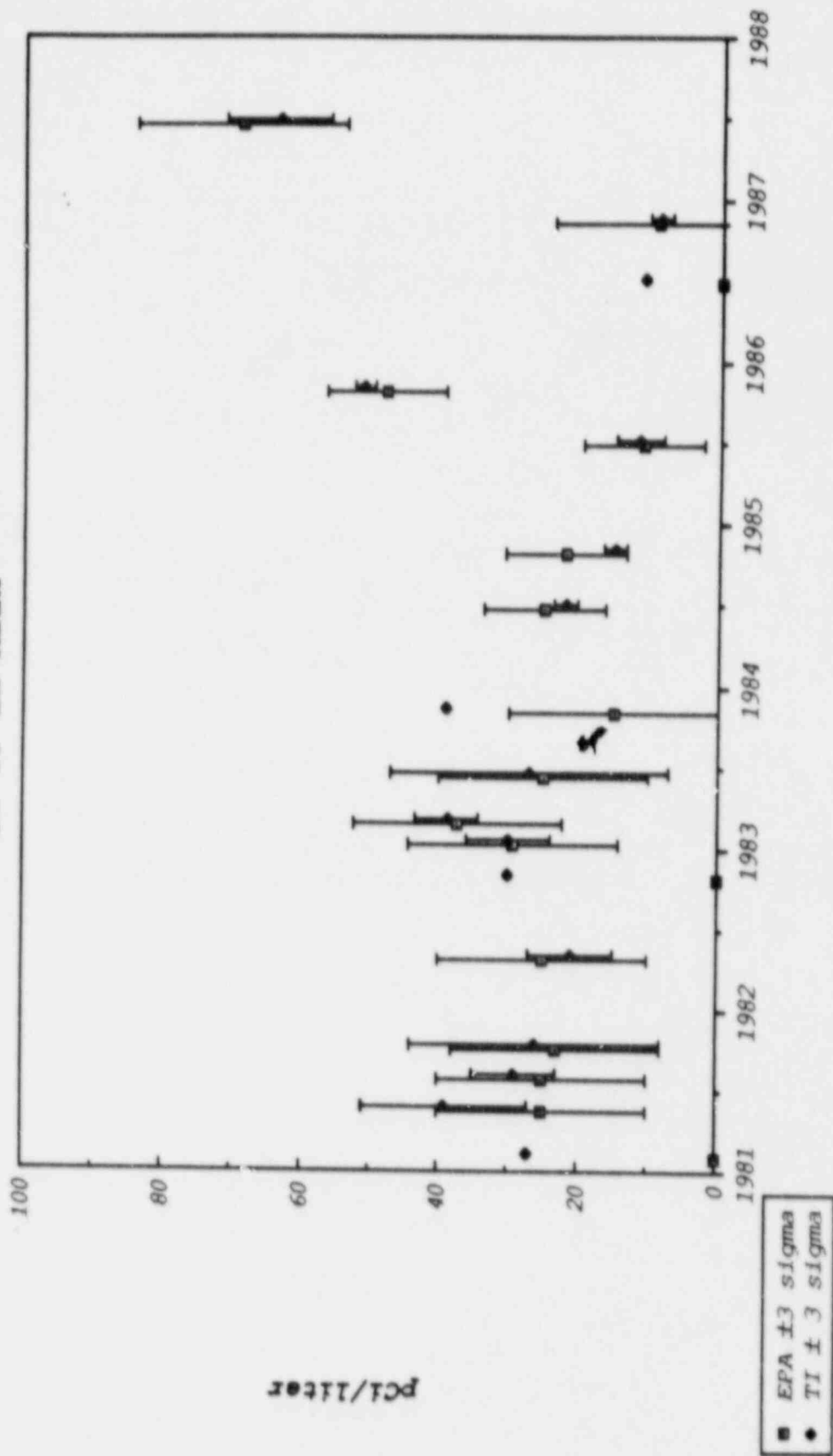


# US EPA CROSS CHECK PROGRAM

## Cs-137 in Milk



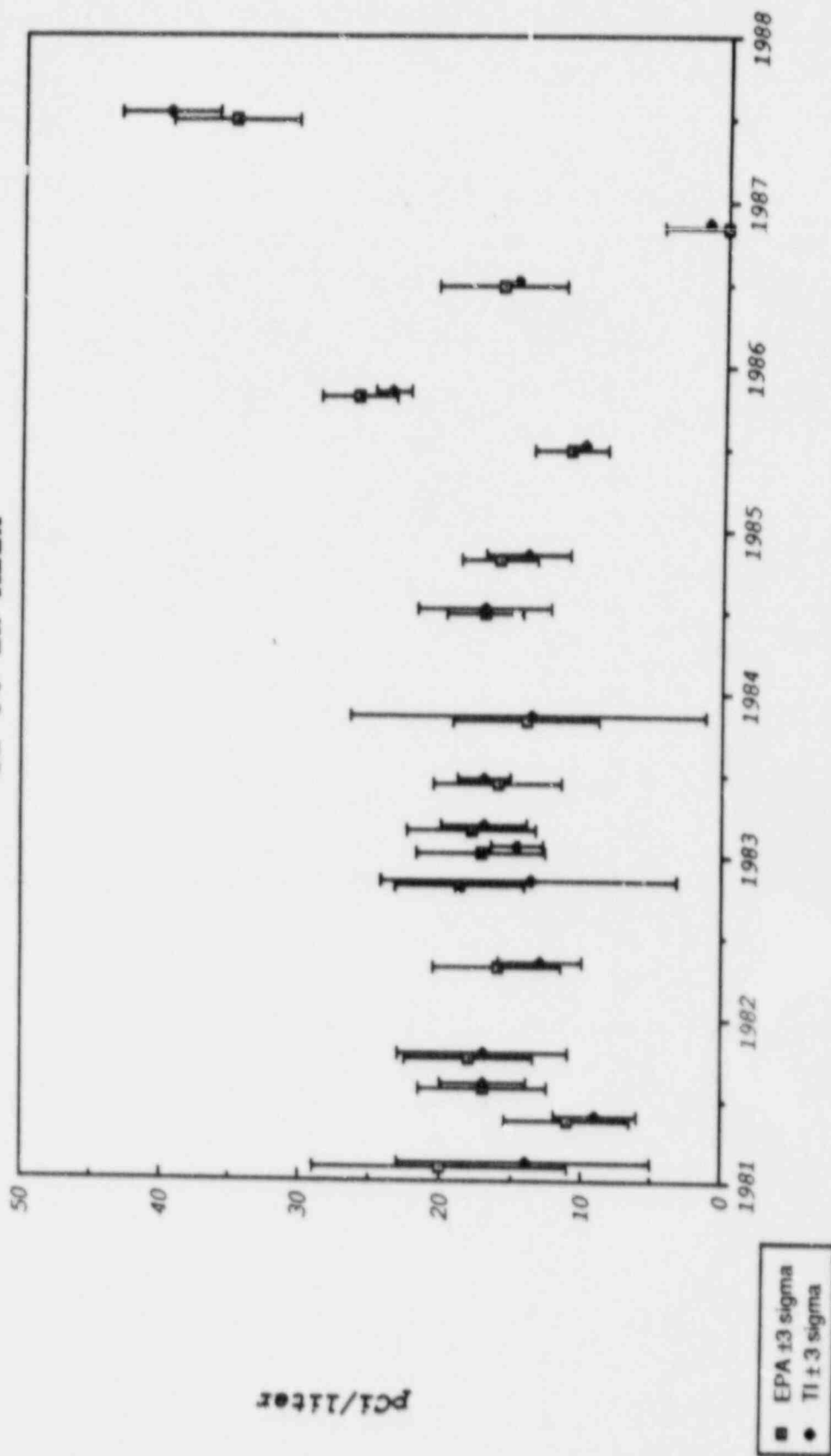
US EPA CROSS CHECK PROGRAM  
Sr-89 in Milk





# US EPA CROSS CHECK PROGRAM

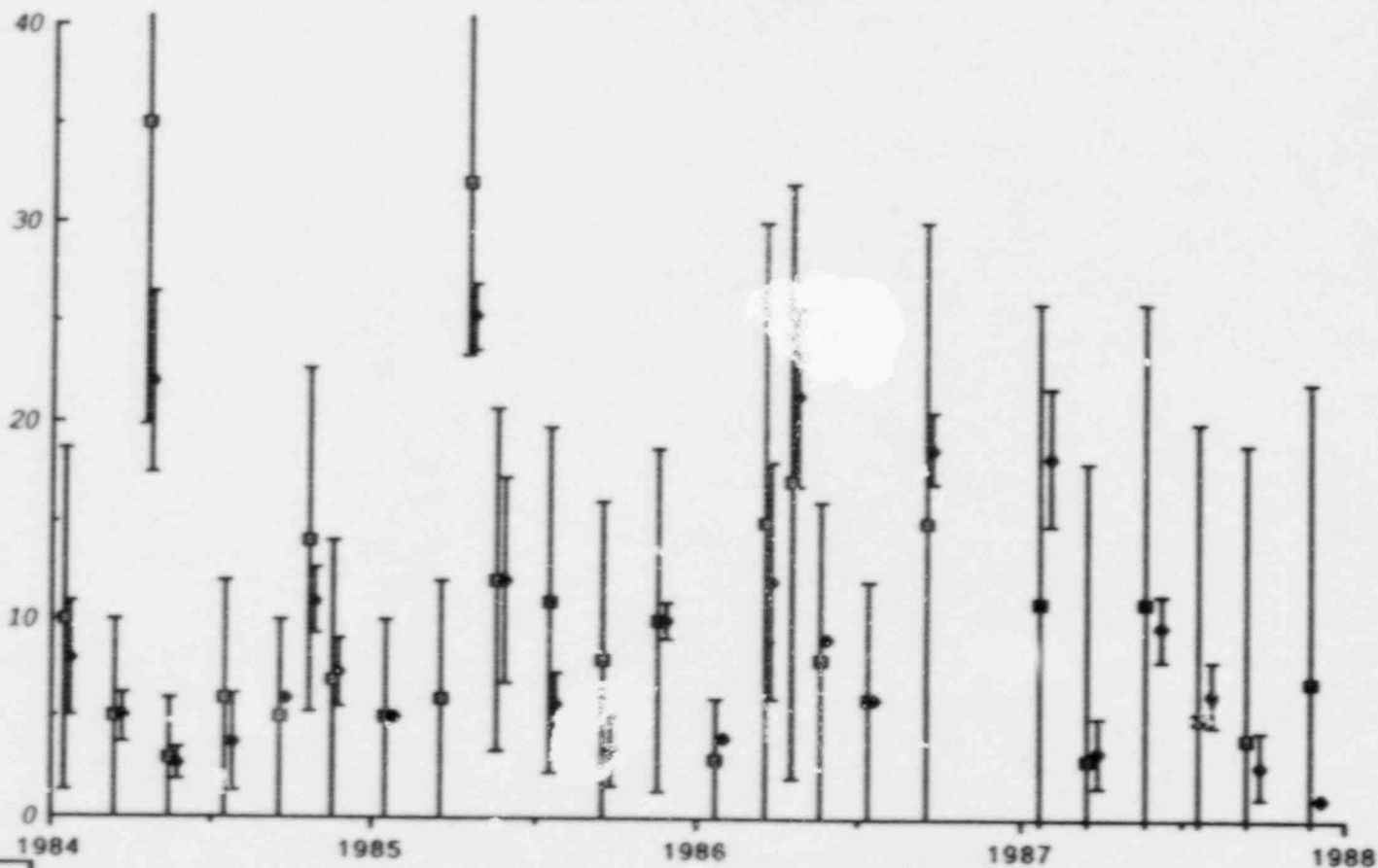
## Sr-90 in Milk



US EPA CROSS CHECK PROGRAM

Gross Alpha in Water

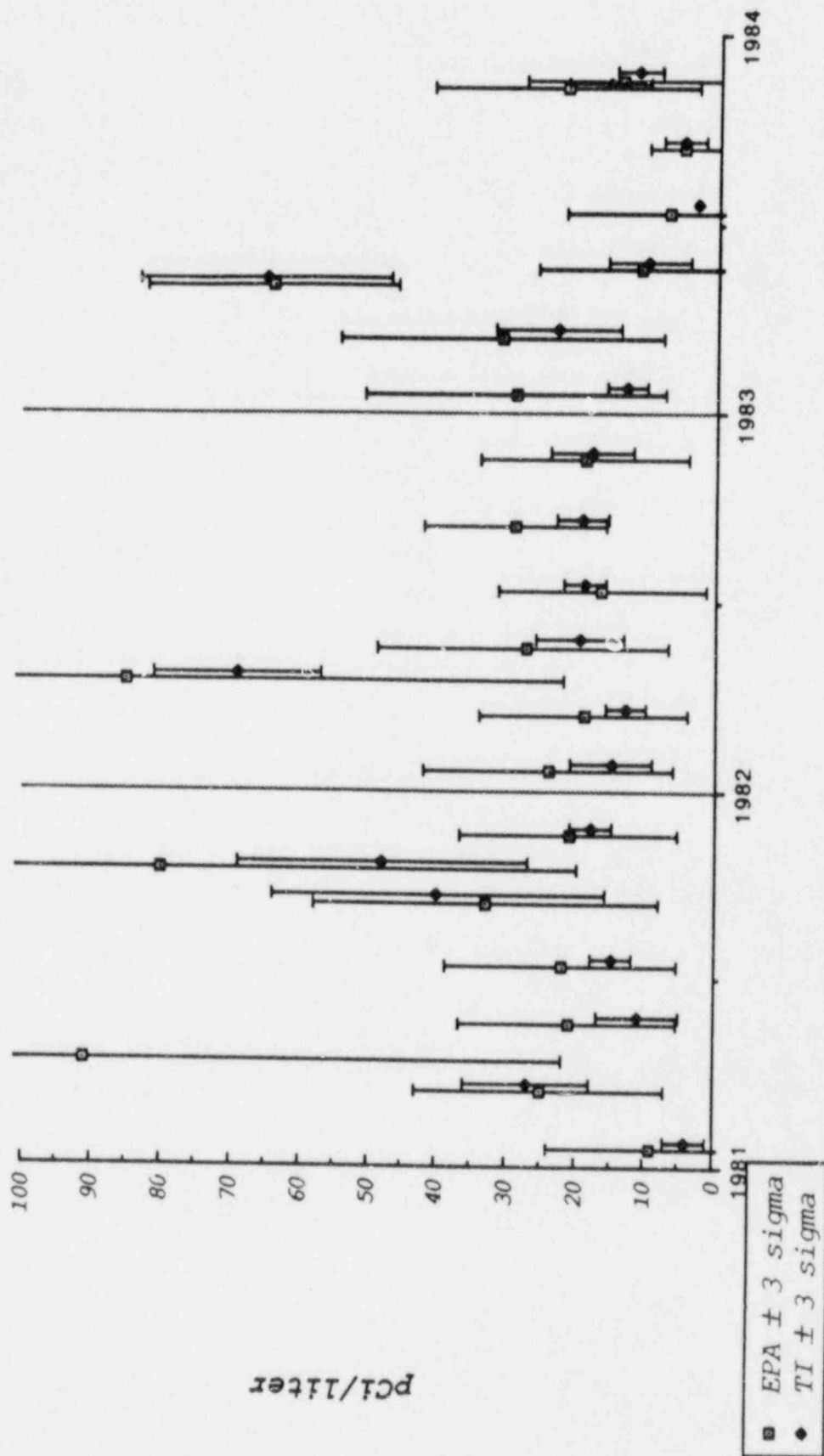
pCi/liter



■ EPA  $\pm 3$  sigma  
● TI  $\pm 3$  sigma

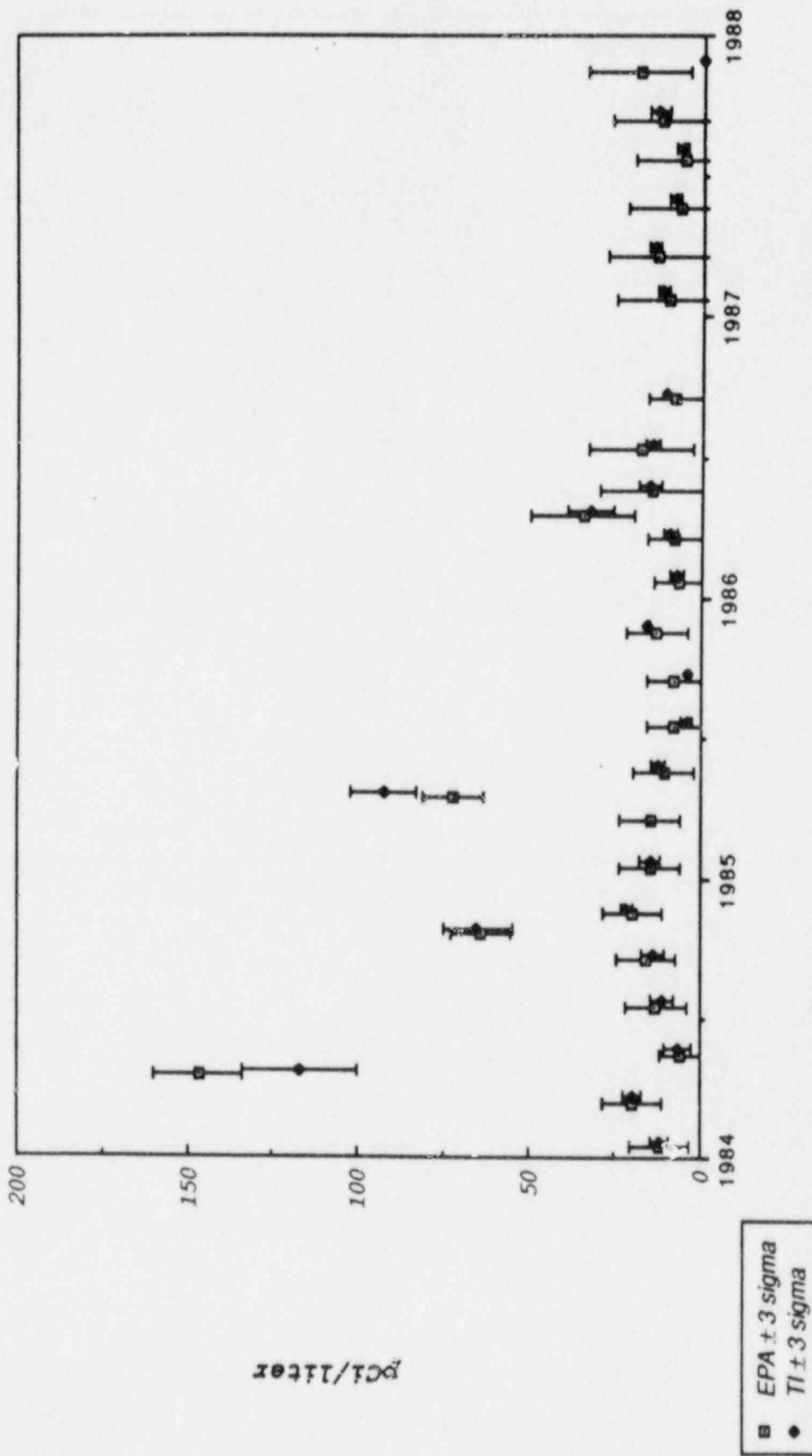
US EPA CROSS CHECK PROGRAM

Gross Alpha in Water



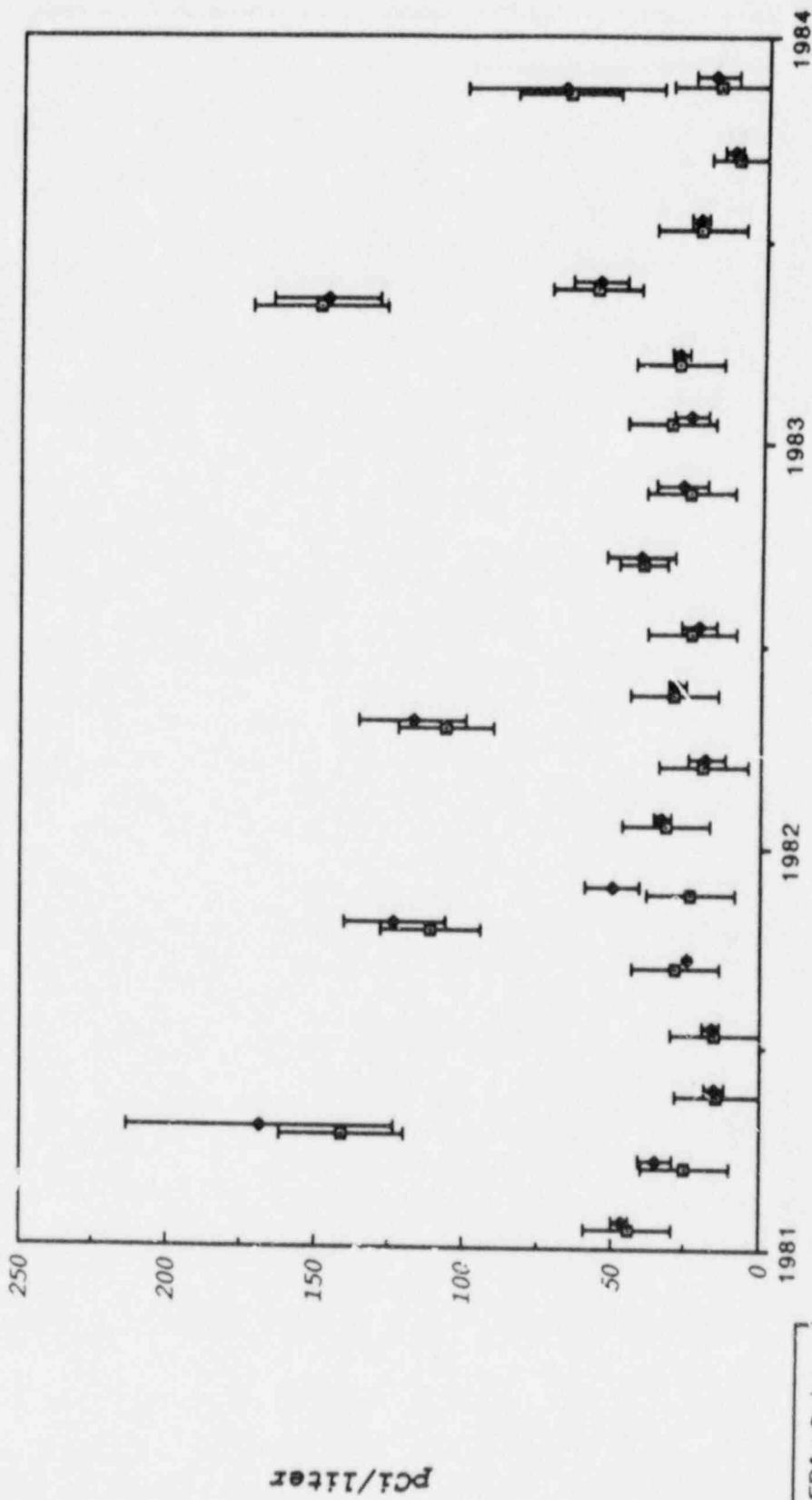
# US EPA CROSS CHECK PROGRAM

Gross Beta in Water



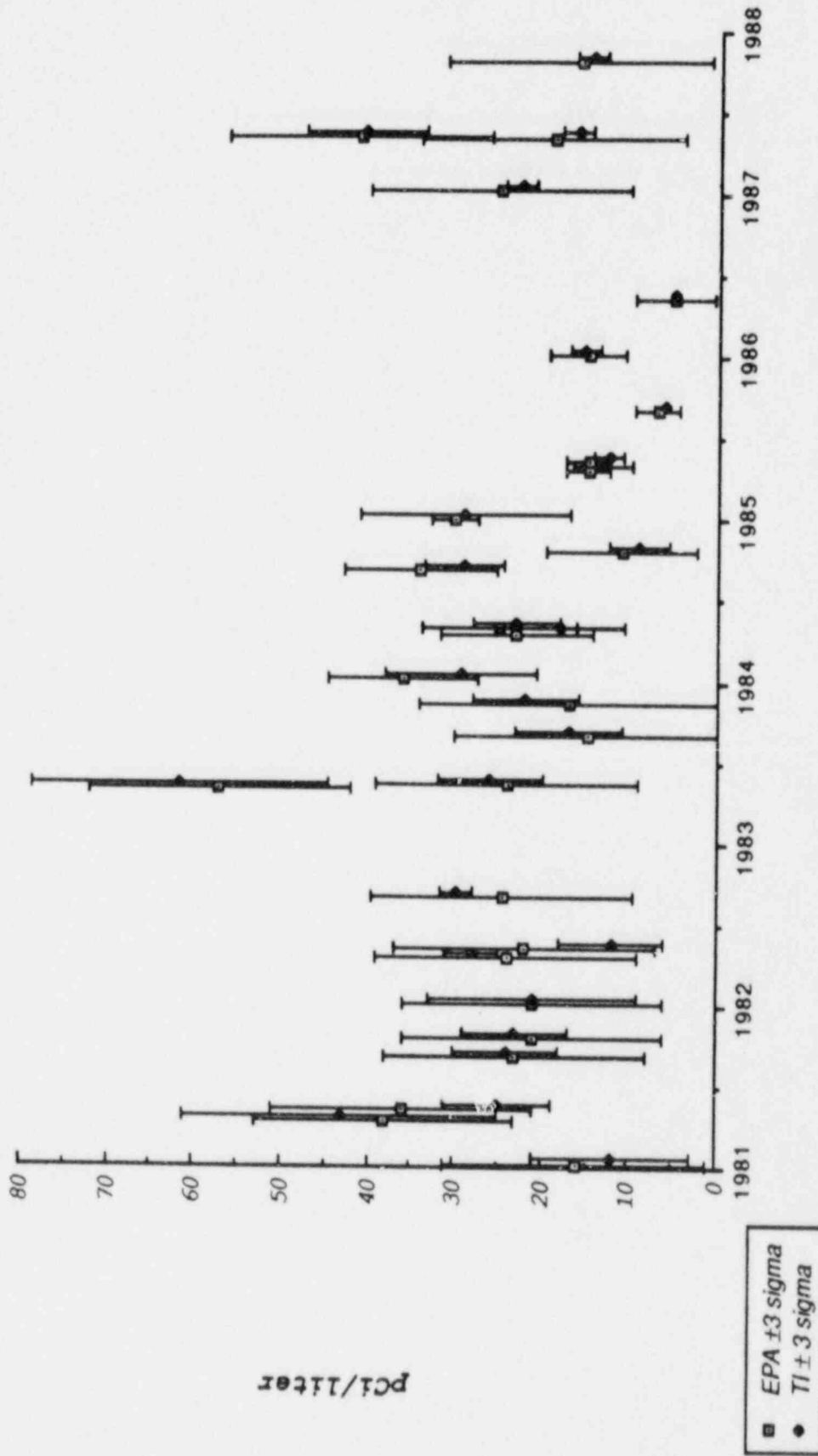
# US EPA CROSS CHECK PROGRAM

Gross Beta in Water



# US EPA CROSS CHECK PROGRAM

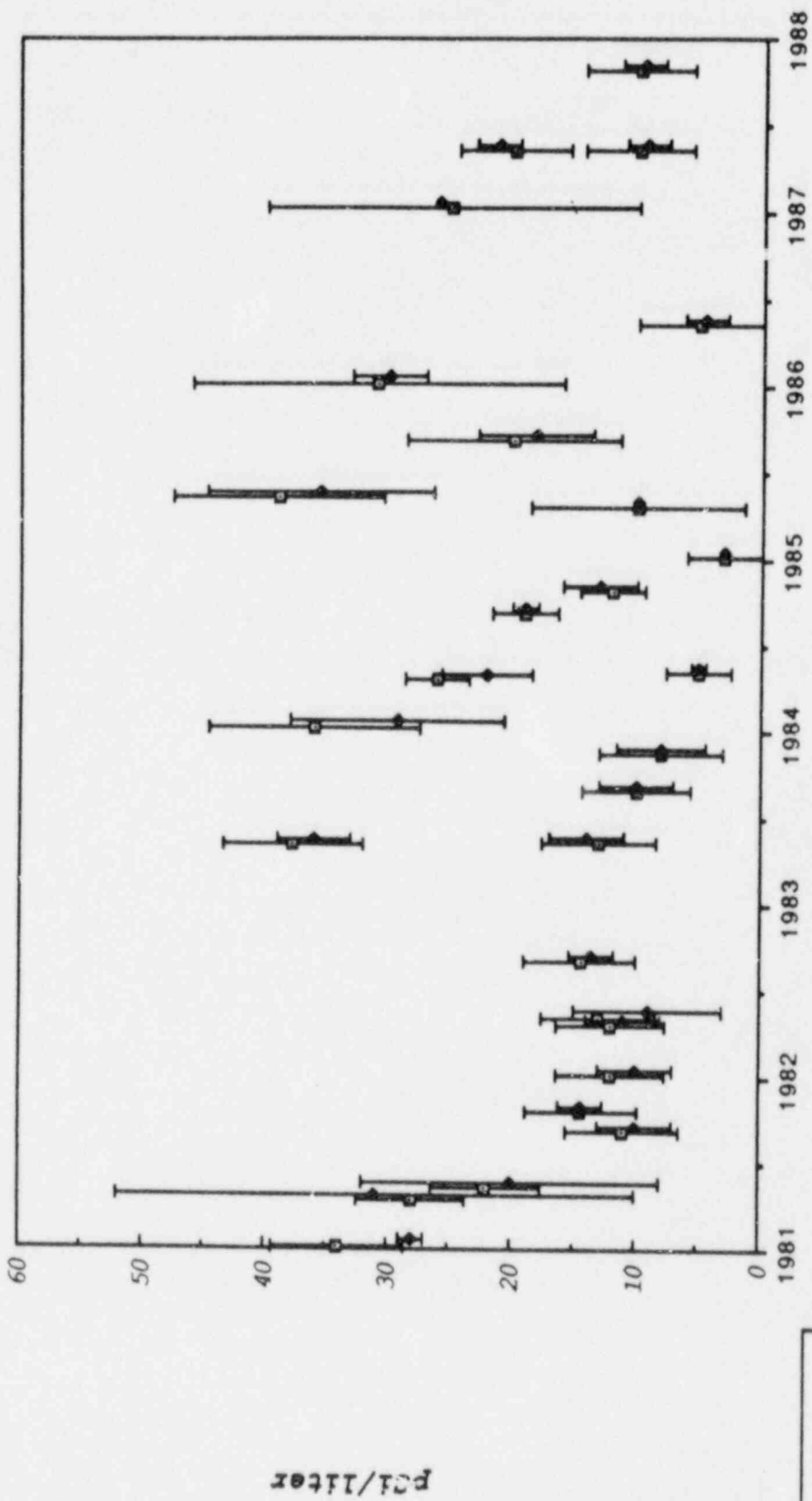
## SR-89 IN Water



pCi/liter

□ EPA ±3 sigma  
● TI ±3 sigma

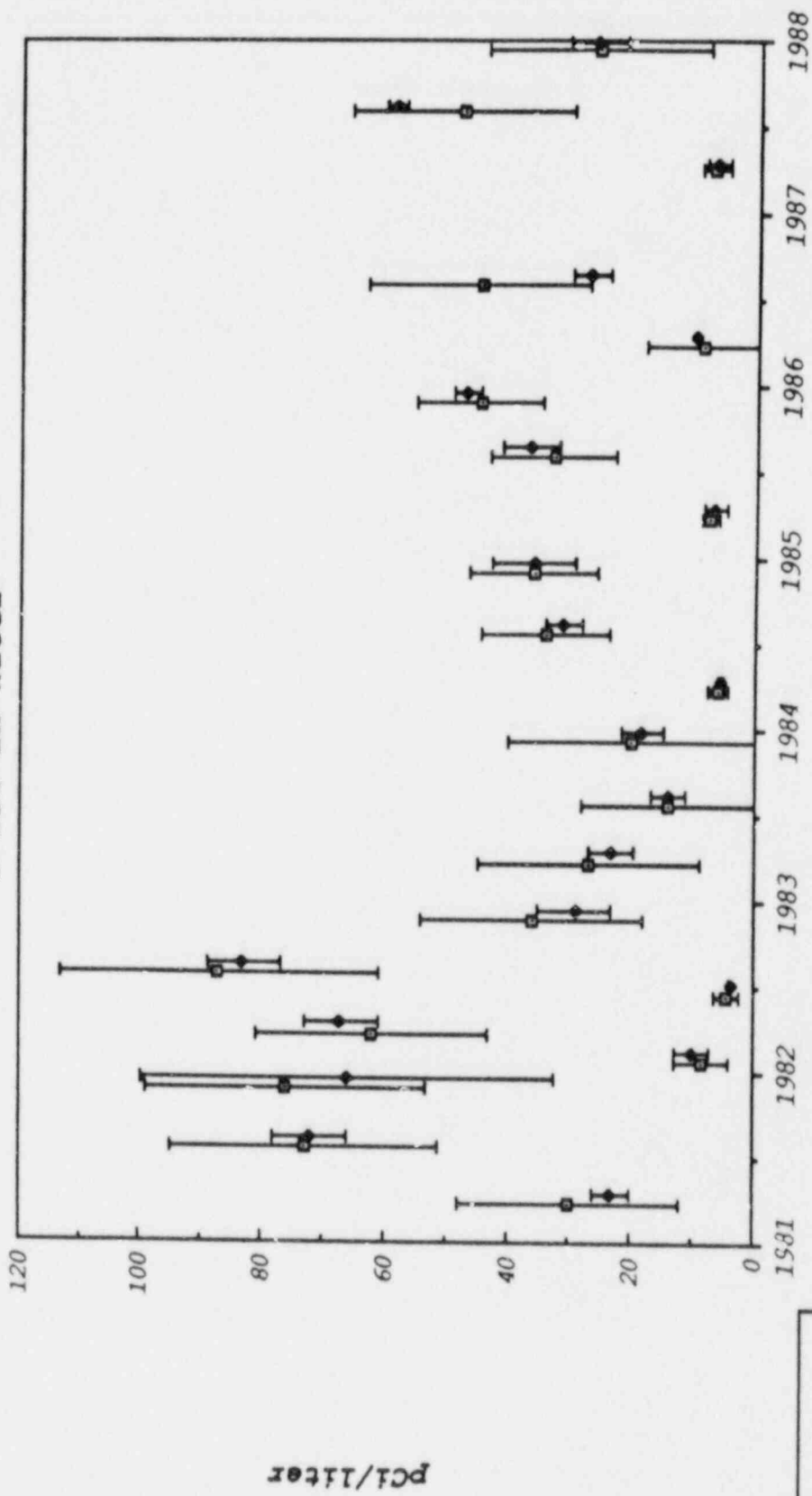
US EPA CROSS CHECK PROGRAM  
SR-90 IN WATER



■ EPA ±3 sigma  
◆ TI ±3 sigma

US EPA CROSS CHECK PROGRAM

I-131 in Water



□ EPA ±3 sigma  
● TI ±3 sigma





US EPA INTERLABORATORY COMPARISON PROGRAM 1987

VEPCO - NORTH ANNA

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EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action
11/04/86	01/09/87	02/09/87	Milk	Sr-89 Sr-90 I-131 Cs-137 K	9.00 ± 5.00 C.00 ± 1.50 40.00 ± 6.00 39.00 ± 5.00 1565.00 ± 78.00	8.67 ± 0.58 <1.33 54.33 ± 2.88 48.00 ± 5.29 1530.00 ± 95.39	-0.11 - 1.54 3.12 -0.78	*** (c)
01/09/87	02/24/87	06/16/87	Water	Sr-89 Sr-90	25.00 ± 5.00 25.00 ± 1.50	22.66 ± 0.58 26.00 ± 0.00	-0.81 1.15	
01/30/87	04/09/87	05/07/87	Food	Sr-90 I-131 Cs-137 K-40	49.00 ± 10.00 78.00 ± 8.00 84.00 ± 5.00 980.00 ± 49.00	50.00 ± 2.83 74.00 ± 1.41 91.00 ± 5.66 984.00 ± 67.10	0.14 -0.71 1.98 0.14	
02/06/87	03/18/87	04/15/87	Water	Co-60 Zn-65 Ru-106 Cs-134 Cs-137	50.00 ± 5.00 91.00 ± 5.00 100.00 ± 5.00 59.00 ± 5.00 87.00 ± 5.00	50.33 ± 1.52 108.33 ± 2.51 100.33 ± 11.15 62.00 ± 5.57 92.00 ± 3.60	0.11 6.00 0.11 1.03 1.73	*** (d)
02/13/87	03/13/87	04/15/87	Water	H-3	4209.00 ± 421.00	4100.00 ± 200.00	-0.45	
02/27/87	03/12/87	05/26/87	Milk	I-131	9.00 ± 0.90	8.67 ± 0.58	-0.64	
04/03/87	04/24/87	06/02/87	Water	I-131	7.00 ± 0.70	6.67 ± 0.58	-0.82	
04/10/87	06/05/87	07/16/87	Air Filter	Gr-Beta Sr-90 Cs-137	43.00 ± 5.00 17.00 ± 1.50 8.00 ± 5.00	42.00 ± 2.64 15.66 ± 0.58 8.00 ± 1.00	-0.34 -1.54 0.00	
04/27/87	06/26/87	07/27/87	Lab Perf.	Ra-226 Ra-228 Gr-Beta Sr-89 Sr-90 Co-60 Cs-134 Cs-137	3.90 ± 0.60 4.00 ± 0.60 66.00 ± 5.00 19.00 ± 5.00 10.00 ± 1.50 8.00 ± 5.00 20.00 ± 5.00 15.00 ± 5.00	3.80 ± 0.10 3.86 ± 0.25 56.00 ± 1.73 16.33 ± 0.58 9.33 ± 0.58 8.00 ± 1.00 15.33 ± 1.52 12.33 ± 1.15	-0.29 -0.48 -3.46 -0.92 -0.77 0.00 -1.61 -0.92	*** (e)

Footnotes at end of table

VEPCO - NORTH ANNA

(Page 2 of 3)

EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action
05/08/87	06/12/87	08/31/87	Water	Sr-89 Sr-90	41.00 ± 5.00 20.00 ± 1.50	40.33 ± 2.31 21.33 ± 0.58	-0.23 1.54	
06/05/87	07/15/87	08/26/87	Water	Cr-51 Co-60 Zn-65 Ru-106 Cs-134 Cs-137	41.00 ± 5.00 64.00 ± 5.00 10.00 ± 5.00 75.00 ± 5.00 40.00 ± 5.00 80.00 ± 5.00	<53.33 63.00 ± 4.36 <9.67 72.00 ± 11.79 34.66 ± 1.52 79.00 ± 4.36	- -0.34 - -1.03 -1.84 -0.34	
05/12/87	07/10/87	07/27/87	Water	H-3	2895.00 ± 357.00	2800.00 ± 100.00	-0.46	
06/26/87	08/13/87	10/01/87	Milk	Sr-89 Sr-90 I-131 Cs-137 K	69.00 ± 5.00 35.00 ± 1.50 59.00 ± 6.00 74.00 ± 5.00 1525.00 ± 76.00	63.67 ± 2.51 39.66 ± 1.15 49.33 ± 3.21 77.00 ± 5.20 1533.33 ± 98.15	-1.84 5.39 -2.79 1.03 0.19	*** (f) ** (g)
07/24/87	08/21/87	09/11/87	Water	Gr-Beta	5.00 ± 5.00	6.33 ± 0.58	0.46	
07/31/87	09/30/87	11/09/87	Food	Sr-89 Sr-90 I-131 Cs-137 K	20.00 ± 5.00 30.00 ± 1.50 80.00 ± 8.00 50.00 ± 5.00 1680.00 ± 84.00	18.67 ± 1.15 31.00 ± 1.00 88.00 ± 10.58 57.33 ± 5.51 1603.33 ± 201.08	-0.46 1.15 1.73 2.54 -1.58	** (h)
08/07/87	09/02/87	11/05/87	Water	I-131	48.00 ± 6.00	58.67 ± 0.58	3.08	*** (i)
08/28/87	10/07/87	12/14/87	Air Filter	Gr-Beta Sr-90 Cs-137	30.00 ± 5.00 10.00 ± 1.50 10.00 ± 5.00	26.33 ± 2.89 9.33 ± 0.58 9.00 ± 1.00	-1.38 -0.77 -0.35	
09/18/87	09/13/87	11/09/87	Water	Gr-Alpha Gr-Beta	4.00 ± 5.00 12.00 ± 5.00	2.67 ± 0.58 13.00 ± 1.00	-0.46 0.35	
10/09/87	11/07/87	12/14/87	Water	Cr-51 Co-60 Zn-65 Ru-106 Cs-134 Cs-137	70.00 ± 5.00 15.00 ± 5.00 46.00 ± 5.00 61.00 ± 5.00 25.00 ± 5.00 51.00 ± 5.00	90.67 ± 11.59 16.33 ± 0.58 50.67 ± 0.58 55.67 ± 4.04 25.67 ± 0.58 54.67 ± 2.08	7.16 0.46 1.62 -1.85 0.23 1.27	*** (j)

Footnotes at end of table

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VEPCO - NORTH ANNA

(Page 3 of 3)

EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action
10/16/87	11/12/87	12/14/87	Water	H-3	4492.00 ± 449.20	4300.00 ± 100.00	-0.74	
10/21/87	01/04/88	02/01/88	Lab Perf.	Ra-226	4.80 ± 0.72	4.77 ± 0.15	-0.08	
				Ra-228	3.60 ± 0.54	3.30 ± 0.30	-0.96	
				Gr-Beta	72.00 ± 5.00	72.67 ± 1.53	-0.23	
				Sr-89	16.00 ± 5.00	14.67 ± 0.58	-0.46	
				Sr-90	10.00 ± 1.50	9.67 ± 0.58	-0.38	
				Co-60	16.00 ± 5.00	19.32 ± 2.52	1.15	
				Cs-134	16.00 ± 5.00	14.33 ± 2.52	-0.58	
				Cs-137	24.00 ± 5.00	25.00 ± 3.61	0.25	
11/20/87	12/16/87	02/01/87	Water	Gr-Beta	19.00 ± 5.00	<1.0	-	(k)
12/04/87	01/12/88	02/08/88	Water	I-131	26.00 ± 6.00	26.33 ± 1.53	0.10	

## Footnotes:

- (a) Average ± experimental sigma.
- (b) Expected laboratory precision (1 sigma, 1 determination).
- (c) The three results were 42, 50 and 52. The efficiency for Cs-137 was checked and no reason for the two high results could be ascertained. The efficiency of the two detectors giving high results is being checked.
- (d) No reason for the high result could be determined. Previous tests showed a normalized deviation from the known of 0.58 (06/06/86) and -0.34 (10/10/86). Future results will be examined for a trend in the Zn-65 results.
- (e) No explanation available yet. (BC working on this)
- (f) The reported high result was due to small aliquot available for the Sr-90 analysis. Inadvertently a large aliquot was used for another analysis leaving 40% of the normal volume for Sr-90. Additionally, the narrow acceptance limits defined by EPA is particularly difficult to meet. For this analysis 63% of the participants were beyond the ± 3 sigma limit.
- (g) The low result is attributed to the application of the resin method rather than the hydroxide method to this analysis. The resin method is inefficient at absorbing protein-bound iodine thus leading to low results. The results obtained by Gel were higher.
- (h) The Cs-137 results in EPA foods have typically been biased high. We are in the process of performing our annual calibrations. We are using a new Amersham mixed gamma standard rather than the most recently prepared NBS standard which is now several years old. Based on preliminary results the three Cs-137 values would be 52.1, 50.3, and 50.9 which average 51.1.
- (i) Erroneously high electrode reading of stable iodide in sample (possibly because of interfering species such as S--) leading to erroneously low chemical yields. After repeating the electrode reading, the calculated average I-131 is 49.6 pCi/l. Technicians have been made aware to be suspicious of high electrode readings. When unusually high readings occur samples will be diluted and/or oxidized and remeasured.
- (j) The data for the Cr-51 results were reviewed. The detector efficiencies appear to be correct. The other five isotopes measured in this sample were within two standard deviations indicating there is no systematic error. Chromium-51 is difficult to measure at this activity level because of the low branching intensity of the gamma ray and being in the high background region of the spectrum since Cr-51 has a low energy gamma ray.
- (k) The EPA sample was not analyzed. A newly trained technician misinterpreted the Sample Receipt Form and proceeded to dilute and analyze instead an in-house blank of deionized water. In the future, all dilutions will be performed by the laboratory supervisor or the laboratory manager to ensure accuracy.

IX. REFERENCES

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1. United States Nuclear Regulatory Commission, Regulatory Guide 4.8 "Environmental Technical Specifications for Nuclear Power Plants", December, 1975.
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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. USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program", Rev. 1, November 1979.