VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 24, 1998

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

Serial No. 98-239
NAPS/JHL
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Pursuant to Technical Specification 6.9.1.8, enclosed is the Annual Radiological Environmental Operating Report for North Anna Power Station Units 1 and 2 for 1997.

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

Very truly yours,

W. R. Matthews
W. R. Matthews
Site Vice President

Enclosure

Commitments made by this letter: None

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

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

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VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION
Radiological Environmental Monitoring Program
January 1, 1997 to December 31, 1997

Prepared by

VIRGINIA ELECTRIC AND POWER COMPANY

and

TELEDYNE BROWN ENGINEERING

Annual Radiological Environmental Operating Report

North Anna Power Station

January 1, 1997 to December 31, 1997

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Preface

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.

Executive Summary

This document is a detailed report on the 1997 North Anna Nuclear Power Station Radiological Environmental Monitoring Program (REMP). Radioactivity levels from January 1 through December 31, 1997 in water, silt, shoreline sediment, milk, aquatic biota, food products, vegetation, and direct exposure pathways have been analyzed, evaluated, and summarized. The REMP is designed to ensure that radiological effluent releases are As Low As is Reasonably Achievable (ALARA), no undue environmental effects occur, and the health and safety of the public is protected. The program also detects any unexpected environmental processes which could allow radiation accumulations in the environment or food pathway chains.

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

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

Teledyne Brown Engineering provides sample analyses for various radioisotopes as appropriate for each sample media. Participation in the Environmental Protection Agency's (EPA) Interlaboratory Comparison Program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the Nuclear Regulatory Commission (NRC) requires that equipment used for radiological environmental monitoring must be able to detect specified minimum Lower Limits of

Detection (LLD). This ensures that analyses are as accurate as possible. Samples with extremely low levels of radiation which cannot be detected are therefore reported as being below the LLD. The NRC also mandates a "reporting level." Licensed nuclear facilities must report any releases equal to or greater than this reporting level. Environmental radiation levels are sometimes referred to as a percent of the reporting level.

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

- The airborne exposure pathway includes airborne iodine, airborne particulate, precipitation, and soil samples. The overall 1997 airborne results were very similar to previous years and to preoperational levels. No increase was noted and there were no detections of fission products or other man-made isotopes in the airborne particulate media during 1997.

- The waterborne exposure pathway includes ground/well water, river water, and surface water samples. No man-made or natural isotopes were detected in Lake Anna surface water except for tritium. The average tritium activity in 1997 was 16% of the NRC reporting level. This has essentially remained unchanged from 1995 levels.

- The aquatic exposure pathway includes sediment/silt and shoreline samples. North Anna sediment contained some cesium-137. During the preoperational period, cesium-137 was detected. Sediment contamination, however, does not provide a direct dose pathway to man. In shoreline soil, which may provide a direct dose pathway, only cesium-137 was detected. Cesium-137 levels were 159 pCi/kg in 1997.

- The ingestion exposure pathway includes milk, fish, and food/vegetation samples. Iodine-131 was not detected in any 1997 milk samples. Although cesium-137 has been detected in the past, it was not detected in 1997 milk samples. Strontium-90 was detected at levels comparable to 1989, and lower than preoperational years. Both strontium-90 and cesium-137 are attributable to atmospheric nuclear weapons testing in the past. Naturally occurring potassium-140 was detected at normal environmental levels.

- Fish samples during 1997 contained cesium-137 at a slightly higher activity than preoperational levels. Steam generator repairs and better liquid waste processing, however, have reduced these activity levels from previous years. Vegetation samples were statistically similar to both control and preoperational levels.

- The direct radiation exposure pathway measures environmental radiation doses by use of thermoluminescent dosimeters (TLDs). TLD results have remained essentially the same since the preoperational period in 1977.

During 1997, as in previous years, operation of the North Anna Nuclear Power Station created no adverse environmental affects or health hazards. The maximum radiation dose calculated for a hypothetical individual at the North Anna Power Station site boundary due to liquid and gaseous effluents released from the site during 1997 was 0.29 millirem. For reference, this dose may be compared to the 360 millirem average annual exposure to every person the United States from natural and man-made sources. Natural sources in the environment provide approximately 82% of radiation exposure to man while Nuclear Power contributes less than 0.1%. These results demonstrate not only compliance with federal and state regulations, but also demonstrate the adequacy of radioactive effluent control at the North Anna Nuclear Power Station.

I. INTRODUCTION

VIRGINIA ELECTRIC AND POWER COMPANY

NORTH ANNA POWER STATION

RADIOLOGICAL ENVIRONMENTAL OPERATING PROGRAM

I. INTRODUCTION

The operational radiological environmental monitoring program conducted for 1997 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, 1997 through December 31, 1997 are summarized.

A. The North Anna Power Station of Virginia Electric and Power Company is located on Lake Anna in Mineral, Virginia, approximately 35 miles south 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 address the release of radioactive effluents. Inplant monitoring is used to ensure release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in North Anna Power Station Offsite Dose Calculation Manual (ODCM).

C. Virginia Electric and Power Company is responsible for collecting the various indicator and control environmental samples. Teledyne Brown Engineering is responsible for sample analysis and submitting 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 control levels, which vary with time due to such external events as cosmic ray bombardment, weapons test fallout, and seasonal variations of naturally occurring isotopes. Data collected prior to the plant operation is used to indicate the degree of natural variation to be expected. This preoperational data is compared with data collected during the operational phase to assist in evaluating the radiological impact of the plant operation.

D. Occasional samples of 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 is compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8 and North Anna's ODCM. These concentrations are based upon the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion of "As Low As Is Reasonably Achievable".

E. This report documents the results of the Radiological Environmental Monitoring Program for 1997 and satisfies the following objectives of the program:

1. Provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of the maximum exposed members of the public resulting from the station operation.

2. Supplements the radiological effluent monitoring program by verifying that radioactive effluents are within allowable limits.

3. Identifies radioactivity changes in the environment.

4. Verifies that the plant operations have no detrimental effect on the health and safety of the public.

III. 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 1997. Figure 1 indicates the locations of the environmental monitoring stations.

2. For routine TLD measurements, two dosimeters made of $CaSO_4$:Dy in a teflon card are deployed at each sampling location. Several TLDs are co-located with NRC and Commonwealth of Virginia direct radiation recording devices.

3. In addition to the Radiological Environmental Monitoring Program required by North Anna Technical Specifications, Virginia Electric and Power Company (VEPCO) splits samples with the Commonwealth of Virginia. All samples listed in Table 1 are shipped to Teledyne Brown Engineering located in Westwood, New Jersey.

4. All samples listed in Table 1 are taken at indicator locations except those labeled "control".

TABLE 1

(Page 1 of 5)

North Anna Power Station - 1997

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	
	Fredericks Hall	02	5.30	SSW	225°	Quarterly & Annually	
	Mineral, Va	03	7.10	WSW	243°	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	287°	Quarterly & Annually	
	Route 752	05	4.20	NNE	20°	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	115°	Quarterly & Annually	
	Bumpass, VA	07	7.30	SSE	167°	Quarterly & Annually	
	End of Route 685	21	1.00	WNW	301°	Quarterly & Annually	
	Route 700	22	1.00	WSW	242°	Quarterly & Annually	
	"Aspen Hills"	23	0.93	SSE	158°	Quarterly & Annually	
	Orange, VA	24	22.00	NW	325°	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	10°	Quarterly	
	Sturgeon's Creek Marina	N-2/34	3.20	N	11°	Quarterly	
	Parking Lot "C" (on-site)	NNE-3/35	0.25	NNE	32°	Quarterly	
	Good Hope Church	NNE-4/36	4.96	NNE	25°	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	42°	Quarterly	
	Lake Anna Marina	NE-6/38	1.49	NE	34°	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	74°	Quarterly	
	Route 689	ENE-8/40	2.43	ENE	65°	Quarterly	
	Near Training Facility	E-9/41	0.30	E	91°	Quarterly	

TABLE 1

(Page 2 of 5)

North Anna Power Station - 1997

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	
	Route 622	ESE-12/44	4.70	ESE	115°	Quarterly	
	VEPCO Biology Lab	SE-13/45	0.75	SE	138°	Quarterly	
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	137°	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	158°	Quarterly	
	Elk Creek	SSE-16/48	2.33	SSE	165°	Quarterly	
	Warehouse Compound	S-17/49	0.22	S	173°	Quarterly	
	Elk Creek Church	S-18/50	1.55	S	178°	Quarterly	
	500 Kv Tower	SSW-19/51	0.36	SSW	197°	Quarterly	
	Route 618	SSW-20/52	5.30	SSW	205°	Quarterly	
	NAPS Access Road	SW-21/53	0.30	SW	218°	Quarterly	
	Route 700	SW-22/54	4.36	SW	232°	Quarterly	
	NAPS Radio Tower	WSW-23/55	0.31	WSW	237°	Quarterly	
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242°	Quarterly	
	South Gate Construction Switchyard	W-25/57	0.25	W	279°	Quarterly	
	Route 685	W-26/58	1.55	W	274°	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301°	Quarterly	
	H. Purcell's Private Rd.	WNW-28/60	1.52	WNW	303°	Quarterly	
	North Gate Construction Side Laydown Area	NW-29/61	0.44	NW	321°	Quarterly	
	Lake Anna Campground	NW-30/62	2.54	NW	319°	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349°	Quarterly	
	Route 208	NNW-32/64	3.43	NNW	344°	Quarterly	
	Bumpass Post Office	C-1/2	7.30	SSE	1.67°	Quarterly	Control
	Orange, VA	C-3/4	22.00	NW	325°	Quarterly	Control
	Mineral, VA	C-5/6	7.10	WSW	243°	Quarterly	Control
	Louisa, VA	C-7/8	11.54	WSW	257°	Quarterly	Control

TABLE 1

(Page 3 of 5)

North Anna Power Station - 1997

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

* In October 1991 the Surface Water Sample location at station 09 was moved to 09A.

TABLE 1

(Page 4 of 5)

North Anna Power Station - 1997

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
Shoreline Soil	Waste Heat Treatment Facility (Second Cooling Lagoon)	08 *	1.10	SSE	148°	Monthly	
	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320°	Semi-Annually	
Soil	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Once/3 years	
	Fredericks Hall	02	5.30	SSW	205°	Once/3 years	
	Mineral, VA	03	7.10	WSW	243°	Once/3 years	
	Wares Crossroads	04	5.10	WNW	287°	Once/3 years	
	Route 752	05	4.20	NNE	20°	Once/3 years	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Once/3 years	
	Levy, VA	06	4.70	ESE	115°	Once/3 years	
	Bumpass, VA	07	7.30	SSE	167°	Once/3 years	
	End of Route 685	21	1.00	WNW	301°	Once/3 years	
	Route 700 (Exclusion Boundary)	22	1.00	WSW	242°	Once/3 years	
	"Aspen Hills"	23	0.93	SSE	158°	Once/3 years	
	Orange, VA	24	22.00	NW	325°	Once/3 years	Control
Milk	Holladay Dairy (R.C. Goodwin)	12	8.30	NW	310°	Monthly	
	Terrell's Dairy (Fredericks Hall)	13	5.60	SSW	205°	Monthly	
Fish	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Semi-Annually	
	Lake Orange	25	16.5	NW	312°	Semi-Annually	Control
Food Products (Broadleaf Vegetation)	Route 713	14	1.20	NE	43°	Monthly if available or at harvest	
	Route 614	15	1.70(1.37)	SE	133°	Monthly if available or at harvest	

* Shoreline soil was changed from station 09 to 08 effective with the August 96 sample.

TABLE 1

(Page 5 of 5)

North Anna Power Station - 1997

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance Miles	Compass 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	

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

Map Designation		Environmental Sta Identification	Map Designation	Environmental Sta Identification
1	(a)	01,NE-5/37	7/8	C-7&8
1A		01A,SE-13/45	1/33	N-1/33
2	(a)	02,SSW-20/52	31/63	NNW-31/63
3	(a)	03,C-5/16	29/61	NW-29/61
4	(a)	04	3/35	NNE-3/35
5	(a)	5	7/39	ENE-7/39
5A	(a)	05A,N-2/34	9/41	E-9/41
6	(a)	6,ESE-12/44	11/93	ESE-11/43
7	(a)	07,C-1&2	17/49	S-17/49
8		8-Water, Fish Sediment Shoreline Soil (d)	19/51	SSW-19/51
9		09-Shoreline Soil Stations NW-30/62	21/53	SW-21/53
9A		09A-Water sample, sediment	23/55	WSW-23/55
11		11-River Water, Sediment	25/57	W-25/57
12		12-Milk	16/48	SSE-16/48
13		13-Milk	18/50	S-18/50
14		14-Vegetation, NE-6/38	14/46	SE-14/46
15		Vegetation	22/54	SW-22/54
16		Vegetation	26/58	W-26/58
21	(a)	21,WNN-27/59	28/60	WNW-28/60
22	(a)	22,WSW-24/56	32/64	NNW-32/64
23	(a)	23-SSE-15/47	8/40	ENE-8/40
24	(a)(b)	24,C-3&4	4/36	NNE-40/36
25	(c)	25-Fish	10/42	E-10/42

(a) Indicates air sample station, annual and quarterly TLD, Triennial soil
(b) In Orange
(c) In Lake Orange
(d) Station 09 changed to 08 effective with the August 96 sample.

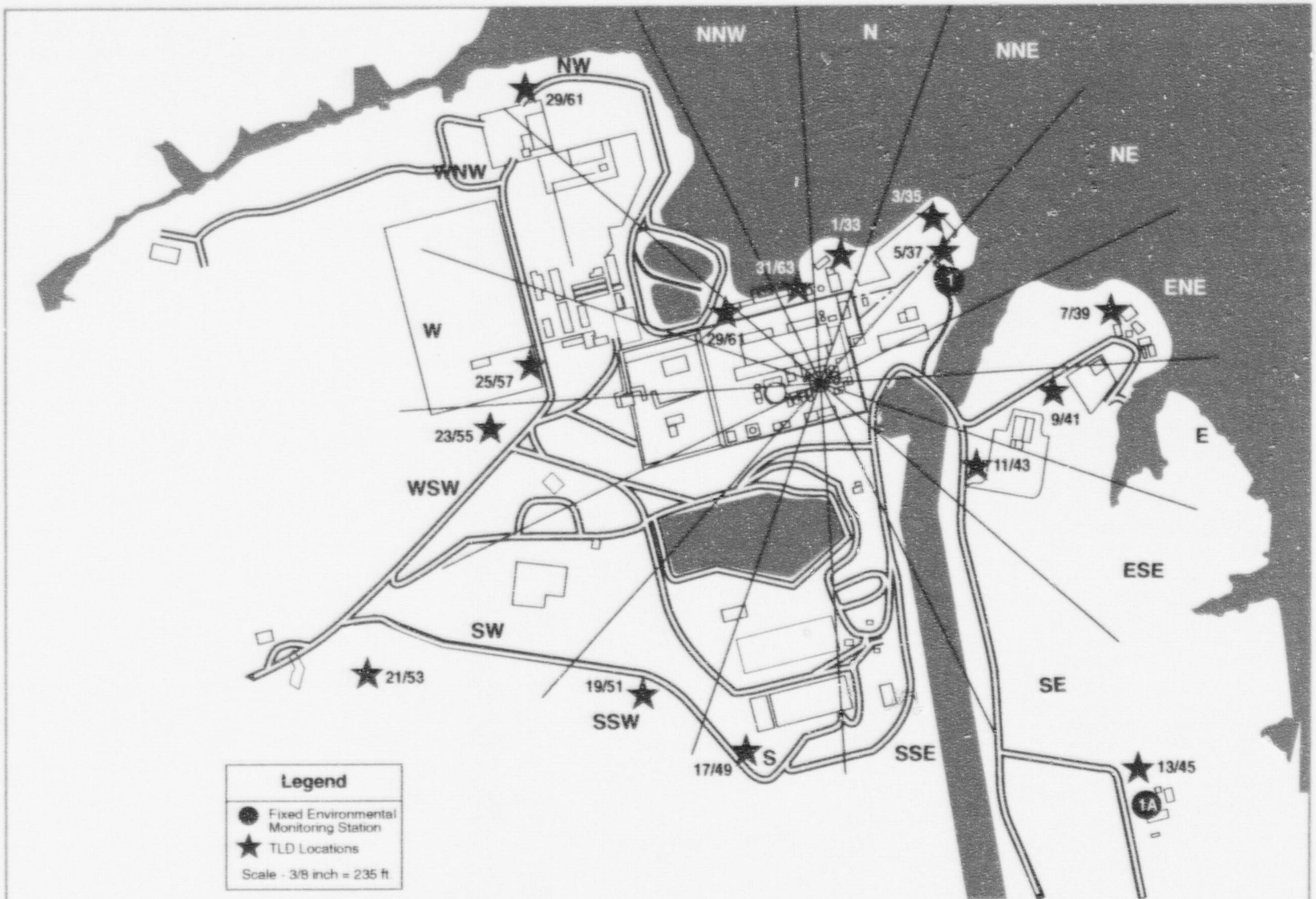

Figure 14. North Anna Site Radiological Monitoring Locations

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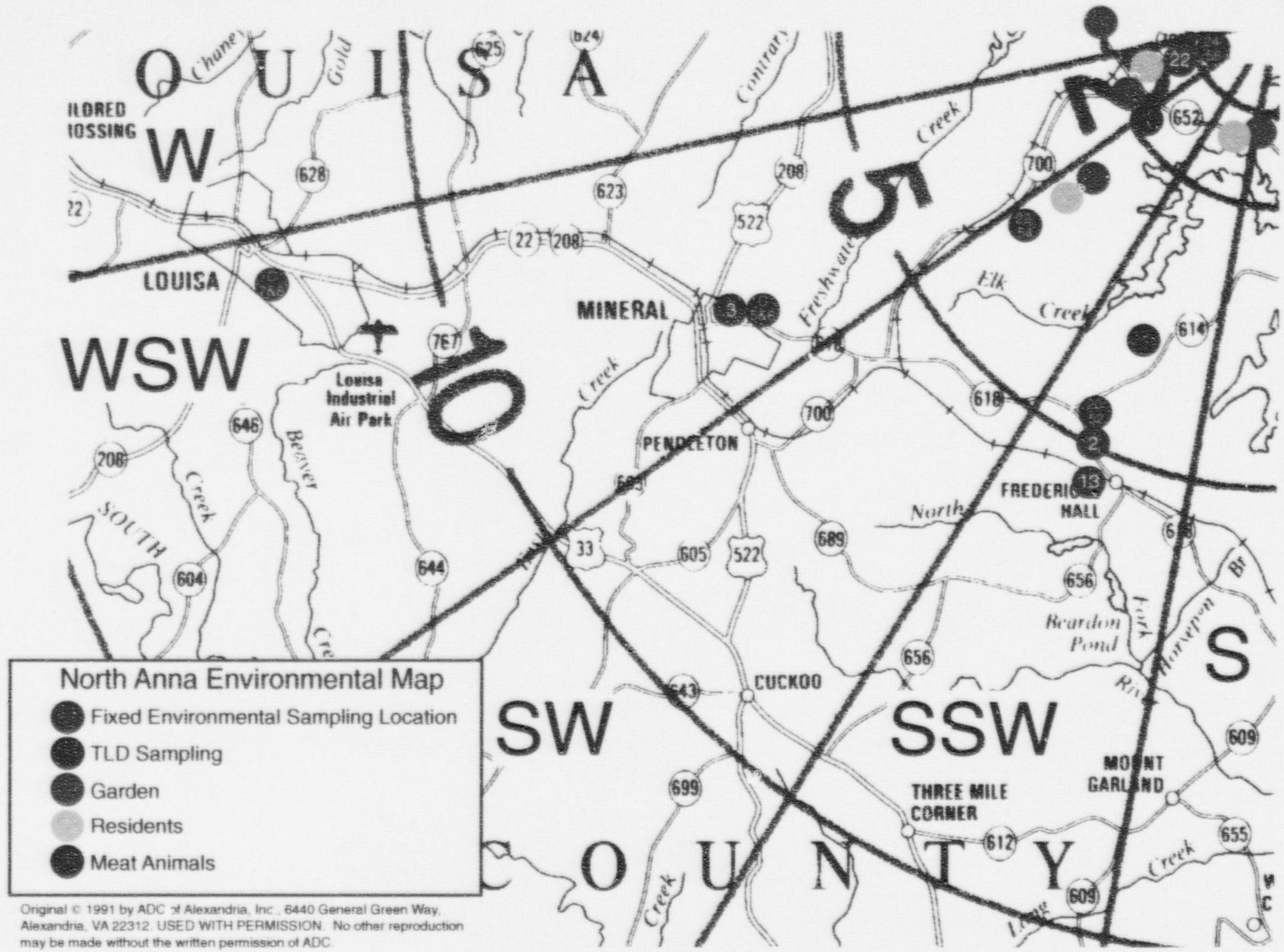
North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
LOUISA
WSW
W
SW
SSW
S
MINERAL
PENDLETON
CUCKOO
FREDERICKS HALL
THREE MILE CORNER
MOUNT GARLAND
Louisa Industrial Air Park
Elk Creek
Beardon Pond
10
5

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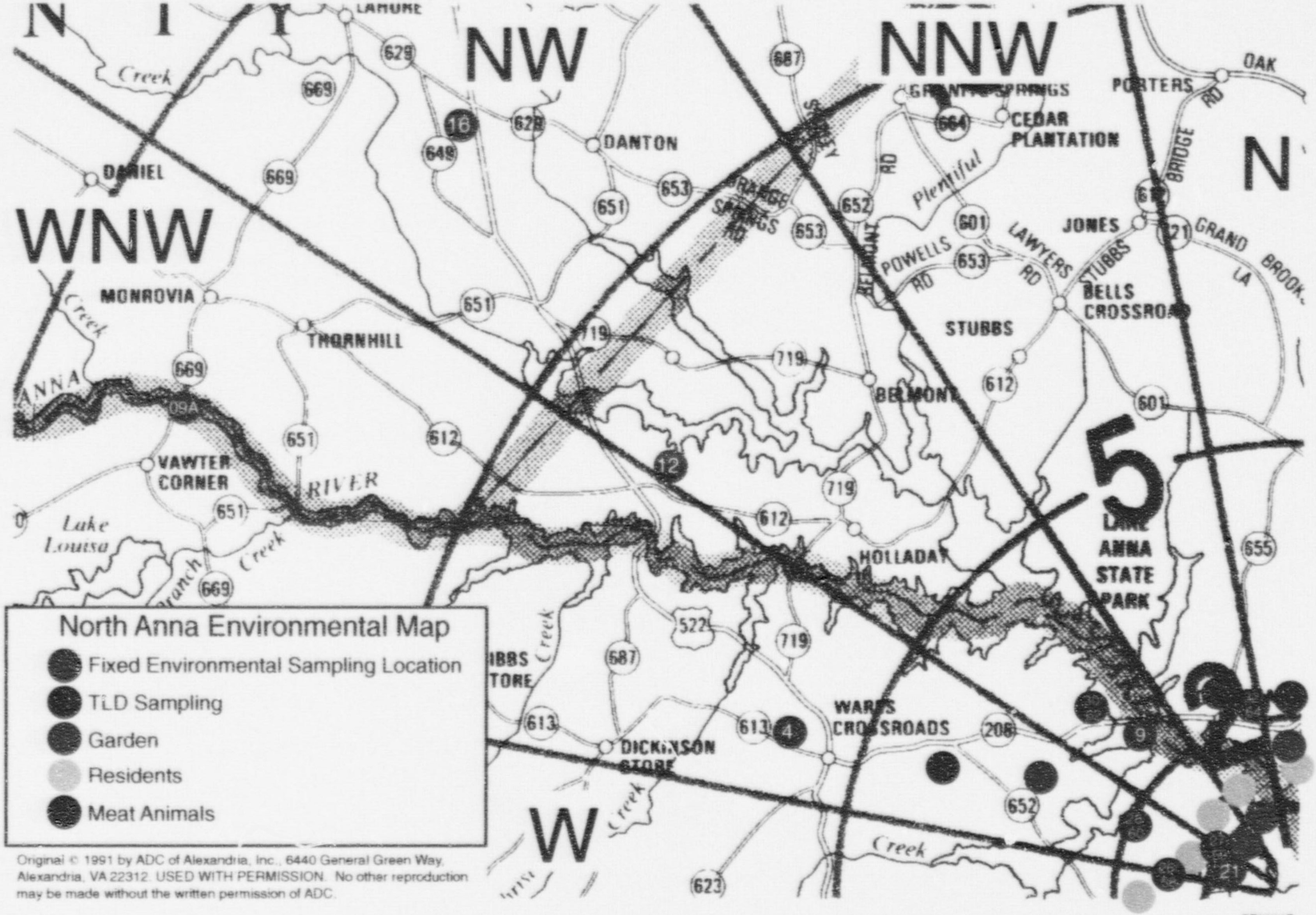
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NNW
WNW
N
W
5
North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
DANTON
DANIEL
MONROVIA
THORNHILL
VAWTER CORNER
Lake Louisa
RIVER
CEDAR PLANTATION
PORTERS
OAK
JONES
BELLS CROSSROAD
STUBBS
BELMONT
HOLLADAY
LAKE ANNA STATE PARK
WARES CROSSROADS
DICKINSON STORE
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LAWYERS RD
GRAND BROOK LA
Plentiful
Creek

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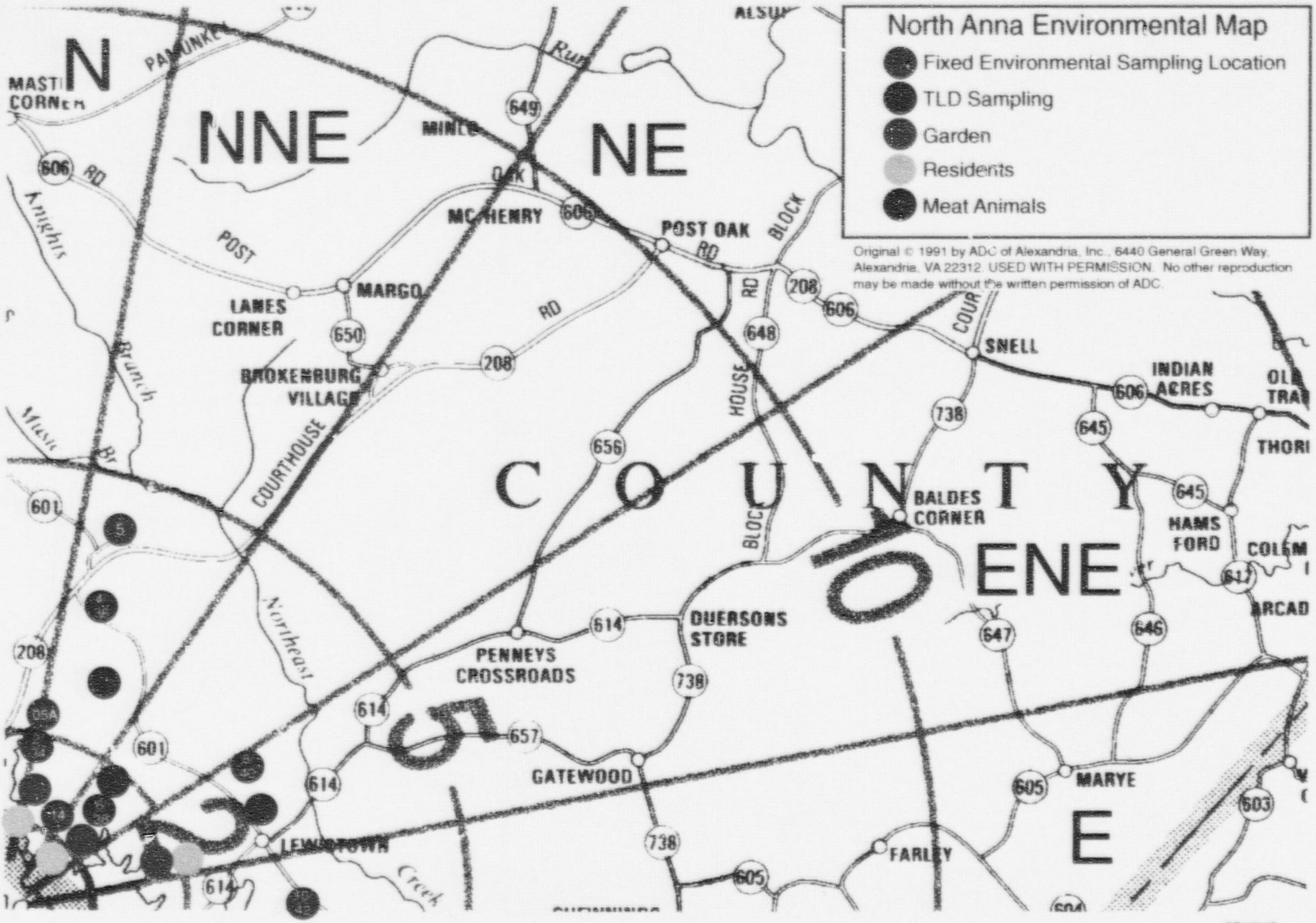

North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
N
NNE
NE
ENE
E
COUNTY
5
10
MASTI CORNER
PAMUNKE
MINLO
OAK
MC HENRY
POST OAK
BLOCK
HOUSE
RD
POST
LANES CORNER
MARGO
BROKENBURG VILLAGE
COURTHOUSE
Knights
Branch
Northeast
Creek
SNELL
INDIAN ACRES
THORI
BALDES CORNER
HAMS FORD
ARCAD
DUERSONS STORE
PENNEYS CROSSROADS
GATEWOOD
LEWISTOWN
MARYE
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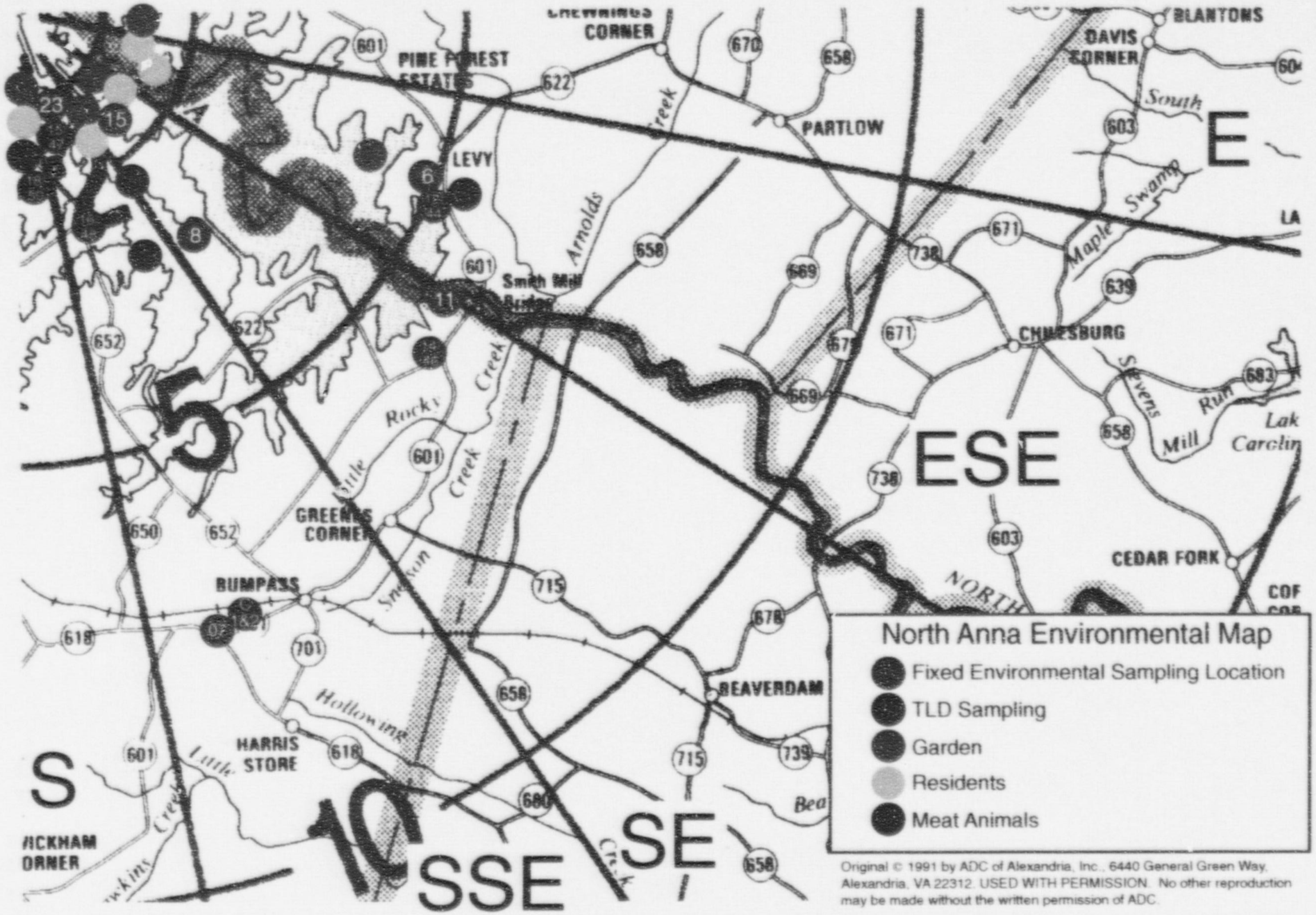


North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
E
ESE
SE
SSE
S
5
10
BLANTONS
DAVIS CORNER
PARTLOW
PINE FOREST ESTATES
LEVY
Smith Mill Bridge
CHILESBURG
CEDAR FORK
GREENS CORNER
BUMPASS
HARRIS STORE
BEAVERDAM
Arnolds
Creek
South
Maple
Swamp
Stevens
Mill
Run
Rocky
Little
Hollowing
NORTH

CB3282A

B. Analysis Program

1. Table 2 summarizes the analysis program conducted by Teledyne Brown Engineering for North Anna Power Station during 1997.

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^3
Airborne Particulate	Weekly	Gross Beta	0.01	pCi/m^3
	Quarterly (a)	Gamma Isotopic		pCi/m^3
		Cs-134	0.05	
		Cs-137	0.06	
	Annually (2nd Quarter Composite)	Sr-89	(c)	pCi/m^3
		Sr-90	(c)	
Surface Water	Monthly	I-131	1(b)	pCi/l
		Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
	Quarterly (a)	Tritium (H-3)	2000	pCi/l
	2nd Quarterly Composite	Sr-89	(c)	pCi/l
		Sr-90	(c)	

* 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 Brown Engineering may be lower than those listed.

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

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

(c) There are no required LLD's for strontium-89/90. LLD's are those achieved by Teledyne Brown Engineering.

TABLE 2

NORTH ANNA POWER STATION

SAMPLE ANALYSIS PROGRAM

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

* 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 Brown Engineering may be lower than those listed.

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

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

(c) There are no required LLD's for strontium-89/90. LLD's are those achieved by Teledyne Brown Engineering.

NORTH ANNA POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Shoreline Soil	Semi-Annual	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	(a)	
		Sr-90	(a)	
Soil	Once per 3 yrs.	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Once per 3 yrs.	Sr-89	(a)	pCi/kg (dry)
		Sr-90	(a)	
Milk	Monthly	I-131	1	pCi/l
	Monthly	Gamma Isotopic		pCi/l
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
	Quarterly	Sr-89	(a)	pCi/l
		Sr-90	(a)	
Fish	Semi-Annual	Gamma Isotopic		pCi/kg (wet)
		Mn-54	130	
		Fe-59	260	
		Co-58	130	
		Co-60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
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 Brown Engineering may be lower than those listed.

(a) There are no required LLD's for strontium-89/90. LLD's are those achieved by Teledyne Brown Engineering.

III. PROGRAM EXCEPTIONS

Appendix B

REMP Exceptions For Scheduled

Sampling And Analysis During 1997 - North Anna

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
STA-14	Food/Vegetation	05/21/97	LLD for I-131 not met because the first analysis produced low chemical yield (11.8). Analysis was repeated but unable to meet LLD due to the short half-life of I-131.
STA-16	Food/Vegetation	08/20/97	LLD for I-131 not met. Sample not received at lab until 15 days after collection. Sample was counted 4 times but could not meet SPEC.
STA-W27	Surface Water	09/15/97	LLD for I-131 not met due to the long lapse of time from collection to receipt at laboratory.
STA-33	Surface Water	07/31/97 09/15/97	LLD for I-131 not met due to the long lapse of time from collection to receipt at laboratory.

IV. SUMMARY AND DISCUSSION OF 1997 ANALYTICAL RESULTS

IV. Summary And Discussion of 1997 Analytical Results

Data from the radiological analyses of environmental media collected during 1997 are tabulated and discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in the Teledyne Brown Engineering Quality Assurance Manual and are explained in the Teledyne Brown Engineering Analytical Procedures. A synopsis of analytical procedures used for the environmental samples is provided in Appendix D. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the 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 Appendix E.

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

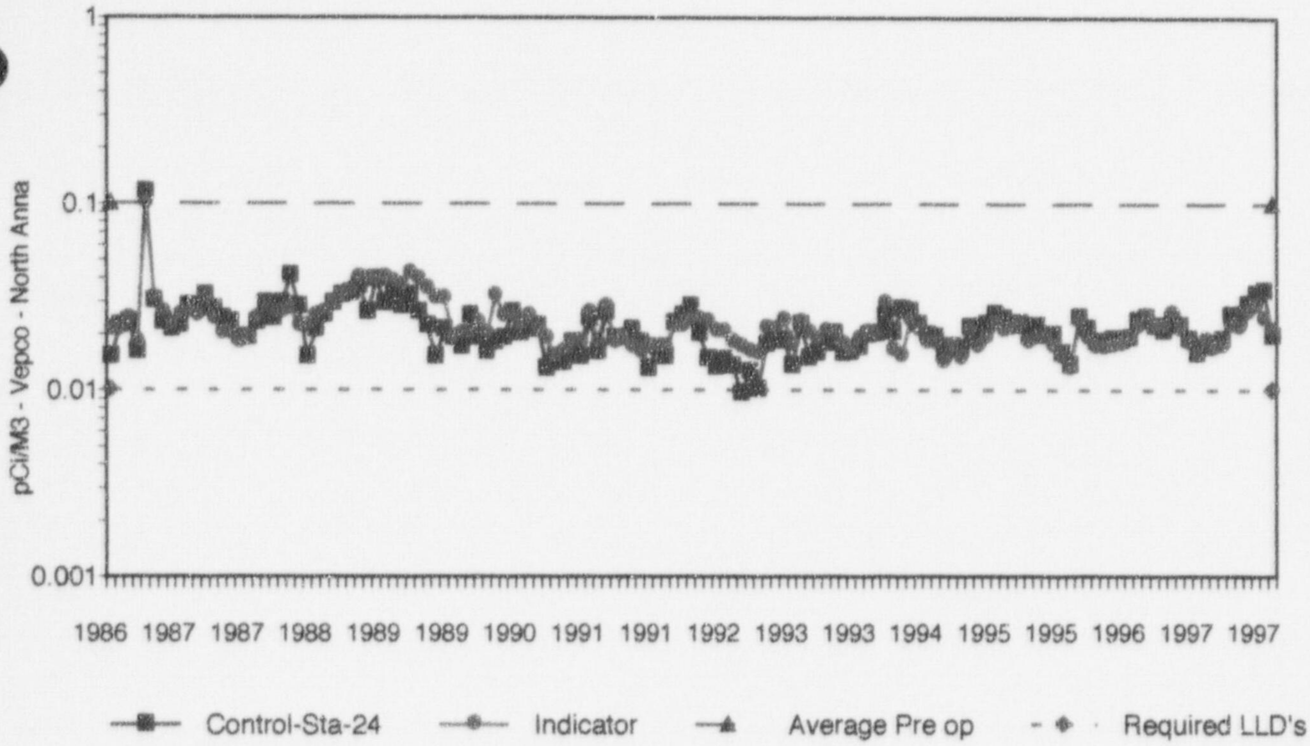
The following is a discussion and summary of the results of the environmental measurements taken during the 1997 reporting period.

A. *Airborne Exposure Pathway*

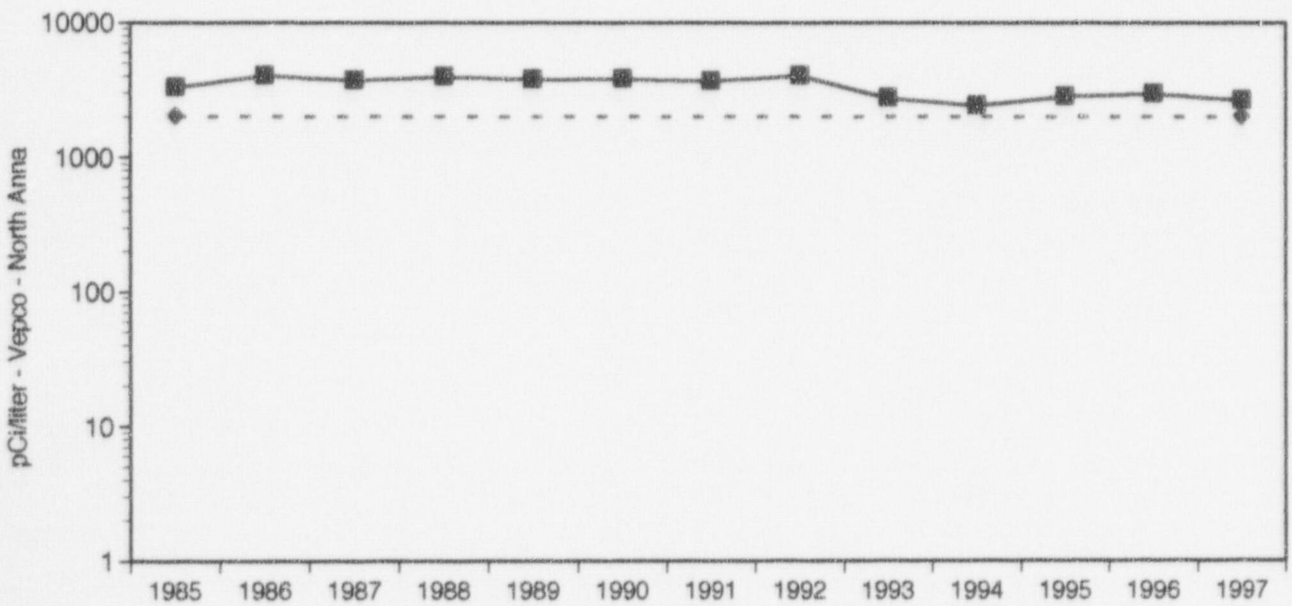
1. Air Iodine/Particulates

Charcoal cartridges used to collect airborne iodine were collected weekly and analyzed by gamma spectrometry for iodine-131. The results are presented in Table B-1. All results were below the required lower limit of detection. For air particulates, gross beta activity was observed in all fifty-two control samples with an average concentration of 0.023 pCi/m^3 and a range of 0.010 to 0.081 pCi/m^3. The average measurement for the indicator locations was 0.021 pCi/m^3 with a range of 0.007 to 0.043 pCi/m^3. The results of the gross beta activities are presented in Table B-2. The gross beta activities for 1997 were comparable to levels measured in the 1982-1996 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing performed in other

TRENDING GRAPH-1: GROSS BETA IN AIR PARTICULATES



TRENDING GRAPH 2: TRITIUM IN RIVER WATER-STATION 11



During the preoperational period, tritium was not detected in the samples analyzed.

countries. During the preoperational period of July 1, 1974 through March 31, 1978 gross beta activities ranged from a low of 0.005 pCi/m^3 to a high of 0.75 pCi/m^3.

Air particulate filters were composited by locations on a quarterly basis and were analyzed by gamma ray spectroscopy. The results are listed in Table B-3. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation, was measured in all 48 composite samples. The average measurement for the control location was 0.117 pCi/m^3 with a range of 0.052 to 0.175 pCi/m^3. The indicator locations had an average concentration of 0.118 pCi/m^3 and a range of 0.054 to 0.181 pCi/m^3. During the preoperational period, beryllium-7 was measured at comparable levels, as would be expected. Naturally occurring potassium-40 was detected in one control samples with a concentration of 0.004 pCi/m^3. Potassium-40 was detected in five indicator samples with an average concentration of 0.007 pCi/m^3 and a range of 0.003 to 0.018 pCi/m^3. All other gamma emitters were below the detection limits. During the preoperational period gamma ray spectroscopy measured several fission products in numerous air particulate filters. All isotopes were attributed to atmospheric nuclear weapons testing conducted before the preoperational period. Among the isotopes measured were zirconium-95, ruthenium-103, ruthenium-106, cesium-137, cerium-141 and cerium-144.

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

2. Precipitation

A sample of rain water was collected monthly at station 01A, on site, 0.75 miles, 138 degrees SE and analyzed for gross beta activity. The results are presented in Table B-4. The average gross beta activity for 1997 in the twelve samples was 3.5 pCi/liter with a range from 1.5 to 9.6 pCi/liter. Semi-annual composites were prepared and analyzed for gamma emitting isotopes and tritium. Beryllium-7 was not detected during 1997. All other gamma emitters were below their detection limits. Tritium was not detected in the semi-annual composite samples. These results were comparable to or lower than those measured in 1986 thru 1996. During the preoperational period gross beta activity in rain water was expressed in nCi per square meter of the collector surface, thus a direct comparison can not be made to the 1997 period. During the preoperational period, tritium was measured in over half of the few quarterly composites made. The tritium activity ranged from 100 to 330 pCi/liter.

3. Soil

Soil samples are collected every three years from twelve stations. Since they were collected in 1995 they were not collected in 1997.

B. *Waterborne Exposure Pathway*

1. Ground/Well Water

Water was sampled quarterly from the on site well at the metrology laboratory. These samples were analyzed for gamma radiation and for tritium. The results are presented in Table B-6. No gamma emitting isotopes were detected during 1997. The second quarter sample was analyzed for strontium-89 and strontium-90. There were no detections of these isotopes above the detection level. Tritium was measured in one sample with a concentration of 240 pCi/liter. No gamma emitting isotopes were detected during the preoperational period. Tritium was measured in most of the samples during that period with concentrations between 80 and 370 pCi/liter.

2. River Water

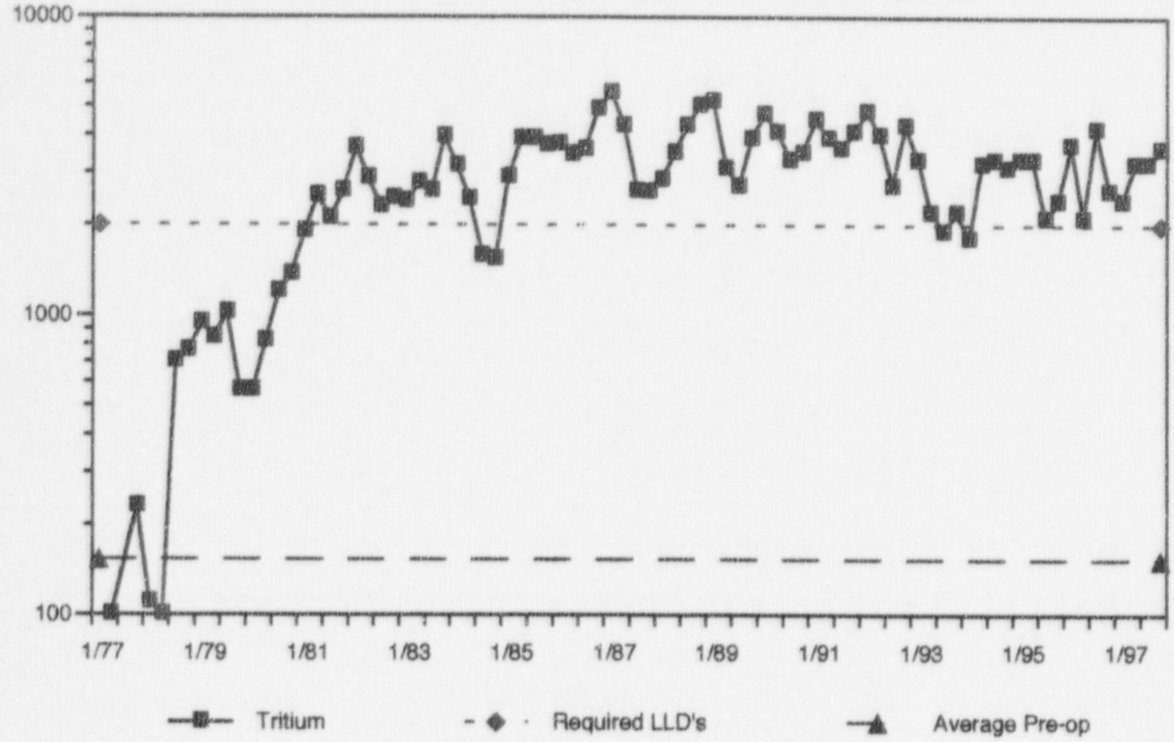
A sample of water from the North Anna River was collected monthly at station 11, 5.8 miles downstream from the discharge lagoon, 128 degrees SSE. The results are presented in Table B-7. The samples were analyzed by gamma spectroscopy monthly. The samples were analyzed for tritium quarterly on a composite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

Potassium-40 was not detected during 1997 and all other gamma emitters were below the detection level. No detections of strontium-89 or strontium-90 occurred. Tritium was measured in all four samples with an average level of 2650 pCi/liter and a range of 2300 to 3000 pCi/liter. This is lower than the average level measured in 1996 of 2950 pCi/liter and a range of 2400 to 3800 pCi/liter. No river water samples were collected during the preoperational period.

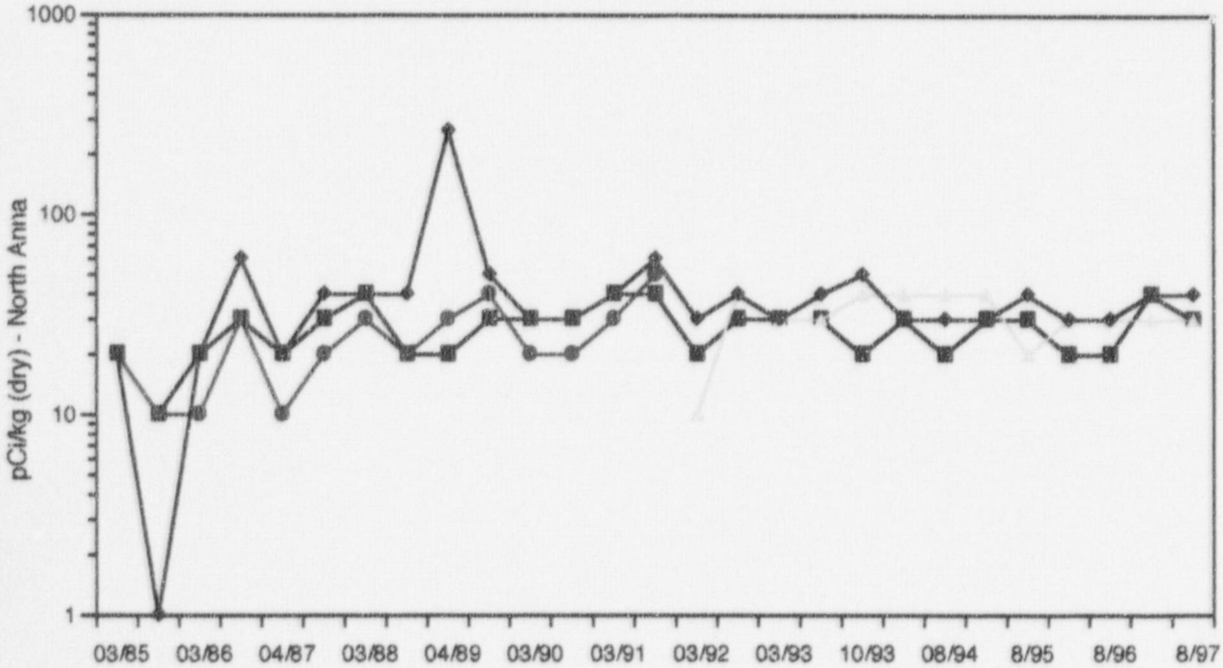
3. Surface Water

Samples of surface water were collected monthly from two stations. Station 08 is at the discharge lagoon, 1.1 miles, 148 degrees SSE on Lake Anna. Station 09A is located 12.9 miles WNW. The samples were analyzed for iodine-131 by radiochemical separation. No

TRENDING GRAPH - 3: TRITIUM IN SURFACE WATER - STA 08



TRENDING GRAPH -4: COBALT-58 IN SEDIMENT SILT



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

iodine was detected in the 24 samples analyzed. The results are presented in Table B-8. The samples were also analyzed by gamma ray spectrometry. No gamma emitters were above their detection level at either sampling station.

A quarterly composite from each station was prepared and analyzed for tritium. The tritium activity at station 08 for the quarterly composites was at an average level of 3100 pCi/liter with a range of 2400 to 3600 pCi/liter. The tritium level had been increasing since the middle of 1978 when the average level was below 300 pCi/liter. However, during 1997 the results were within the same range as those measured in 1986 thru 1996. During the preoperational period tritium was measured in several samples with concentrations between 90 and 250 pCi/liter. Tritium was not detected at station 09A.

Samples of surface water were collected by the Commonwealth of Virginia from two stations. Station W-33 is located at the discharge lagoon while station W-27 is located on the North Anna River at the RT. 208 Bridge, which is upstream of the site. Twenty-four samples were collected and analyzed by gamma ray spectroscopy. The results are presented in Table B-9. All gamma emitters were below their detection levels.

Four samples from each station were analyzed for tritium during 1997. The average activity at station W-33 in all samples was 2650 pCi/liter with a range of 2300 to 3400 pCi/liter. This is slightly lower than the 2985 pCi/liter measured during 1996 at this station. Tritium was measured in two samples at station W-27 with an average activity of 1600 pCi/liter and a range of 1300 to 1900 pCi/liter. This is higher than the average of 800 pCi/liter measured at station W-27 during 1996.

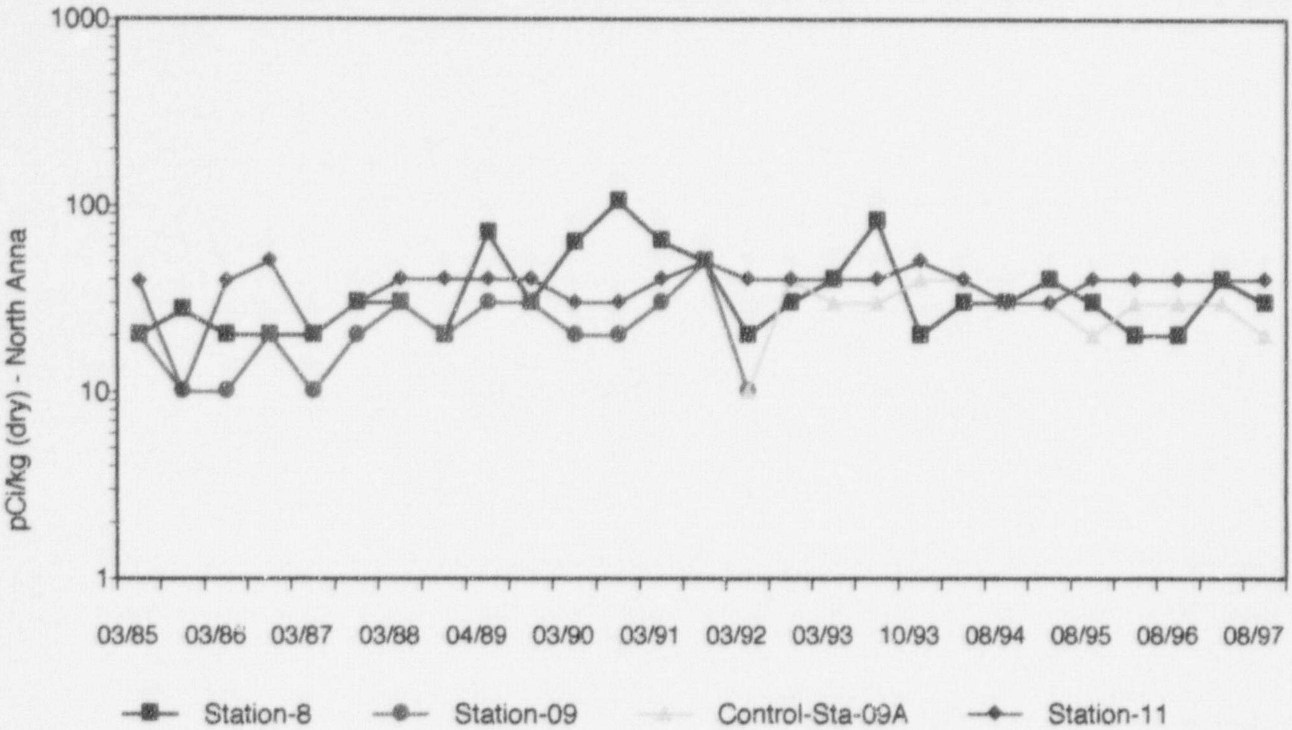
C. *Aquatic Exposure Pathway*

1. Sediment/Silt

Sediment samples were collected during February and August from each of three locations and were analyzed by gamma spectrometry. The results are presented in Table B-10. One man-made and a number of naturally occurring radioisotopes were detected in these samples. Cesium-137 was detected in three samples with an average activity of 65 pCi/kg (dry weight) and a range from 48.0 to 90.1 pCi/kg (dry weight). The highest reading for cesium-137 was obtained from station 11 located 5.80 miles SSE.

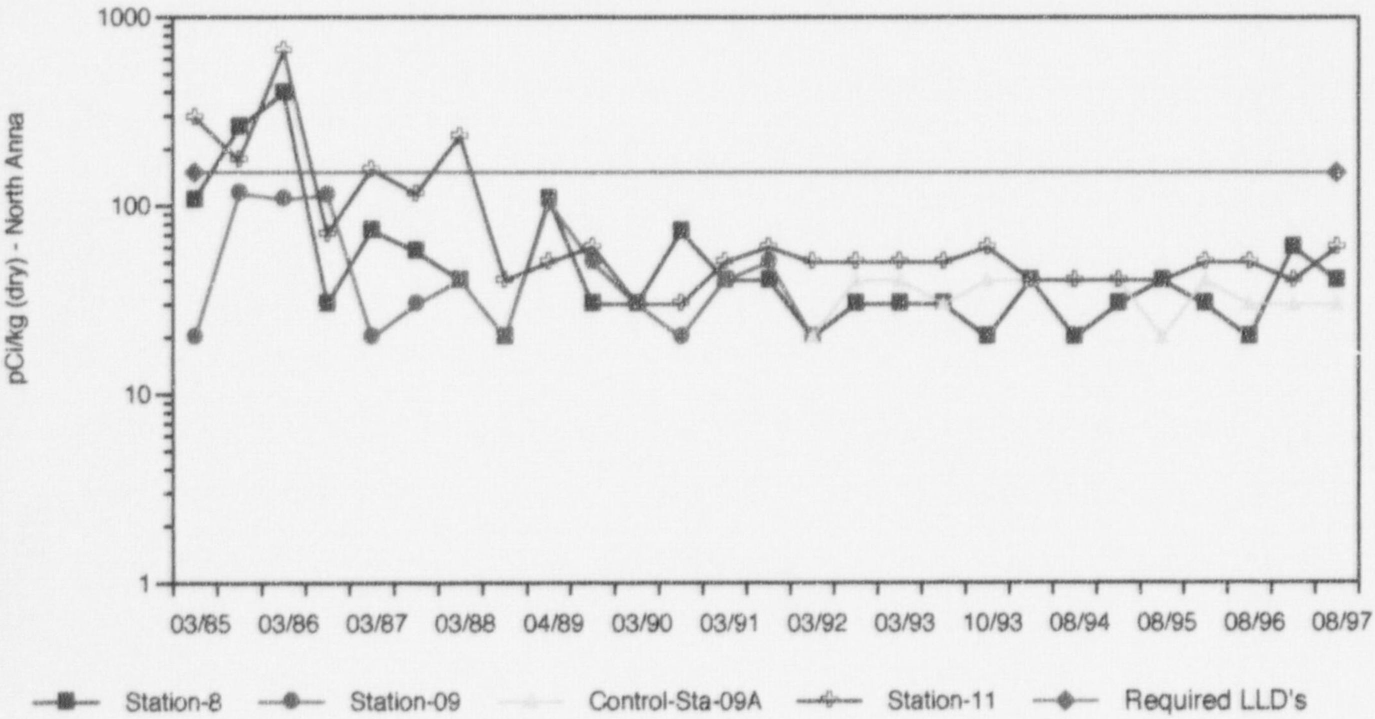
Naturally occurring potassium-40 was observed in all six samples with an average activity of 12483 pCi/kg (dry weight) and a range from 2500 to 18200 pCi/kg (dry weight).

TRENDING GRAPH - 5: COBALT-60 IN SEDIMENT SILT



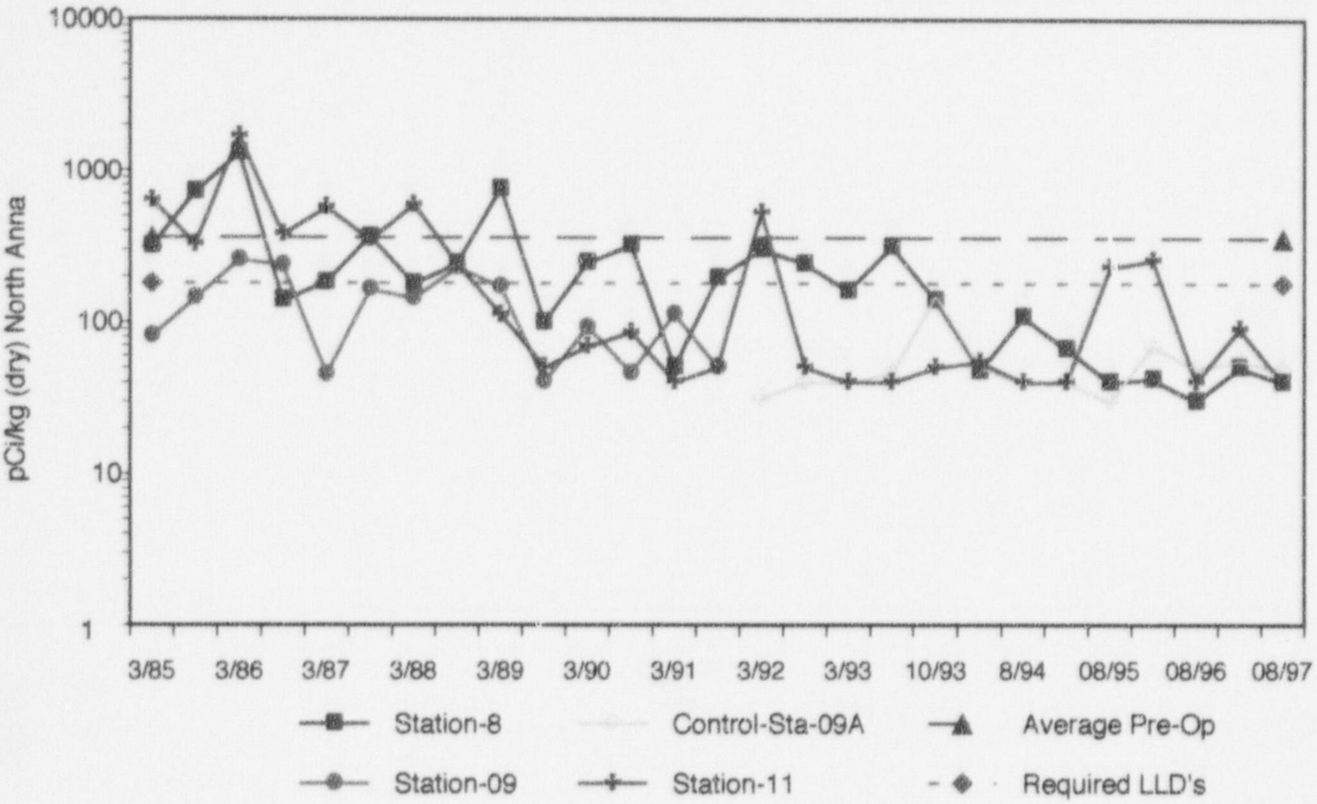
During the preoperational period, cobalt-60 was not detected in the samples analyzed.

TRENDING GRAPH - 6: CESIUM-134 IN SEDIMENT SILT

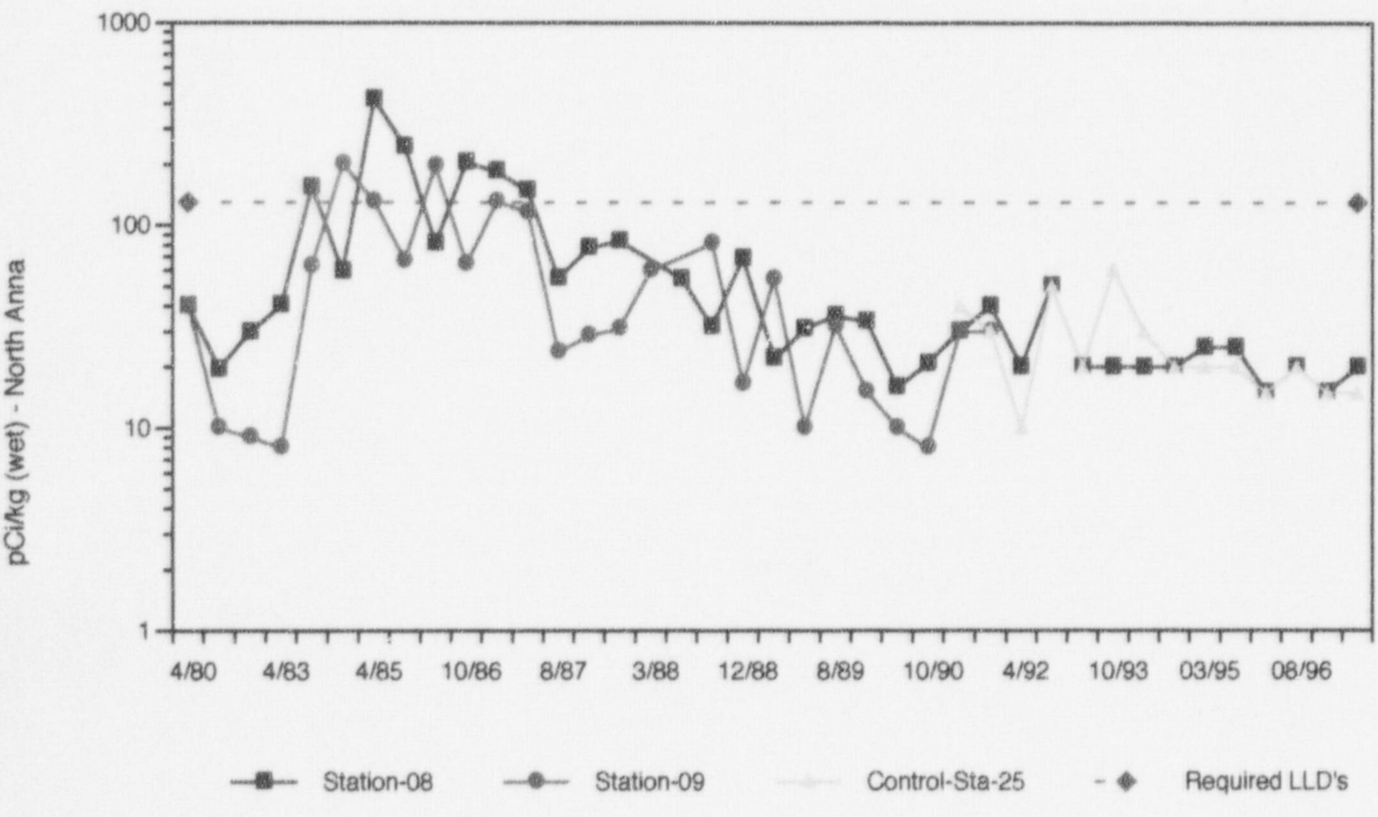


During the preoperational period, cesium-134 was not detected in the samples analyzed.

TRENDING GRAPH - 7: CESIUM-137 IN SEDIMENT SILT

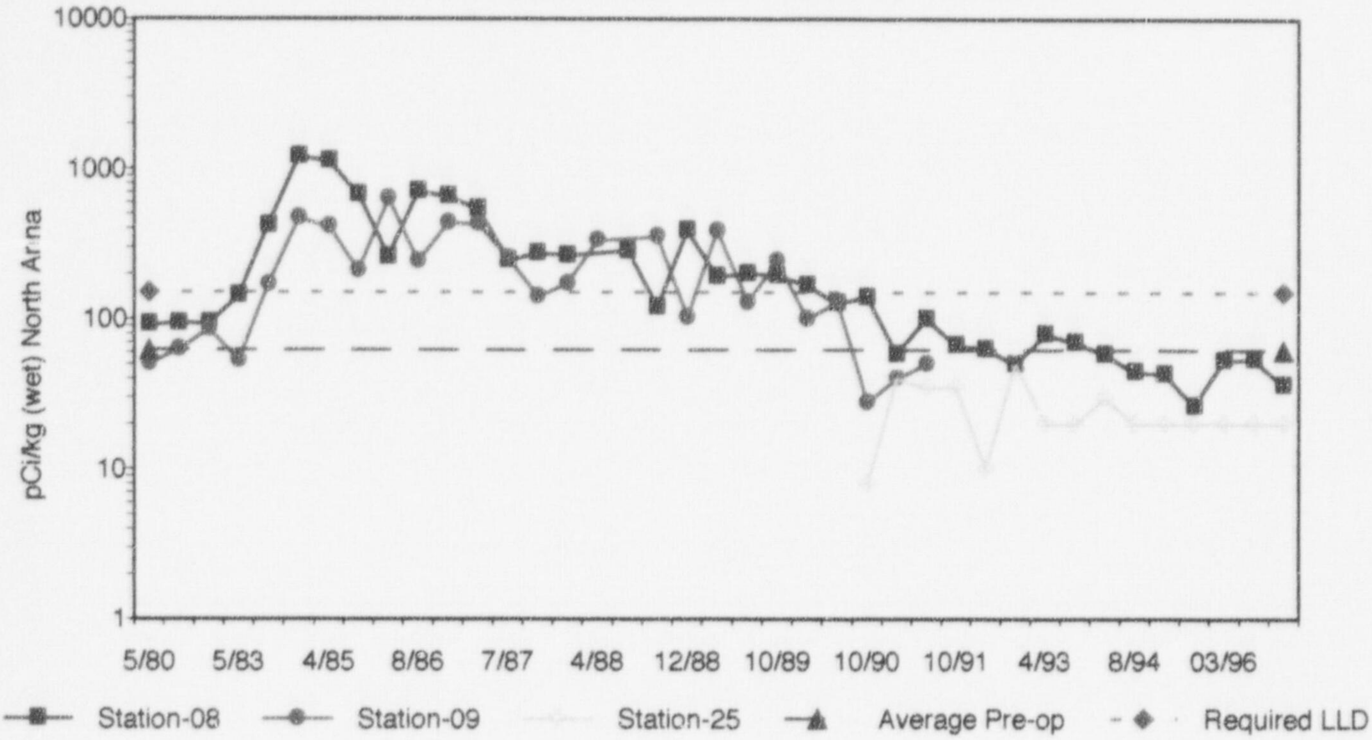


TRENDING GRAPH - 8: CESIUM-134 IN FISH



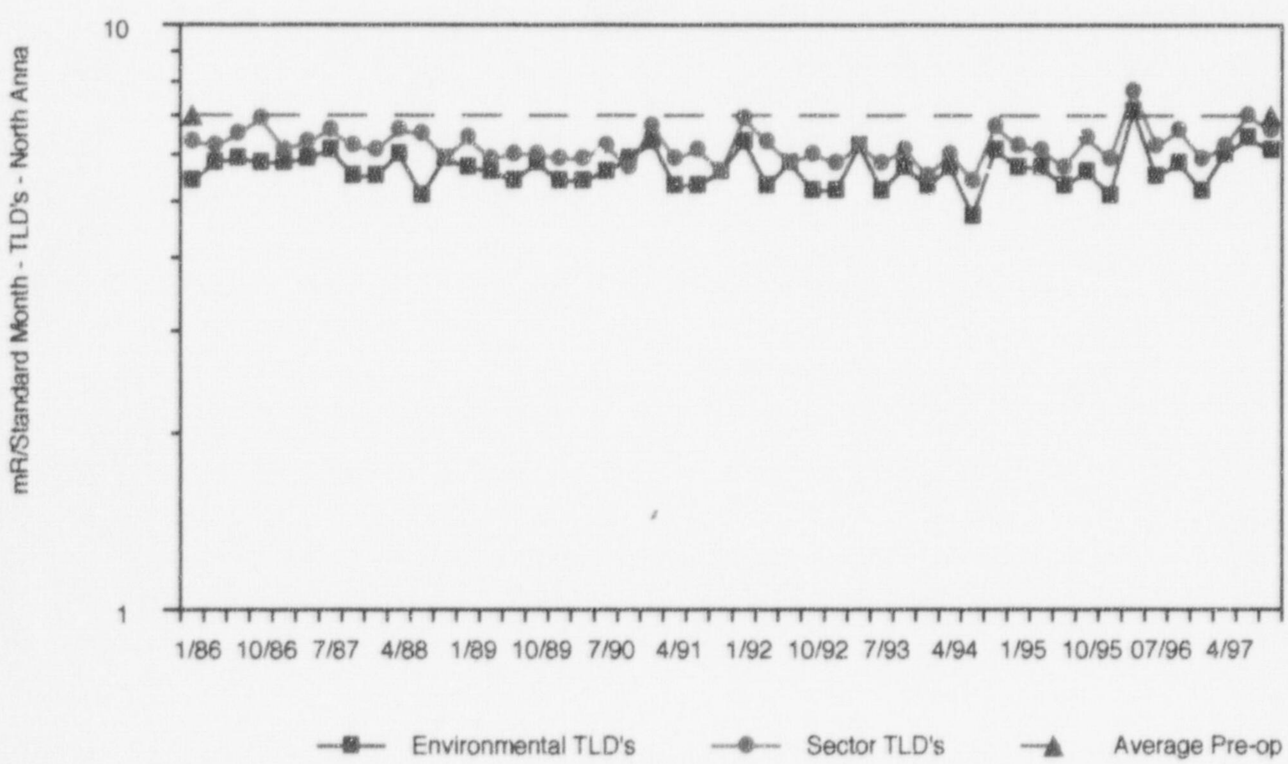
During the preoperational period, cesium-134 was not detected in the samples analyzed.
Station 25 replaced station 09.

TRENDING GRAPH - 9: CESIUM-137 IN FISH



Station 25 replaced station 09.

TRENDING GRAPH - 10: ENVIRONMENTAL RADIATON - TLD's



Radium-226 was measured in all six samples with an average concentration of 1468 pCi/kg (dry weight) and a range of 970 to 1990 pCi/kg (dry weight). Also naturally occurring, thorium-228 was observed in all six samples with an average concentration of 978 pCi/kg (dry weight) and a range of 580 to 1800 pCi/kg (dry weight). The August samples were analyzed for strontium-89 and strontium-90. There were no detections of strontium-89 or strontium-90 in aquatic sediment/silt.

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

2. Shoreline Soil

A sample of shoreline sediment was collected in February and August from station 09, 2.2 miles upstream of the North Anna Power Station. The samples were analyzed by gamma ray spectrometry. The results are presented in Table B-11. The naturally occurring nuclide potassium-40 was measured in both samples with an average activity of 1805 pCi/kg (dry weight) and a range of 770 to 2840 pCi/kg (dry weight). Cosmogenic beryllium-7 was not measured during 1997. Thorium-228 was measured in both samples at an average of 244 pCi/kg (dry weight) and a range of 240 to 247 pCi/kg (dry weight). Radium-226 was measured in one sample with a concentration of 1160 pCi/kg (dry weight). Cesium-137, a fission product, was monitored in both samples with an average level of 159 pCi/kg (dry weight) and a range of 147 to 170 pCi/kg (dry weight).

The August sample was analyzed for strontium and there were no detections of strontium-89 or strontium-90.

D. *Ingestion Exposure Pathway*

1. Milk

The results of the iodine-131 analysis of milk samples are presented in Table B-12. A sample was collected monthly from two stations. A total of 24 samples were analyzed during 1997. There were no measurements of iodine-131 above the detection limits.The milk samples were also analyzed by gamma ray spectroscopy and the results are also presented in Table B-12. A total of 24 samples were analyzed. Naturally occurring potassium-40 was measured in all samples with an average of 1281 pCi/liter and a range of 1020 to 1430 pCi/liter. The fission product cesium-137 has been detected sporadically in recent years and the activity has been attributed to global fallout from past atmospheric weapons testing. However, cesium-137 was not detected at levels above LLD in any milk samples during 1997. All other gamma emitters were below their detection levels. A quarterly composite was prepared from each of the two collection stations and analyzed for strontium-89 and strontium-90. Strontium-89 was not detected at levels above LLD in any of the samples monitored. Strontium-90 was detected in the eight samples monitored with an average level of 1.16 pCi/liter and a range of 0.45 to 1.8 pCi/liter. This is similar to activities determined in previous years and lower than the preoperational levels of 2.2 to 5.4 pCi/liter.

2. Fish

Aquatic biota can be sensitive indicators of radionuclide accumulation in the environment because of their ability to concentrate certain chemical elements which have radioactive isotopes. The results are presented in Table B-13. Eight samples of fish were collected during 1997. These samples were analyzed by gamma ray spectroscopy and the naturally occurring isotope potassium-40 was found in all samples at an average of 1783 pCi/kg (wet weight) with a range of 1050 to 2270 pCi/kg (wet weight). The fission product cesium-137 was measured in four samples at an average of 33.2 pCi/kg (wet weight) and a range of 24.7 to 37.4 pCi/kg (wet weight). During the preoperational period cesium-137 was measured in one-fourth of the fish samples collected with concentrations between 31 and 66 pCi/kg (wet weight). All other gamma emitters were below their detection levels.

3. Food/Vegetation

Thirty-five food samples were collected from five locations and analyzed by gamma spectrometry. The results are presented in Table B-14. Naturally occurring potassium-40 was monitored in all 35 samples with an average activity level of 13615 pCi/kg (wet weight) and a range of 3640 to 25400 pCi/kg (wet weight). Cosmogenic beryllium-7 was detected in 33 of the 35 samples with an average concentration of 3588 pCi/kg (wet weight) and a range of 644 to 13200 pCi/kg (wet weight). Radium was measured in one sample with an activity of 1110 (wet weight). The terrestrial nuclide thorium-228 was detected in five samples at an average activity of 337 pCi/kg (wet weight) and a range of 114 to 740 pCi/kg (wet weight).

Neither cesium-134 nor cesium-137, both of which are fission products, were detected at levels above LLD during 1997, though cesium-137 has been detected in some samples at low-levels in previous years.Cesium-137 was measured in broadleaf garden vegetation during the preoperational period with concentrations between 53 and 98 pCi/kg (wet weight).

E. *Direct Radiation Exposure Pathway*

1. TLD Dosimeters

Thermoluminescent dosimeters (TLDs) determine environmental radiation doses and the results are presented in Table B-15. Individual measurements of external radiation levels in the environs of the North Anna site had an average dose of 6.1 mR/standard month with a range of 3.6 to 9.1 mR/standard month. This is comparable to the preoperational range. The control station, No. 24, had an average reading of 5.8 mR/standard month with a range of 4.6 to 6.5 mR/standard month.

Sector TLDs are deployed quarterly at thirty-two locations in the environs of the North Anna site. Two badges are placed at each location. The results are presented in Table B-16. The average level of the 32 locations (two badges at each location) was 6.6 mR/standard month with a range of 3.9 to 10.1 mR/standard month. The eight control TLDs, collected quarterly from four locations, showed an average reading of 5.7 mR/standard month with a range of 3.9 to 7.6 mR/standard month. During the preoperational period (starting in 1977), when the calculation of the TLD dose included a correction for the in-transit dose, the doses were measured between 4.3 and 8.8 mR/standard month.

V. CONCLUSIONS

V. Conclusions

The results of the 1997 Radiological Environmental Monitoring Program for the North Anna Nuclear Power Station have been presented. The following sections discuss each pathway individually followed by a program summary.

Airborne Exposure Pathway

Air particulate gross beta concentrations of all the indicator locations for 1997 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. Gross beta concentrations in the preoperational period were highly variable, ranging from 0.0043 to 0.75 pCi/CuM, due to occasional atmospheric nuclear weapons tests. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). There were no detections above the LLD for fission products nor other man-made isotopes in the particulate media during 1997. Iodine-131 was not detected in the charcoal filters analyzed during 1997.

A precipitation sample was collected monthly during 1997 and analyzed for gross beta activity. All the gross beta activities were comparable to those measured in previous years. During the preoperational period the average gross beta activity was 0.92 pCi/liter. Semi-annual composites were analyzed for gamma emitting isotopes and tritium. All gamma emitters were below their detection limits. Tritium was not observed above the LLD during this reporting period in 1997. During the preoperational period the average tritium activity was 165 pCi/liter.

Waterborne Exposure Pathway

No man-made or natural isotopes were monitored in the surface water of Lake Anna except tritium. The average tritium activity during 1997 at the waste heat treatment facility was 3100 pCi/liter which is 16.0% of the reporting level for a water sample. In 1996 the tritium level was 3150 pCi/liter. The preoperational level was 150 pCi/liter and has been rising since 1977. Tritium was not measured upstream of the site, at station 09A.

The samples of surface water collected by the Commonwealth of Virginia at the waste heat treatment facility had similar tritium results with a measurement of 2650 pCi/liter as compared to 2985 pCi/liter for 1996. The upstream location had two measurements at an average activity of 1600 pCi/liter as compared to 800 pCi/liter for 1996. No 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 2650 pCi/liter. The average tritium in 1996 had been 2950 pCi/liter. No gamma emitters were detected.

Ground water from the environmental well on site contained no gamma emitters. There were also no detections of tritium in ground/well water during 1997.

Aquatic Pathway

Sediment/silt samples provide a sensitive indicator of discharges from nuclear power stations. The sediment from North Anna environmental samples indicated that one man-made isotope was present. Cesium-137 was detected in three samples at three locations. During the preoperational period, cesium-137 was measured in samples of aquatic sediment. Sediment contamination does not provide a direct dose pathway to man.

The samples of shoreline soil monitored downstream of the site contained no measurement of cesium-134. Cesium-137 was measured in both samples at an average level of 159 pCi/kg which was lower than the average of 510 pCi/kg detected in 1996.

Ingestion Pathway

Iodine-131 was not detected in any of the twenty-four milk samples using the radiochemical separation method. Although cesium-137 has been detected occasionally in previous years and attributed to past atmospheric nuclear weapons testing there were no detections during 1997. Strontium-90 was measured in all eight milk samples. Strontium-90 is attributed to past atmospheric nuclear weapons testing. No strontium-89 was detected in any of the milk samples. Naturally occurring potassium-40 was measured in all the milk samples at normal environmental levels.

Activity in fish and vegetation samples along with milk does present a direct dose pathway to man. Fish samples during 1997 showed the presence of one man-made isotope, cesium-137. This isotope was at an activity level somewhat higher than preoperational levels but statistically similar to levels in 1987 through 1996. Only cesium-137 was measured in preoperational environmental fish samples. Due to primary and secondary steam generator problems experienced at North Anna during 1984/1985, a build up in activity levels both in effluents and fish did occur. Repairs to the steam generators and better liquid waste processing have reduced these activity levels in effluents and thus decreased activity levels are now being observed in the fish. The average level of activity during 1997 of cesium-137 was 1.7.% of the reporting level.

No vegetation samples contained the man-made isotope cesium-137 during 1997. Cesium-137 has been measured in the past and in preoperational samples.

Direct Exposure Pathway

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

Program Conclusions

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

As a method of referencing the measured radionuclide concentrations in sample media to the dose consequence, the data may be compared to the Reporting Level Concentrations listed in the Offsite Dose Calculation Manual. These concentrations are based upon 25% of the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion "As Low as is Reasonably Achievable." Based upon the evidence of the environmental monitoring program the station is operating within regulatory limits. Thus, no unusual radiological characteristics were observed in the environs of the North Anna Nuclear Power Station during 1997.

VI. REFERENCES

VI. References

1. Virgir.ia Electric and Power Company, North Anna Power Station Technical Specifications, Units 1 and 2.

2. Virginia Electric and Power Company, Station Administrative Procedure, VPAP-2103, "Offsite Dose Calculation Manual.

3. Title 10 Code of Federal Regulation, Part 50 (10CFR50), "Domestic Licensing of Production and Utilization Facilities."

4. United States Nuclear Regulatory Commission Regulatory Guide 1.109, Rev. 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I," October, 1977.

5. United States Nuclear Regulatory Commission, Regulatory Guide 4.8 "Environmental Technical Specifications for Nuclear Power Plants," December, 1975.

6. USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program," Rev. 1, November 1979.

7. NUREG 0472, "Radiological Effluent Technical Specifications for PWRs," Rev. 3, March 1982.

APPENDIX A
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
ANNUAL SUMMARY TABLES - 1997

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1997

Docket No. 50-338/339

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Air Iodine (pCi/m^3)	I-131	624	0.04	-(0/572) -	N/A		N/A	-(0/52) -	0
Airborne Particulates ($1E-03\ pCi/m^3$)	Gross Beta	624	5	20.6(572-572) (7.0-43)	24	22.0 mi NW	23.0(52/52) (10-81)	23.0(52/52) (10-81)	0
	Gamma	48							
	Be-7	48	10	118(44/44) (53.5-181)	01	0.20 mi NE	127(4/4) (57.5-164)	117(4/4) (51.8-175)	0
	K-40	48	10	7.04(5/44) (3.38-18.0)	21	1 0 mi WNW	18.0(1/4) -	3.79(1/4) -	0
	Sr-89	12	3	-(0/11) -	N/A		N/A	-(0/1) -	0
	Sr-90	12	0.4	-(0/11) -	N/A		N/A	-(0/1) -	0
Ground Well Water (pCi/liter)	Gamma	4							
	K-40	4	60	-(0/4) -	N/A		N/A	-(0/0) -	0
	Tritium	4	2000	240(1/4) -	01A	0.75 mi SE	240(1/4) -	-(0/0) -	0
	Sr-89	1	3	-(0/1) -	N/A		N/A	-(0/0) -	0
	Sr-90	1	0.4	-(0/1) -	N/A		N/A	-(0/0) -	0

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

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD*	All Indicator Locations Mean Range	Location with Highest Mean Name	Location with Highest Mean Distance Direction	Location with Highest Mean Mean Range	Control Location Mean Range	Non-routine Reported Measurements
River Water (pCi/liter)	Gamma	12							
	K-40	12	200	-(0/12) -	N/A		N/A	-(0/0) -	0
	Tritium	4	2000	2650(4/4) (2300-3000)	11	5.8 mi.SSE	2650(4/4) (2300-3000)	-(0/0) -	0
	Sr-89	1	3	-(0/1) -	N/A		N/A	-(0/0) -	0
	Sr-90	1	0.4	-(0/1) -	N/A		N/A	-(0/0) -	0
Precipitation (pCi/liter)	Monthly								
	Gross Beta	12	4	3.51(12/12) (1.5-9.6)	01A	0.2 mi. NE	3.51(12/12) (1.5-9.6)	-(0/0) -	0
	Gamma (Semi-Annually)	2							
	Tritium	2	2000	-(0/2) -	N/A		N/A	-(0/0) -	0
Surface Water (pCi/liter) Regular Monthlies	I-131	24	0.5	-(0/12) -	N/A		N/A	-(0/12) -	0
	Gamma	24							
	K-40	24	200	-(0/12) -	N/A		N/A	-(0/12) -	0
	Tritium	8	2000	3100(4/4) (2400-3600)	08	1.10 mi SSE	3100(4/4) (2400-3600)	-(0/4) -	0

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

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD*	All Indicator Locations Mean Range	Location with Highest Mean Name	Location with Highest Mean Distance Direction	Location with Highest Mean Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Surface Water (pCi/liter) Regular Monthlies	Sr-89	1		-(0/1) -	N/A		N/A	-(0/1) -	0
	Sr-90	1		-(0/1) -	N/A		N/A	-(0/1) -	0
Surface Water (pCi/liter) State Splits	Gamma	24							
	K-40	24	200	-(0/24) -	N/A		N/A	-(0/0) -	0
	Tritium	8	2000	2200(6/8) (300-4200)	W33		2650(4/4) (2300-3400)	-(0/0) -	0
Sediment Silt	Gamma	6							
(pCi/kg (dry))	Be-7	6		-(0/4) -	09A	2.20 mi NW	442(1/2) -	442(1/2) -	0
	K-40	6	200	12825(4/4) (2500-18200)	11	5.8 mi SSE	16600(2/2) (15000-18200)	11800(2/2) (11600-12000)	0
	Cs-137	6	194	90.1(1/4) -	11	5.8 mi SSE	90.1(1/2) -	51.7(2/2) (48-55.4)	0
	Ra-226	6	100	1555(4/4) (970-1990)	11	5.8 mi SSE	1630(2/2) (1600-1660)	1555(2/2) (1500-1610)	0
	Th-228	6	30	1240(4/4) (580-1800)	11	5.8 mi. SSE	1475(2/2) (1150-1800)	681(2/2) (580-782)	0
	Sr-89 (Annually)	3	4.0	-(0/2) -	N/A		N/A	-(0/1) -	0
	Sr-90 (Annually)	3	0.8	-(0/2) -	N/A		N/A	-(0/1) -	0

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

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1997

Docket No. 50-338/339

Medium or Pathway Sampled (Unit)	AN/Alysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measure-ments
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Shoreline Soil	Gamma	2							
(pCi/kg (dry))	Be-7	2		-(0/2) -				-(0/0) -	0
	K-40	2	200	1805(2/2) (770-2840)	8	1.10 mi SSE	1805(2/2) (770-2840)	-(0/0) -	0
	Cs-137	2	40	159(2/2) (147-170)	8	1.10 mi SSE	159(2/2) (147-170)	-(0/0) -	0
	Ra-226	2	100	1160(1/2) -	8	1.10 mi SSE	1160(1/2) -	-(0/0) -	0
	Th-228	2	30	244(2/2) (240-247)	8	1.10 mi SSE	244(2/2) (240-247)	-(0/0) -	0
	Sr-89 (Annually)	1	4.0	-(0/1) -	N/A		N/A	-(0/0) -	0
	Sr-90 (Annually)	1	0.8	-(0/1) -	N/A		N/A	-(0/0) -	0
Milk (pCi/liter)	I-131	24	0.5	-(0/24) -	N/A		N/A	-(0/0) -	0
	Gamma	24							
	K-40	24	100	1276(12/12) (1020-1410)	12	8.3 mi. NW	1287(12/12) (1130-1430)	-(0/0) -	0
	Sr-89 (Quarterly)	8	5	-(0/8) -	N/A		N/A	-(0/0) -	0
	Sr-90 (Quarterly)	8	0.8	1.16(8/8) (0.45-1.8)	12	8.3 mi. NW	1.22(4/4) (0.45-1.8)	-(0/0) -	0

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

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Fish pCi/kg (wet)	Gamma	8							
	K-40	8	200	1705(4/4) (1050-2270)	25	16.5 mi. NW	1860(4/4) (1560-2030)	1860(4/4) (1560-2030)	0
	Cs-137	8	40	33.2(4/4) (24.7-37.4)	08	1.10 mi. SSE	33.2(3/4) (24.7-37.4)	-(0/4) -	0
Food Vegetation (pCi/kg (wet))	Gamma Dose	35							
	Be-7	35	-	3588(33/35) (644-13200)	21	1.00 mi WNW	4903(7/7) (2060-13200)	-(0/0) -	0
	K-40	35	-	13615(35/35) (3640-25400)	23	0.93 mi SSE	15659(7/7) (4310-25400)	-(0/0) -	0
	Cs-137	35	80	-(0/35) -	N/A		N/A	-(0/0) -	0
	Ra-226	35	-	1110(1/35) -	21	1.00 mi. WNW	1110(1/7) -	-(0/0) -	0
	Th-228	35	-	337(5/35) (114-740)	14	1.20 mi NE	740(1/7) -	-(0/0) -	0

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

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1997

Docket No. 50-338/339

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Direct Radiation (mR/std. month) (Regular TLDs)	Gamma Dose	48	0.2	6.12(44/44) (3.6-9.1)	01	0.2 mi. NE	8.30(4/4) (7.5-9.1)	5.75(4/4) (4.6-6.5)	0
Direct Radiation (mR/std. Month) (Annual TLDs)	Gamma Dose	12	0.2	5.96(11/11) (4.6-8.1)	01	0.2 mi. NE	8.1(1/1) -	5.6(1/1) -	0
Direct Radiation (mR/std. Month) (Sector TLDs)	Gamma Dose	288	0.2	6.70(256/256) (4.0-10.1)	19/51	0.30 mi. SW	8.15(8/8) (7.2-9.0)	5.73(32/32) (3.9-7.6)	0

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

APPENDIX B
DATA TABLES

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

North Anna Power Station, Louisa County, Virginia - 1997

pCi/m^3 ± 2 Sigma

Collection Date	STATIONS 01	02	03	04	05	05A	06	07	21	22	23	24
JANUARY												
01/02-01/08	< .02	< .02	< .02	< .02	< .008	< .009	< .009	< .009	< .009	< .006	< .02	< .02
01/08-01/15	< .01	< .01	< .01	< .01	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
01/15-01/22	< .008	< .008	< .008	< .008	< .006	< .008	< .008	< .008	< .008	< .006	< .01	< .01
01/22-01/29	< .008	< .008	< .008	< .008	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
FEBRUARY												
01/29-02/05	< .01	< .01	< .01	< .01	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
02/05-02/12	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .007	< .01	< .01
02/12-02/19	< .02	< .02	< .02	< .02	< .008	< .01	< .01	< .01	< .01	< .009	< .01	< .01
02/19-02/26	< .007	< .007	< .007	< .007	< .006	< .006	< .006	< .006	< .006	< .005	< .01	< .01
MARCH												
02/26-03/05	< .01	< .01	< .01	< .01	< .007	< .008	< .008	< .008	< .008	< .005	< .01	< .01
03/05-03/12	< .01	< .01	< .01	< .01	< .007	< .01	< .01	< .01	< .01	< .009	< .009	< .009
03/12-03/19	< .009	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .02	< .02
03/19-03/26	< .008	< .008	< .008	< .008	< .005	< .007	< .007	< .007	< .007	< .005	< .01	< .01
03/26-04/02	< .01	< .01	< .01	< .01	< .007	< .01	< .01	< .01	< .01	< .009	< .01	< .01
APRIL												
04/02-04/10	< .006	< .006	< .006	< .006	< .005	< .006	< .006	< .006	< .006	< .004	< .01	< .009
04/10-04/16	< .02	< .02	< .02	< .02	< .009	< .01	< .01	< .01	< .01	< .007	< .02	< .02
04/16-04/23	< .009	< .009	< .009	< .009	< .008	< .01	< .01	< .01	< .01	< .007	< .02	< .009
04/23-04/30	< .02	< .01	< .01	< .01	< .007	< .01	< .01	< .01	< .01	< .009	< .01	< .01
MAY												
04/30-05/07	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .009	< .009
05/07-05/14	< .01	< .01	< .01	< .01	< .007	< .008	< .008	< .008	< .008	< .005	< .01	< .01
05/14-05/21	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
05/21-05/28	< .009	< .009	< .009	< .009	< .007	< .01	< .01	< .01	< .01	< .007	< .006	< .009
JUNE												
05/28-06/04	< .008	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .009	< .01	< .01
06/04-06/11	< .01	< .01	< .01	< .01	< .008	< .009	< .009	< .009	< .009	< .007	< .008	< .008
06/11-06/18	< .01	< .01	< .01	< .01	< .009	< .009	< .009	< .009	< .009	< .006	< .01	< .02
06/18-06/25	< .01	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .009	< .01	< .01
06/25-07/02	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .008	< .02	< .01

TABLE B-1: IODINE-131 CONCENTRATION IN FILTERED AIR

North Anna Power Station, Louisa County, Virginia - 1997

pCi/m^3 ± 2 Sigma Page 2 of 2

Collection Date	STATIONS 01	02	03	04	05	05A	06	07	21	22	23	24
JULY												
07/02-07/09	< .008	< .008	< .008	< .008	< .006	< .008	< .008	< .008	< .008	< .006	< .01	< .01
07/09-07/16	< .008	< .008	< .008	< .008	< .007	< .008	< .008	< .008	< .008	< .006	< .01	< .01
07/16-07/23	< .01	< .01	< .01	< .01	< .007	< .008	< .009	< .009	< .009	< .006	< .01	< .01
07/23-07/30	< .02	< .02	< .02	< .02	< .01	< .03	< .03	< .03	< .03	< .02	< .04	< .04
AUGUST												
07/30-08/06	< .005	< .005	< .005	< .005	< .004	< .008	< .008	< .008	< .008	<.006	< .01	< .009
08/06-08/13	< .02	< .02	< .02	< .02	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
08/13-08/20	< .01	< .01	< .01	< .01	< .006	< .008	< .008	< .008	< .008	< .005	< .01	< .01
08/20-08/27	< .009	< .009	< .009	< .009	< .007	< .008	< .008	< .008	< .008	< .006	< .02	< .01
SEPTEMBER												
08/27-09/04	< .008	< .009	< .008	< .008	< .006	< .009	< .009	< .009	< .009	< .007	< .008	< .007
09/04-09/11	< .01	< .01	< .01	< .01	< .007	< .02	< .02	< .02	< .02	< .01	< .01	< .009
09/11-09/17	< .02	< .02	< .02	< .02	< .009	< .02	< .02	< .02	< .02	< .01	< .008	< .01
09/17-09/24	< .02	< .02	< .02	< .02	< .008	< .02	< .02	< .02	< .02	< .01	< .008	< .008
09/24-10/01	< .01	< .01	< .01	< .01	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
OCTOBER												
10/01-10/08	< .01	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .007	< .01	< .006
10/08-10/15	< .01	< .01	< .01	< .01	< .009	< .008	< .008	< .008	< .008	< .005	< .01	< .02
10/15-10/22	< .01	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .007	< .01	< .01
10/22-10/29	< .01	< .01	< .01	< .01	< .006	< .007	< .007	< .007	< .007	< .005	< .008	< .008
NOVEMBER												
10/29-11/05	< .01	< .01	< .02	< .01	< .007	< .009	< .009	< .009	< .008	< .006	< .008	< .009
11/05-11/12	< .007	< .007	< .008	< .008	< .005	< .006	< .006	< .007	< .006	< .004	< .01	< .01
11/12-11/19	< .01	< .01	< .01	< .01	< .007	< .01	< .01	< .02	< .01	< .01	< .008	< .04 (a)
11/19-11/25	< .008	< .009	< .009	< .008	< .007	< .01	< .01	< .01	< .01	< .01	< .02	< .02
11/25-12/03	< .01	< .01	< .01	< .01	< .007	< .01	< .01	< .01	< .01	< .008	< .01	< .01
DECEMBER												
12/03-12/10	< .01	< .01	< .01	< .01	< .006	< .006	< .006	< .006	< .006	< .005	< .01	< .01
12/10-12/17	< .01	< .01	< .01	< .01	< .009	< .008	< .008	< .008	< .007	< .006	< .01	< .008
12/17-12/23	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .01	< .02	< .02
12/23-12/31	< .02	< .02	< .02	< .02	< .008	< .01	< .01	< .01	< .01	< .01	< .007	< .006

(a) Low sample volume; sampler not running. Volume estimated at minimum of 75 cu. m.

TABLE B-2

(Page 1 of 4)

NORTH ANNA - 1997

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
JANUARY													
01/02-01/08	24 ± 2	19 ± 2	24 ± 2	24 ± 2	20 ± 2	20 ± 2	22 ± 2	17 ± 2	20 ± 2	22 ± 2	21 ± 2	21 ± 2	21 ± 4
01/08-01/15	24 ± 2	20 ± 2	21 ± 2	23 ± 2	21 ± 2	23 ± 2	24 ± 2	19 ± 2	20 ± 2	23 ± 2	22 ± 2	23 ± 2	22 ± 3
01/15-01/22	25 ± 2	21 ± 2	25 ± 2	24 ± 2	19 ± 2	23 ± 2	25 ± 2	21 ± 2	10 ± 2	24 ± 2	27 ± 2	24 ± 2	22 ± 9
01/22-01/29	21 ± 2	17 ± 2	19 ± 2	20 ± 2	21 ± 2	21 ± 2	20 ± 2	18 ± 2	20 ± 2	21 ± 2	21 ± 2	21 ± 2	20 ± 3
FEBRUARY													
01/29-02/05	27 ± 2	17 ± 2	24 ± 2	24 ± 2	23 ± 2	24 ± 2	24 ± 2	21 ± 2	15 ± 2	24 ± 2	27 ± 2	23 ± 2	23 ± 7
02/05-02/12	19 ± 2	17 ± 2	15 ± 2	17 ± 2	17 ± 2	16 ± 2	17 ± 2	16 ± 2	12 ± 2	18 ± 2	16 ± 2	17 ± 2	16 ± 3
02/12-02/19	20 ± 2	20 ± 2	18 ± 2	20 ± 2	19 ± 2	19 ± 2	18 ± 2	16 ± 2	13 ± 2	19 ± 2	20 ± 2	21 ± 2	19 ± 4
02/19-02/26	18 ± 2	13 ± 2	15 ± 2	14 ± 2	14 ± 2	15 ± 2	16 ± 2	13 ± 2	8.0 ± 1.4	17 ± 2	15 ± 2	14 ± 2	14 ± 5
MARCH													
02/26-03/05	14 ± 2	10 ± 1	11 ± 2	11 ± 2	11 ± 2	12 ± 2	12 ± 2	10 ± 1	7.1 ± 1.3	11 ± 2	11 ± 2	11 ± 2	11 ± 3
03/05-03/12	19 ± 2	18 ± 2	19 ± 2	19 ± 2	19 ± 2	20 ± 2	20 ± 2	15 ± 2	11 ± 2	19 ± 2	19 ± 2	17 ± 2	18 ± 5
03/12-03/19	21 ± 2	20 ± 2	18 ± 2	20 ± 2	18 ± 2	18 ± 2	22 ± 2	17 ± 2	14 ± 2	22 ± 2	21 ± 2	20 ± 2	19 ± 5
03/19-03/26	16 ± 2	14 ± 2	14 ± 2	14 ± 2	16 ± 2	15 ± 2	13 ± 2	13 ± 2	9.8 ± 1.4	17 ± 2	14 ± 2	14 ± 2	14 ± 4
03/26-04/02	18 ± 2	17 ± 2	17 ± 2	17 ± 2	16 ± 2	17 ± 2	16 ± 2	15 ± 2	12 ± 2	17 ± 2	16 ± 2	16 ± 2	15 ± 6
Quarter Avg. ± 2 s.d.	**20 ± 7**	**16 ± 9**	**18 ± 8**	**19 ± 8**	**18 ± 6**	**19 ± 7**	**19 ± 8**	**16 ± 6**	**13 ± 9**	**20 ± 7**	**19 ± 10**	**19 ± 8**	**18 ± 9**

TABLE B-2

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CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
APRIL													
04/02-04/10	19 ± 2	19 ± 2	20 ± 2	21 ± 2	20 ± 2	17 ± 2	18 ± 2	16 ± 2	13 ± 2	19 ± 2	21 ± 2	20 ± 2	19 ± 5
04/10-04/16	24 ± 2	20 ± 2	20 ± 2	25 ± 2	22 ± 2	20 ± 2	21 ± 2	22 ± 2	18 ± 2	23 ± 2	21 ± 2	17 ± 2	21 ± 5
04/16-04/23	26 ± 2	23 ± 2	22 ± 2	26 ± 2	26 ± 2	23 ± 2	23 ± 2	23 ± 2	15 ± 2	26 ± 2	25 ± 2	21 ± 2	23 ± 6
04/23-04/30	12 ± 2	10 ± 2	11 ± 2	11 ± 2	11 ± 2	12 ± 2	11 ± 2	9.1 ± 1.4	8.2 ± 1.4	13 ± 2	11 ± 2	10 ± 1	11 ± 3
MAY													
04/30-05/07	20 ± 2	18 ± 2	16 ± 2	18 ± 2	18 ± 2	17 ± 2	19 ± 2	17 ± 2	10 ± 1	17 ± 2	19 ± 2	19 ± 2	17 ± 5
05/07-05/14	17 ± 2	16 ± 2	20 ± 2	16 ± 2	17 ± 2	17 ± 2	14 ± 2	17 ± 2	17 ± 2	16 ± 2	18 ± 2	17 ± 2	17 ± 3
05/14-05/21	19 ± 2	20 ± 2	22 ± 2	20 ± 2	18 ± 2	20 ± 2	16 ± 2	18 ± 2	21 ± 2	19 ± 2	20 ± 2	20 ± 2	19 ± 3
05/21-05/28	15 ± 2	13 ± 2	19 ± 2	14 ± 2	12 ± 2	13 ± 2	12 ± 2	11 ± 2	15 ± 2	13 ± 2	16 ± 2	15 ± 2	14 ± 4
JUNE													
05/28-06/04	11 ± 1	11 ± 1	11 ± 1	10 ± 1	10 ± 1	13 ± 2	8.4 ± 1.3	10 ± 1	13 ± 2	9.9 ± 1.4	12 ± 2	13 ± 2	11 ± 3
06/04-06/11	14 ± 2	11 ± 2	15 ± 2	14 ± 2	11 ± 2	11 ± 1	11 ± 2	12 ± 2	13 ± 2	13 ± 2	14 ± 2	13 ± 2	13 ± 3
06/11-06/18	21 ± 2	20 ± 2	20 ± 2	21 ± 2	21 ± 2	18 ± 2	18 ± 2	19 ± 2	25 ± 2	19 ± 2	22 ± 2	24 ± 2	21 ± 6
06/18-06/25	25 ± 2	20 ± 2	26 ± 2	25 ± 2	22 ± 2	21 ± 2	21 ± 2	21 ± 2	25 ± 2	26 ± 2	27 ± 2	23 ± 2	24 ± 5
06/25-07/02	21 ± 2	18 ± 2	20 ± 2	19 ± 2	18 ± 2	17 ± 2	15 ± 2	17 ± 2	23 ± 2	19 ± 2	20 ± 2	20 ± 2	19 ± 4
Quarter Avg. ± 2 s.d.	**19 ± 10**	**17 ± 9**	**19 ± 9**	**18 ± 11**	**17 ± 10**	**17 ± 7**	**16 ± 9**	**16 ± 9**	**17 ± 11**	**18 ± 10**	**19 ± 9**	**18 ± 8**	**18 ± 2**

TABLE B-2

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CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
JULY													
07/02-07/09	19 ± 2	18 ± 2	20 ± 2	20 ± 2	17 ± 2	21 ± 2	17 ± 2	20 ± 2	24 ± 2	22 ± 2	22 ± 2	22 ± 2	20 ± 4
07/09-07/16	29 ± 2	24 ± 2	28 ± 2	28 ± 2	24 ± 2	26 ± 2	21 ± 2	26 ± 2	26 ± 2	27 ± 2	28 ± 2	27 ± 2	26 ± 5
07/16-07/23	25 ± 2	24 ± 2	26 ± 2	25 ± 2	23 ± 2	24 ± 2	21 ± 2	24 ± 2	27 ± 2	21 ± 2	29 ± 2	29 ± 2	25 ± 5
07/23-07/30	22 ± 2	20 ± 2	18 ± 2	20 ± 2	18 ± 2	20 ± 2	16 ± 2	19 ± 2	19 ± 2	20 ± 2	20 ± 2	22 ± 2	20 ± 3
AUGUST													
07/30-08/06	27 ± 2	25 ± 2	27 ± 2	26 ± 2	23 ± 2	23 ± 2	17 ± 2	24 ± 2	20 ± 2	25 ± 2	27 ± 2	26 ± 2	24 ± 6
08/06-08/13	28 ± 2	26 ± 2	28 ± 2	29 ± 2	28 ± 2	25 ± 2	27 ± 2	27 ± 2	22 ± 2	29 ± 2	30 ± 2	29 ± 2	27 ± 4
08/13-08/20	19 ± 2	17 ± 2	21 ± 2	20 ± 2	18 ± 2	16 ± 2	17 ± 2	12 ± 2	15 ± 2	17 ± 2	19 ± 2	19 ± 2	18 ± 5
08/20-08/27	19 ± 2	20 ± 2	20 ± 2	19 ± 2	19 ± 2	17 ± 2	18 ± 2	18 ± 2	15 ± 2	19 ± 2	19 ± 2	22 ± 2	19 ± 3
SEPTEMBER													
08/27-09/04	29 ± 2	28 ± 2	30 ± 2	26 ± 2	27 ± 2	24 ± 2	24 ± 2	23 ± 2	19 ± 2	29 ± 2	30 ± 2	30 ± 2	27 ± 7
09/04-09/11	33 ± 2	31 ± 2	34 ± 2	31 ± 2	31 ± 2	28 ± 2	29 ± 2	24 ± 2	18 ± 2	31 ± 2	30 ± 2	32 ± 2	29 ± 9
09/11-09/17	29 ± 2	31 ± 3	29 ± 2	28 ± 2	25 ± 2	25 ± 2	24 ± 2	22 ± 2	21 ± 2	29 ± 2	28 ± 2	30 ± 3	27 ± 7
09/17-09/24	34 ± 2	33 ± 2	33 ± 2	34 ± 2	29 ± 2	29 ± 2	31 ± 2	27 ± 2	24 ± 2	32 ± 2	30 ± 2	33 ± 2	31 ± 6
09/24-10/01	18 ± 2	19 ± 2	19 ± 2	19 ± 2	18 ± 2	15 ± 2	17 ± 2	15 ± 2	14 ± 2	23 ± 2	16 ± 2	19 ± 2	18 ± 5
Quarter Avg. ± 2 s.d.	**25 ± 11**	**24 ± 11**	**26 ± 11**	**25 ± 10**	**23 ± 10**	**23 ± 9**	**21 ± 10**	**22 ± 9**	**20 ± 8**	**25 ± 10**	**25 ± 10**	**26 ± 10**	**24 ± 19**

TABLE B-2

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CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
OCTOBER													
10/01-10/08	43 ± 3	40 ± 3	41 ± 3	39 ± 3	36 ± 2	34 ± 2	36 ± 2	31 ± 2	29 ± 2	40 ± 3	39 ± 3	41 ± 3	37 ± 9
10/08-10/15	38 ± 3	41 ± 3	41 ± 3	36 ± 3	38 ± 3	32 ± 2	34 ± 2	28 ± 2	26 ± 2	38 ± 3	33 ± 2	40 ± 3	35 ± 10
10/15-10/22	26 ± 2	28 ± 2	30 ± 2	25 ± 2	24 ± 2	21 ± 2	22 ± 2	20 ± 2	22 ± 2	24 ± 2	28 ± 2	30 ± 2	25 ± 7
10/22-10/29	19 ± 2	21 ± 2	18 ± 2	19 ± 2	18 ± 2	15 ± 2	18 ± 2	14 ± 2	15 ± 2	17 ± 2	18 ± 2	20 ± 2	18 ± 4
NOVEMBER													
10/29-11/05	22 ± 2	21 ± 2	26 ± 2	19 ± 2	21 ± 2	18 ± 2	18 ± 2	13 ± 2	15 ± 2	20 ± 2	19 ± 2	22 ± 2	20 ± 7
11/05-11/12	19 ± 2	15 ± 2	14 ± 2	16 ± 2	14 ± 2	15 ± 2	18 ± 2	15 ± 2	15 ± 2	12 ± 2	18 ± 2	17 ± 2	15 ± 5
11/12-11/19	20 ± 2	17 ± 2	18 ± 2	18 ± 2	15 ± 2	18 ± 2	18 ± 2	18 ± 2	17 ± 2	13 ± 2	17 ± 2	81 ± 12 (a)	23 ± 37
11/19-11/25	34 ± 3	36 ± 3	32 ± 3	36 ± 3	27 ± 2	32 ± 3	36 ± 3	34 ± 3	27 ± 2	31 ± 2	37 ± 3	24 ± 2	32 ± 8
11/25-12/03	26 ± 2	26 ± 2	24 ± 2	30 ± 2	27 ± 2	25 ± 2	30 ± 2	27 ± 2	27 ± 2	24 ± 2	27 ± 2	27 ± 2	27 ± 4
DECEMBER													
12/03-12/10	14 ± 2	12 ± 2	10 ± 2	14 ± 2	12 ± 2	13 ± 2	14 ± 2	14 ± 2	13 ± 2	14 ± 2	11 ± 2	13 ± 2	13 ± 3
12/10-12/17	20 ± 2	17 ± 2	16 ± 2	21 ± 2	18 ± 2	18 ± 2	23 ± 2	16 ± 2	19 ± 2	17 ± 2	20 ± 2	20 ± 2	19 ± 4
12/17-12/23	33 ± 3	31 ± 3	32 ± 3	37 ± 3	30 ± 3	29 ± 2	30 ± 2	36 ± 3	32 ± 3	32 ± 3	31 ± 3	29 ± 2	32 ± 5
12/23-12/31	16 ± 2	15 ± 2	15 ± 2	17 ± 2	15 ± 2	14 ± 1	18 ± 2	14 ± 2	16 ± 2	15 ± 2	16 ± 2	16 ± 2	16 ± 2
Quarter Avg. ± 2 s.d.	**25 ± 18**	**25 ± 20**	**24 ± 20**	**25 ± 18**	**23 ± 17**	**22 ± 15**	**24 ± 16**	**22 ± 17**	**21 ± 13**	**23 ± 19**	**24 ± 18**	**29 ± 35**	**24 ± 19**
Annual Avg. ± 2 s.d.	**23 ± 13**	**21 ± 15**	**22 ± 14**	**22 ± 14**	**20 ± 12**	**20 ± 11**	**20 ± 13**	**19 ± 12**	**18 ± 12**	**21 ± 13**	**22 ± 13**	**23 ± 21**	**21 ± 14**

(a) Low sample volume: sampler not running, volume estimated at minimum of 75 m^3

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

North Anna Power Station, Louisa County, Virginia - 1997

1.0 E-03 pCi/m^3 ± 2 Sigma

Station	Nuclide	First Quarter 01/02-04/02	Second Quarter 04/02-07/02	Third Quarter 07/02-10/01	Fourth Quarter 10/01-12/31	Average ± 2 s.d.
STA-01	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	148 ± 15	138 ± 14	164 ± 16	57.5 ± 5.7	127 ± 95
	K-40	3.38 ± 1.76	< 4	< 6	< 6	3.38 ± 17.6
	Co-60	< 0.3	< 0.2	< 0.2	< 0.2	-
	Ru-103	< 0.7	< 0.4	< 0.6	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.2	-
	Th-228	< 0.4	< 0.5	< 0.3	< 0.3	-
STA-02	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	123 ± 12	113 ± 11	157 ± 16	57.4 ± 5.7	113 ± 83
	K-40	< 10	< 4	< 5	< 5	-
	Co-60	< 0.3	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.8	< 0.4	< 0.6	< 0.3	-
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.3	-
	Th-228	< 0.4	< 0.4	< 0.4	< 0.4	-
STA-03	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	156 ± 16	107 ± 11	175 ± 17	60.9 ± 6.1	125 ± 103
	K-40	< 4	< 4	< 5	< 5	-
	Co-60	< 0.3	< 0.3	< 0.2	< 0.3	-
	Ru-103	< 0.6	< 0.3	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.2	-
	Th-228	< 0.4	< 0.4	< 0.3	< 0.3	-
STA-04	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	130 ± 13	105 ± 10	173 ± 17	61.6 ± 6.2	117 ± 93
	K-40	< 6	< 4	< 4	< 4	-
	Co-60	< 0.2	< 0.2	< 0.2	< 0.2	-
	Ru-103	< 0.6	< 0.3	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.2	< 0.3	< 0.3	-
	Th-228	< 0.3	< 0.4	< 0.4	< 0.3	-

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

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

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

North Anna Power Station, Louisa County, Virginia - 1997

1.0 E-03 pCi/m^3 ± 2 Sigma

Station	Nuclide	First Quarter 01/02-04/02	Second Quarter 04/02-07/02	Third Quarter 07/02-10/01	Fourth Quarter 10/01-12/31	Average ± 2 s.d.
STA-05	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	174 ± 17	99.4 ± 9.9	159 ± 16	55.1 ± 5.5	122 ± 10
	K-40	4.02 ± 2.00	< 10	< 10	3.80 ± 2.02	3.91 ± 0.31
	Co-60	< 0.3	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.8	< 0.5	< 0.8	< 0.5	-
	Cs-134	< 0.3	< 0.3	< 0.4	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.4	< 0.3	-
	Th-228	< 0.5	< 0.5	< 0.6	< 0.5	-
STA-05A	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	163 ± 16	110 ± 10	169 ± 17	54.3 ± 5.4	124 ± 107
	K-40	< 4	< 5	< 5	< 5	-
	Co-60	< 0.2	< 0.2	< 0.2	< 0.2	-
	Ru-103	< 0.6	< 0.4	< 0.6	< 0.3	-
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.3	-
	Cs-137	< 0.2	< 0.2	< 0.3	< 0.3	-
	Th-228	< 0.4	< 0.4	< 0.5	< 0.4	-
STA-06	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	166 ± 17	89 ± 9	144 ± 14	57.2 ± 5.7	114 ± 100
	K-40	< 5	< 6	< 7	6.02 ± 2.36	6.02 ± 2.36
	Co-60	< 0.3	< 0.2	< 0.3	< 0.3	-
	Ru-103	< 0.9	< 0.4	< 0.6	< 0.4	-
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.3	-
	Th-228	< 0.7	< 0.3	< 0.4	< 0.4	-
STA-07	Sr-89	(a)	< 1	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	115 ± 12	110 ± 10	169 ± 17	62.2 ± 6.2	114 ± 87
	K-40	< 8	< 5	< 4	< 5	-
	Co-60	< 0.2	< 0.2	< 0.3	< 0.2	-
	Ru-103	< 0.6	< 0.3	< 0.6	< 0.3	-
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.2	-
	Th-228	< 0.4	< 0.5	< 0.5	< 0.4	-

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

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

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

North Anna Power Station, Louisa County, Virginia - 1997

1.0 E-03 pCi/m³ ± 2 Sigma Page 3 of 3

Station	Nuclide	First Quarter 01/02-04/02	Second Quarter 04/02-07/02	Third Quarter 07/02-10/01	Fourth Quarter 10/01-12/31	Average ± 2 s.d.
STA-21	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	95.9 ± 9.6	110 ± 10	133 ± 13	53.5 ± 5.3	98.1 ± 66.0
	K-40	< 5	16 ± 3	< 9	18.0 ± 4.0	18.0 ± 4.0
	Co-60	< 0.3	< 0.4	< 0.3	< 0.4	-
	Ru-103	< 0.6	< 0.4	< 0.8	< 0.4	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.4	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-
	Th-228	< 0.4	< 0.4	< 0.4	< 0.4	-
STA-22	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	142 ± 14	99 ± 10	181 ± 18	55.8 ± 5.6	119 ± 108
	K-40	< 6	< 4	< 4	< 4	-
	Co-60	< 0.2	< 0.2	< 0.2	< 0.2	-
	Ru-103	< 0.6	< 0.3	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.2	-
	Th-228	< 0.3	< 0.4	< 0.3	< 0.3	-
STA-23	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	146 ± 15	120 ± 10	174 ± 17	59.1 ± 5.9	125 ± 98
	K-40	< 4	< 4	< 4	< 4	-
	Co-60	< 0.2	< 0.	< 0.2	< 0.2	-
	Ru-103	< 0.5	< 0.3	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.2	-
	Th-228	< 0.3	< 0.3	< 0.3	< 0.3	-
STA-24	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	131 ± 13	110 ± 10	175 ± 18	51.8 ± 5.2	117 ± 102
	K-40	< 10	< 7	< 7	3.79 ± 1.97	3.79 ± 1.97
	Co-60	< 0.3	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.9	< 0.4	< 0.7	< 0.4	-
	Cs-134	< 0.4	< 0.2	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-
	Th-228	< 0.5	< 0.4	< 0.4	< 0.3	-

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

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

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

Station 01A -- (On Site)

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma Page 1 of 1

Collection Dates	Gross Beta	Rainfall (inches)
12/26/96-01/29/97	2.8 ± 0.6	2.34
01/29/97-02/26/97	3.5 ± 0.7	2.35
02/26/97-03/26/97	3.4 ± 0.7	5.68
03/26/97-04/30/97	4.4 ± 0.7	2.74
04/30/97-05/28/97	9.6 ± 1.6	0.92
05/28/97-06/25/97	2.1 ± 0.6	4.92
06/25/97-07/30/97	2.9 ± 0.7	3.76
07/30/97-08/27/97	3.2 ± 0.7	2.80
08/27/97-09/24/97	3.4 ± 0.7	2.36
09/24/97-10/29/97 (a)	2.2 ± 0.6	3.36
10/29/97-11/25/97	1.5 ± 0.6	2.97
11/25/97-12/31/97	3.1 ± 0.7	2.28
Average ± 2 s.d.	**3.5 ± 4.1**	

(a) Sample volume 700 mls due to lower than normal precipitation.

SEMI-ANNUAL PRECIPITATION COMPOSITES

12/26/96-06/25/97	06/25/97-12/31/97
Be-7 = < 20	Be-7 = < 40
H-3 = < 200	H-3 = < 300

TABLE B-5 SOIL

Soil samples are collected every three years from twelve stations. Since the samples were collected in 1995, Table B-5 will not be included in the 1997 report.

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

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

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Ba-140	Th-228
STATION 01A								
03/26/97	(a)	(a)	< 200	< 30	< 60	< 0.2	< 8	< 9
06/25/97	< 0.8	< 0.4	< 200	< 30	< 50	< 0.3	< 5	< 6
09/24/97	(a)	(a)	< 200	< 30	< 60	< 0.2	< 6	< 7
12/31/97	(a)	(a)	240 ± 160	< 40	< 90	< 8	< 6	< 7
Average ±2 sd			**240 ± 160**					

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

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

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

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - 11										
01/14/97	(a)	(a)	2300 ± 200	< 40	< 60	< 0.2	< 4	< 5	< 100	< 9
02/13/97	(a)	(a)	(b)	< 30	< 50	< 0.4	< 4	< 7	< 80	< 7
03/11/97	(a)	(a)	(b)	< 40	< 100	< 0.2	< 5	< 6	< 80	< 7
04/14/97	< 1	< 0.3	2400 ± 300	< 30	< 50	< 0.5	< 4	< 6	< 80	< 7
05/12/97	(a)	(a)	(b)	< 40	< 100	< 0.2	< 5	< 8	< 80	< 7
06/16/97	(a)	(a)	(b)	< 30	< 80	< 0.3	< 3	< 4	< 60	< 6
07/14/97	(a)	(a)	3000 ± 300	< 30	< 40	< 0.2	< 4	< 4	< 60	< 5
08/08/97	(a)	(a)	(b)	< 40	< 50	< 1	< 3	< 10	< 80	< 7
09/16/97	(a)	(a)	(b)	< 30	< 60	< 0.3	< 3	< 7	< 60	< 5
10/13/97	(a)	(a)	2900 ± 300	< 30	< 100	< 0.2	< 4	< 5	< 70	< 6
11/12/97	(a)	(a)	(b)	< 30	< 80	< 0.2	< 3	< 4	< 60	< 5
12/15/97	(a)	(a)	(b)	< 30	< 50	< 0.4	< 4	< 4	< 60	< 5
Average ± 2 s.d.			**2650 ± 702**							

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

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

(b) Tritium analysis performed on quarterly composite.

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

North Anna Power Station, Louisa County, Virginia - 1997

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 - 08										
01/14	(a)	(a)	2400 ± 200	< 30	< 60	< 0.2	< 4	< 6	< 70	< 7
02/13	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 6	< 70	< 6
03/11	(a)	(a)	(b)	< 30	< 50	< 0.2	< 4	< 7	< 70	< 6
04/14	< 1	< 0.6	3200 ± 300	< 30	< 90	< 0.4	< 4	< 6	< 70	< 6
05/12	(a)	(a)	(b)	< 30	< 50	< 0.2	< 4	< 5	< 70	< 6
06/16	(a)	(a)	(b)	< 40	< 100	< 0.4	< 5	< 5	< 90	< 7
07/14	(a)	(a)	3200 ±300	< 30	< 60	< 0.2	< 4	< 6	< 80	< 7
08/08	(a)	(a)	(b)	< 30	< 60	< 1	< 4	< 9	< 70	< 6
09/16	(a)	(a)	(b)	< 30	< 40	< 0.3	< 3	< 6	< 70	< 6
10/13	(a)	(a)	3600 ± 300	< 20	< 40	< 0.2	< 3	< 5	< 50	< 5
11/12	(a)	(a)	(b)	< 30	< 50	< 0.2	< 3	< 4	< 80	< 7
12/15	(a)	(a)	(b)	< 30	< 50	< 0.4	< 4	< 5	< 70	< 6
Avg. ± 2. s.d.			**3100 ± 1007**							
STATION - 09A										
01/14	(a)	(a)	< 200	< 30	< 50	< 0.2	< 4	< 6	< 80	< 7
02/13	(a)	(a)	(b)	< 30	< 70	< 0.4	< 3	< 6	< 60	< 6
03/11	(a)	(a)	(b)	< 30	< 100	< 0.2	< 4	< 6	< 70	< 6
04/14	< 1	< 0.3	< 200	< 30	< 70	< 0.5	< 3	< 5	< 60	< 6
05/12	(a)	(a)	(b)	< 30	< 100	< 0.2	< 4	< 5	< 70	< 6
06/16	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 5	< 70	< 7
07/14	(a)	(a)	< 200	< 30	< 50	< 0.2	< 4	< 5	< 70	< 6
08/08	(a)	(a)	(b)	< 40	< 50	< 0.9	< 4	< 9	< 80	< 7
09/16	(a)	(a)	(b)	< 30	< 90	< 0.3	< 4	< 8	< 70	< 6
10/13	(a)	(a)	< 300	< 30	< 50	< 0.2	< 3	< 4	< 70	< 6
11/12	(a)	(a)	(b)	< 20	< 50	< 0.2	< 3	< 4	< 70	< 6
12/15	(a)	(a)	(b)	< 30	< 70	< 0.4	< 4	< 6	< 60	< 5

* All gamma emitters other than those listed were <LLD.
** I-131 by radiochemistry
(a) Analysis performed only with second quarter.
(b) Analysis performed quarterly.

TABLE B-9: GAMMA EMITTER AND TRITIUM CONCENTRATIONS IN SURFACE WATER*

State-Split Samples

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma

Collection Dates	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - W-27								
01/31	< 200	< 30	< 40	< 0.3	< 3	< 5	< 50	< 5
02/28	(a)	< 30	< 70	< 0.5	< 3	< 8	< 60	< 6
03/31	(a)	< 30	< 60	< 0.8	< 3	< 6	< 50	< 5
04/30	< 200	< 30	< 50	< 0.5	< 4	< 9	< 70	< 6
05/31	(a)	< 30	< 100	< 0.3	< 4	< 5	< 70	< 6
06/30	(a)	< 30	< 50	< 0.5	< 3	< 6	< 70	< 6
07/31	1300 ±200	< 30	< 50	< 1	< 4	< 10	< 70	< 6
08/31	(a)	< 40	< 90	< 0.8	< 4	< 10	< 70	< 7
09/15	(a)	< 60	< 100	< 3 (b)	<5	< 30	< 80	< 8
10/31	1900 ± 300	< 30	< 50	< 0.5	< 4	< 7	< 80	< 7
11/30	(a)	< 30	< 50	< 0.6	< 4	< 8	< 70	< 6
12/31	(a)	< 40	< 90	< 1	< 4	< 20	< 70	< 6
Avg. ± 2 s.d.	**1600 ± 849**							
STATION - W-33								
01/31	2500 ± 200	< 30	< 50	< 0.3	< 3	< 4	< 70	< 6
02/28	(a)	< 40	< 50	< 0.5	< 4	< 10	< 80	< 7
03/31	(a)	< 30	< 90	< 0.7	< 4	< 8	< 70	< 6
04/30	2400 ± 200	< 30	< 70	< 0.4	< 3	< 9	< 60	< 5
05/31	(a)	< 30	< 60	< 0.3	< 3	< 6	< 80	< 7
06/30	(a)	< 40	< 100	< 0.5	< 4	< 10	< 80	< 7
07/31	3400 ± 300	< 30	< 50	< 2 (b)	< 4	< 10	< 60	< 5
08/31	(a)	< 30	< 50	< 1	< 4	< 8	< 70	< 6
09/15	(a)	< 30	< 40	< 3 (b)	< 3	< 20	< 60	< 5
10/31	2300 ± 300	< 30	< 50	< 0.4	< 3	< 6	< 70	< 6
11/30	(a)	< 30	< 70	< 0.7	< 4	< 9	< 60	< 5
12/31	(a)	< 50	< 100	< 1	< 5	< 20	< 80	< 7
Avg. ± 2 s.d.	**2650 ± 1013**							

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

(a) Tritium analysis performed on the first monthly composite of each quarter.

(b) LLD not met due to the long delay from collection date to receipt at laboratory.

TABLE B-10: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN SEDIMENT SILT*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/kg ± 2 Sigma Page 1 of 1

Nuclide	STA-08 02/05	STA-09A 02/05	STA-11 02/05	STA-08 08/18	STA-09A 08/18	STA-11 08/18	Average ± 2 Sigma
Sr-89	(a)	(a)	(a)	< 800	< 1000	< 900	-
Sr-90	(a)	(a)	(a)	< 200	< 300	< 200	-
Be-7	< 400	442 ± 206	< 300	< 300	< 300	< 400	442 ± 206
K-40	15600 ± 1600	11600 ± 1200	18200 ± 1800	2500 ± 400	12000 ± 1000	15000 ± 2000	12483 ± 10933
Mn-54	< 50	< 30	< 40	< 20	< 30	< 40	-
Co-58	< 40	< 30	< 40	< 30	< 30	< 40	-
Co-60	< 40	< 30	< 40	< 30	< 20	< 40	-
Cs-134	< 60	< 30	< 40	< 40	< 30	< 60	-
Cs-137	< 50	55.4 ± 28.8	90.1 ± 28.9	< 40	48 ± 22	< 40	65 ± 45
Ra-226	1990 ± 790	1610 ± 430	1660 ± 530	970 ± 500	1500 ± 400	1600 ± 600	1468 ± 569
Th-228	1430 ± 140	782 ± 78	1150 ± 120	580 ± 60	580 ± 60	1800 ± 200	978 ± 1030

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

TABLE B-11: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN SHORELINE SOIL*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/kg ± 2 Sigma Page 1 of 1

Nuclide	Station-08 02/05/97	Station-08 08/18/97	Average ± 2 Sigma
Sr-89	(a)	< 1000	-
Sr-90	(a)	< 200	-
Be-7	< 200	< 300	-
K-40	2840 ± 340	770 ± 220	1805 ± 2927
Mn-54	< 20	< 20	-
Co-58	< 20	< 30	-
Co-60	< 20	< 30	-
Cs-134	< 20	< 30	-
Cs-137	147 ± 24	170 ± 30	159 ± 33
Ra-226	1160 ± 420	< 500	1160 ± 420
Th-228	247 ± 34	240 ± 30	244 ± 10

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

TABLE B-12: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma

MONTH	NUCLIDE	STATION-12	STATION-13
JANUARY	Sr-89	< 1	< 1
	Sr-90	0.81 ± 0.16	0.97 ± 0.16
	K-40	1150 ± 120	1020 ± 100
	Cs-137	< 4	< 5
	I-131	< 0.2	< 0.2
FEBRUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1370 ± 140	1170 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.5	< 0.2
MARCH	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1430 ± 140	1160 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.3	< 0.2
APRIL	Sr-89	< 2	< 2
	Sr-90	1.8 ± 0.3	1.6 ± 0.2
	K-40	1250 ± 130	1240 ± 120
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.2
MAY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1320 ± 130	1250 ± 130
	Cs-137	< 4	< 4
	I-131	< 0.3	< 0.2
JUNE	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1130 ± 110	1400 ± 140
	Cs-137	< 5	< 4
	I-131	< 0.3	< 0.3

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

(a) Strontium 89/90 analyses performed on the last monthly sample of each quarter.

TABLE B-12: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/l ± 2 Sigma

MONTH	NUCLIDE	STATION-12	STATION-13
JULY	Sr-89	< 5	< 2
	Sr-90	1.8 ± 0.5	1.2 ± 0.2
	K-40	1170 ± 120	1410 ± 140
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
AUGUST	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1280 ± 130	1210 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
SEPTEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1290 ± 130	1410 ± 140
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.3
OCTOBER	Sr-89	< 2	< 2
	Sr-90	0.45 ± 0.28	0.63 ± 0.26
	K-40	1330 ± 130	1360 ± 140
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
NOVEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1340 ± 130	1380 ± 140
	Cs-137	< 4	< 3
	I-131	< 0.4	< 0.5
DECEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1380 ± 140	1300 ± 130
	Cs-137	< 5	< 4
	I-131	< 0.2	< 0.2

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

(a) Strontium 89/90 analyses performed on the last monthly sample of each quarter.

TABLE B-13: GAMMA EMITTER CONCENTRATIONS IN FISH*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/kg ± 2 Sigma

Collection Date	Station	Sample Type	K-40	Co-58	Cs-134	Cs-137
02/04	25	Fish (a)	1830 ± 180	< 10	< 10	< 20
02/04	25	Catfish (b)	2020 ± 210	< 20	< 20	< 20
02/06	08	Fish (a)	2270 ± 230	< 20	< 20	35.0 ± 16.3
02/06	08	Catfish (b)	2250 ± 220	< 10	< 10	37.4 ± 13.4
08/21	08	Fish (a)	1250 ± 180	< 10	< 20	35.8 ± 15.0
08/19	25	Fish (a)	1560 ± 160	< 20	< 20	< 20
08/19	08	Catfish (b)	1050 ± 140	< 20	< 20	24.7 ± 12.5
08/19	25	Catfish (b)	2030 ± 200	< 10	< 10	< 10
Avg. ± 2 s.d.			**1783 ± 909**			**33.2 ± 11.5**

* All gamma emitters other than those listed were <LLD.
(a) Non-bottom dwelling species of gamefish.
(b) Bottom dwelling species of fish.

TABLE B-14: GAMMA EMITTER CONCENTRATIONS IN FOOD/VEGETATION*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/kg ± 2 Sigma Page 1 of 2

Thers were no food/vegetation samples for all stations during January, February, March, November and December due to seasonal unavailability.

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 14								
04/25	1510 ± 150	6640 ± 660	< 60	< 20	< 20	< 20	< 200	< 20
05/21	2430 ± 460	18800 ± 1900	< 70 (a)	< 60	< 50	< 50	< 900	< 80
06/18	644 ± 242	16100 ± 1600	< 50	< 40	< 30	< 30	< 500	< 50
07/16	3800 ± 400	18000 ± 2000	< 30	< 50	< 40	< 40	< 700	< 60
08/20	2720 ± 420	5730 ± 570	< 50	< 50	< 50	< 50	< 800	< 70
09/17	4220 ± 460	11600 ± 1200	< 10	< 60	< 50	< 50	< 900	740 ± 74
10/15	3280 ± 330	3640 ± 360	< 30	< 30	< 20	< 20	< 300	< 30
STATION 15								
04/25	5720 ± 570	19200 ± 1900	< 60	< 40	< 40	< 40	< 600	114 ± 38
05/21	2270 ± 520	9700 ± 970	< 20	< 70	< 60	< 60	< 1000	< 100
06/18	703 ± 295	17700 ± 1800	< 40	< 50	< 40	< 40	< 600	< 60
07/16	2440 ± 240	21600 ± 2200	< 40	< 30	< 30	< 20	< 400	< 30
08/20	7800 ± 780	5450 ± 680	< 60	< 90	< 80 (c)	< 80	< 1000	325 ± 98
09/17	1880 ± 430	9470 ± 950	< 5	< 70	< 50	< 60	< 900	< 90
10/15	5790 ± 580	14300 ± 1400	< 40	< 70	< 60	< 60	< 1000	< 90
STATION 16								
04/25	1480 ± 170	12700 ± 1300	< 40	< 20	< 20	< 20	< 300	< 30
05/21	2400 ± 350	15900 ± 1600	< 20	< 40	< 40	< 40	< 700	< 60
06/18	733 ± 212	16900 ± 1700	< 30	< 30	< 30	< 30	< 500	< 50
07/16	4300 ± 400	4400 ± 400	< 40	< 30	< 30	< 30	< 600	< 60
08/20	5100 ± 510	10500 ± 1000	< 70 (b)	< 30	< 30	< 20	< 400	< 40
09/17	4850 ± 490	12000 ± 1200	< 5	< 40	< 30	< 30	< 600	< 60
10/15	2660 ± 270	13800 ± 1400	< 40	< 30	< 20	< 20	< 400	< 40

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

(a) LLD not met because the first analysis produced a low chemical yield (11.8%). The analysis was repeated producing a higher yield (50.7%), however, by that time the detection limit was too difficult to obtain because of the short half-life of I-131.

(b) LLD not met. Sample received at lab 15 days after collection. Sample counted 4 times but LLD could not be met.

(c) The LLD for Cs-134 could not be met due to low density of the matrix. Only 56g filled a one liter marinelli.

TABLE B-14: GAMMA EMITTER CONCENTRATION IN FOOD/VEGETATION*

North Anna Power Station, Louisa County, Virginia - 1997

pCi/kg ± 2 Sigma

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 21								
04/25	13200 ± 1300	18800 ± 1900	< 50	< 60	< 50	< 50	< 800	125 ± 58
05/21	2060 ± 400	15400 ± 1500	< 20	< 50	< 40	< 50	< 1000	< 80
06/18	< 500	17700 ± 1800	< 30	< 60	< 60	< 50	< 900	< 80
07/16	2110 ± 390	22600 ± 2300	< 30	< 50	< 50	< 50	< 800	< 70
08/20	4500 ± 450	6730 ± 670	< 40	< 20	< 20	< 10	< 300	< 30
09/17	4060 ± 470	11700 ± 1200	< 7	< 60	< 50	< 50	< 1000	< 90
10/15	3490 ± 430	9860 ± 990	< 30	< 60	< 60	< 50	1110 ± 600	380 ± 73
STATION 23								
04/25	4590 ± 460	25400 ± 2500	< 30	< 60	< 50	< 50	< 800	< 70
05/21	2010 ± 360	17200 ± 1700	< 30	< 60	< 50	< 60	< 800	< 80
06/18	< 500	15600 ± 1600	< 40	< 50	< 50	< 50	< 800	< 80
07/16	7600 ± 800	11000 ± 1000	< 30	< 70	< 50	< 50	< 900	< 90
08/20	4150 ± 420	16900 ± 1700	< 50	< 50	< 40	< 40	< 700	< 70
09/17	2380 ± 400	19200 ± 1900	< 7	< 60	< 50	< 50	< 800	< 70
10/15	1540 ± 320	4310 ± 430	< 40	< 50	< 40	< 40	< 700	< 60
Average ± 2 s.d.	**3588 ± 4998**	**13615 ± 11250**					**1110 ±600**	**337 ± 509**

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

TABLE B-15: DIRECT RADIATION MEASUREMENTS -- QUARTERLY AND ANNUAL TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1997

mR/Std. Month (30.4 days) ± 2 Sigma Page 1 of 1

Station Number	First Qtr 12/27/96 04/02/97	Second Qtr 04/02/97 07/02/97	Third Qtr 07/02/97 10/01/97	Fourth Qtr 10/01/97 01/07/98	Quarterly Average	Annual TLD 07/03/96-07/02/97
01	7.5 ± 0.1	8.3 ± 0.3	8.3 ± 0.2	9.1 ± 0.5	8.3 ± 1.3	8.1 ± 0.2
02	3.6 ± 0.2	4.7 ± 0.2	5.2 ± 0.1	5.4 ± 0.2	4.7 ± 1.6	4.6 ± 0.1
03	4.0 ± 0.1	4.7 ± 0.2	4.8 ± 0.1	5.2 ± 0.2	4.7 ± 1.0	4.6 ± 0.1
04	4.2 ± 0.3	5.1 ± 0.6	5.4 ± 0.1	5.7 ± 0.1	5.1 ± 1.3	5.4 ± 0.9
05	4.9 ± 0.2	6.0 ± 0.3	6.6 ± 0.8	6.7 ± 0.2	6.1 ± 1.7	5.9 ± 0.1
05A	4.7 ± 0.3	5.8 ± 0.3	5.8 ± 0.1	6.2 ± 0.1	5.6 ± 1.3	5.3 ± 0.2
06	6.3 ± 0.1	7.1 ± 0.2	7.6 ± 0.2	8.3 ± 0.3	7.3 ± 1.7	7.1 ± 0.3
07	4.8 ± 0.2	5.5 ± 0.2	6.0 ± 0.2	6.3 ± 0.3	5.7 ± 1.3	5.6 ± 0.2
21	4.8 ± 0.0	5.5 ± 0.2	5.8 ± 0.2	5.9 ± 1.1	5.5 ± 1.0	5.3 ± 0.2
22	6.0 ± 0.2	6.6 ± 0.2	6.9 ± 0.1	7.8 ± 0.1	6.8 ± 1.5	6.4 ± 0.2
23	6.4 ± 0.1	7.4 ± 0.2	8.1 ± 0.2	8.2 ± 0.2	7.5 ± 1.7	7.6 ± 0.1
24	4.6 ± 0.1	5.8 ± 0.4	6.1 ± 0.1	6.5 ± 0.2	5.8 ± 1.6	5.6 ± 0.1
Average ± 2 s.d.	**5.2 ± 2.3**	**6.0 ± 2.2**	**6.4 ± 2.3**	**6.8 ± 2.5**	**6.1 ± 2.6**	**6.0 ± 2.3**

TABLE B-16: DIRECT RADIATION MEASUREMENTS - SECTOR QUARTERLY TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1997

mR/Std. Month (30.4 days) ± 2 Sigma

Station Number	First Qtr. 12/27-04/02	Second Qtr. 04/02-07/02	Third Qtr. 07/02-10/01	Fourth Qtr. 10/01-01/07	Average ± 2 s.d.
N-1	6.2 ± 0.3	6.6 ± 0.3	7.1 ± 0.3	7.4 ± 0.1	6.8 ± 1.1
N-2	4.9 ± 0.2	4.9 ± 0.1	6.0 ± 0.1	6.1 ± 0.1	5.5 ± 1.3
NNE-3	8.6 ± 0.2	8.7 ± 0.2	9.7 ± 0.1	10.1 ± 0.1	9.3 ± 1.5
NNE-4	5.3 ± 0.1	5.7 ± 0.6	6.6 ± 0.1	6.5 ± 0.3	6.0 ± 1.3
NE-5	7.8 ± 0.2	7.6 ± 0.3	8.7 ± 0.3	8.8 ± 0.4	8.2 ± 1.2
NE-6	5.3 ± 0.2	5.4 ± 0.2	6.4 ± 0.2	6.5 ± 0.1	5.9 ± 1.3
ENE-7	6.4 ± 0.1	6.8 ± 0.4	7.8 ± 0.2	7.8 ± 0.2	7.2 ± 1.4
ENE-8	4.5 ± 0.1	4.4 ± 0.1	5.6 ± 0.0	6.4 ± 0.3	5.2 ± 1.9
E-9	6.7 ± 0.2	6.8 ± 0.3	8.2 ± 0.3	8.1 ± 0.3	7.5 ± 1.6
E-10	5.9 ± 0.2	6.1 ± 0.5	7.0 ± 0.3	6.9 ± 0.6	6.5 ± 1.1
ESE-11	5.9 ± 0.1	5.8 ± 0.2	6.9 ± 0.2	7.0 ± 0.5	6.4 ± 1.3
ESE-12	6.5 ± 0.1	6.5 ± 0.2	8.0 ± 0.3	7.8 ± 0.4	7.2 ± 1.6
SE-13	6.5 ± 0.2	6.5 ± 0.2	7.3 ± 0.2	7.6 ± 0.5	7.0 ± 1.1
SE-14	8.4 ± 0.2	8.3 ± 0.4	9.4 ± 0.2	9.8 ± 0.1	9.0 ± 1.5
SSE-15	6.6 ± 0.2	6.7 ± 0.1	7.9 ± 0.1	8.1 ± 0.4	7.3 ± 1.6
SSE-16	4.9 ± 0.2	5.5 ± 0.4	5.9 ± 0.1	5.9 ± 0.1	5.6 ± 0.9
S-17	8.1 ± 0.3	8.4 ± 0.3	9.4 ± 0.5	9.3 ± 0.2	8.8 ± 1.3
S-18	4.3 ± 0.0	4.3 ± 0.1	5.2 ± 0.1	5.3 ± 0.3	4.8 ± 1.1
SSW-19	7.2 ± 0.2	7.9 ± 0.3	8.6 ± 0.3	8.3 ± 0.3	8.0 ± 1.2
SSW-20	4.1 ± 0.1	4.2 ± 0.1	5.0 ± 0.1	5.1 ± 0.1	4.6 ± 1.0
SW-21	5.4 ± 0.2	5.4 ± 0.3	6.3 ± 0.2	6.4 ± 0.4	5.9 ± 1.1
SW-22	6.2 ± 0.2	6.6 ± 0.4	7.3 ± 0.1	7.2 ± 0.5	6.8 ± 1.0
WSW-23	7.6 ± 0.2	7.5 ± 0.3	8.2 ± 0.2	8.6 ± 0.1	8.0 ± 1.0
WSW-24	6.2 ± 0.2	6.4 ± 0.3	7.2 ± 0.2	7.4 ± 0.4	6.8 ± 1.2
W-25	7.7 ± 0.2	8.4 ± 0.3	8.7 ± 0.3	8.8 ± 0.3	8.4 ± 1.0
W-26	4.7 ± 0.2	4.8 ± 0.3	5.6 ± 0.1	6.0 ± 0.4	5.3 ± 1.3
WNW-27	4.9 ± 0.1	4.9 ± 0.1	5.9 ± 0.3	5.8 ± 0.4	5.4 ± 1.1
WNW-28	4.7 ± 0.1	5.2 ± 0.1	5.9 ± 0.2	6.2 ± 0.1	5.5 ± 1.4
NW-29	7.6 ± 0.3	8.1 ± 0.1	8.9 ± 0.3	8.9 ± 0.7	8.4 ± 1.3
NW-30	4.6 ± 0.3	4.5 ± 0.1	5.5 ± 0.1	5.8 ± 1.0	5.1 ± 1.3
NNW-31	5.3 ± 0.2	5.7 ± 0.2	6.3 ± 0.1	6.7 ± 0.1	6.0 ± 1.2
NNW-32	5.3 ± 0.1	5.7 ± 0.2	6.8 ± 0.6	6.8 ± 0.3	6.2 ± 1.5
N-33	6.3 ± 0.3	6.3 ± 0.4	7.4 ± 0.2	7.2 ± 0.4	6.8 ± 1.2
N-34	4.8 ± 0.1	5.0 ± 0.1	5.8 ± 0.1	5.9 ± 0.3	5.4 ± 1.1
NNE-35	8.4 ± 0.3	8.5 ± 0.1	9.6 ± 0.3	9.9 ± 0.3	9.1 ± 1.5
NNE-36	5.3 ± 0.3	5.6 ± 0.3	6.8 ± 0.1	6.8 ± 0.4	6.1 ± 1.6
NE-37	7.5 ± 0.2	7.8 ± 0.3	8.5 ± 0.3	8.7 ± 0.4	8.1 ± 1.1
NE-38	5.1 ± 0.1	5.5 ± 0.2	6.4 ± 0.2	6.5 ± 0.3	5.9 ± 1.4
ENE-39	6.5 ± 0.2	6.8 ± 0.4	7.6 ± 0.3	7.5 ± 0.4	7.1 ± 1.1
ENE-40	4.4 ± 0.1	4.7 ± 0.3	5.6 ± 0.2	6.4 ± 0.3	5.3 ± 1.8
E-41	6.6 ± 0.2	6.7 ± 0.4	8.0 ± 0.2	8.1 ± 0.3	7.4 ± 1.6
E-42	5.9 ± 0.3	6.1 ± 0.2	7.3 ± 0.2	7.0 ± 0.3	6.6 ± 1.4
ESE-43	6.0 ± 0.3	6.1 ± 0.2	7.1 ± 0.3	7.2 ± 0.2	6.6 ± 1.3
ESE-44	6.3 ± 0.2	6.7 ± 0.5	7.8 ± 0.3	7.7 ± 0.2	7.1 ± 1.5
SE-45	6.2 ± 0.1	6.7 ± 0.2	7.1 ± 0.2	7.4 ± 0.3	6.9 ± 1.0

TABLE B-16: DIRECT RADIATION MEASUREMENTS

SECTOR QUARTERLY TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1997

mR/Std. Month (30.4 days) ± 2 Sigma

Station Number	First Qtr 12/27-04/02	Second Qtr 04/02-07/02	Third Qtr 07/02-10/01	Fourth Qtr 10/01-01/07	Average ± 2 S.d.
SE-46	8.5 ± 0.2	8.6 ± 0.3	9.4 ± 0.2	9.8 ± 0.4	9.1 ± 1.3
SSE-47	6.3 ± 0.3	7.0 ± 0.1	7.6 ± 0.2	8.2 ± 0.2	7.3 ± 1.6
SSE-48	4.9 ± 0.3	5.2 ± 0	6.2 ± 0.2	6.2 ± 0.2	5.6 ± 1.4
S-49	8.1 ± 0.3	9.0 ± 0.4	9.6 ± 0.6	9.7 ± 0.3	9.1 ± 1.5
S-50	4.0 ± 0.3	4.3 ± 0.2	5.2 ± 0.2	5.3 ± 0.2	4.7 ± 1.3
SSW-51	7.3 ± 0.2	8.2 ± 0.9	9.0 ± 0.4	8.7 ± 0.3	8.3 ± 1.5
SSW-52	4.3 ± 0.2	4.4 ± 0.5	5.0 ± 0.1	5.4 ± 0.4	4.8 ± 1.0
SW-53	4.9 ± 0.4	5.5 ± 0.4	6.1 ± 0.2	6.5 ± 0.3	5.8 ± 1.4
SW-54	6.2 ± 0.2	6.4 ± 0.2	7.3 ± 0.2	7.6 ± 0.2	6.9 ± 1.4
WSW-55	7.4 ± 0.3	7.7 ± 0.3	8.5 ± 0.1	9.0 ± 0.3	8.2 ± 1.5
WSW-56	5.9 ± 0.2	6.4 ± 0.2	7.1 ± 0.1	7.6 ± 0.4	6.8 ± 1.5
W-57	7.7 ± 0.3	8.0 ± 0.2	8.9 ± 0.2	9.3 ± 0.1	8.5 ± 1.5
W-58	4.7 ± 0.1	4.8 ± 0.2	5.7 ± 0.1	6.0 ± 0.1	5.3 ± 1.3
WNW-59	4.6 ± 0.1	4.8 ± 0.1	5.7 ± 0.2	5.9 ± 0.2	5.3 ± 1.3
WNW-60	4.4 ± 0.1	4.9 ± 0.2	5.8 ± 0.1	6.2 ± 0.1	5.3 ± 1.6
NW-61	7.4 ± 0.3	8.2 ± 0.1	8.6 ± 0.4	9.0 ± 0.2	8.3 ± 1.4
NW-62	4.4 ± 0.1	4.7 ± 0.2	5.2 ± 0.2	5.7 ± 0.1	5.0 ± 1.1
NNW-63	5.4 ± 0.1	5.4 ± 0.2	6.1 ± 0.2	6.6 ± 0.1	5.9 ± 1.2
NNW-64	5.3 ± 0.2	5.7 ± 0.3	6.5 ± 0.2	6.8 ± 0.1	6.1 ± 1.4
C-1	4.7 ± 0.1	5.7 ± 0.2	5.9 ± 0.2	6.6 ± 0.2	5.7 ± 1.6
C-2	4.7 ± 0.1	5.6 ± 0.3	6.0 ± 0.3	6.4 ± 0.2	5.7 ± 1.5
C-3	4.7 ± 0.2	5.6 ± 0.3	6.1 ± 0.2	6.6 ± 0.2	5.8 ± 1.6
C-4	4.4 ± 0.9	5.7 ± 0.1	5.9 ± 0.1	6.8 ± 0.0	5.7 ± 2.0
C-5	3.9 ± 0.1	4.7 ± 0.2	5.0 ± 0.1	5.4 ± 0.2 (a)	4.8 ± 1.3
C-6	3.9 ± 0.1	4.5 ± 0.3	4.9 ± 0.1	5.6 ± 0.2	4.7 ± 1.4
C-7	5.7 ± 0.1	6.5 ± 0.1	6.9 ± 0.1	7.5 ± 0.3	6.7 ± 1.5
C-8	5.9 ± 0.1	6.7 ± 0.2	7.1 ± 0.1	7.6 ± 0.6	6.8 ± 1.4
Average	**5.9 ± 2.6**	**6.2 ± 0.6**	**7.0 ± 2.7**	**7.2 ± 2.6**	**6.6 ± 2.8**

(a) Value based on areas 1, 2, and 3. Area 4 was outside the acceptance criteria when compared to average of other areas.

APPENDIX C
LAND USE CENSUS - 1997

VIRGINIA POWER
NORTH ANNA POWER STATION
Annual Radiological Environmental Land Use Census Data for 1997
July (1-31)

Sector	Nearest Resident KM	Nearest Site Boundary KM	Milch * Cow KM	Meat Animal KM	Milch * Goat KM	Veg. Garden 500 Sq Ft. KM
N	2.14	1.40		3.23		2.98
NNE	1.51	1.36		4.22		1.87
NE	1.57	1.32		2.51		1.80
ENE	3.17	1.31		4.12		3.17
E	1.95	1.33				1.95
ESE	2.53	1.37		7.74		5.63
SE	2.20	1.41		2.20		2.20
SSE	1.47	1.47		3.83		2.30
S	1.67	1.52		2.32		1.96
SSW	2.30	1.62		6.61		2.20
SW	4.83	1.70				4.83
WSW	2.86	1.75		2.86		2.86
W	2.48	1.71				3.20
WNW	1.61	1.64		6.13		4.28
NW	1.57	1.56				1.77
NNW	1.72	1.45		3.57		1.80

* Note: No milch cow or goats within a five mile radius of North Anna Power Station
M = Mile

VIRGINIA POWER
NORTH ANNA POWER STATION
Annual Radiological Environmental Land Use Census Data for 1997
July (1-31)

Sector	Nearest Resident M	Nearest Site Boundary M	Milch * Cow M	Meat Animal M	Milch * Goat M	Veg. Garden 500 Sq Ft. M
N	1.33	0.87		2.01		1.85
NNE	0.94	0.85		2.62		1.16
NE	0.98	0.82		1.56		1.12
ENE	1.97	0.81		2.56		1.97
E	1.21	0.83				1.21
ESE	1.57	0.85		4.81		3.50
SE	1.37	0.88		1.37		1.37
SSE	0.91	0.91		2.38		1.43
S	1.04	0.94		1.44		1.22
SSW	1.43	1.01		4.11		1.37
SW	3.00	1.06				3.00
WSW	1.78	1.09		1.78		1.78
W	1.54	1.06				1.99
WNW	1.00	1.02		3.83		2.66
NW	0.98	0.97				1.10
NNW	1.07	0.90		2.22		1.12

* Note: No milch cow or goats within a five mile radius of North Anna Power Station
KM = Kilometer

VIRGINIA POWER
NORTH ANNA POWER STATION
COMPARISON OF THE 1997 TO 1996 LAND USE CENSUS

I. No changes were observed in the nearest resident.

II. No changes were observed in the nearest site boundary distances.

III. No changes were observed in the nearest milch cow/goat status.

IV. No changes were observed in the nearest vegetable garden.

V. No changes were observed in the nearest meat animal status.

APPENDIX D
SYNOPSIS OF ANALYTICAL PROCEDURES

ANALYTICAL PROCEDURES SYNOPSIS

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

GROSS BETA ANALYSIS OF SAMPLES

Air Particulates

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

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

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

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

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

where:

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

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

Introduction

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

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

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

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

Detection Capability

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

The minimum detectable level (MDL) for water samples is nominally 1.6 picoCuries per liter for gross beta at the 4.66 sigma level (1.0 pCi/l at the 2.83 sigma level), assuming that 1 liter of sample is used and that $\frac{1}{2}$ gram of sample residue is mounted on the planchette. These figures are based upon a counting time of 50 minutes and upon representative values of counting efficiency and background of 0.2 and 1.2 cpm, respectively.

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

ANALYSIS OF SAMPLES FOR TRITIUM

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:

RESULT	=	$2(3.234)\ T_N\ V_N(C_G - B)/(C_N\ V_S)$
TWO SIGMA ERROR	=	$2(3.234)\ T_N\ V_N(E)^{1/2}/(C_N\ V_S)$
LLD	=	$3.3\ (3.234)T_N\ V_N(E)^{1/2}/(C_N\ V_S)$

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 net cpm of the standard of volume V_N
C_G	=	the gross cpm of the sample of volume V_S
B	=	the background of the detector in cpm
Δt	=	counting time for the sample
E	=	$S/T^2 + B/t^2$

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 $Sr(NO_3)_2$ using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a minimum of 5 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Milk

Stable strontium carrier is added to 1 liter of sample and the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved and precipitated as $SrN0_3$ 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 a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Soil and Sediment

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrachloric acid. The mixture is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(N0_3)_2$ using fuming (90% nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm2 aluminum absorber for low level beta counting.

Organic Solids

A wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in hydrochloric acid. The sample is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(N0_3)$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a minimum of 5 days period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 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 $Sr(N0_3)_2$ using fuming (90%) nitric acid. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with 80 mg/cm^2 aluminum absorber for low 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:

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

WHERE:	N	=	total counts from sample (counts)
	Δt	=	counting time for sample (min)
	B_C	=	background rate of counter (cpm) using absorber configuration
	2.22	=	dpm/pCi
	V	=	volume or weight of sample analyzed
	B_A	=	background addition from Sr-90 and ingrowth of Y-90
	B_A	=	$0.016\,(K) + (K)\,E_{Y/abs})\,(IG_{Y-90})$
	Y_S	=	chemical yield of strontium
	DF_{SR-89}	=	decay factor from the mid collection date to the counting date for SR-89
	E_{SR-89}	=	efficiency of the counter for SR-89 with the 80 mg/cm.sq. aluminum absorber
	K	=	$(N\Delta t - B_C)_{Y-90}/(E_{Y-90}\,IF_{Y-90}\,DF_{Y-90}Y_1)$
	$DF_{Y-90})$	=	the decay factor for Y-90 from the "milk" time to the mid count time
	E_{Y-90}	=	efficiency of the counter for Y-90
	IF_{Y-90}	=	ingrowth factor for Y-90 from scavenge time to milking time
	IG_{Y-90}	=	the ingrowth factor for Y-90 into the strontium mount from the "milk" time to the mid count time
	0.016	=	the efficiency of measuring SR-90 through a No. 6 absorber
	$EY_{/abs}$	=	the efficiency of counting Y-90 through a No. 6 absorber
	B	=	background rate of counter (cpm)
	Y_1	=	chemical yield of yttrium
	Y_2	=	chemical yield of strontium
	DF	=	decay factor of yttrium from the radiochemical milking time to the mid count time
	E	=	efficiency of the counter for Y-90
	IF	=	ingrowth factor for Y-90 from scavenge time to the radio-chemical milking time

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

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

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

RESULT	=	$(N/\Delta t-B)/(2.22\ E\ V\ Y\ DF)$
TWO SIGMA ERROR	=	$2((N/\Delta t+B)/\Delta t)^{1/2}/(2.22\ E\ V\ Y\ DF)$
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 collection to the counting date
	E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
	E	=	$E_s(\exp-0.0061M)/(\exp-0.0061M_s)$
	E_s	=	efficiency of the counter determined from an I-131 standard mount
	Ms	=	mass of PdI_2 on the standard mount, mg
	M	=	mass of PDI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

A 1.0 liter Marinelli beaker is filled with a representative aliquot of the sample. The sample is then counted for approximately 1000 minutes with a shielded 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 approximately 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 approximately 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 at a low temperature, less than 100°C. The soil or sediment is loaded fully into a tared, standard 300 cc container and weighed. The sample is then counted for approximately six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height and analysis.

Charcoal Cartridges (Air Iodine)

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a 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 thirteen airborne particulate filters for a quarterly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded 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 of pCi/mass:

RESULT		=	(S-B)/(2.22 t E V F DF)
TWO SIGMA ERROR		=	$2(S+B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$
LLD		=	$4.66(B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$
where:	S	=	Area, in counts, of sample peak and background (region of spectrum of interest)
	B	=	Background area, in counts, under sample peak, determined by a linear interpolation of the representative backgrounds on 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 mid-collection date to the counting date

ENVIRONMENTAL DOSIMETRY

Teledyne Brown Engineering uses a $CaSO_4$: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 Brown Engineering 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 milliRoentgen (mR):

RESULT	=	$D = (D_1+D_2+D_3+D_4)/4$
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
	D1	=	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
	D	=	the average net mR of all 4 areas of the TLD.

APPENDIX E
INTERLABORATORY COMPARISON PROGRAM

Interlaboratory Comparison Program

Teledyne Brown Engineering participates in the 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. Beginning with 1996 the EPA discontinued providing milk and air particulate filter samples. For replacements, we have purchased comparable spiked samples from Analytics, Inc.

In this section the third quarter 1997 data summary tables are presented for isotopes in the various sample media applicable to the North Anna Power Station's Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases and the steps taken to prevent reoccurrence.

VEPCO - NORTH ANNA

EPA INTERLABORATORY COMPARISON PROGRAM 1997

EPA Preparation	Date TI Mailed Re sults	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)(c)	**Warning ***Action
01/17/97	03/28/97	04/23/97	Water	Sr-89	12.0 ± 5.0	10.00 ± 1.00	0.69	
				Sr-90	25.0 ± 5.0	25.00 ± 0.00	0.00	
01/31/97	02/28/97	04/21/97	Water	Gr-Alpha	5.2 ± 5.0	8.10 ± 0.89	1.00	
				Gr-Beta	14.7 ± 5.0	15.00 ± 1.00	0.10	
02/07/97	03/21/97	04/21/97	Water	I-131	86.0 ± 9.0	106.00 ± 4.36	3.85	** (d)
02/14/97	04/04/97	05/01/97	Water	Ra-226	5.9 ± 0.9	5.27 ± 0.23	-1.22	
				Ra-228	8.2 ± 2.1	8.40 ± 0.30	0.16	
03/07/97	04/04/97	04/28/97	Water	H-3	7900.0 ± 790.0	7366.67 ±378.59	-1.17	
04/15/97	06/23/97	08/13/97	Water	Gr-Beta	102.1 ± 15.3	103.33 ± 5.77	0.14	
				Sr-89	24.0 ± 5.0	23.00 ± 1.00	-0.35	
				Sr-90	13.0 ± 5.0	12.67 ± 1.15	-0.12	
				Co-60	21.0 ± 5.0	22.67 ± 0.58	0.58	
				Cs-134	31.0 ± 5.0	28.67 ± 0.58	-0.81	
				Cs-137	22.0 ± 5.0	24.67 ± 1.53	0.92	
				Gr-Alpha	48.0 ± 12.0	54.67 ± 1.53	0.96	
				Ra-226	13.0 ± 2.0	13.00 ± 1.00	0.00	
				Ra-228	3.1 ± 0.8	4.87 ± 0.12	3.82	***(e)
06/06/97	07/18/97	09/10/97	Water	Co-60	18.0 ± 5.0	19.00 ± 0.00	0.35	
				Zn-65	100.0 ± 10.0	99.33 ± 1.15	-0.12	
				Cs-134	22.0 ± 5.0	18.67 ± 1.15	-1.15	
				Cs-137	49.0 ± 5.0	48.67 ± 0.58	-0.12	
				Ba-133	25.0 ± 5.0	22.33 ± 2.52	-0.92	
06/13/97	08/07/97	09/10/97	Water	Ra-226	3.0 ± 0.5	3.43 ± 0.49	1.50	
				Ra-228	3.1 ± 0.8	3.43 ± 0.23	0.72	
06/18/97	08/06/97	09/10/97	Water	Gr-Alpha	3.1 ± 5.0	2.93 ± 0.25	-0.06	
				Gr-Beta	15.1 ± 5.0	14.00 ± 1.00	0.38	
07/11/97	08/15/97	11/04/97	Water	Sr-89	44.0 ± 5.0	38.33 ± 1.53	-1.96	
				Sr-90	16.0 ± 5.0	25.00 ± 0.00	3.12	***(f)
08/08/97	09/05/97	09/29/97	Water	H-3	11010 ± 1101.0	12000.00 ± 0.00	1.56	

VEPCO - NORTH ANNA

EPA INTERLABORATORY COMPARISON PROGRAM 1997

(Page 2 of 2)

EPA Preparation	Date TI Mailed Re sults	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)(c)	**Warning ***Action
09/12/97	11/06/97	12/09/97	Water	Ra-226	20.0 ± 3.0	20.00 ± 1.73	0.00	
				Ra-228	8.0 ± 2.0	7.40 ± 0.17	-0.52	
09/19/97	10/03/97	12/01/97	Water	I-131	10.0 ± 6.0	11.00 ± 0.00	0.29	
10/21/97	12/03/97	02/19/98	Water	Gr-Beta	143.4 ± 21.5	136.67 ± 5.77	-0.54	
				Sr-89	36.0 ± 5.0	36.00 ± 1.00	0.00	
				Sr-90	22.0 ± 5.0	21.67 ± 2.08	-0.12	
				Co-60	10.0 ± 5.0	10.67 ± 0.58	0.23	
				Cs-134	41.0 ± 5.0	41.33 ± 0.58	0.12	
				Cs-137	34.0 ± 5.0	36.00 ± 1.00	0.69	
				Gr-Alpha	49.9 ± 12.5	45.67 ± 1.15	-0.59	
				Ra-226	5.0 ± 0.8	5.90 ± 0.10	1.95	
				Ra-228	5.0 ± 1.3	4.27 ± 0.12	-0.98	
10/31/97	12/03/97	01/23/98	Water	Gr-Alpha	14.7 ± 5.0	19.67 ± 1.53	1.72	
				Gr-Beta	48.9 ± 5.0	50.67 ± 3.51	0.61	
11/07/97	01/07/98	01/26/98	Water	Co-60	27.0 ± 5.0	25.00 ± 1.00	-0.69	
				Zn-65	75.0 ± 8.0	71.00 ± 3.67	-0.87	
				Cs-134	10.0 ± 5.0	10.67 ± 0.58	0.23	
				Cs-137	74.0 ± 5.0	76.00 ± 1.00	0.69	
				Ba-133	99.0 ± 10.0	78 67 ± 0.58	-3.52	***(g)

Footnotes:

(a) Average ± experimental sigma.

(b) Expected laboratory precision (1 sigma, 1 determination)

(c) Normalized deviation from the known.

(d) Erroneously high reading of the stable iodine content by ion specific electrode occurred, causing an erroneously low chemical yield. If the electrode reading is ignored, the average I-131 result becomes 90 pCi/l, in good agreement with the given value. An erroneous electrode reading can be caused by certain chemical species in the sample, such as sulfide. We will investigate suspiciously high electrode readings by performing a gravimetric yield on the sample without the addition of iodide carrier or the I-131 content of active samples can also be verified by performing a gamma spectral analysis.

(e) An investigation discovered a low chemical yield on one sample and the loss of another during analysis. In the future we will repeat analyses of samples with yields less than 85%.

(f) Error apparently caused by insufficient training. The strontium separation chemistry was performed on 7/22/97 by a summer employee. Initial results for the three samples did not agree well, so all were remilked by a senior analyst. This was insufficient to correct the problem. In-house QC samples showed satisfactory results at this time. There will be additional qualification of analysts according to performance on in-house blanks and spikes.

(g) No apparent cause for the discrepancy could be identified. No corrective action has been taken. The investigation is continuing. An update will be provided, if a cause is determined and corrective action taken.

ANALYTICS CROSS CHECK COMPARISON PROGRAM 1997

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b)
E0975-396 TI #41238 03/20/97	Milk	I-131	18 ± 1	20 ± 1	0.90
		Ce-141	L.T. 1.	232 ± 12	-
		Cr-51	381 ± 38	387 ± 19	0.98
		Cs-134	132 ± 13	143 ± 7	0.92
		Cs-137	128 ± 13	114 ± 6	1.12
		Co-58	89 ± 9	79 ± 4	1.13
		Mn-54	195 ± 20	176 ± 9	1.11
		Fe-59	161 ± 16	144 ± 7	1.12
		Zn-65	171 ± 17	165 ± 8	1.04
		CO-60	179 ± 18	176 ± 9	1.02
E0976-396 TI #41239 03/20/97	Milk	Sr-89	13 ± 3	25 ± 1	0.52 (c)
		Sr-90	16 ± 1	19 ± 1	0.84
E1092-396 TI #49899-901 06/19/97	Air Filter	Ce-141	143 ± 8	132 ± 7	1.08
		Cr-51	229 ± 17	198 ± 10	1.16
		Cs-134	74 ± 4	81 ± 4	0.91
		Cs-137	143 ± 8	115 ± 6	1.24
		Co-58	89 ± 5	77 ± 4	1.16
		Mn-54	102 ± 6	84 ± 4	1.21
		Fe-59	98 ± 6	75 ± 4	1.31
		Zn-65	188 ± 11	139 ± 7	1.35
		Co-60	113 ± 7	104 ± 5	1.09
EI093-396 TI #49902-04 06/19/97	Cartridge	I-131	106 ± 6	88 ± 4	1.20
E1094-396 TI #49893-95 06/19/97	Air Filter	Sr-90	88 ± 5	96 ± 5	0.92
E1095-396 TI #49896-98 06/19/97	Air Filter	Gross Alpha	103 ± 6	93 ± 5	1.11
		Gross Beta	210 ± 6	193 ± 10	1.09
E1204-396 TI #57520 09/18/97	Milk	I-131	97 ± 10	87 ± 4	1.11
		Ce-141	83 ± 8	77 ± 4	1.08
		Cr-51	323 ± 40	304 ± 15	1.06
		Cs-134	98 ± 10	102 ± 5	0.96
		Cs-137	117 ± 12	107 ± 5	1.09
		Co-58	64 ± 6	60 ± 3	1.07
		Mn-54	99 ± 10	88 ± 4	1.13
		Fe-59	132 ± 13	119 ± 6	1.11
		Zn-65	218 ± 22	196 ± 10	1.11
		Co-60	209 ± 21	197 ± 10	1.06

ANALYTICS CROSS CHECK COMPARISON PROGRAM 1997

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b)
E1203-396	Milk	Sr-89	14 ± 1	15 ± 1	0.93
TI #57517		Sr-90	18 ± 1	14 ± 1	1.29
09/18/97					

Footnotes:

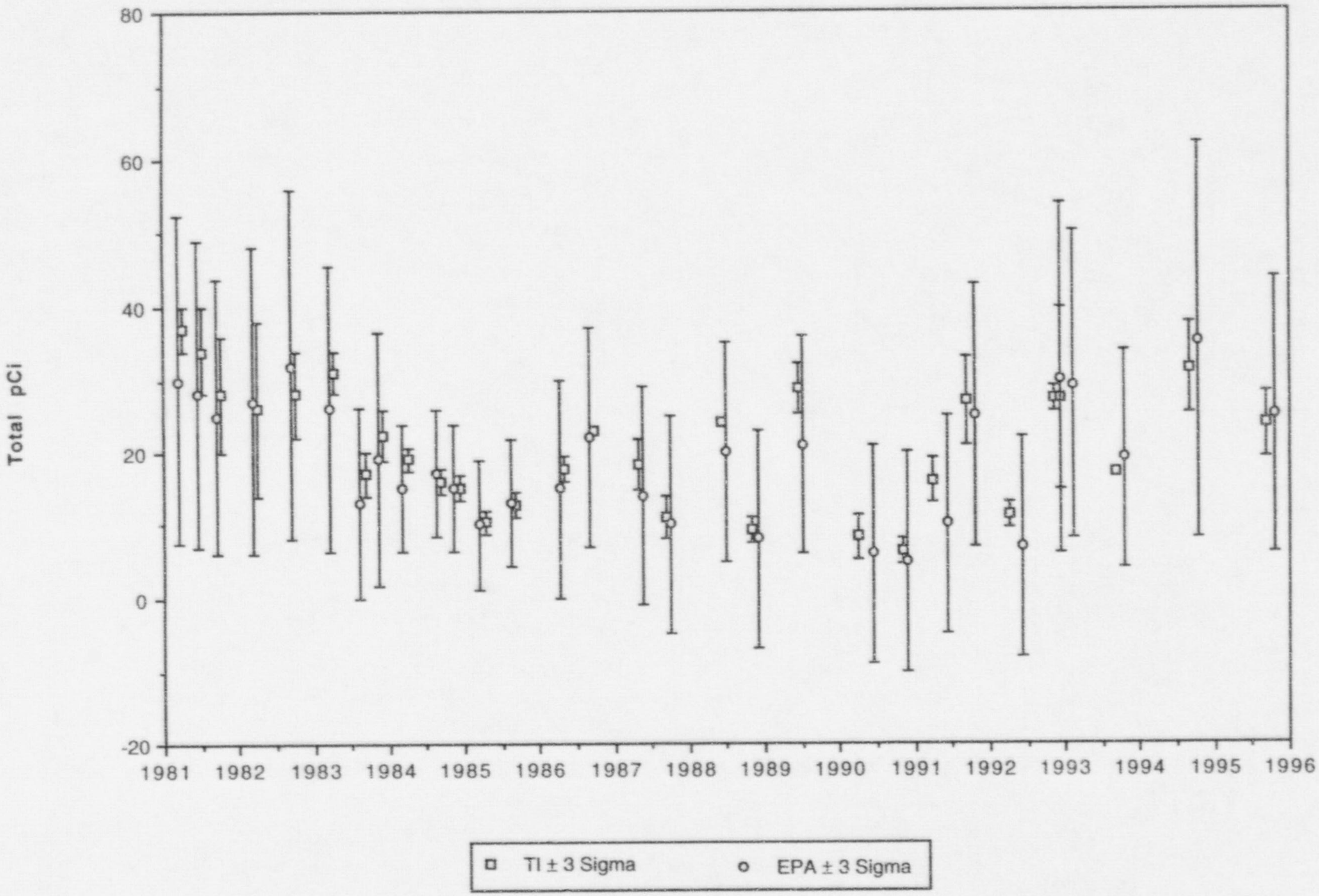
(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% eror is reported. Units are total pCi for air particulate filters.

(b) Ratio of Teledyne Brown Engineering to Analytics results.

(c) Caused by incorrect rinsing of the strontium extraction column. Additional training was conducted on 9/5/97 and was documented in the analyst's training file. Subsequent tests on two milk samples spiked with Sr-89 produced good results.

EPA CROSS CHECK PROGRAM

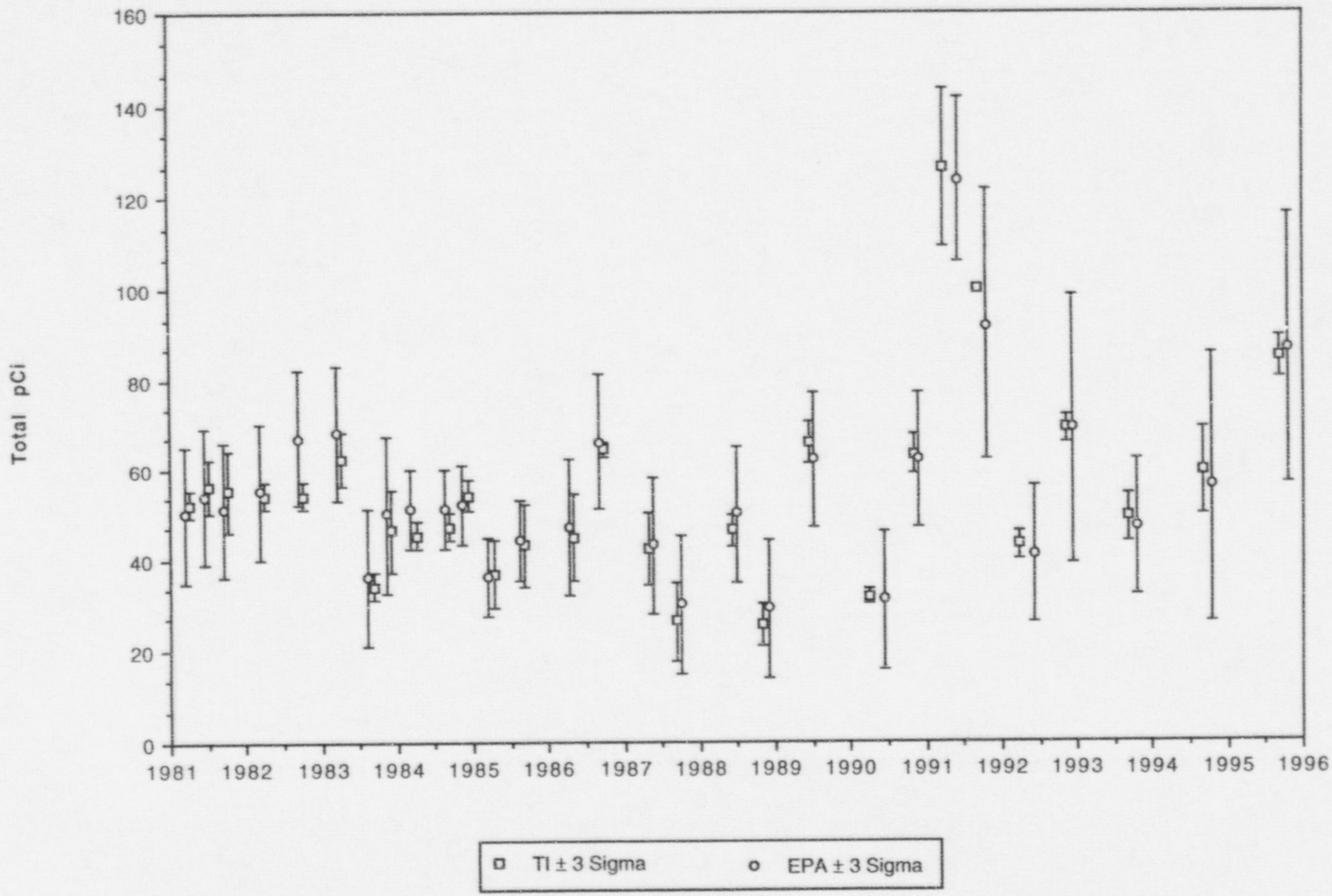
GROSS ALPHA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

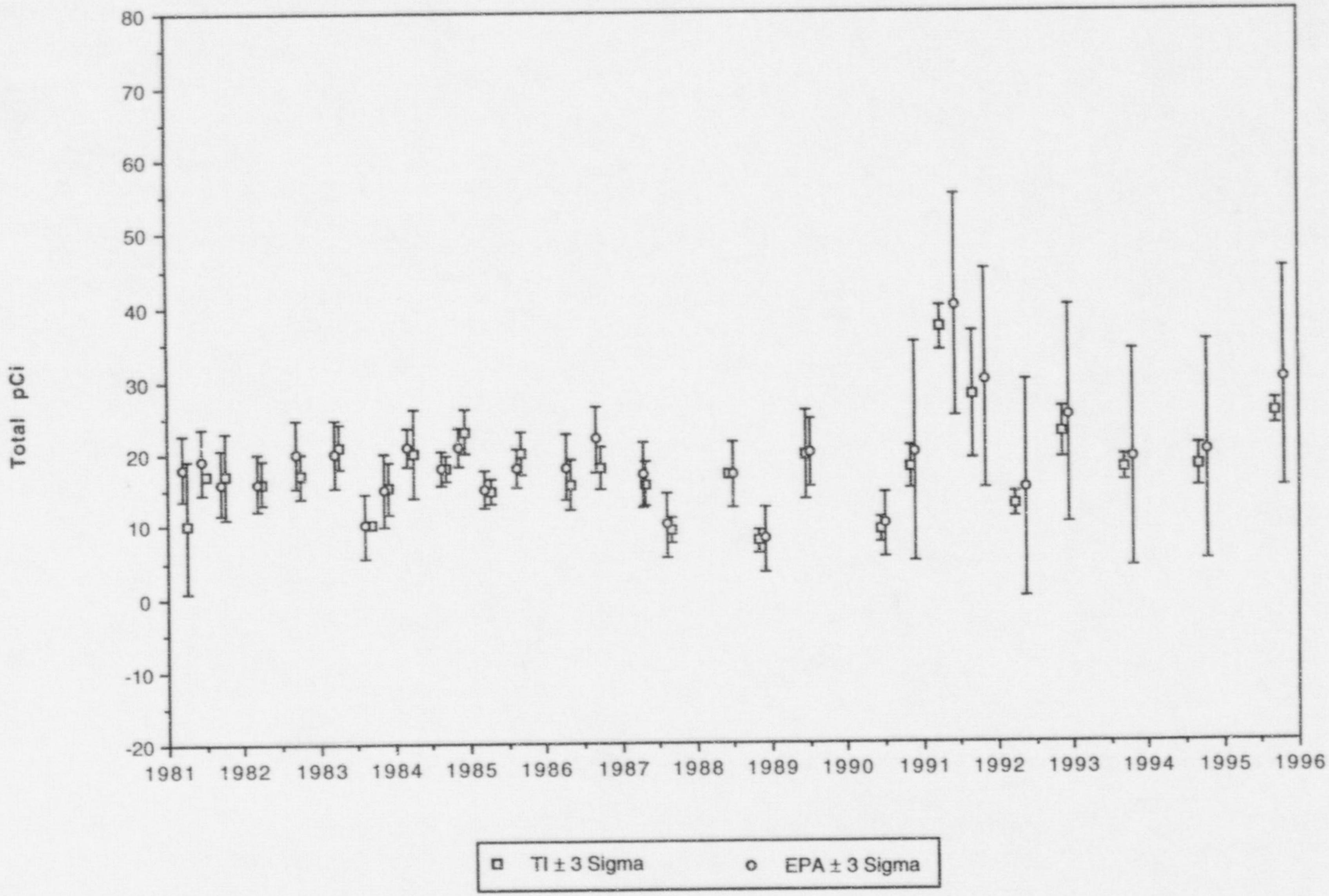
GROSS BETA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

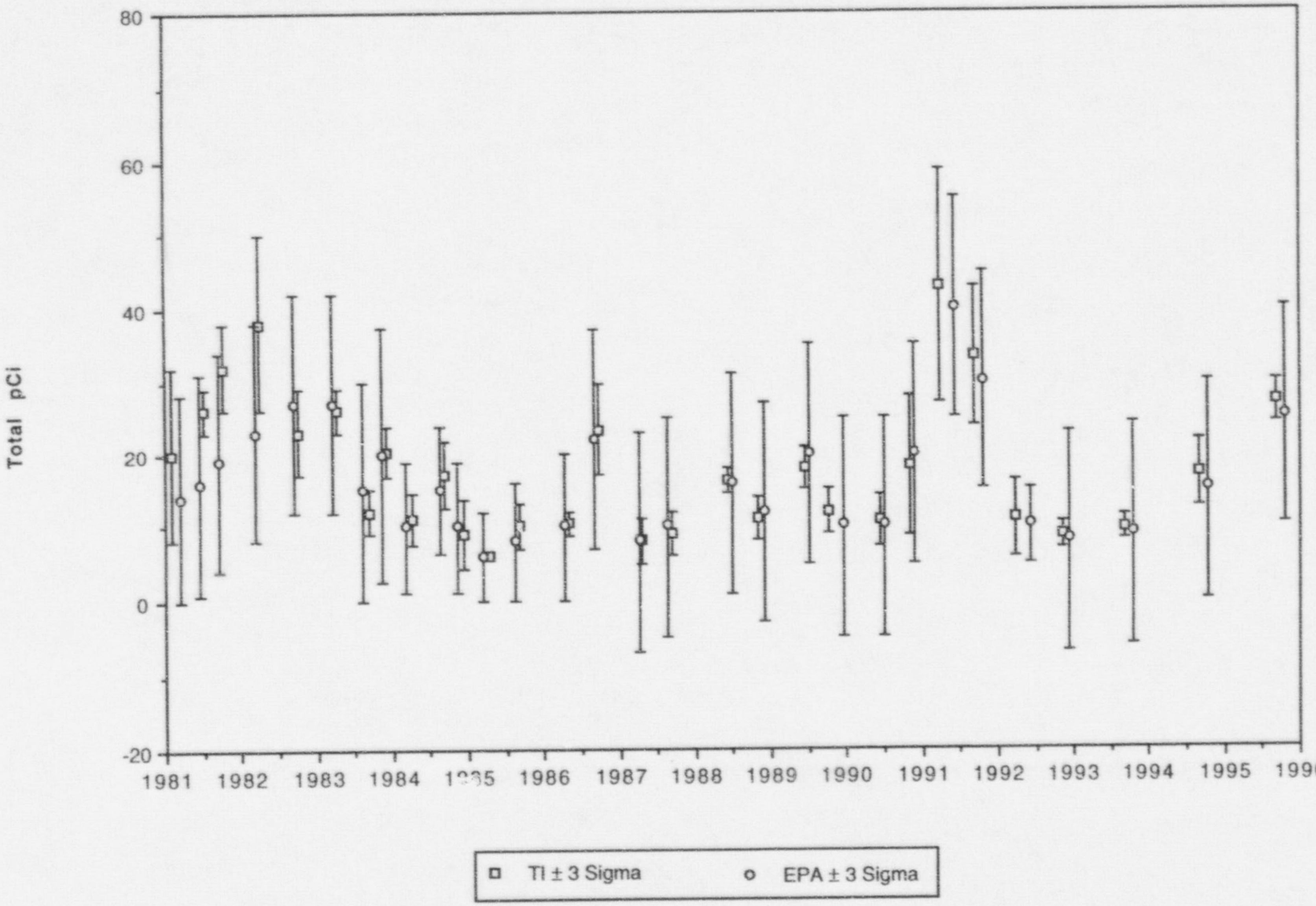
STRONTIUM-90 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samaples in 1996.

EPA CROSS CHECK PROGRAM

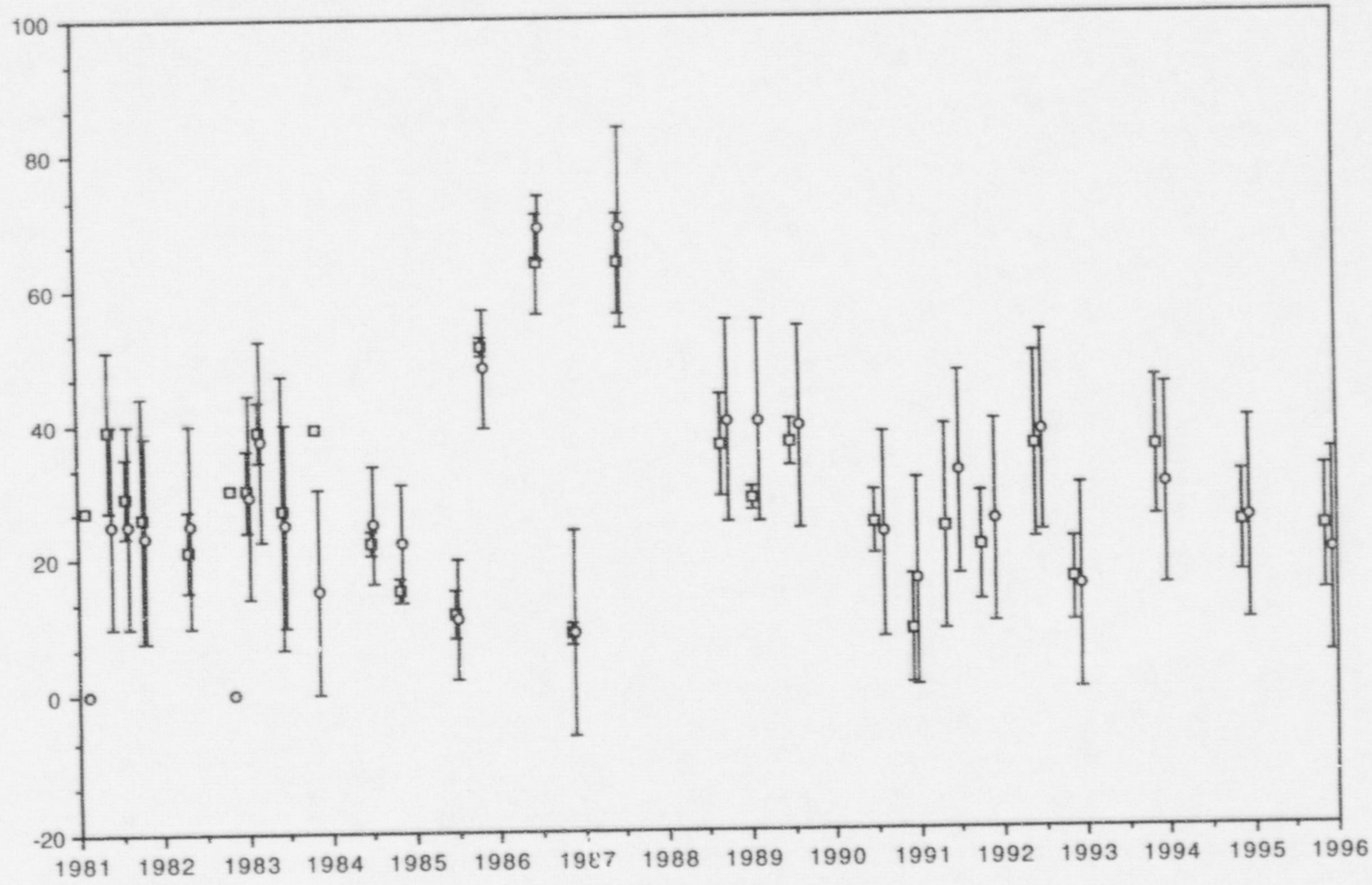
CESIUM-137 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

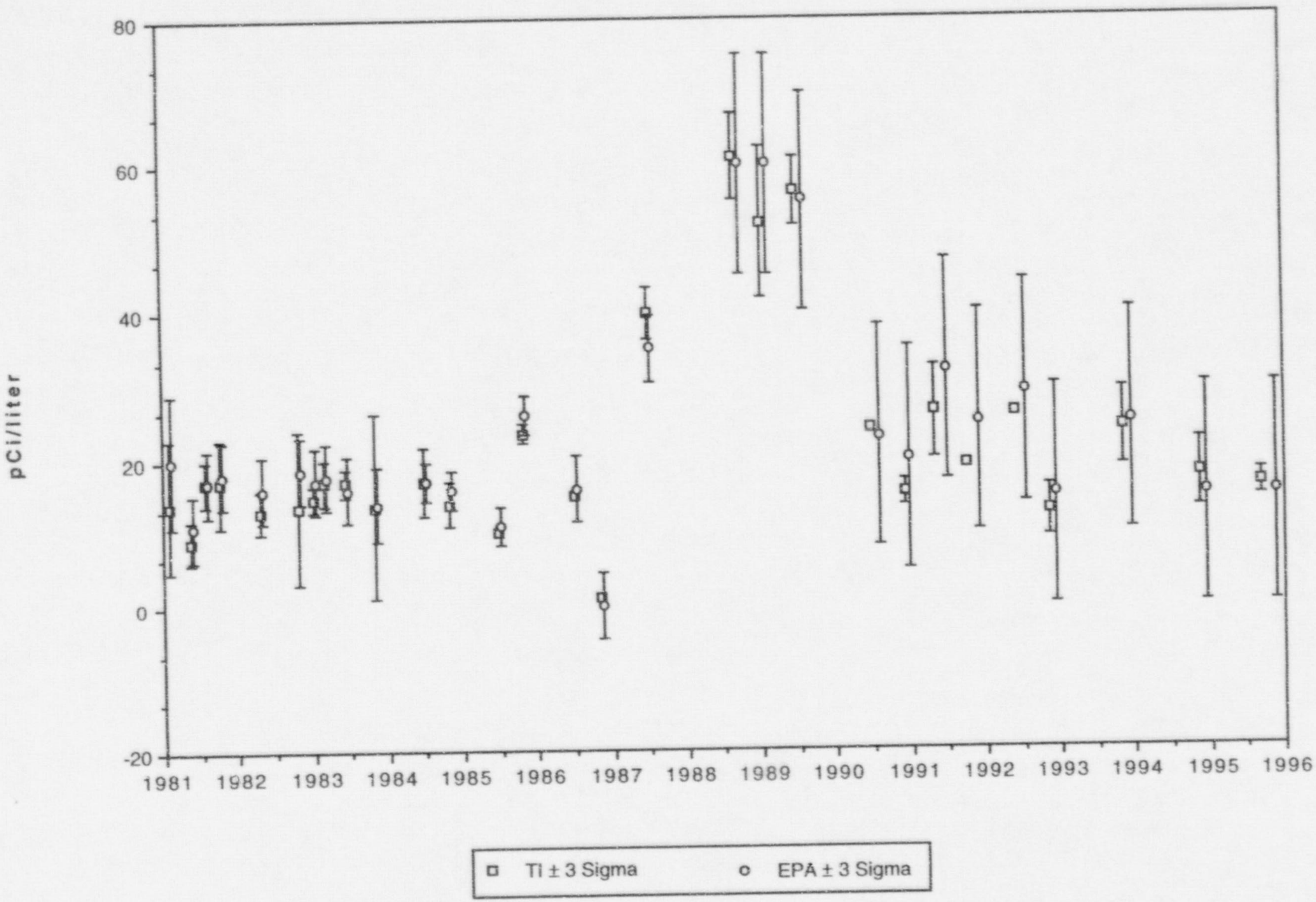
STRONTIUM-89 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

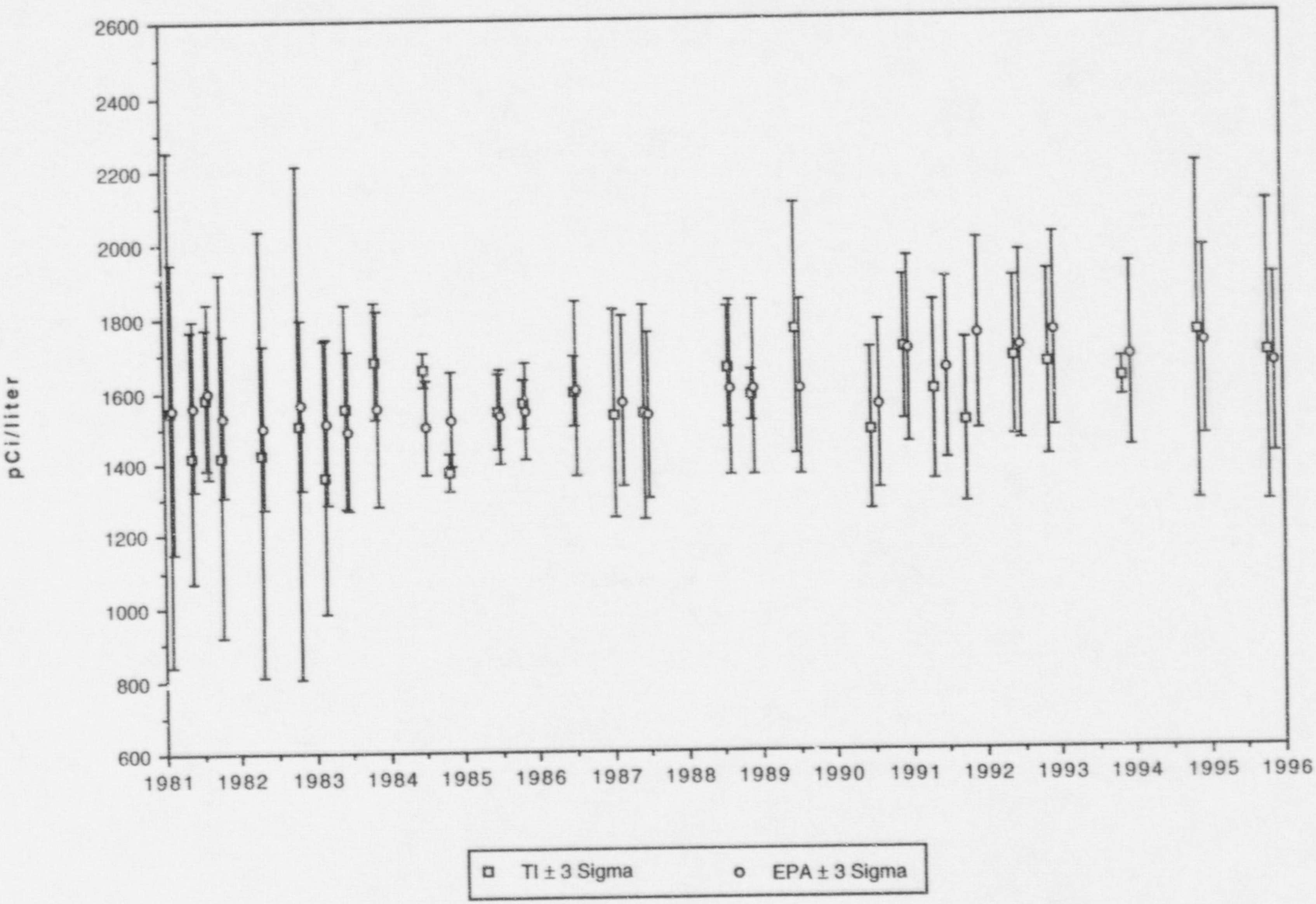
STRONTIUM-90 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

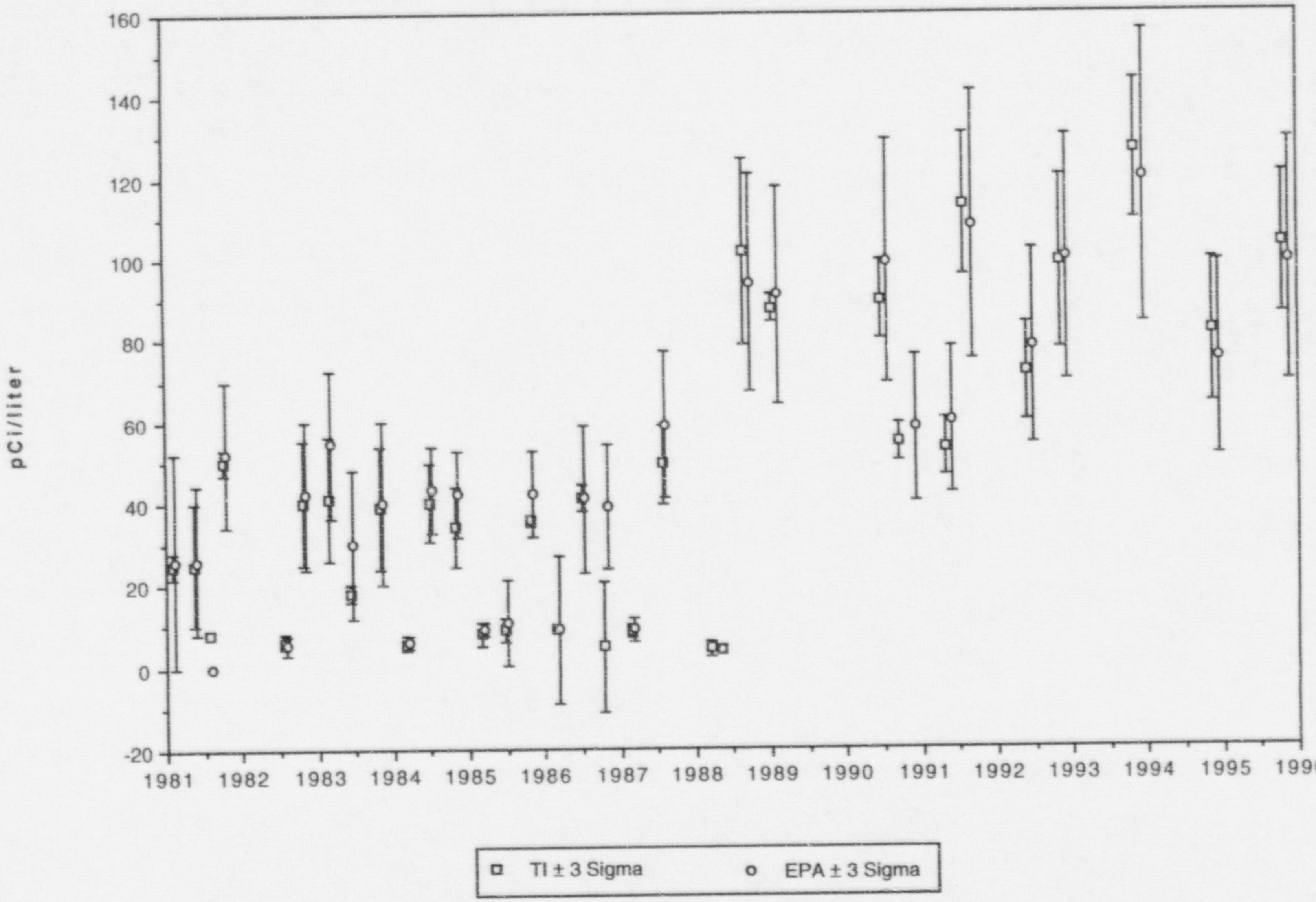
POTASSIUM-40 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

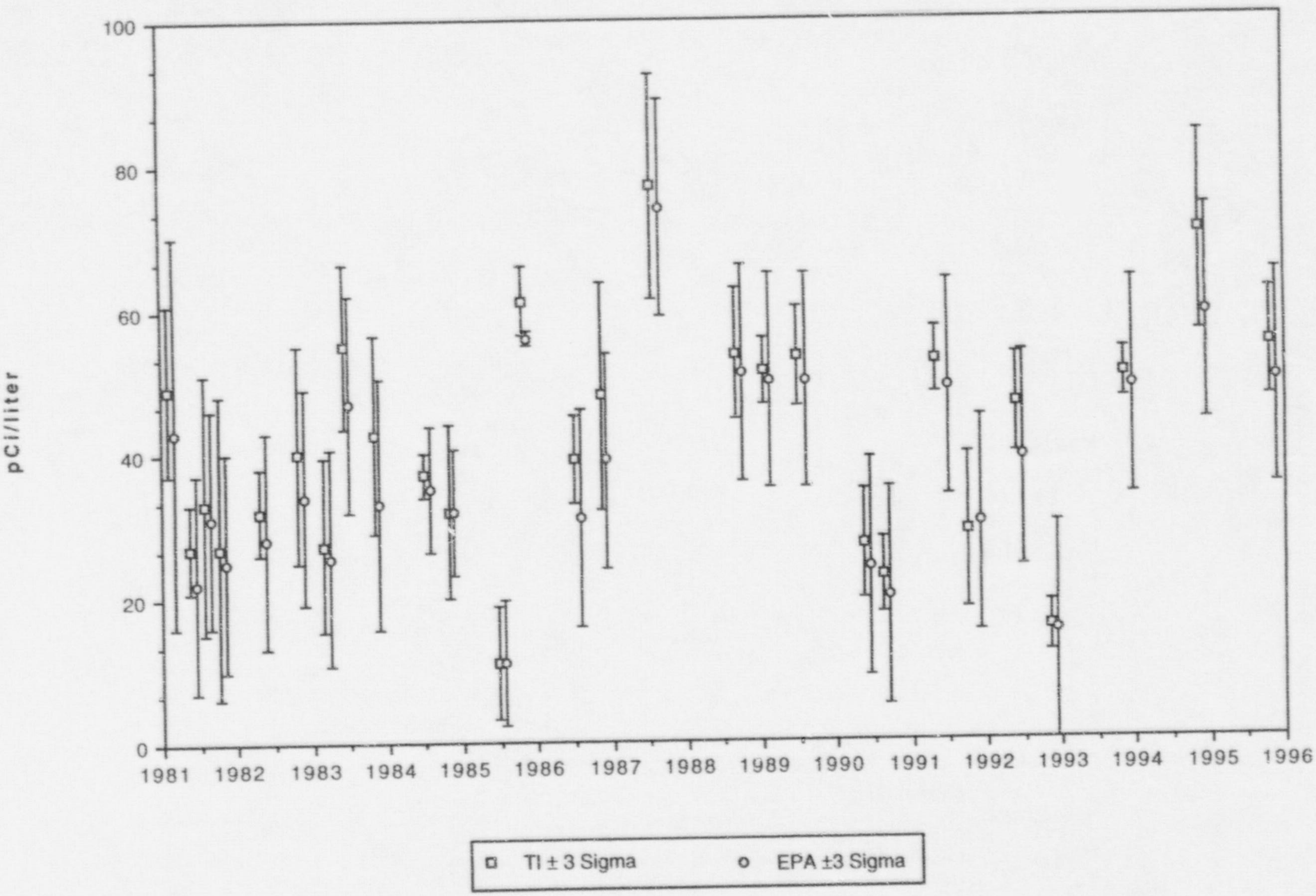
IODINE-131 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

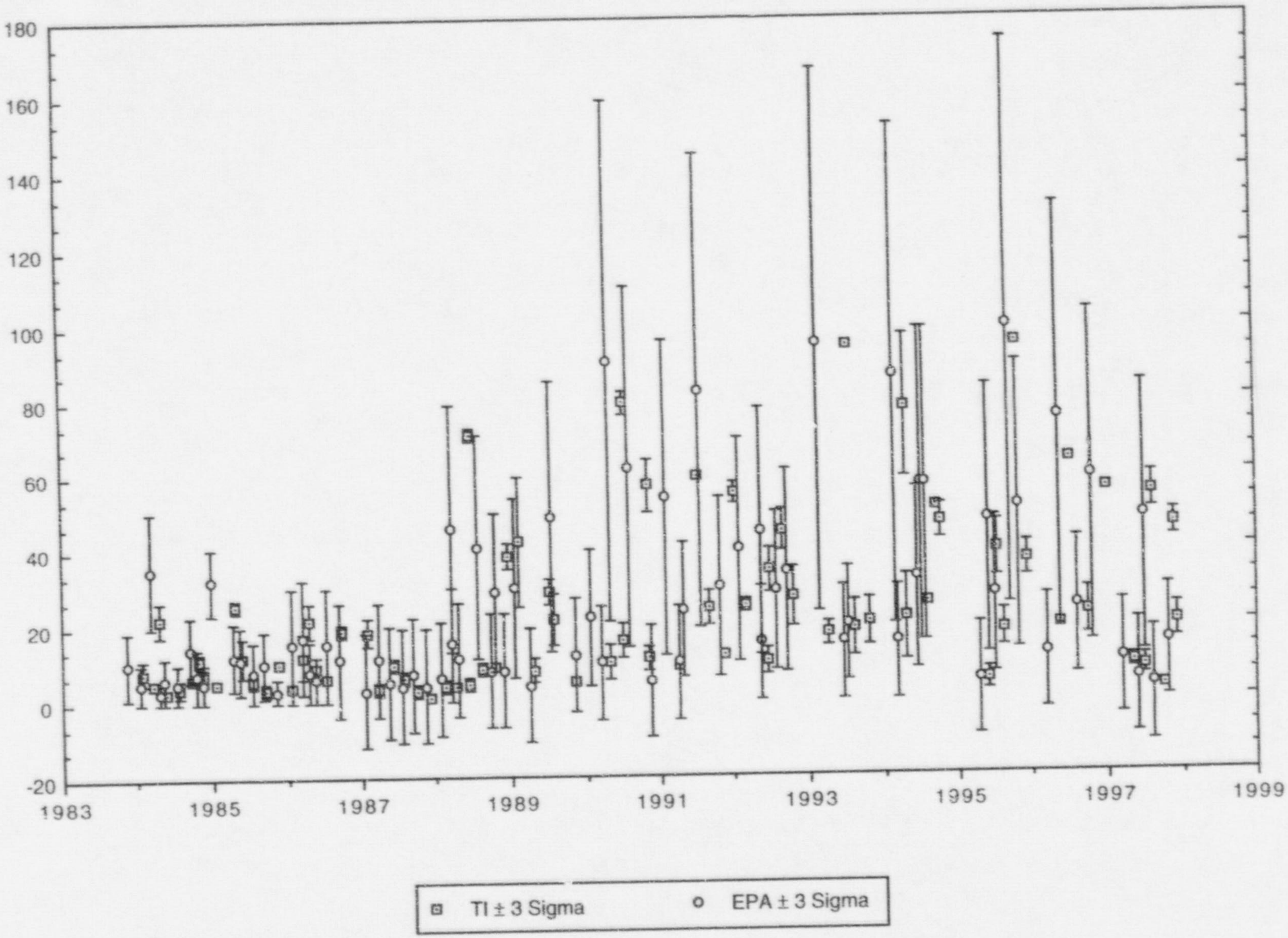
CESIUM-137 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

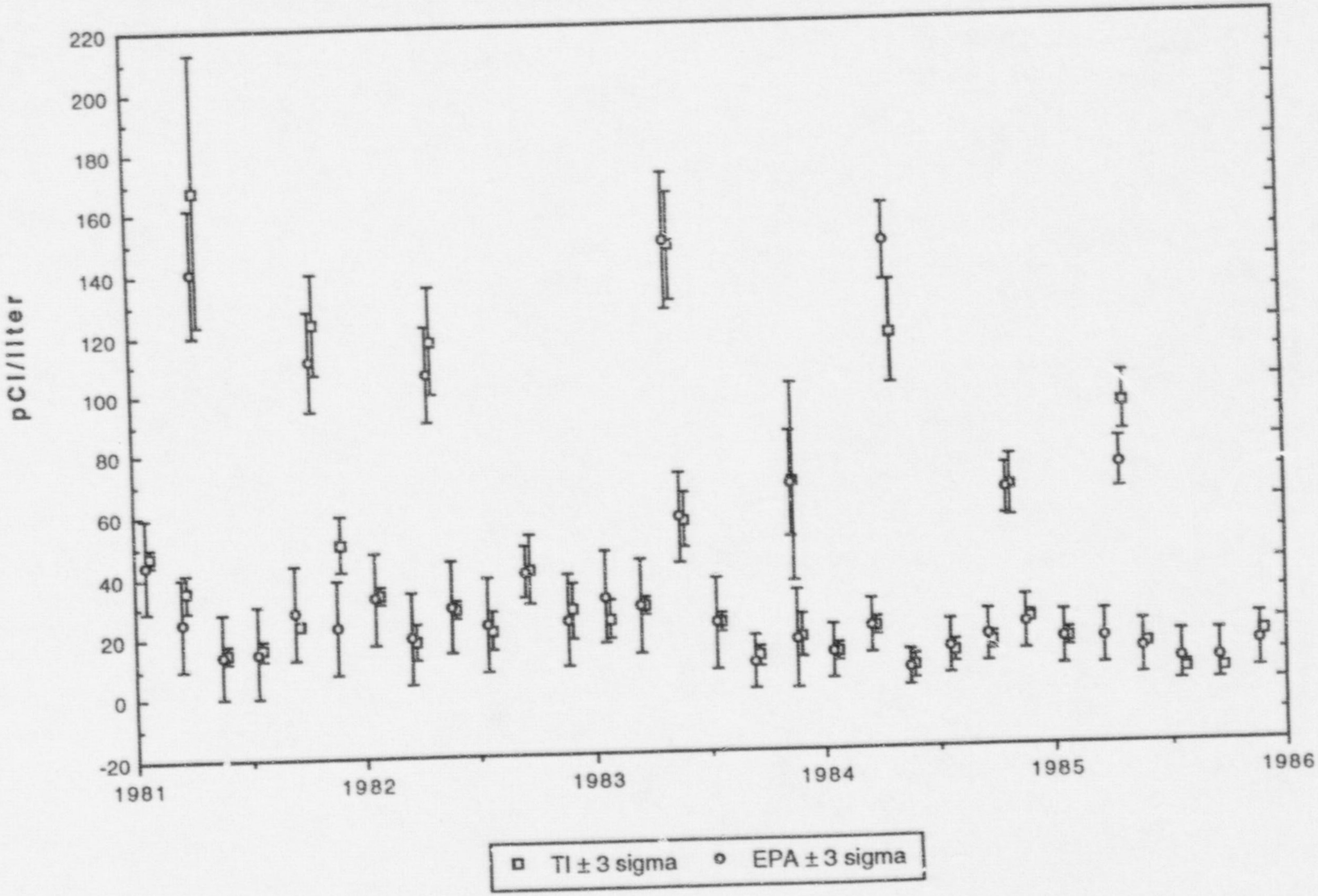
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)



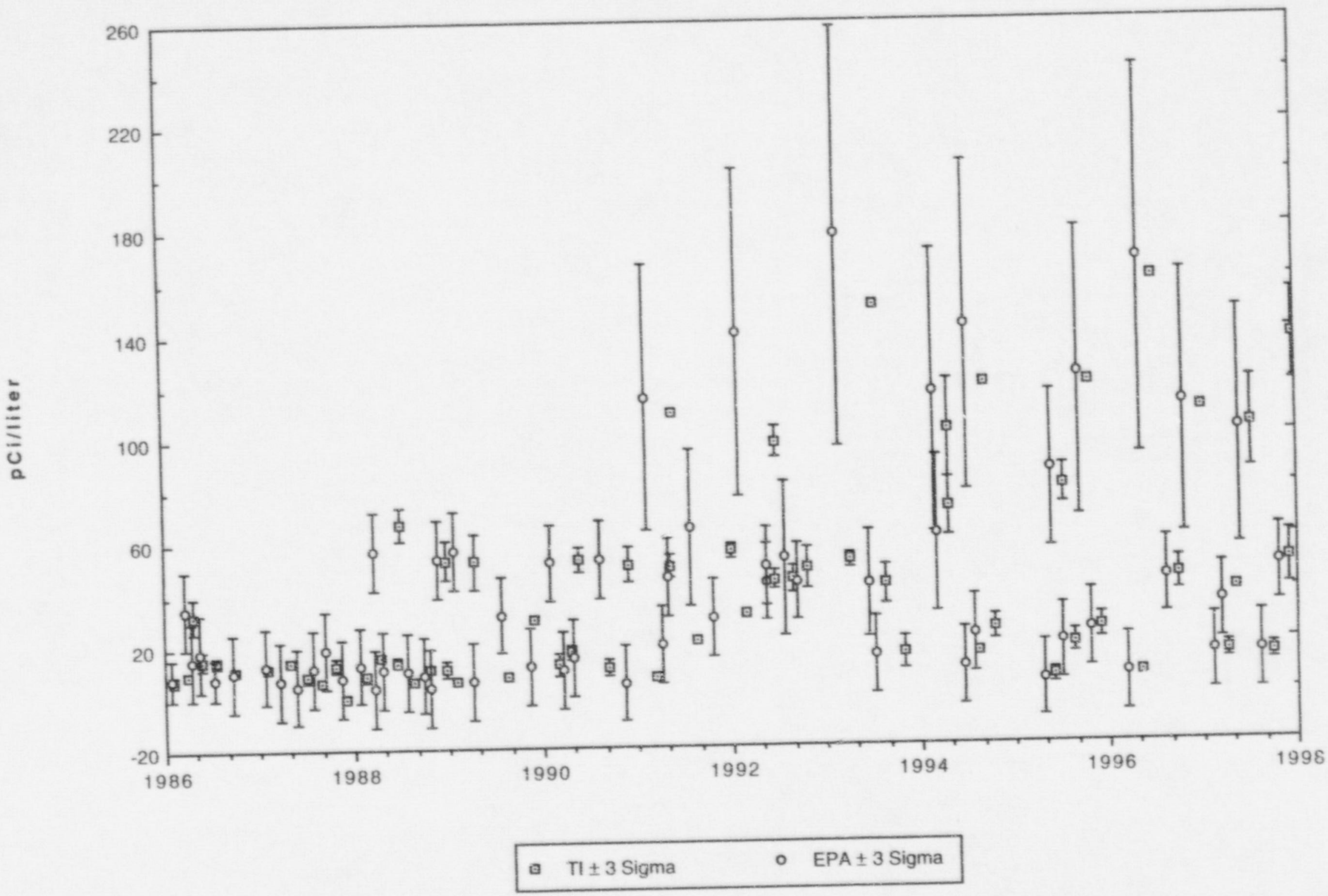
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)



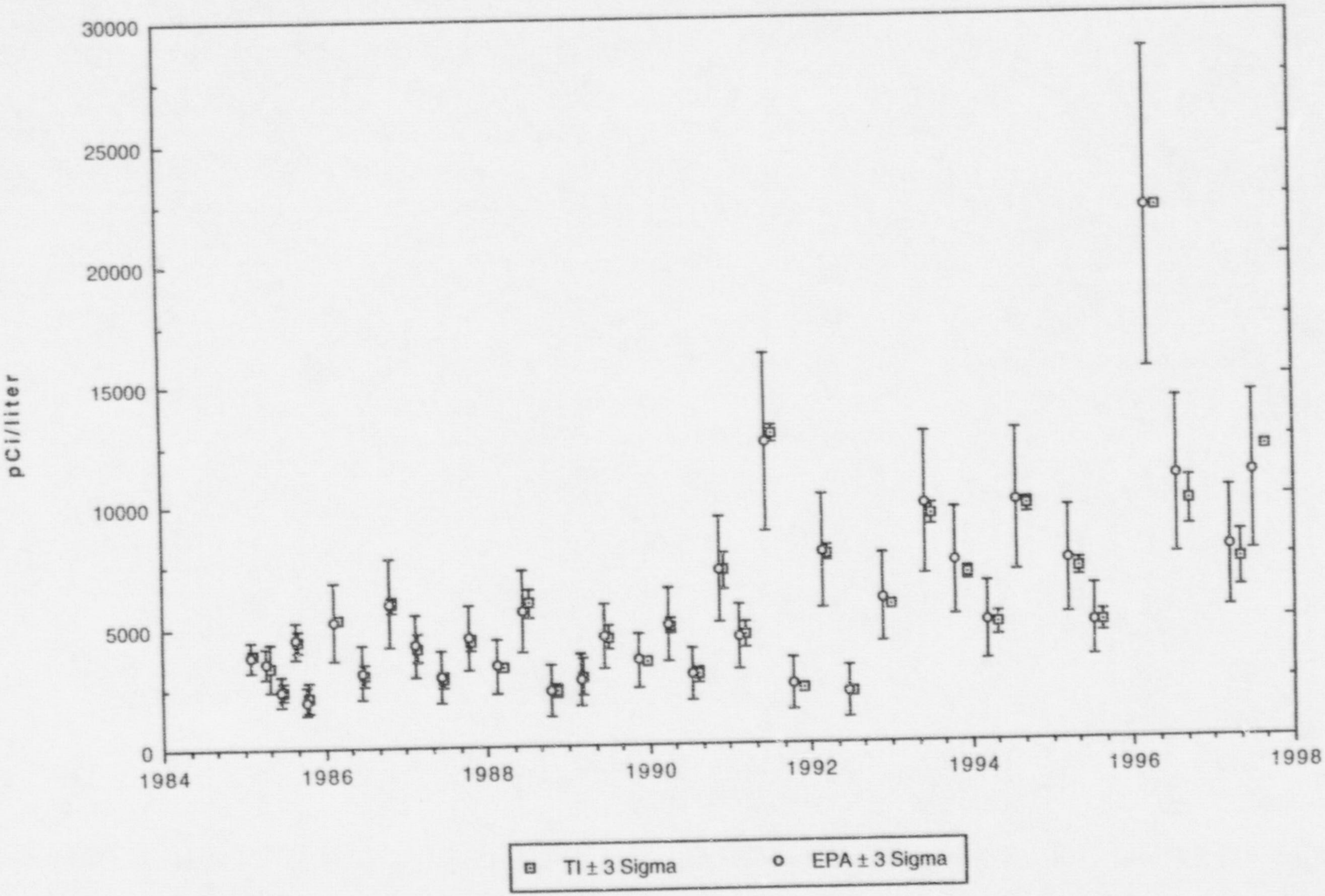
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 2 of 2)



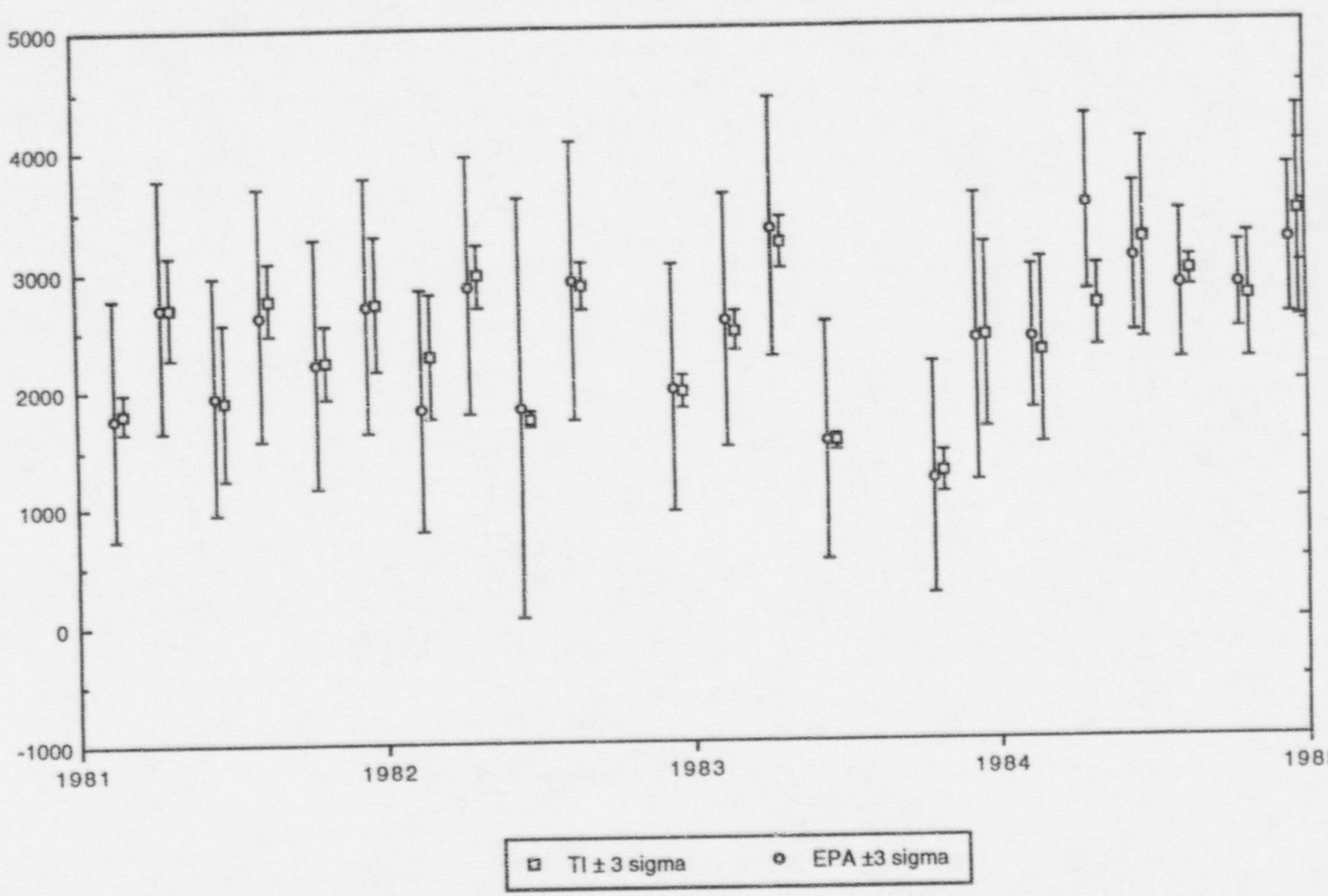
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 2 of 2)



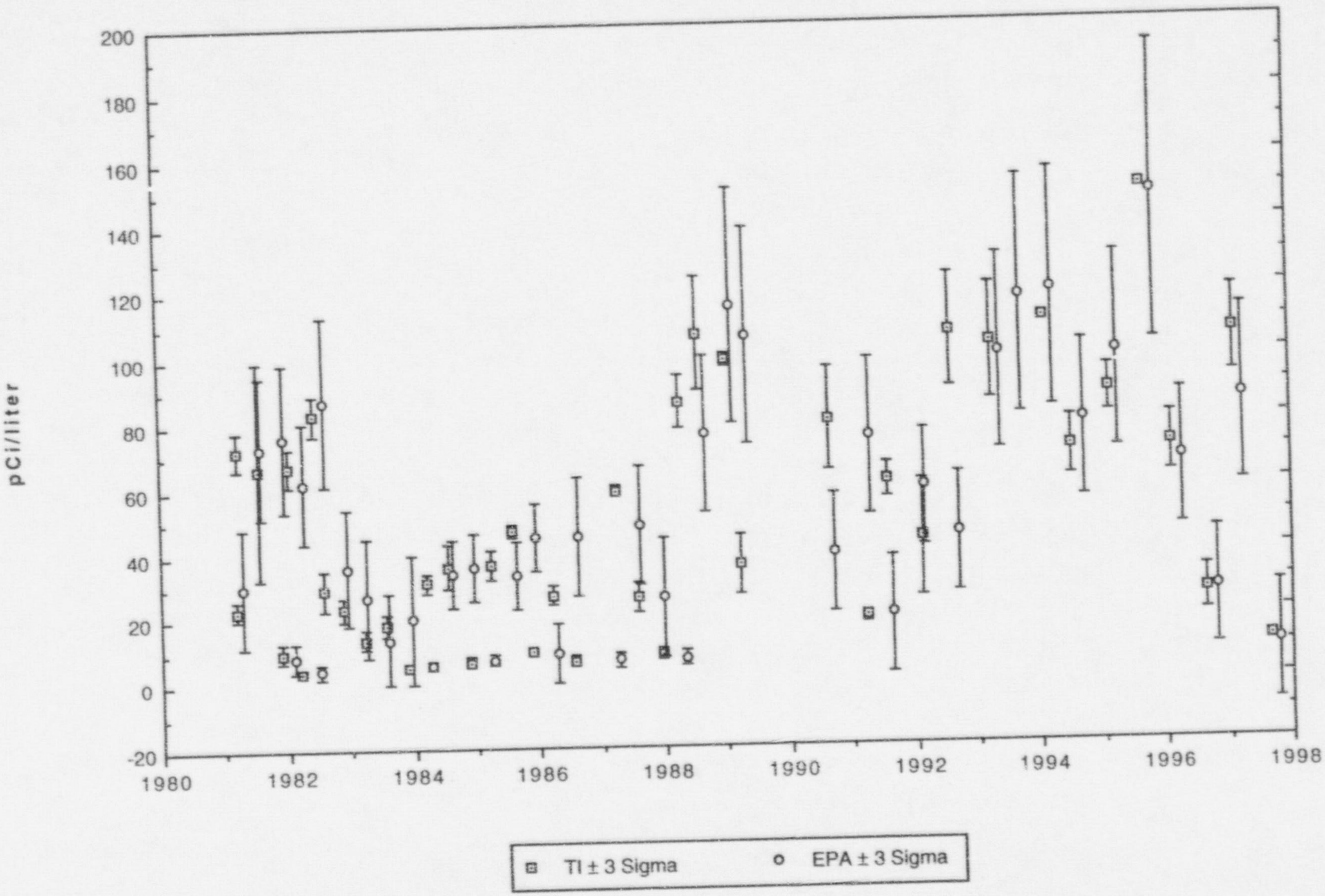
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



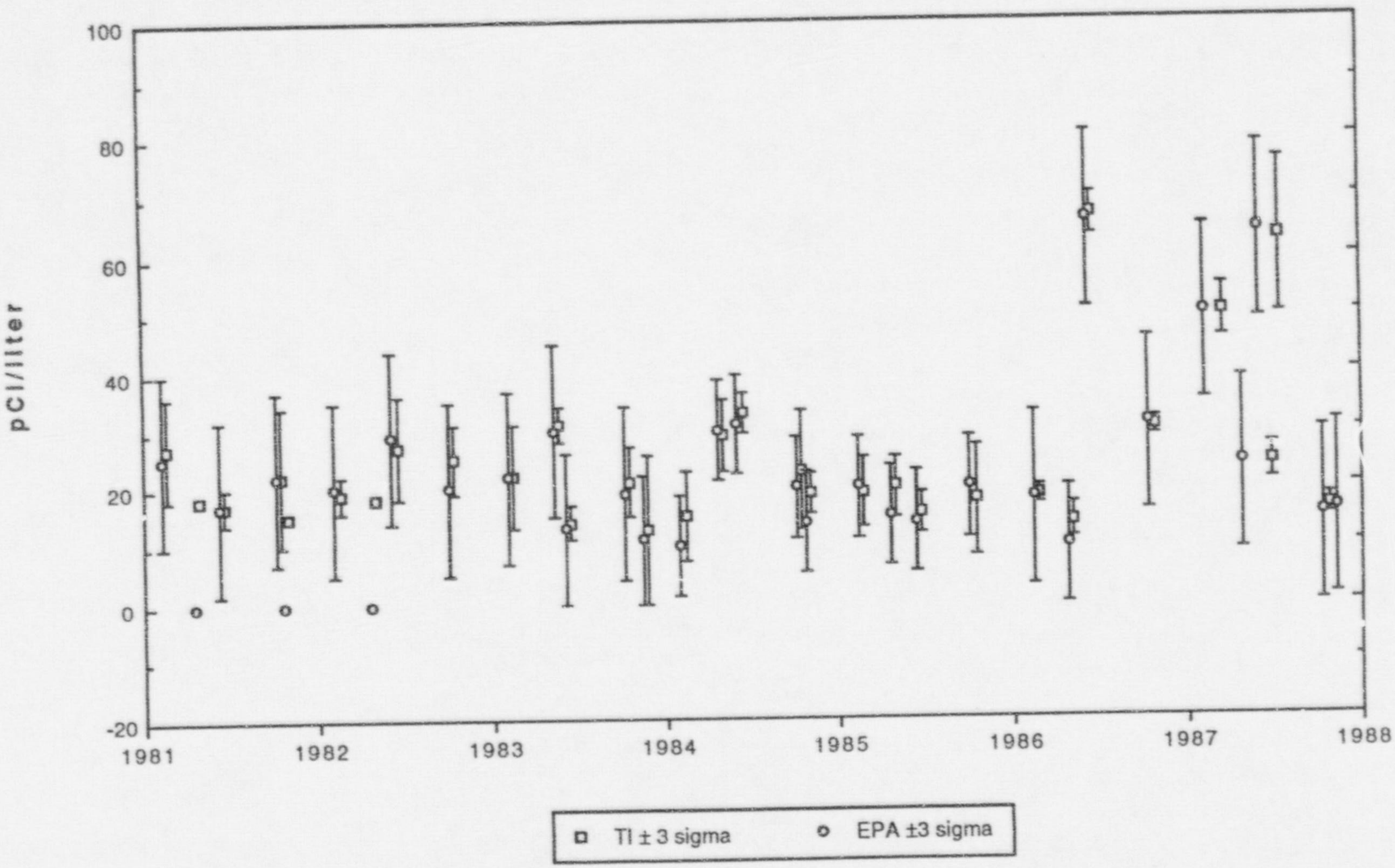
EPA CROSS CHECK PROGRAM

IODINE-131 IN WATER (pg. 1 of 1)



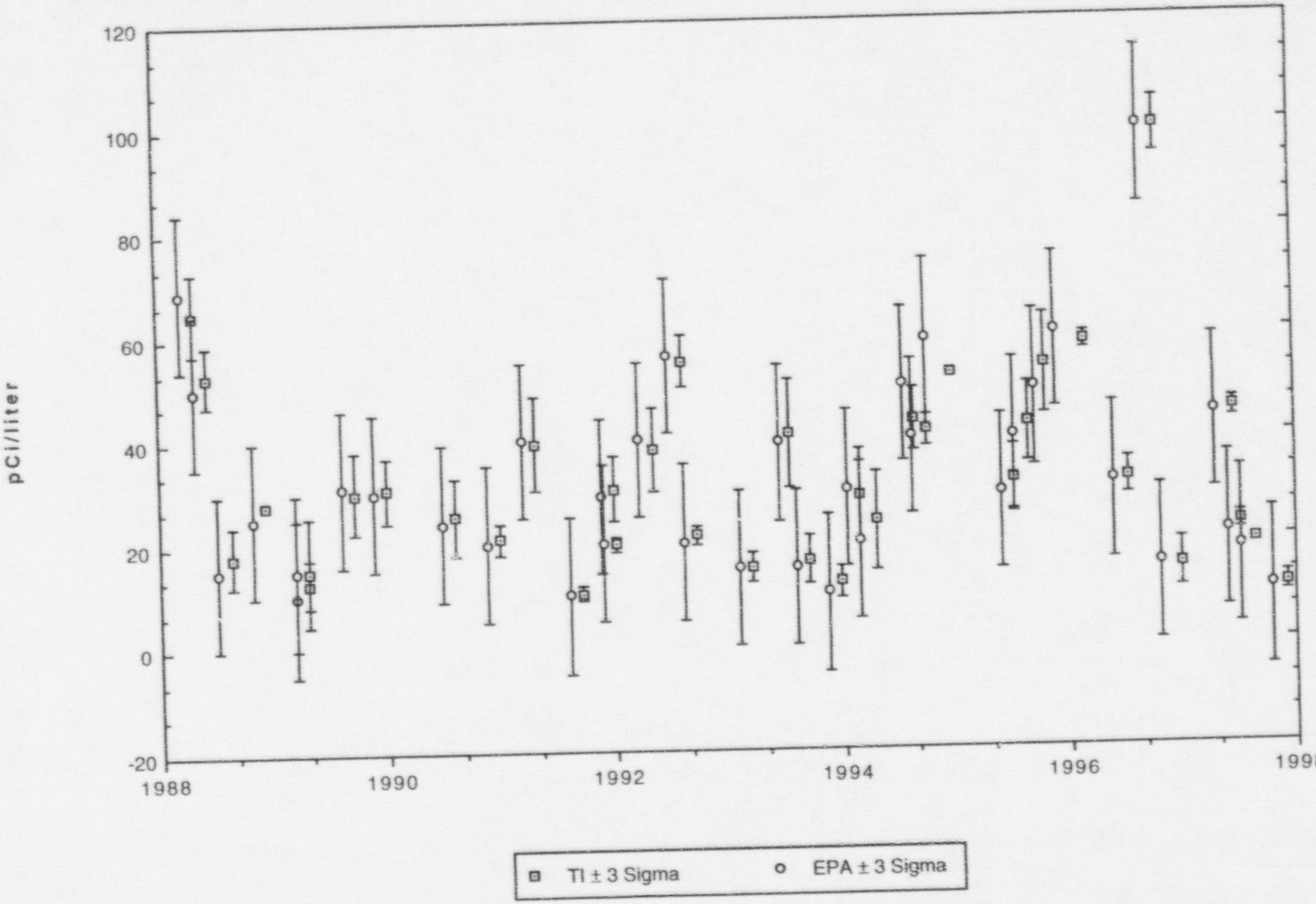
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



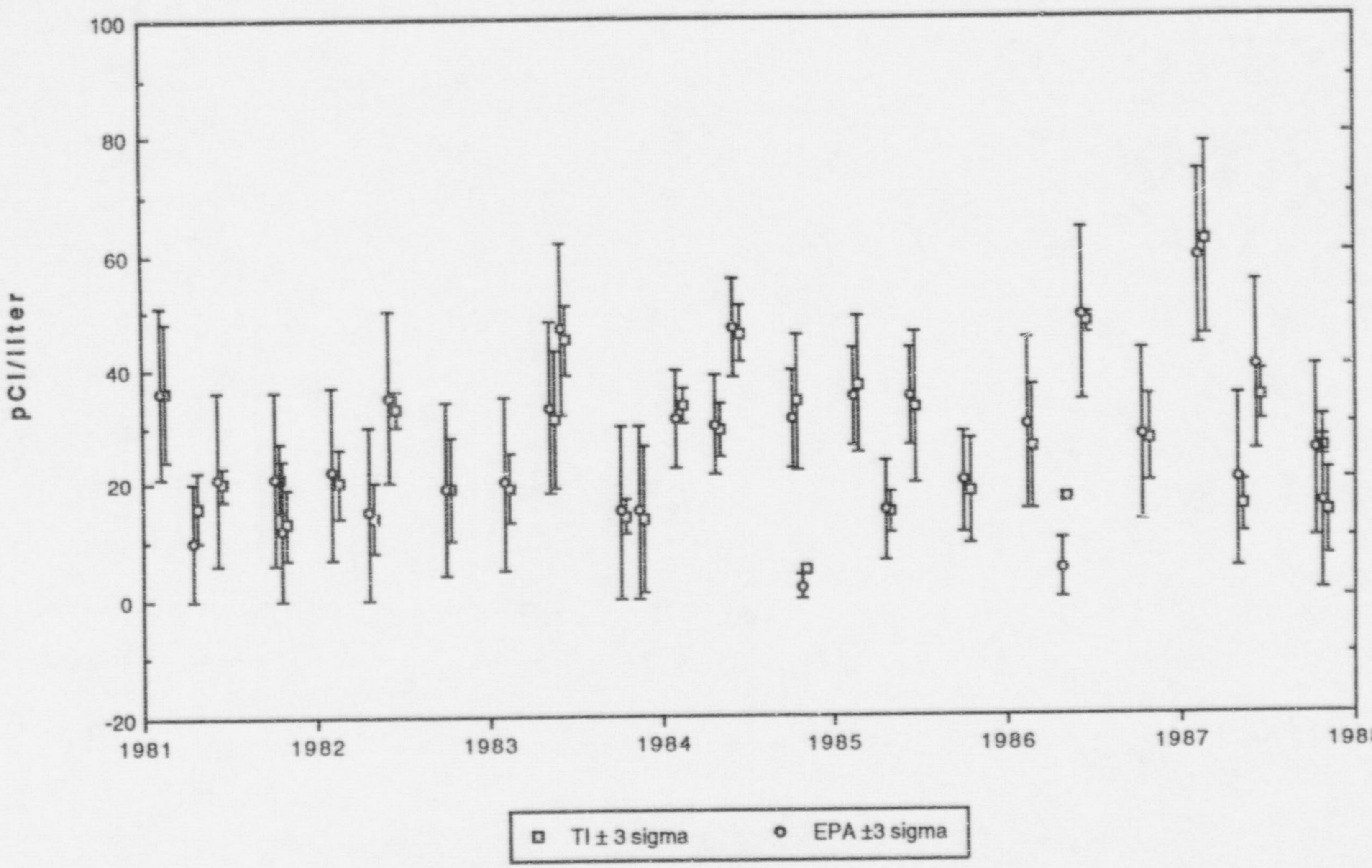
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg. 2 of 2)



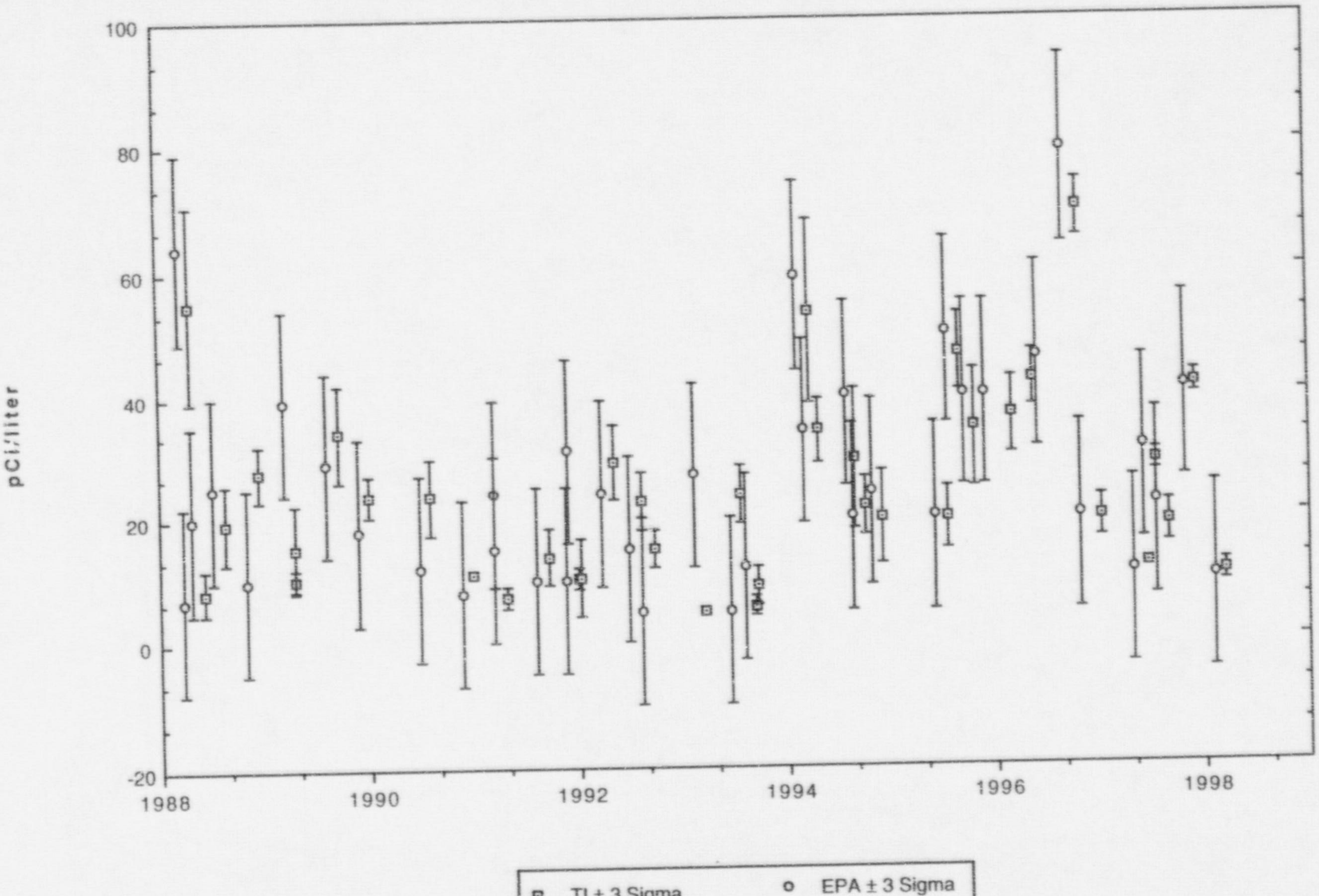
EPA CROSS CHECK PROGRAM

CESIUM-134 IN WATER (pg. 1 of 2)



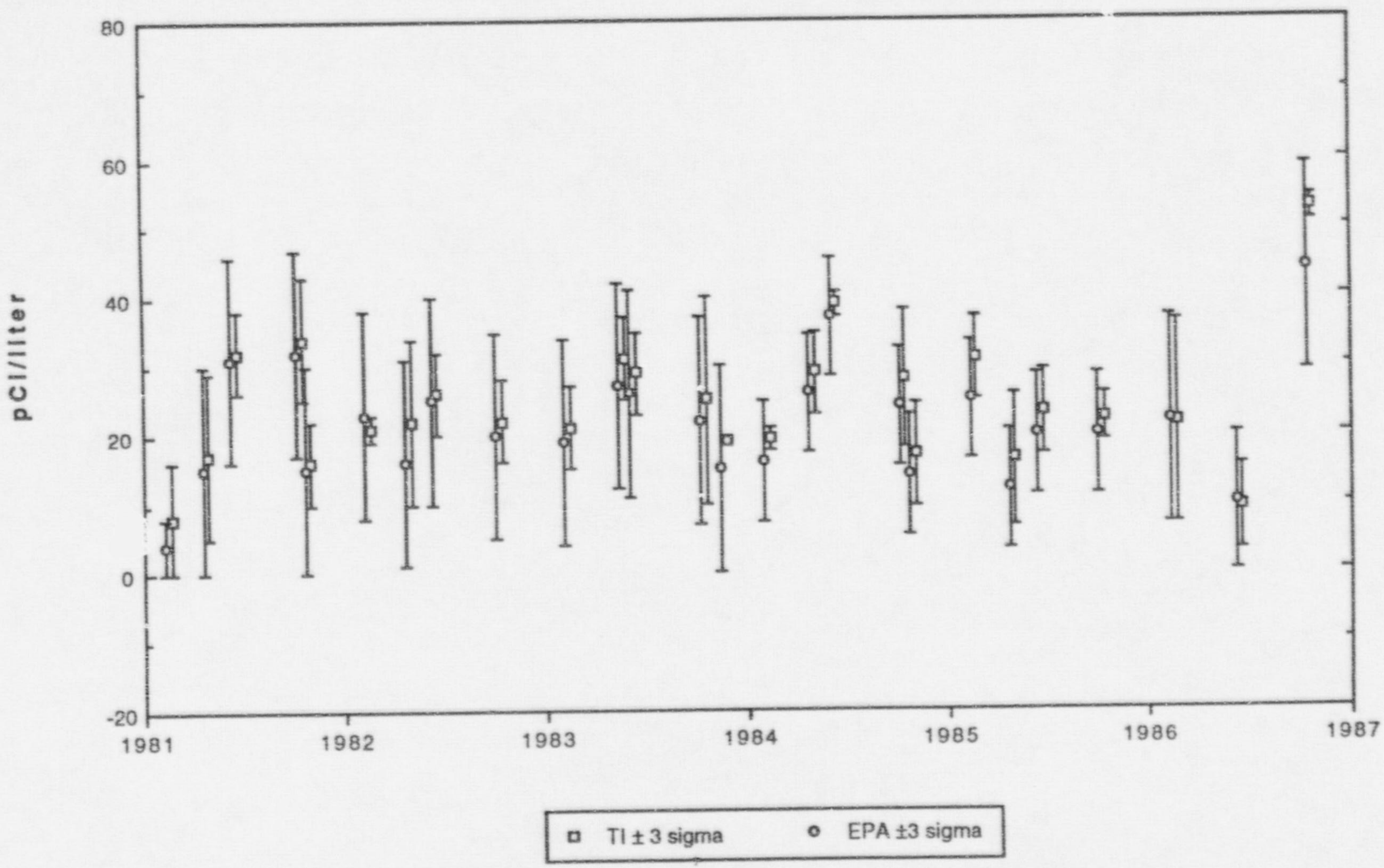
EPA CROSS CHECK PROGRAM

CESIUM-134 IN WATER (pg. 2 of 2)



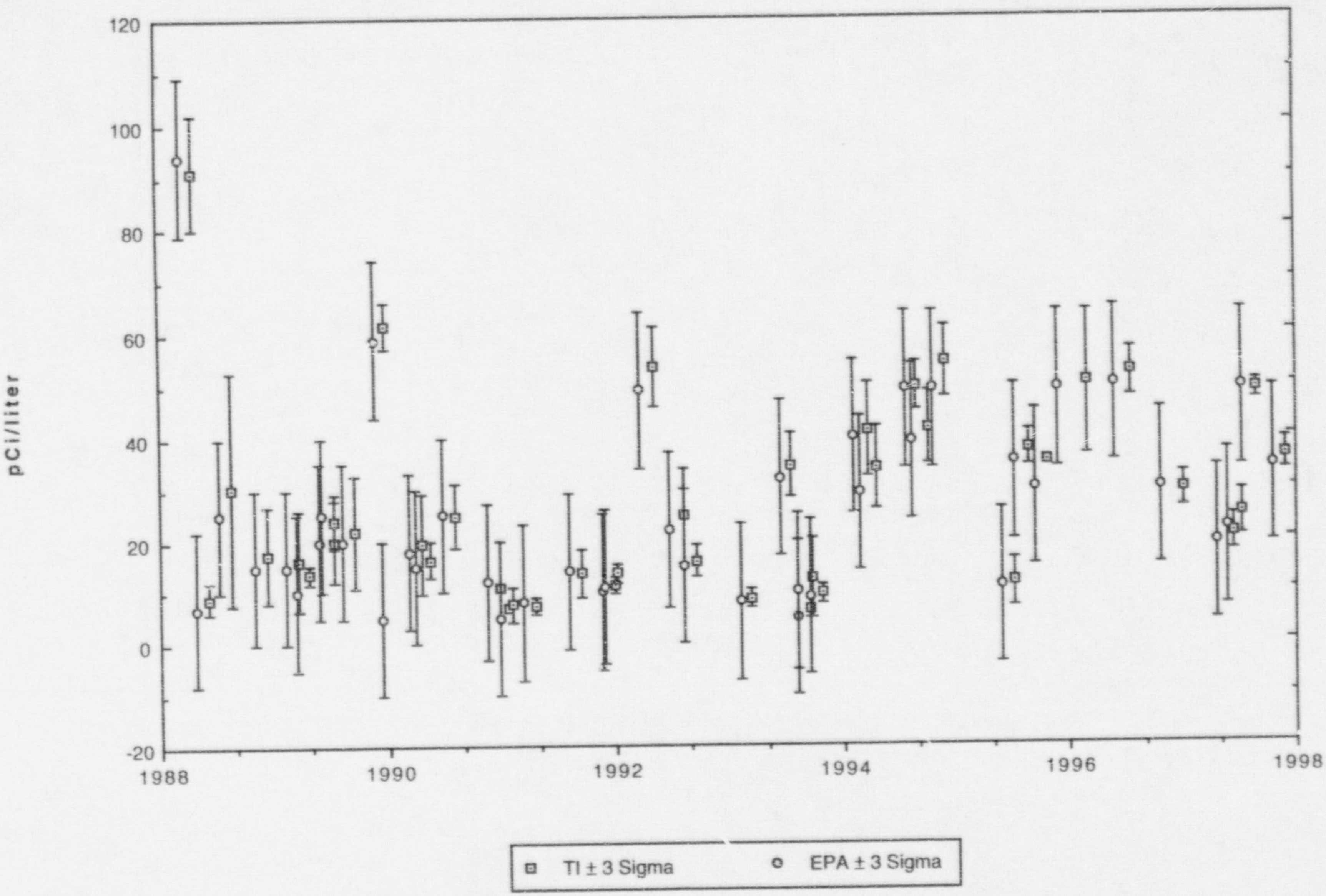
EPA CROSS CHECK PROGRAM

CESIUM-137 IN WATER (pg. 1 of 2)



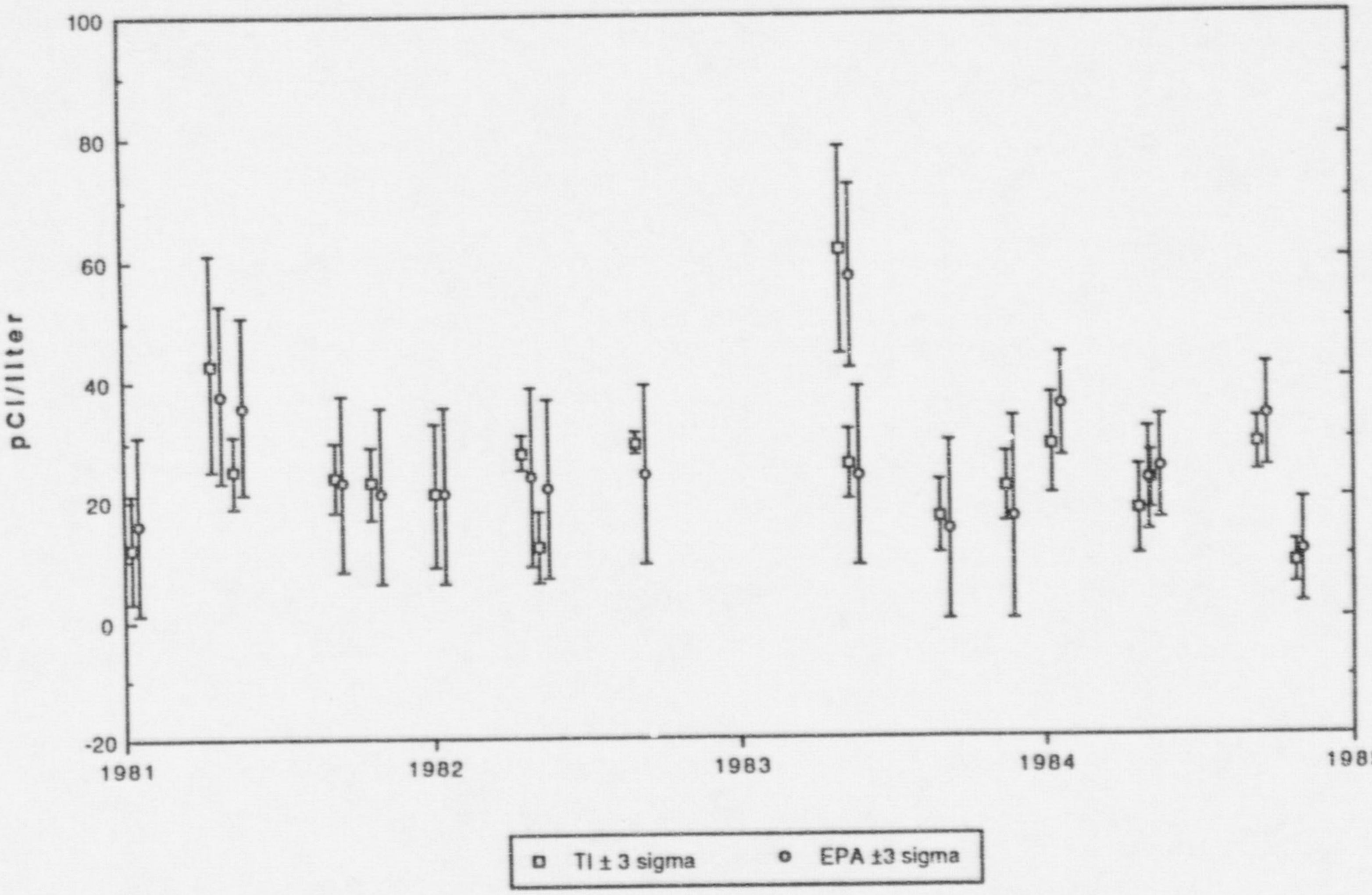
EPA CROSS CHECK PROGRAM

CESIUM-137 IN WATER (pg. 2 of 2)



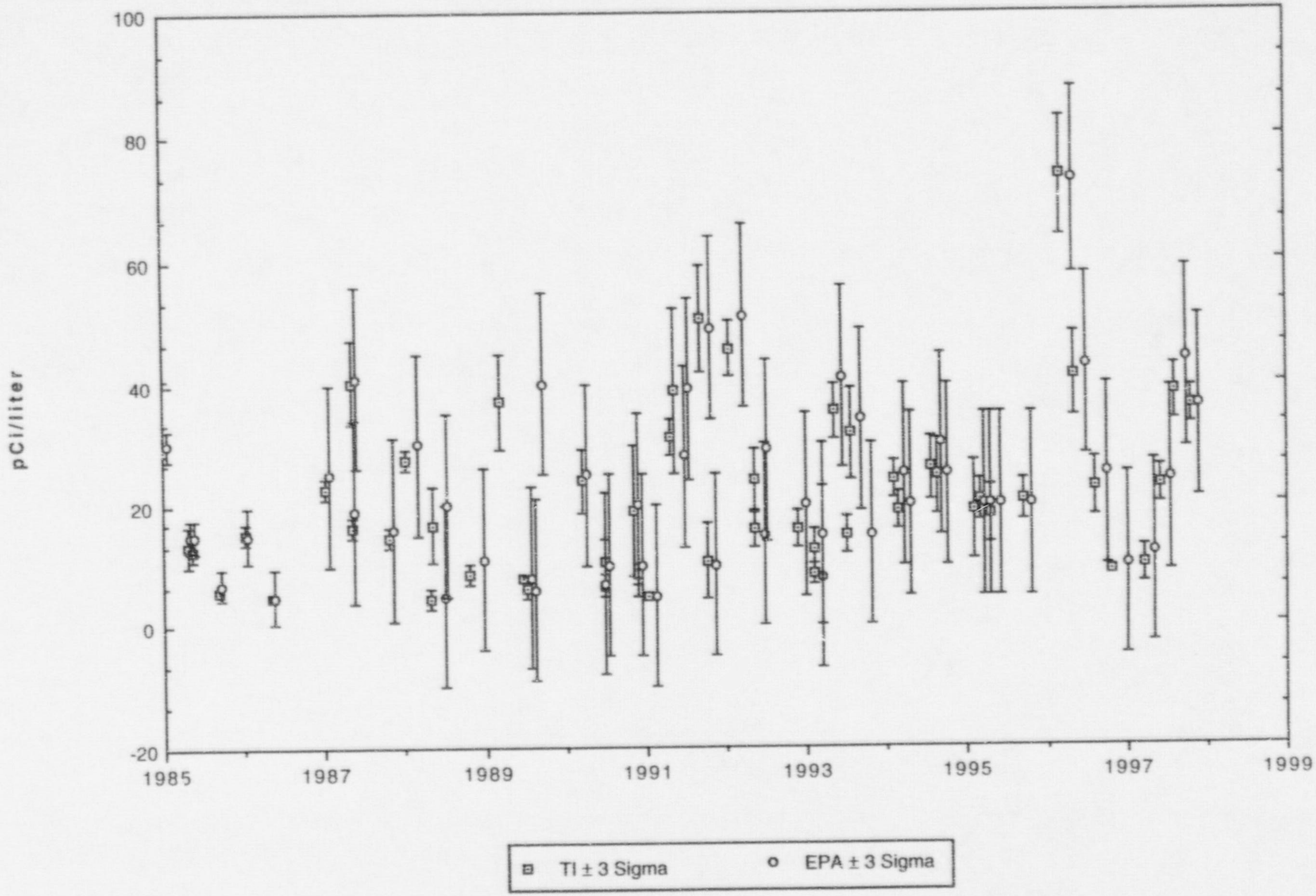
EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER (pg. 1 of 2)



EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER (pg. 2 of 2)



EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN WATER (pg. 1 of 1)