VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 28, 2000

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

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Gentlemen:

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

North Anna Units 1 and 2 Technical Specifications 6.9.1.8 require the submittal of an Annual Radiological Environmental Operating Report. Accordingly, enclosed is the Annual Radiological Environmental Operating Report for North Anna Units 1 and 2 and North Anna Independent Spent Fuel Storage Installation for the reporting period of January 1, 1999 through December 31, 1999.

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

Very truly yours,

W. R. Matthews
Site Vice President

Enclosure

Commitments made by this letter: None

JE25

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

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

North Anna Power Station

1999 Annual Radiological Environmental Operating Report

VIRGINIA POWER

VIRGINIA ELECTRIC AND POWER COMPANY

NORTH ANNA POWER STATION

Radiological Environmental Monitoring Program

January 1, 1999 to December 31, 1999

Prepared by

VIRGINIA ELECTRIC AND POWER COMPANY

and

TELEDYNE BROWN ENGINEERING

Annual Radiological Environmental Operating Report
North Anna Power Station

January 1, 1999 to December 31, 1999

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Preface

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

Executive Summary

This document is a detailed report on the 1999 North Anna Nuclear Power Station Radiological Environmental Monitoring Program (REMP). Radioactivity levels from January 1 through December 31, 1999 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 Electric and Power Company (VEPCO) 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 an interlaboratory comparison program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the Nuclear Regulatory Commission (NRC) requires that equipment used for radiological environmental monitoring must be able to detect specified minimum Lower Limits of Detection (LLD). This ensures that analyses are as accurate as possible. Samples with 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 1999 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 1999.

- 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 1999 was 13.4% 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, no cesium-137 was detected.

- The ingestion exposure pathway includes milk, fish, and food/vegetation samples. Iodine-131 was not detected in any 1999 milk samples. Although cesium-137 has been detected in the past, it was not detected in 1999 milk samples. Strontium-90 was detected at levels comparable to 1998, and lower than preoperational years. Both strontium-90 and cesium-137 are attributable to atmospheric nuclear weapons testing in the past. Naturally occurring potassium-40 was detected at normal environmental levels.

- Fish samples during 1999 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 1999, as in previous years, operation of the North Anna Nuclear Power Station created no adverse environmental affects or health hazards. The maximum total body dose calculated for a hypothetical individual at the North Anna Power Station site boundary due to liquid and gaseous effluents released from the site during 1999 would be approximately 0.58 millirem. For reference, this dose may be compared to the 360 millirem average annual exposure to every person in the United States from natural and man-made sources. Natural sources in the environment provide approximately 82% of radiation exposure to man while Nuclear Power contributes 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 1999 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, 1999 through December 31, 1999 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 a pressurized water reactor (PWR) nuclear steam supply system and turbine generator furnished by Westinghouse Electric Corporation. Each unit is designed with a gross electrical output of 979 megawatts electric (MWe). Unit 1 achieved commercial operation on June 6, 1978, and Unit 2 on December 14, 1980. An independent spent fuel storage facility was licensed for dry cask storage of spent fuel in 1998.

B. The United States Nuclear Regulatory Commission (USNRC) regulations require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as is reasonably achievable (ALARA). To ensure these criteria are met, the operating license for North Anna Power Station includes Technical Specifications which address the release of radioactive effluents. Inplant monitoring is used to ensure release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in North Anna Power Station Offsite Dose Calculation Manual (ODCM).

C. 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 1999 and satisfies the following objectives of the program:

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

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

3. Identifies radioactivity changes in the environment.

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

II. SAMPLING AND ANALYSIS PROGRAM

II. SAMPLING AND ANALYSIS PROGRAM

A. *Sampling Program*

1. Table 1 summarizes the sampling program for North Anna Power Station during 1999. 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".

* Routine splitting of samples with the Commonwealth of Virginia has been discontinued. Samples are only split if requested by the Commonwealth of Virginia.

TABLE 1

(Page 1 of 5)

North Anna Power Station - 1999

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	0.24	NNE	32°	Quarterly	
	Good Hope Church	NNE-4/36	4.96	NNE	25°	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	42°	Quarterly	
	Lake Anna Marina	NE-6/38	1.46	NE	34°	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	74°	Quarterly	
	Route 689	ENE-8/40	2.43	ENE	65°	Quarterly	
	Near Training Facility	E-9/41	0.30	E	91°	Quarterly	

North Anna Power Station - 1999

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	
	NAPS Access Rd.	S-17/49	0.47	S	173°	Quarterly	
	Elk Creek Church	S-18/50	1.55	S	178°	Quarterly	
	NAPS Access Rd.	SSW-19/51	0.42	SSW	197°	Quarterly	
	Route 618	SSW-20/52	5.30	SSW	205°	Quarterly	
	500kv Tower	SW-21/53	0.6	SW	218°	Quarterly	
	Route 700	SW-22/54	4.36	SW	232°	Quarterly	
	NAPS Radio Tower	WSW-23/55	0.38	WSW	237°	Quarterly	
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242°	Quarterly	
	South Gate Switchyard	W-25/57	0.32	W	279°	Quarterly	
	Route 685	W-26/58	1.55	W	274°	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301°	Quarterly	
	Route 685	WNW-28/60	1.40	WNW	303°	Quarterly	
	North Gate Construction Side Laydown Area	NW-29/61	0.45	NW	321°	Quarterly	
	Lake Anna Campground	NW-30/62	2.54	NW	319°	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349°	Quarterly	
	Route 208	NNW-32/64	3.43	NNW	344°	Quarterly	
	Bumpass Post Office	C-1/2	7.30	SSE	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 - 1999

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) (Route 669 Bridge)	09A	12.90	WNW	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

North Anna Power Station - 1999

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°	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	1.37	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

North Anna Power Station - 1999

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	Control
	End of Route 685	21	1.00	WNW	301°	Monthly if available or at harvest	
	Aspen Hills	23	0.93	SSE	158°	Monthly if available or at harvest	

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

Map Designation		Environmental 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	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.

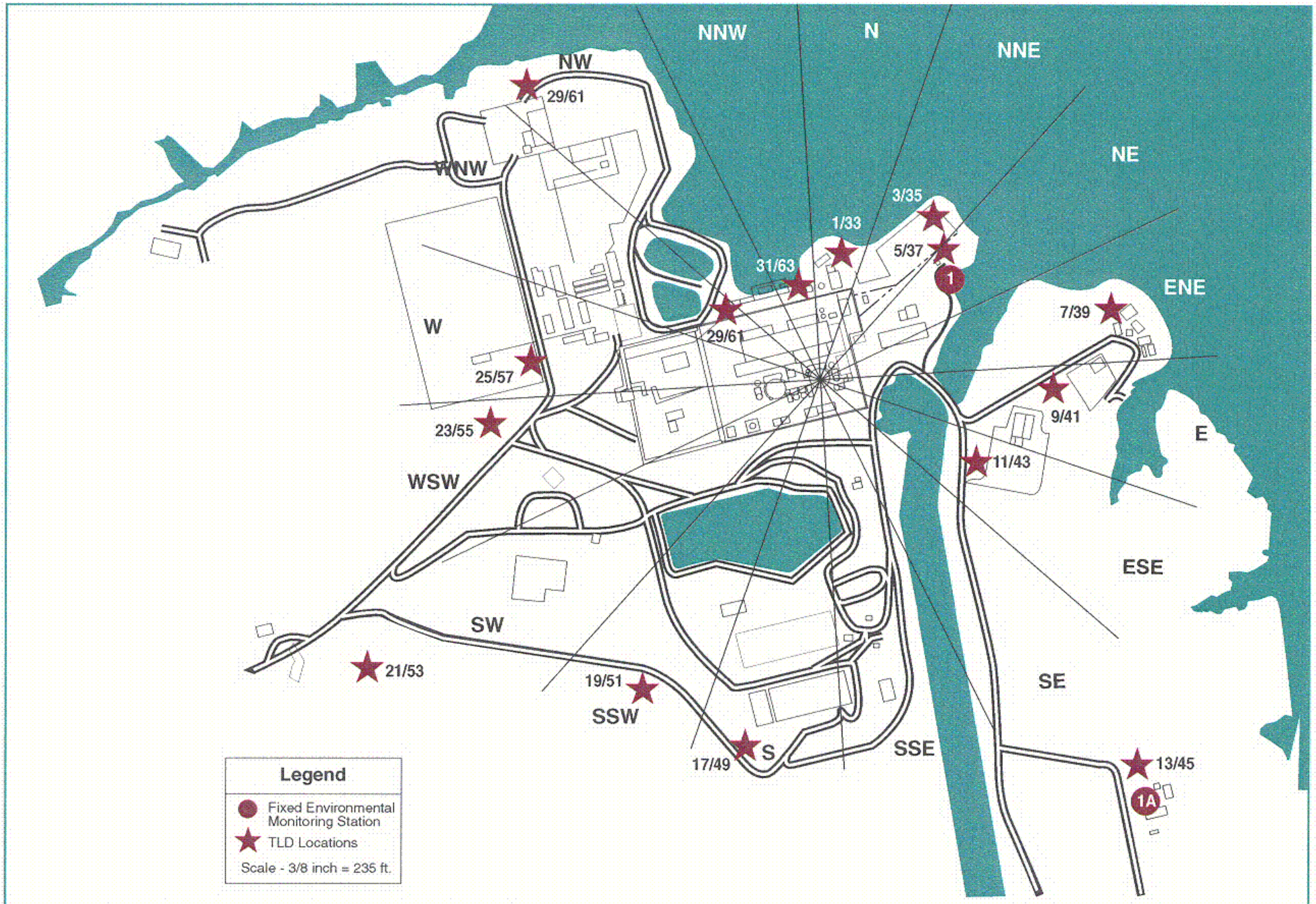

Figure 1. North Anna Site Radiological Monitoring Locations

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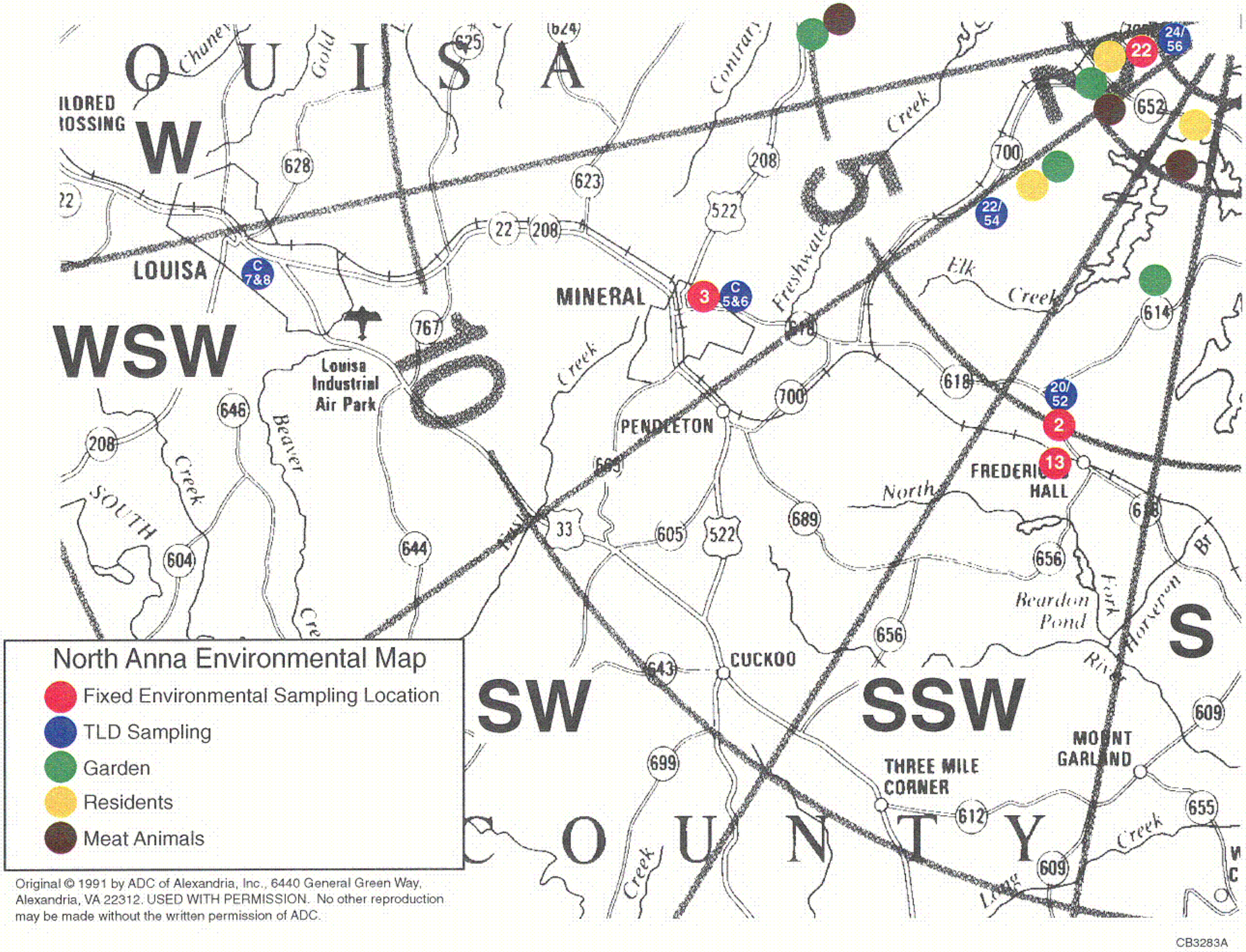
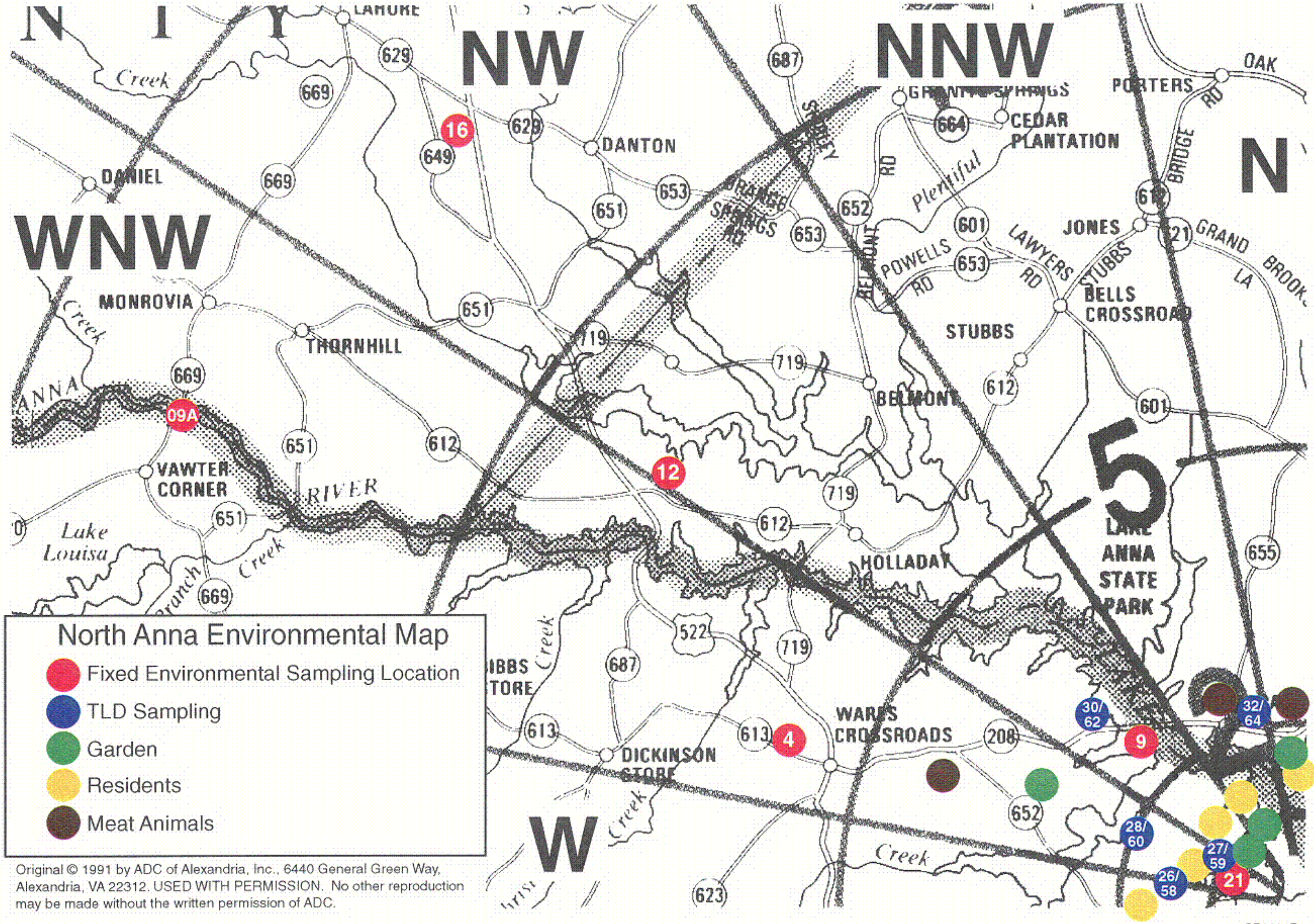

North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
LOUISA
MINERAL
PENDLETON
CUCKOO
FREDERICKS HALL
THREE MILE CORNER
MOUNT GARLAND
Louisa Industrial Air Park
W
WSW
SW
SSW
S
LOUISA
COUNTY
5
10
C 7&8
C 5&6
3
22
24/56
22/54
20/52
2
13
Elk Creek
North
Beaver
Freshwater
Contrary
Reardon Pond
SOUTH
CB3283A

C2


North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
NW
NNW
N
WNW
W
5
DANTON
DANIEL
MONROVIA
THORNHILL
VAWTER CORNER
Lake Louisa
RIVER
PORTERS
OAK
CEDAR PLANTATION
JONES
BELLS CROSSROAD
STUBBS
BELMONT
HOLLADAY
LAKE ANNA STATE PARK
WARES CROSSROADS
DICKINSON STORE
Creek
16
09A
12
4
9
21
30/62
32/64
28/60
27/59
26/58

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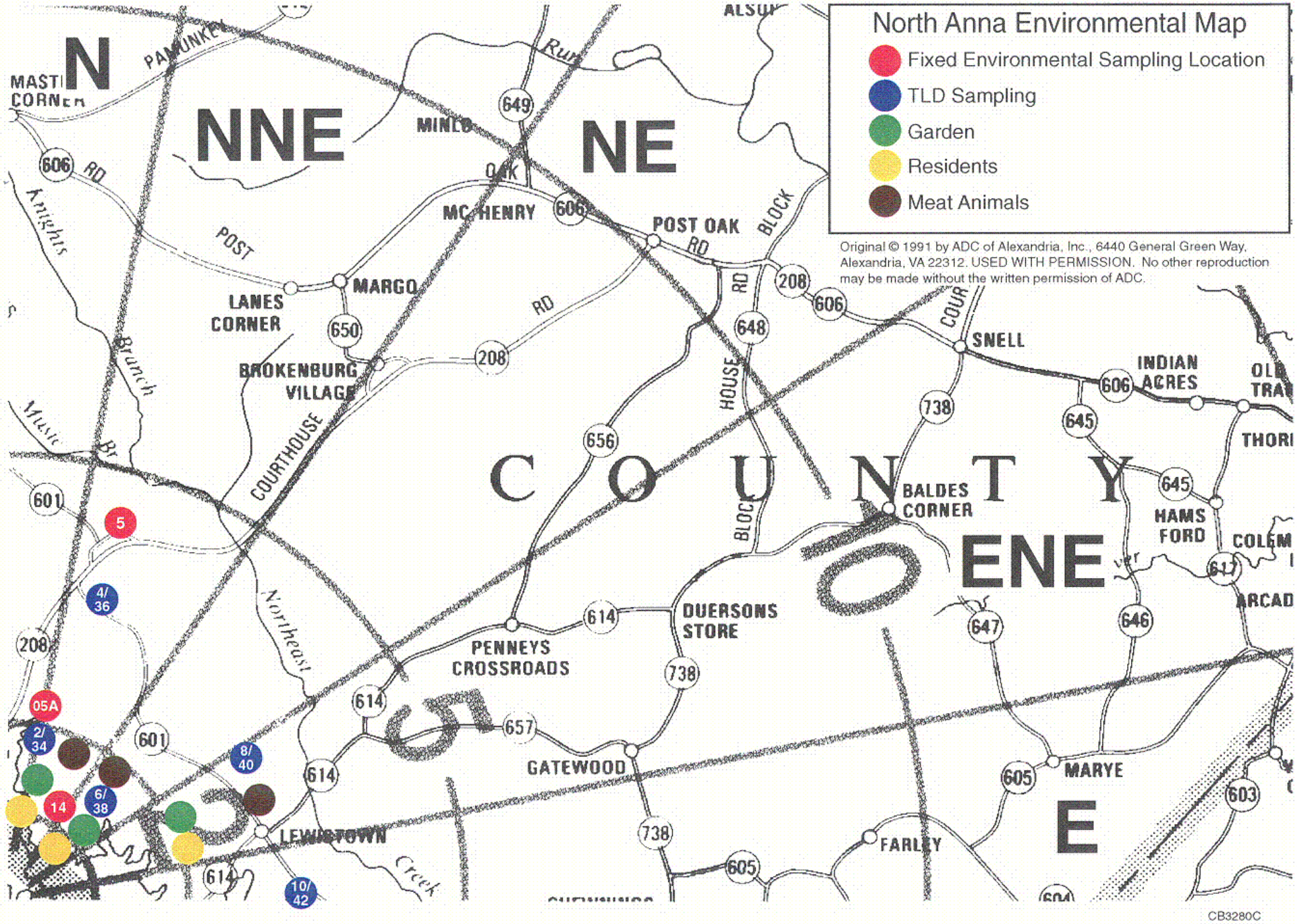
C-3


North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
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ENE
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C O U N T Y
MC HENRY
POST OAK
MARGO
LANES CORNER
BROKENBURG VILLAGE
SNELL
INDIAN ACRES
BALDES CORNER
HAMS FORD
PENNEYS CROSSROADS
DUERSONS STORE
GATEWOOD
MARYE
LEWISTOWN
5
05A
14
4/36
2/34
6/38
8/40
10/42
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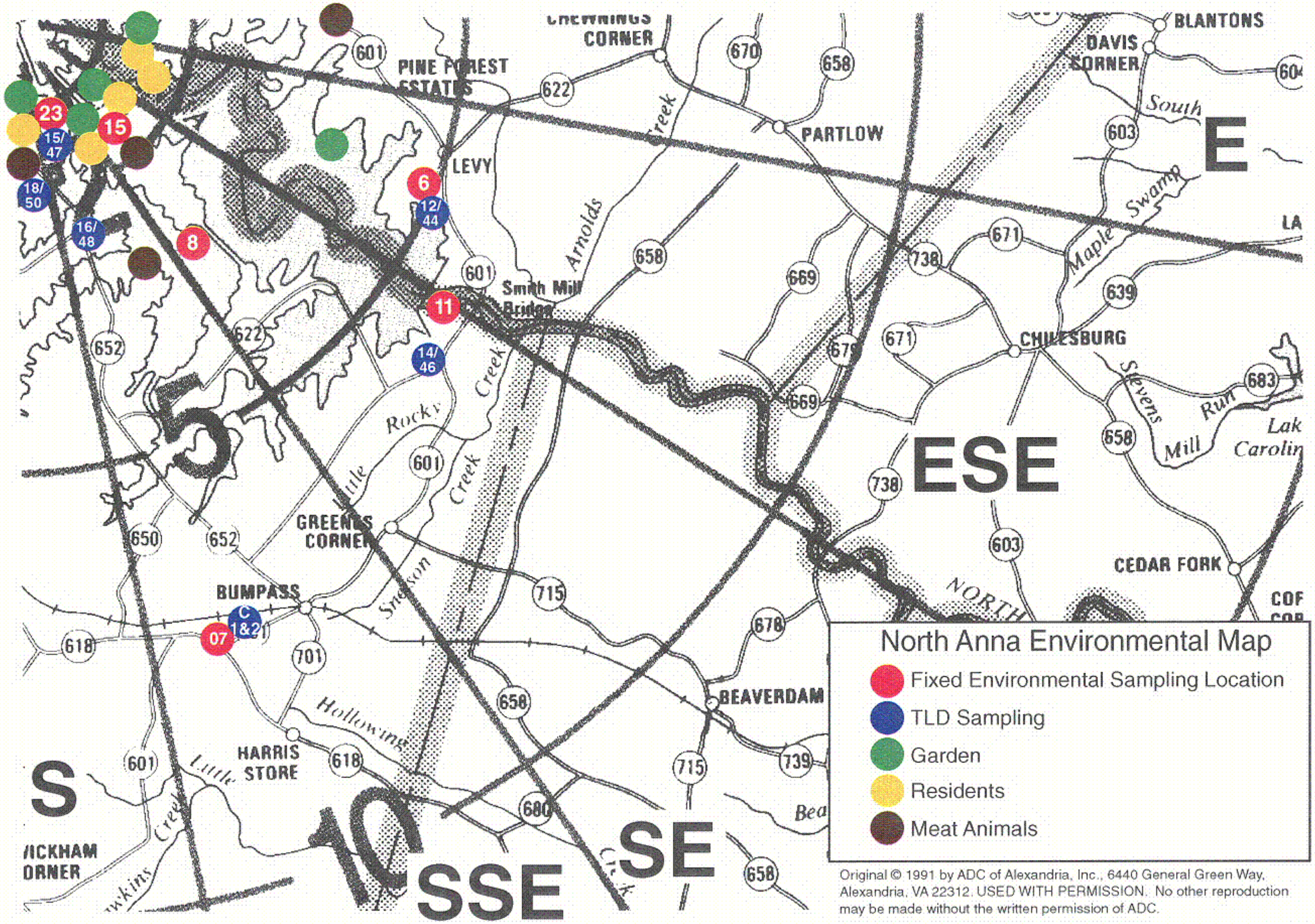
North Anna Environmental Map
Fixed Environmental Sampling Location
TLD Sampling
Garden
Residents
Meat Animals
CORNER
PINE FOREST ESTATES
PARTLOW
BLANTONS
DAVIS CORNER
LEVY
Smith Mill Bridge
CHILESBURG
CEDAR FORK
BEAVERDAM
BUMPASS
GREENS CORNER
HARRIS STORE
E
ESE
SE
SSE
S
5
10
601
622
670
658
603
671
738
639
669
679
683
652
650
618
701
715
678
739
680
23
15
15/47
18/50
16/48
8
6
12/44
11
14/46
07
C 1&2

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B. Analysis Program

1. Table 2 summarizes the analysis program conducted by Teledyne Brown Engineering for North Anna Power Station during 1999.

TABLE 2

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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

(Page 2 of 3)

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	Quarterly (a)	Gamma Isotopic		pCi/l
(Well Water)	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	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
Sediment		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	(c)	pCi/kg (dry)
		Sr-90	(c)	
Precipitation	Monthly	Gross Beta		pCi/l
	Semi-Annual	Gamma Isotopic		pCi/l
	Composite			

* 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
(Page 3 of 3)

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)

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 1999 - North Anna

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
All stations	Air Iodine/ Air Particulates	04/01-04/08	Samples were collected but lost by carrier. Not received at the lab.
Sta-03	Air Iodine	07/21-07/28	Positive result detected and confirmed by three gamma scans on different detectors. Result was slightly above lab detection limit. Result for this station for Air Particulates was in normal limits.
Sta-01A	Precipitation	01/27-02/24	Sample was collected but lost by carrier. Not received at the lab. Insufficient volume for back-up.

IV. SUMMARY AND DISCUSSION OF 1999 ANALYTICAL RESULTS

IV. Summary and Discussion of 1999 Analytical Results

Data from the radiological analyses of environmental media collected during 1999 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 Acceptable Program (November 1979, Revision 1) and the ODCM.

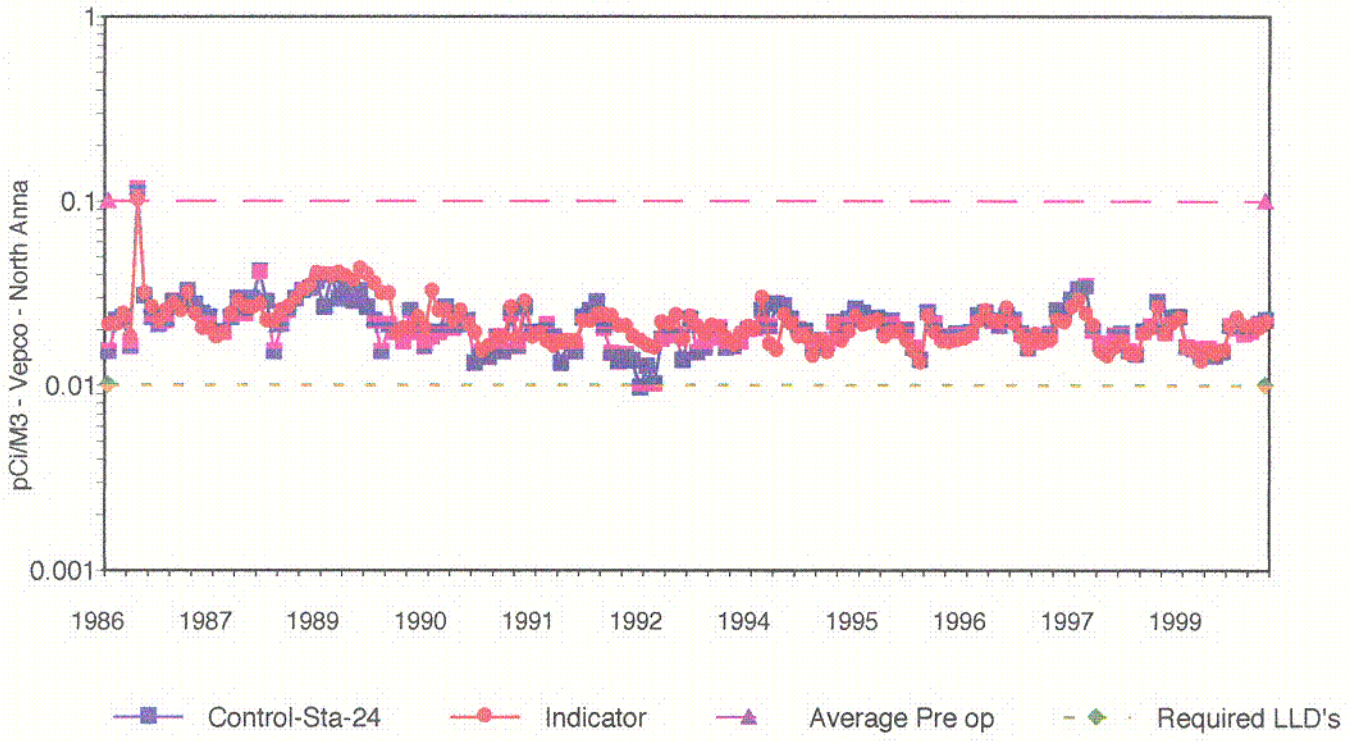
The following is a discussion and summary of the results of the environmental measurements taken during the 1999 reporting period.

A. Airborne Exposure Pathway

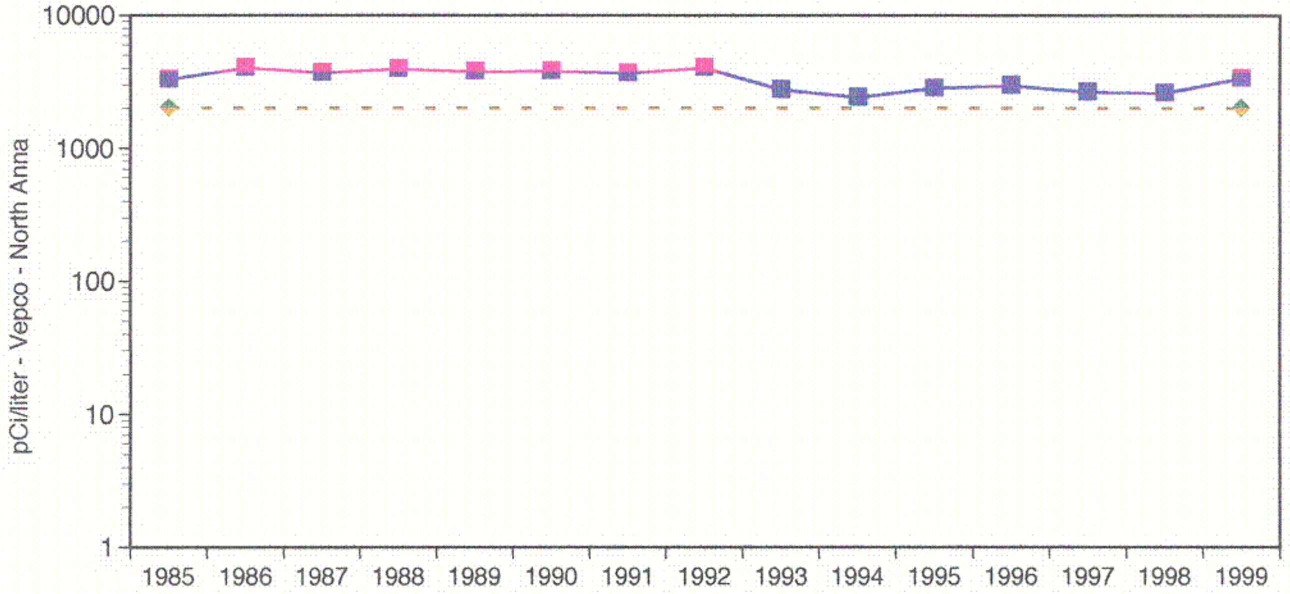
1. Air Iodine/Particulates

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 except for one measurement from Station 03 at 0.03 pCi/m^3. For air particulates, gross beta activity was observed in all 51 control samples with an average concentration of 0.018 pCi/m^3 and a range of 0.011 to 0.034 pCi/m^3. The average measurement for the indicator locations was 0.018 pCi/m^3 with a range of 0.010 to 0.036 pCi/m^3. The results of the gross beta activities are presented in Table B-2. The gross beta activities for 1999 were comparable to levels

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.

Tritium   Required LLD's

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measured in the 1982-1998 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing performed in other countries. During the preoperational period of July 1, 1974 through March 31, 1978 gross beta activities ranged from a low of 0.005 pCi/m^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 0.084 pCi/m^3 with a range of 0.072 to 0.102 pCi/m^3. The indicator locations had an average concentration of 0.080 pCi/m^3 and a range of 0.055 to 0.119 pCi/m^3. During the preoperational period, beryllium-7 was measured at comparable levels, as would be expected. Naturally occurring potassium-40 was not detected in any control samples. Potassium-40 was detected in nine indicator samples with an average concentration of 0.004 pCi/m^3 and a range of 0.003 to 0.007 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 rainwater was collected monthly at station 01A, on site, 0.75 miles, 138 degrees SE and analyzed for gross beta activity. The February sample was not received at the lab. The results are presented in Table B-4. The average gross beta activity for 1999 in the 11 samples was 3.0 pCi/liter with a range from 1.4 to 6.5 pCi/liter. Semi-annual composites were prepared and analyzed for gamma emitting isotopes and tritium. Beryllium-7 was not detected during the semi-annual composite sample for the first half of 1999. All other gamma emitters were below their detection limits. Tritium was not detected in the semi-annual composite samples. These results were comparable to or lower than those measured in 1986 through 1998. During the preoperational period gross beta activity in rain water was expressed in pCi per square meter of the collector surface, 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. They were collected and analyzed in 1998, therefore will not be collected during 1999.

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 1999. 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 also not measured above the detection level. 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 1999 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 3350 pCi/liter and a range of 3000 to 3800 pCi/liter. This is higher than the average level measured in 1998 of 2433 pCi/liter and a range of 1900 to 3000 pCi/liter. No river water samples were collected during the preoperational period.

3. Surface Water

Samples of surface water were collected monthly from two stations. Station 08 is at the discharge lagoon, 1.1 miles, 148 degrees SSE on Lake Anna. Station 09A is located 12.9 miles WNW. The samples were analyzed for iodine-131 by radiochemical separation. No iodine was detected in the 24 samples analyzed. The results are presented in Table B-8. The samples were also analyzed by gamma ray spectrometry. 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 3975 pCi/liter with a range of 3300 to 4900 pCi/liter. Tritium was not detected at station 09A. The tritium level had been increasing since the middle of 1978 when the average level was below 300 pCi/liter. However, during 1999 the results were within the same range as those measured in 1986 through 1998. During the preoperational period tritium was measured in several samples with concentrations between 90 and 250 pCi/liter..

C. *Aquatic Exposure Pathway*

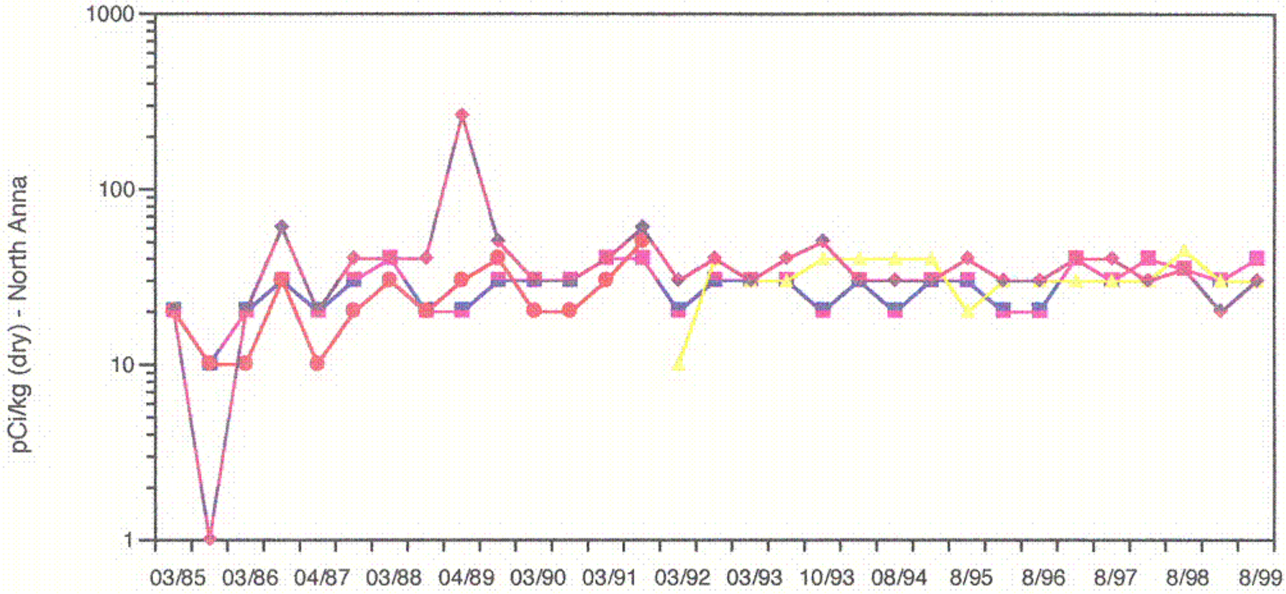
1. Sediment/Silt

Sediment samples were collected during February and August from each of three locations and were analyzed by gamma spectrometry. The results are presented in Table B-10. One man-made and a number of naturally occurring radioisotopes were detected in these samples. Cesium-137 was detected in one sample with an activity of 142 pCi/kg (dry weight). The reading for cesium-137 was obtained from station 09A located 2.20 miles NW.

Naturally occurring potassium-40 was observed in all six samples with an average activity of 14750 pCi/kg (dry weight) and a range from 10700 to 20800 pCi/kg (dry weight). Radium-226 was measured in five of the six samples with an average concentration of 1940 pCi/kg (dry weight) and a range of 1530 to 2410 pCi/kg (dry weight). Also naturally occurring, thorium-228 was observed in all six samples with an average concentration of 1225 pCi/kg (dry weight) and a range of 593 to 1890 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.

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.

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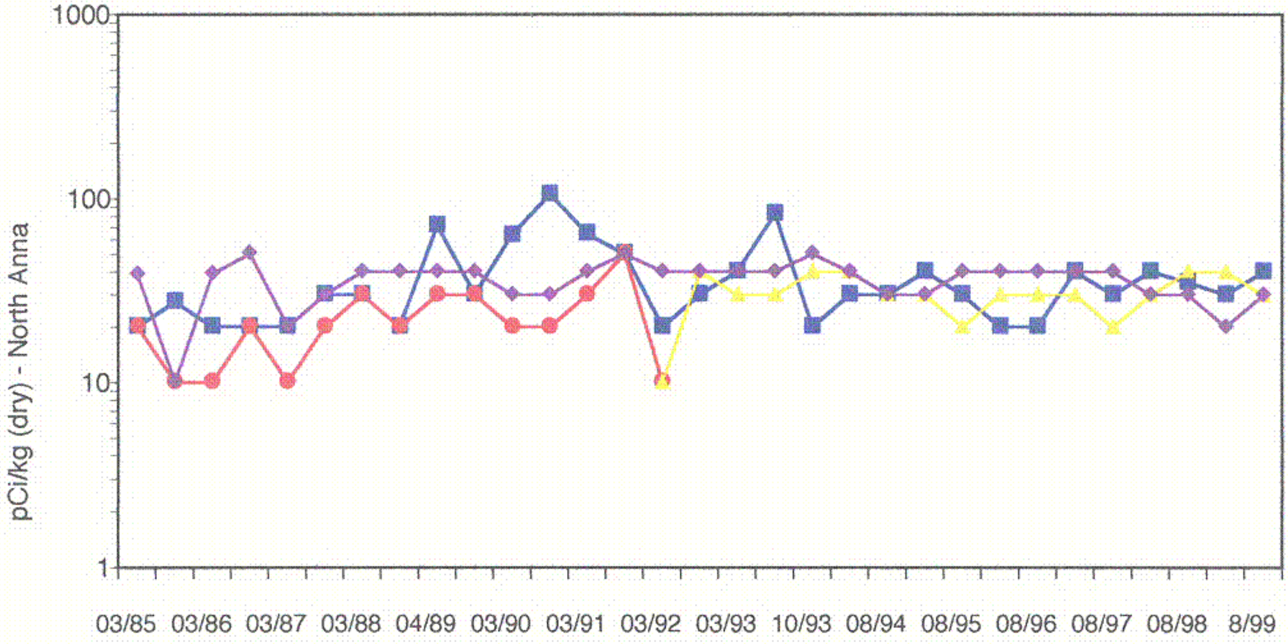
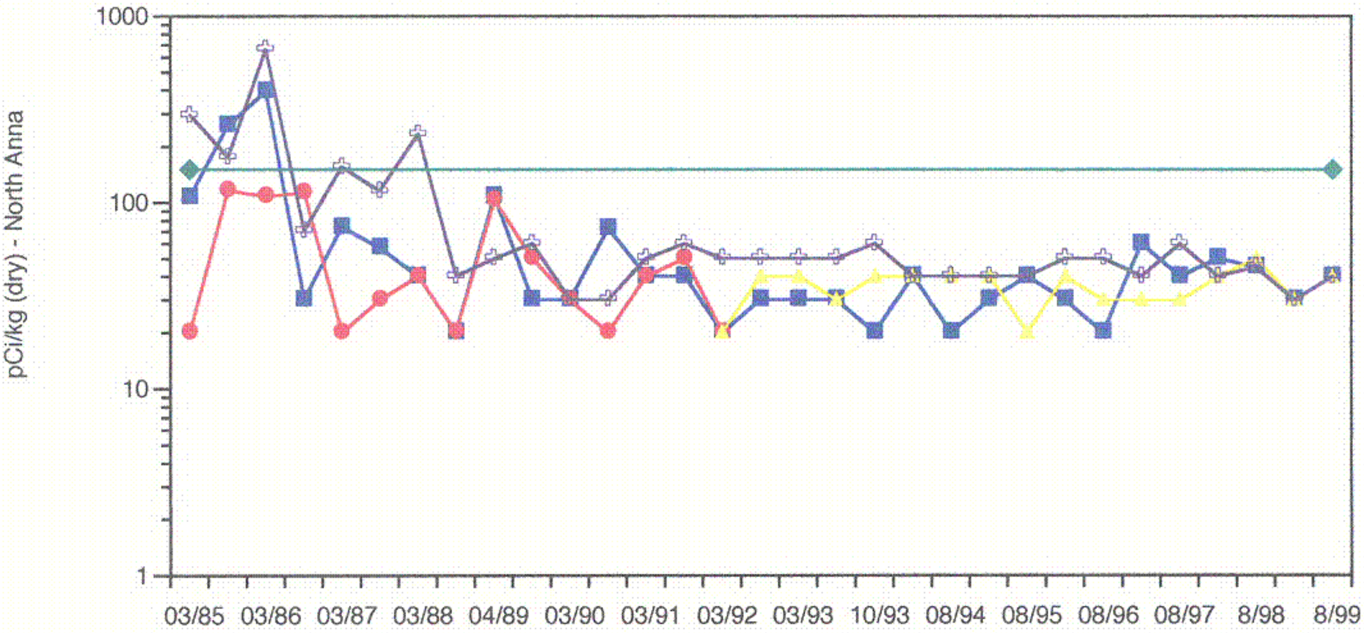
TRENDING GRAPH - 5: COBALT-60 IN SEDIMENT SILT



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

Station-8 Station-09 Control-Sta-09A Station-11

TRENDING GRAPH - 6: CESIUM-134 IN SEDIMENT SILT



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

Station-8 Station-09 Control-Sta-09A Station-11 Required LLD's

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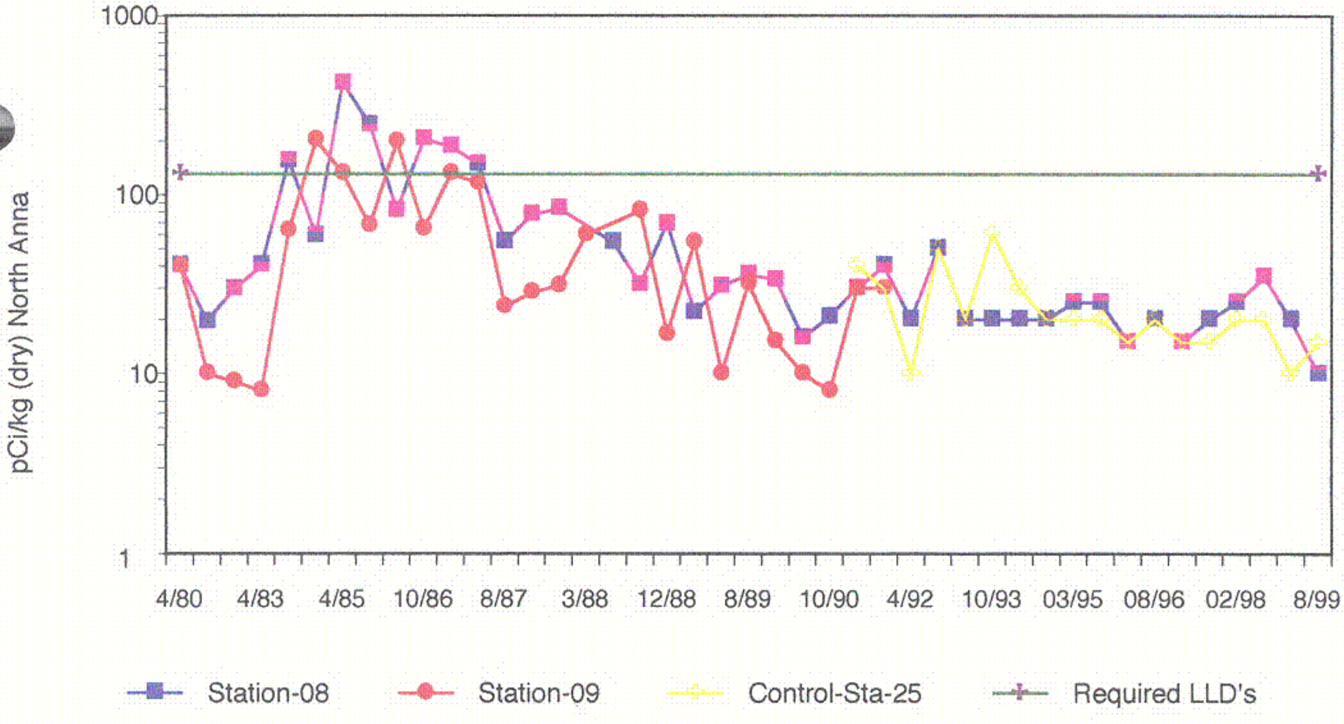
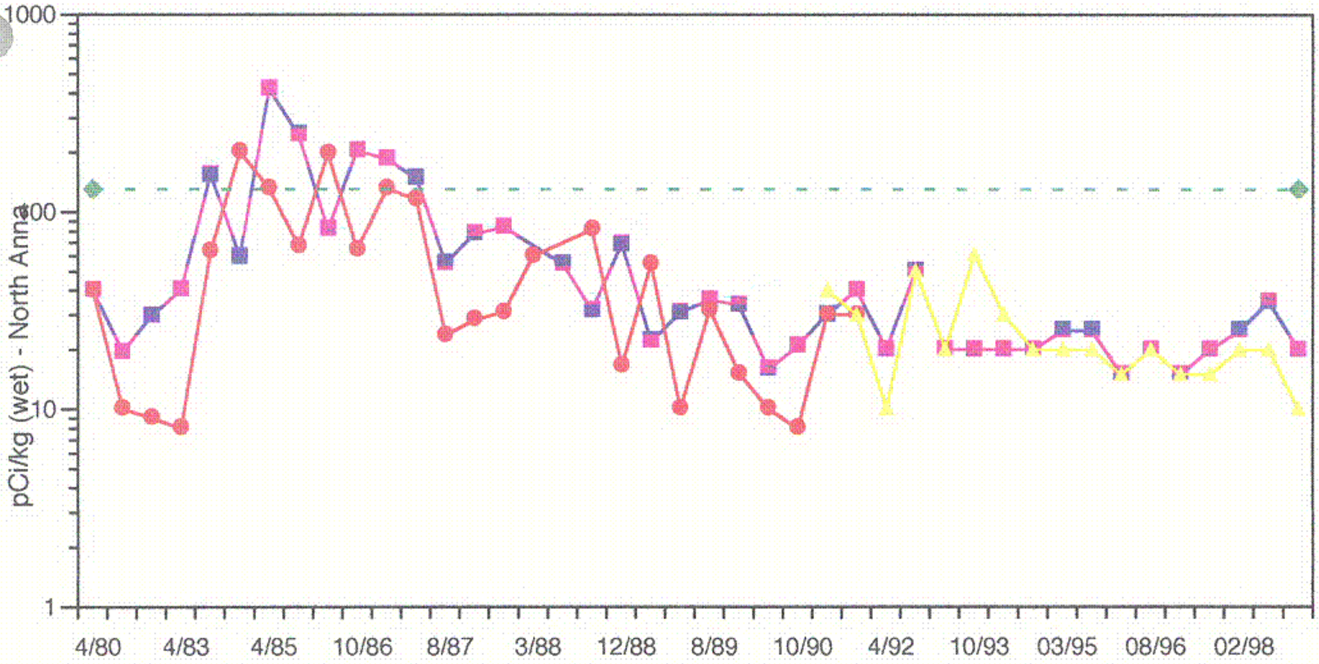
TRENDING GRAPH - 7: CESIUM-137 IN SEDIMENT SILT



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.

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

2. Shoreline Soil

A sample of shoreline sediment was collected in February and August from station 08. The samples were analyzed by gamma ray spectrometry. The results are presented in Table B-11. The naturally occurring nuclide potassium-40 was detected in both samples with an average activity of 1583 pCi/kg (dry weight) and a range of 895to 2270 pCi/kg (dry weight). Cosmogenic beryllium-7 was not detected during 1999. Thorium-228 was detected in both samples at an average of 341 pCi/kg (dry weight) and a range of 289 to 392 pCi/kg (dry weight). Radium-226 was detected in one sample with a concentration of 692 pCi/kg (dry weight). Cesium-137, a fission product, was not detected during 1999.

The August sample was analyzed for strontium. There was no detection of strontium-89 in shoreline soil. Strontium-90 was measured in the one sample with a concentration of 2300 pCi/kg (dry weight).

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 1999. 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 1291 pCi/liter and a range of 1100 to 1470 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 1999. 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 all eight samples monitored with an average level of 1.28 pCi/liter and a range of 0.96 to 2.4 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 during 1999. These samples were analyzed by gamma ray spectroscopy and the naturally occurring isotope potassium-40 was found in all samples at an average of 1289 pCi/kg (wet weight) with a range of 1000 to 1800 pCi/kg (wet weight). The fission product cesium-137 was measured in four samples an average activity of 37.8 pCi/kg (wet weight) and a range of 30.0 to 48.7 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.

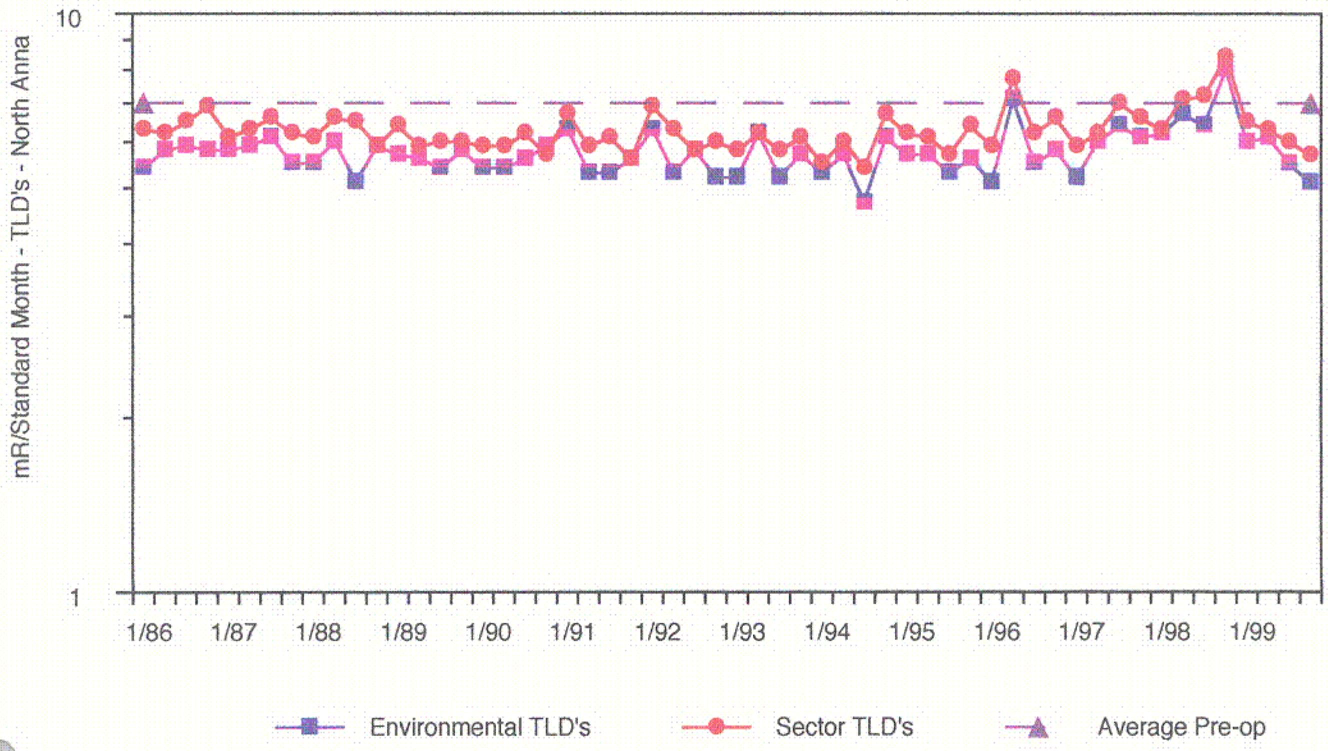
3. Food/Vegetation

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 samples with an average activity level of 21833pCi/kg (wet weight) and a range of 8270 to 36500 pCi/kg (wet weight). Cosmogenic beryllium-7 was detected in all samples with an average concentration of 2952 pCi/kg (wet weight) and a range of 447 to 9910 pCi/kg (wet weight). The terrestrial nuclide thorium-228 was detected in thirteen samples with an average activity of 170 pCi/kg (wet weight) and a range of 20.7 to 710 pCi/kg (wet weight).

Cesium-134, a fission product, was not detected at levels above LLD during 1999. Cesium-137 was detected in five samples at an average activity of 40.1 pCi/kg (wet weight) and a range of 22.4 to 57.6 pCi/kg (wet weight). Cesium-137 has been detected in some samples at low-levels in previous years. Cesium-137 was measured in broadleaf

TRENDING GRAPH - 9: CESIUM-137 IN FISH

TRENDING GRAPH - 10: ENVIRONMENTAL RADIATON - TLD's



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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 5.7 mR/standard month with a range of 3.6 to 8.2 mR/standard month. This is comparable to the preoperational range. The control station, No. 24, had an average reading of 5.4 mR/standard month with a range of 4.6 to 6.1 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 6.2 mR/standard month with a range of 3.6 to 9.5 mR/standard month. The eight control TLDs, collected quarterly from four locations, showed an average reading of 5.2 mR/standard month with a range of 3.4 to 7.1 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 1999 Radiological Environmental Monitoring Program for the North Anna Nuclear Power Station and ISFSI have been presented. The following sections discuss each pathway individually followed by a program summary.

Airborne Exposure Pathway

Air particulate gross beta concentrations of all the indicator locations for 1999 followed the gross beta concentrations at the control location. The gross beta concentrations were comparable to levels observed since 1982 except for a five week period in 1987 which was influenced by the Chernobyl accident. Gross beta concentrations in the preoperational period were highly variable, ranging from 0.0043 to 0.75 pCi/CuM, due to occasional atmospheric nuclear weapons tests. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). There were no detections above the LLD for fission products nor other man-made isotopes in the particulate media during 1999. Iodine-131 was not detected in the charcoal filters during 1999 except for one measurement at Station 03, 7.1 miles, 243 WSW during the last week of July with a marginally positive result of 0.026 pCi/CuM.

A precipitation sample was collected monthly during 1999 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 1999. 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 1999 at the waste heat treatment facility was 3975 pCi/liter, which is 13.2% of the reporting level for a water sample. In 1998 the tritium level was 2675 pCi/liter. The preoperational level was 150 pCi/liter and has risen since 1977, though it has remained relatively consistent since 1986.

The Commonwealth of Virginia discontinued the state sampling program in the third quarter of 1998.

River water collected from the North Anna River, 5.8 miles downstream of the site had an average tritium level of 3350 pCi/liter. The average tritium in 1998 had been 2600 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 1999.

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 one sample at the control location. 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 also not detected during 1999. Cesium-137 was measured during 1998 at an average of 276 pCi/kg.

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 1999. 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 1999 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 1998. 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 1999 of cesium-137 was 1.9% of the reporting level.

One vegetation sample for the control station contained cesium-137 at a level of 50.5 pCi/kg. There were also four samples for the indicator stations that measured cesium-137 at an average level of 37.6 pCi/kg. Cesium-137 has been measured in the past and in preoperational samples.

Direct Exposure Pathway

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

Program Conclusions

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

As a method of referencing the measured radionuclide concentrations in sample media to the dose consequence, the data may be compared to the Reporting Level Concentrations listed in the Offsite Dose Calculation Manual. These concentrations are based upon 25% of the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion "As Low as is Reasonably Achievable." Based upon the evidence of the environmental monitoring program the station is operating within regulatory limits. Thus, no unusual radiological characteristics were observed in the environs of the North Anna Nuclear Power Station during 1999.

VI. REFERENCES

VI. References

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

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

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

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

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

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

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

APPENDIX A
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
ANNUAL SUMMARY TABLES - 1999

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD*	All Indicator Locations Mean Range	Location with Highest Mean Name	Distance Direction	Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Air Iodine (pCi/m^3)	I-131	612	0.04	0.026(1/561) -	03	7.1 mi WSW	0.026(1/51) --	(0/51) -	1
Airborne Particulates (1E-03 pCi/m^3)	Gross Beta	612	5	18.0(561/561) (9.8-36)	22	1.0 mi. WSW	19.1(51/51) (11-32)	17.8(51/51) (11-34)	0
	Gamma	48							
	Be-7	48	10	79.9(44/44) (54.9-119)	05	4.2 mi. NNE	86.2(4/4) (62.8-117)	84.2(4/4) (71.7-102)	0
	K-40	48	10	4.99(9/44) (3.4-7.4)	03	7.1 mi. WSW	6.63(2/4) (5.85-7.4)	(0/4) -	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	(0/4) -	N/A		N/A -	(0/0) -	0
	Sr-89	1	3	(0/1) -	N/A		N/A	(0/0) -	0
	Sr-90	1	0.4	(0/1) -	N/A		N/A	(0/0) -	0

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

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	3350(4/4) (3000-3800)	11	5.8 mi. SE	3350(4/4) (3000-3800)	(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	11	4	2.99(11/11) (1.4-6.5)	01A	0.75 mi. SE	2.99(11/11) (1.4-6.5)	(0/0) -	0
	Gamma (Semi-Annually)	2			N/A		N/A		0
	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	3975(4/4) (3300-4900)	08	1.10 mi SSE	3975(4/4) (3300-4900)	-(0/4) -	0

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

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
Sediment Silt (pCi/kg (dry))	Gamma	6							
	Be-7	6		(0/4) -	NA			(0/2) -	0
	K-40	6	200	16225(4/4) (13200-20800)	08	1.1 mi SSE	18650(2/2) (16500-20800)	11800(2/2) (10700-12900)	0
	Cs-137	6	194	(0/4) -	09A	12.9 mi. WNW	142(1/2) -	142(1/2) -	0
	Ra-226	6	100	1963(4/4) (1530-2410)	08	1.1 mi. SSE	1970(2/2) (1530-2410)	1850(1/2) -	0
	Th-228	6	30	1429(4/4) (966-1890)	08	1.1 mi. SSE	1810(2/2) (1730-1890)	817(2/2) (593-1040)	0
	Sr-89 (Annually)	3	4.0	(0/2) -	N/A		N/A	(0/1) -	0
	Sr-90 (Annually)	3	0.8	5200(2/2) (4600-5800)	11	5.8 mi. SSE	5800(1/2) -	4800(1/1) -	0

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

Medium or Pathway Sampled (Unit)	Analysis		LLD*	All Indicator Locations	Location with Highest Mean			Control Location	Non-routine Reported Measurements
	Type	Total No.		Mean Range	Name	Distance Direction	Mean Range	Mean Range	
Shoreline Soil (pCi/kg (dry))	Gamma	2							
	Be-7	2		(0/2) -	N/A		N/A	(0/0) -	0
	K-40	2	200	1583(2/2) (895-2270)	8	1.1 mi. SSE	1583(2/2) (895-2270)	(0/0) -	0
	Cs-137	2	40	(0/2)	N/A		N/A	(0/0)	0
	Ra-226	2	100	692(1/2) -	8	1.1 mi. SSE	692(1/2) -	(0/0) -	0
	Th-228	2	30	341(2/2) (289-392)SSE	8	1.1 mi.	341(2/2) (289-392)	(0/0) -	0
	Sr-89 (Annually)	1	4.0	(0/1) -	N/A		N/A	(0/0) -	0
	Sr-90 (Annually)	1	0.8	2300(1/1) -	N/A		2300(1/1) -	(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	1291(24/24) (1110-1470)	12	8.3 mi. NW	1332(12/12) (1160-1470)	(0/0) -	0
	Sr-89 (Quarterly)	8	5	N/A			N/A		0
	Sr-90 (Quarterly)	8	0.8	1.28(8/8) (0.96-2.4)	12	8.3 mi. NW	1.45(4/4) (0.99-2.4)	(0/0) -	0

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

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1999

Docket No. 50-338/339

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD*	All Indicator Locations Mean Range	Location with Highest Mean Name	Distance Direction	Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Fish pCi/kg (wet)	Gamma	8							
	K-40	8	200	1303(4/4) (1020-1800)	08	1.1 mi. SSE	1303(4/4) (1020-1800)	1275(4/4) (1000-1560)	0
	Cs-137	8	40	37.8(4/4) (30.0-48.7)	08	1.1 mi. SSE	37.8(4/4) (30.0-48.7)	(0/4) -	0
Food Vegetation (pCi/kg (wet))	Gamma Dose	35							
	Be-7	35	-	3089(28/28) (447-9910)	21	1.0 mi. WNW	3923(7/7) (828-9910)	2406(7/7) (761-5960)	0
	K-40	35	-	21153(28/28) (8270-36500)	16	12.6 mi. NW	24557(6/6) (18600-30900)	24557(7/7) (18600-30900)	0
	Cs-137	35	80	37.6(4/28) (22.4-57.6)	16	12.6 mi. NW	50.5(1/6) -	50.5(1/7) -	0
	Ra-226	35	-	506(8/28) (225--965)	14	1.2 mi. NE	203(2/6) (129-276)	416(1/7) -	0
	Th-228	35	-	180(12/28) (20.7-710)	14	1.2 mi. NE	203(2/6) (129-276)	58.4(1/7) -	0

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

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	5.69(44/44) (3.6-8.2)	01	0.2 mi. NE	7.63(4/4) (6.7-8.2)	5.38(4/4) (4.6-6.1)	0
Direct Radiation (mR/std. Month) (Annual TLDs)	Gamma Dose	12	0.2	6.66(11/11) (4.5-12.7)	23	0.93 mi. SSE	9.1(1/1) -	6.3(1/1) -	0
Direct Radiation (mR/std. Month) (Sector TLDs)	Gamma Dose	288	0.2	6.23(256/256) (3.6-9.5)	17/49	0.47 mi. S	9.08(8/8) (8.7-9.4)	5.19(32/32) (3.4-7.1)	0

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

APPENDIX B
DATA TABLES

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

North Anna Power Station, Louisa County, Virginia - 1999

pCi/m^3 ± 2 Sigma

Collection Date	01	02	03	04	05	05A	06	07	21	22	23	24
JANUARY												
12/30-01/07	< .007	< .007	< .007	< .007	< .006	< .007	< .009(a)	< .007	< .007	< .005	< .01	< .01
01/07-01/13	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .01	< .01
01/13-01/20	< .008	< .007	< .007	< .007	< .006	< .01	< .01	< .01	< .01	< .009	< .02	< .02
01/20-01/27	< .006	< .007	< .006	< .007	< .005	< .01	< .01	< .01	< .01	< .007	< .005	< .008
01/27-02/03	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .006	< .01	< .01
FEBRUARY												
02/03-02/10	< .02	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .009	< .009
02/10-02/17	< .008	< .008	< .008	< .008	< .007	< .008	< .008	< .008	< .008	< .005	< .01	< .01
02/17-02/24	< .008	< .007	< .007	< .007	< .005	< .006	< .006	< .007	< .007	< .005	< .01	< .01
02/24-03/04	< .005	< .005	< .005	< .005	< .004	< .009	< .009	< .009	< .009	< .006	< .007	< .007
MARCH												
03/04-03/11	< .008	< .009	< .009	< .009	< .007	< .007	< .007	< .008	< .008	< .005	< .009	< .01
03/11-03/17	< .008	< .008	< .008	< .008	< .006	< .007	< .007	< .007	< .006	< .005	< .01	< .01
03/17-03/24	< .007	< .007	< .006	< .007	< .006	< .008	< .008	< .008	< .008	< .006	< .007	< .007
03/24-03/31	< .01	< .01	< .01	< .01	< .008	< .009	< .009	< .009	< .009	< .006	< .01	< .009
APRIL												
04/01-04/08 (b)												
04/08-04/14	< .03(c)	< .008	< .008	< .008	< .007	< .01	< .01	< .01	< .01	< .009	< .006	< .01
04/14-04/21	< .008	< .008	< .008	< .008	< .006	< .007	< .007	< .007	< .008	< .005	< .01	< .01
04/21-04/28	< .008	< .008	< .009	< .008	< .007	< .008	< .008	< .008	< .008	< .005	< .007	< .007
MAY												
04/28-05/05	< .008	< .007	< .008	< .008	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01
05/05-05/12	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
05/12-05/19	< .008	< .008	< .009	< .008	< .006	< .01	< .01	< .01	< .01	< .009	< .01	< .01
05/19-05/26	< .008	< .008	< .008	< .008	< .006	< .007	< .007	< .007	< .007	< .005	< .01	< .01
05/26-06/02	< .008	< .008	< .008	< .008	< .006	< .008	< .008	< .008	< .008	< .005	< .01	< .01
JUNE												
06/02-06/09	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .009	< .009
06/09-06/16	< .006	< .006	< .006	< .006	< .005	< .01	< .01	< .01	< .01	< .007	< .01	< .01
06/16-06/23	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .005	< .008
06/23-06/30	< .009	< .009	< .009	< .009	< .007	< .01	< .01	< .01	< .01	< .01	< .006	< .009

(a) Volume lower due to sampler malfunction.
(b) Samples for the week of 04/01-04/08 collected, but lost by carrier.

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

North Anna Power Station, Louisa County, Virginia - 1999

pCi/m^3 ± 2 Sigma

Collection Date	STATIONS 01	02	03	04	05	05A	06	07	21	22	23	24
JULY												
06/30-07/07	< .008	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .009	< .005	< .008
07/07-07/14	< .03	< .03	< .03	< .03	< .008	< .008	< .008	< .008	< .01	< .01	< .01	< .01
07/14-07/21	< .007	< .008	< .007	< .008	< .005	< .007	< .007	< .007	< .007	< .005	< .007	< .008
07/21-07/28	< .02	< .01	.03±.005 (a)	< .01	< .01	< .01	< .01	< .01	< .01	< .008	< .01	< .01
AUGUST												
07/28-08/04	< .007	< .008	< .008	< .008	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
08/04-08/11	< .009	< .009	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .009	< .007	< .007
08/11-08/18	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
08/18-08/25	< .008	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .008	< .01	< .01
08/25-09/01	< .008	< .008	< .008	< .008	< .006	< .01	< .01	< .01	< .01	< .009	< .007	< .01
SEPTEMBER												
09/01-09/08	< .009	< .009	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .009	< .005	< .008
09/08-09/15	< .009	< .009	< .009	< .009	< .007	< .009	< .009	< .009	< .009	< .006	< .006	< .006
09/15-09/22	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .01	< .01
09/22-09/29	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .01	< .01
OCTOBER												
09/29-10/05	< .01	< .009	< .01	< .009	< .006	< .02	< .02	< .01	< .01	< .009	< .01	< .01
10/05-10/13	< .006	< .007	< .006	< .006	< .004	< .01	< .01	< .01	< .01	< .007	< .01	< .01
10/13-10/20	< .01	< .01	< .01	< .01	< .008	< .008	< .007	< .007	< .007	< .005	< .006	< .009
10/20-10/27	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .008	< .006	< .009
10/27-11/04	< .02	< .01	< .01	< .01	< .007	< .009	< .009	< .009	< .009	< .006	< .005	< .007
NOVEMBER												
11/04-11/09	< .01	< .01	< .01	< .01	< .04 (b)	< .02	< .02	< .02	< .02	< .01	< .01	< .01
11/09-11/17	< .01	< .01	< .01	< .01	< .008	< .007	< .007	< .007	< .007	< .005	< .008	< .007
11/17-11/24	< .01	< .01	< .01	< .01	< .008	< .01	< .01	< .01	< .01	< .007	< .01	< .01
11/24-12/01	< .007	< .007	< .007	< .007	< .005	< .01	< .01	< .01	< .01	< .007	< .01	< .01
DECEMBER												
12/01-12/08	< .008	< .008	< .008	< .008	< .005	< .008	< .009	< .008	< .008	< .006	< .01	< .01
12/08-12/15	< .008	< .008	< .008	< .008	< .006	< .01	< .01	< .01	< .01	< .008	< .01	< .01
12/15-12/22	< .009	< .009	< .009	< .009	< .006	< .01	< .01	< .01	< .01	< .008	< .01	< .01
12/22-12/29	< .01	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .007	< .01	< .01

(a) Result confirmed by 3 counts on different detectors.
(b) Low sample volume due to sampler not running; volume estimated.

TABLE B-2

(Page 1 of 4)

NORTH ANNA - 1999

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													
12/30-01/07	17 ± 2	15 ± 1	17 ± 2	16 ± 1	14 ± 1	16 ± 2	13 ± 2(a)	16 ± 1	16 ± 2	16 ± 1	16 ± 2	16 ± 2	16 ± 2
01/07-01/13	24 ± 2	18 ± 2	20 ± 2	20 ± 2	21 ± 2	22 ± 2	22 ± 2	19 ± 2	20 ± 2	21 ± 2	23 ± 2	22 ± 2	21 ± 3
01/13-01/20	15 ± 2	12 ± 2	12 ± 2	15 ± 2	13 ± 2	13 ± 2	14 ± 2	13 ± 2	13 ± 2	13 ± 2	14 ± 2	13 ± 2	13 ± 2
01/20-01/27	14 ± 2	12 ± 1	13 ± 2	11 ± 1	10 ± 1	11 ± 1	13 ± 2	12 ± 2	13 ± 2	13 ± 2	13 ± 2	12 ± 2	12 ± 2
01/27-02/03	17 ± 2	15 ± 2	17 ± 2	18 ± 2	17 ± 2	17 ± 2	18 ± 2	16 ± 2	18 ± 2	17 ± 2	16 ± 2	17 ± 2	17 ± 2
FEBRUARY													
02/03-02/10	17 ± 4	15 ± 2	14 ± 2	17 ± 2	14 ± 2	15 ± 2	16 ± 2	15 ± 2	15 ± 2	17 ± 2	16 ± 2	17 ± 2	16 ± 2
02/10-02/17	13 ± 1	13 ± 2	14 ± 2	14 ± 2	14 ± 2	15 ± 2	16 ± 2	14 ± 2	15 ± 2	14 ± 2	16 ± 2	15 ± 2	14 ± 2
02/17-02/24	17 ± 2	17 ± 2	15 ± 2	18 ± 2	18 ± 2	17 ± 2	18 ± 2	17 ± 2	15 ± 2	17 ± 2	17 ± 2	15 ± 2	17 ± 2
02/24-03/04	15 ± 1	12 ± 1	13 ± 1	15 ± 1	13 ± 1	12 ± 1	14 ± 1	12 ± 1	13 ± 1	15 ± 1	14 ± 1	15 ± 1	14 ± 2
MARCH													
03/04-03/11	15 ± 2	15 ± 2	15 ± 2	16 ± 2	14 ± 2	14 ± 2	12 ± 2	12 ± 2	12 ± 2	17 ± 2	12 ± 2	14 ± 2	14 ± 3
03/11-03/17	11 ± 2	11 ± 2	9.8 ± 1.5	10 ± 1	9.9 ± 1.5	11 ± 2	11 ± 2	12 ± 2	12 ± 2	11 ± 1	13 ± 2	12 ± 2	11 ± 2
03/17-03/24	14 ± 2	11 ± 1	12 ± 2	14 ± 2	15 ± 2	13 ± 2	14 ± 2	14 ± 2	13 ± 2	15 ± 2	15 ± 2	14 ± 2	14 ± 3
03/24-03/31	15 ± 2	13 ± 1	15 ± 2	15 ± 2	14 ± 2	14 ± 2	15 ± 2	15 ± 2	16 ± 2	15 ± 2	14 ± 2	17 ± 2	15 ± 2
Quarter Avg. ± 2 s.d.	**16 ± 6**	**14 ± 4**	**14 ± 5**	**15 ± 6**	**14 ± 6**	**15 ± 6**	**15 ± 6**	**14 ± 4**	**15 ± 5**	**15 ± 5**	**15 ± 6**	**15 ± 5**	**15 ± 5**

(a) Volume lower due to sampler malfunction.

TABLE B-2

(Page 2 of 4)

NORTH ANNA - 1999

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													
04/01-04/08 (b)													
04/08-04/14	24 ± 5(c)	12 ± 2	13 ± 2	14 ± 2	15 ± 2	17 ± 2	16 ± 2	15 ± 2	15 ± 2	17 ± 2	14 ± 2	15 ± 2	16 ± 6
04/14-04/21	14 ± 2	12 ± 1	11 ± 1	13 ± 1	13 ± 1	11 ± 1	13 ± 1	12 ± 1	13 ± 1	13 ± 1	14 ± 2	14 ± 2	13 ± 2
04/21-04/28	17 ± 2	17 ± 2	14 ± 2	19 ± 2	14 ± 2	17 ± 2	19 ± 2	15 ± 2	16 ± 2	17 ± 2	23 ± 2	18 ± 2	17 ± 5
MAY													
04/28-05/05	10 ± 1	9.8 ± 1.3	9.9 ± 1.4	12 ± 1	11 ± 1	11 ± 1	10 ± 1	10 ± 1	11 ± 1	11 ± 1	11 ± 1	11 ± 1	11 ± 1
05/05-05/12	13 ± 2	13 ± 2	13 ± 2	14 ± 2	15 ± 2	16 ± 2	16 ± 2	14 ± 2	15 ± 2	15 ± 2	16 ± 2	15 ± 2	15 ± 2
05/12-05/19	13 ± 2	11 ± 1	12 ± 2	12 ± 2	12 ± 2	13 ± 2	11 ± 1	10 ± 1	11 ± 1	11 ± 1	13 ± 2	11 ± 1	12 ± 2
05/19-05/26	16 ± 2	12 ± 2	15 ± 2	13 ± 2	15 ± 2	14 ± 2	16 ± 2	15 ± 2	14 ± 2	14 ± 2	14 ± 2	14 ± 2	14 ± 2
05/26-06/02	21 ± 2	20 ± 2	20 ± 2	20 ± 2	19 ± 2	22 ± 2	20 ± 2	23 ± 2	20 ± 2	22 ± 2	19 ± 2	20 ± 2	21 ± 2
JUNE													
06/02-06/09	21 ± 2	17 ± 2	18 ± 2	18 ± 2	17 ± 2	22 ± 2	20 ± 2	20 ± 2	20 ± 2	19 ± 2	19 ± 2	17 ± 2	19 ± 3
06/09-06/16	16 ± 2	12 ± 1	14 ± 2	15 ± 2	14 ± 2	15 ± 2	14 ± 2	14 ± 2	12 ± 1	14 ± 2	14 ± 2	14 ± 2	14 ± 2
06/16-06/23	13 ± 2	11 ± 1	13 ± 2	14 ± 2	12 ± 1	14 ± 2	12 ± 2	13 ± 2	12 ± 2	13 ± 2	13 ± 2	12 ± 2	13 ± 2
06/23-06/30	12 ± 2	15 ± 2	14 ± 2	17 ± 2	14 ± 2	17 ± 2	13 ± 2	15 ± 2	14 ± 2	18 ± 2	16 ± 2	17 ± 2	15 ± 4
Quarter Avg. ± 2 s.d.	**16 ± 8**	**14 ± 6**	**14 ± 6**	**15 ± 5**	**14 ± 4**	**16 ± 7**	**15 ± 7**	**15 ± 7**	**14 ± 6**	**15 ± 7**	**16 ± 7**	**15 ± 6**	**15 ± 6**

(a) Samples for the week of 04/01-04/08 collected, but lost by carrier.
(b) Low sample volume.

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

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													
09/29-10/05	13 ± 2	15 ± 2	17 ± 2	22 ± 2	19 ± 2	21 ± 2	19 ± 2	20 ± 2	15 ± 2	19 ± 2	20 ± 2	19 ± 2	18 ± 5
10/05-10/13	17 ± 2	17 ± 2	20 ± 2	20 ± 2	20 ± 2	22 ± 2	22 ± 2	22 ± 2	18 ± 2	20 ± 2	21 ± 2	16 ± 2	20 ± 4
10/13-10/20	12 ± 2	16 ± 2	14 ± 2	18 ± 2	16 ± 2	18 ± 2	16 ± 2	17 ± 2	16 ± 2	20 ± 2	15 ± 2	15 ± 2	16 ± 2
10/20-10/27	18 ± 2	17 ± 2	20 ± 2	18 ± 2	18 ± 2	18 ± 2	20 ± 2	18 ± 2	19 ± 2	19 ± 2	19 ± 2	18 ± 2	19 ± 2
10/27-11/04	31 ± 2	28 ± 2	25 ± 2	31 ± 2	32 ± 2	31 ± 2	27 ± 2	33 ± 2	28 ± 2	32 ± 2	29 ± 2	29 ± 2	30 ± 5
NOVEMBER													
11/04-11/09	27 ± 3	24 ± 2	29 ± 3	25 ± 2	26 ± 7 (a)	32 ± 3	28 ± 3	32 ± 3	25 ± 2	30 ± 3	29 ± 3	24 ± 2	28 ± 6
11/09-11/17	34 ± 2	29 ± 2	33 ± 2	32 ± 2	29 ± 2	36 ± 2	28 ± 2	36 ± 2	30 ± 2	32 ± 2	32 ± 2	34 ± 2	32 ± 5
11/17-11/24	13 ± 2	9.8 ± 1.4	12 ± 1	14 ± 2	11 ± 1	13 ± 2	11 ± 1	14 ± 2	11 ± 1	12 ± 1	12 ± 2	14 ± 2	12 ± 3
11/24-12/01	17 ± 2	15 ± 2	19 ± 2	21 ± 2	14 ± 2	14 ± 2	17 ± 2	18 ± 2	18 ± 2	19 ± 2	17 ± 2	21 ± 2	18 ± 5
DECEMBER													
12/01-12/08	20 ± 2	19 ± 2	19 ± 2	22 ± 2	20 ± 2	19 ± 2	20 ± 2	21 ± 2	19 ± 2	21 ± 2	20 ± 2	23 ± 2	20 ± 3
12/08-12/15	21 ± 2	18 ± 2	20 ± 2	22 ± 2	20 ± 2	21 ± 2	18 ± 2	21 ± 2	22 ± 2	21 ± 2	23 ± 2	22 ± 2	21 ± 3
12/15-12/22	17 ± 2	16 ± 2	18 ± 2	20 ± 2	17 ± 2	18 ± 2	19 ± 2	14 ± 2	20 ± 2	18 ± 2	19 ± 2	20 ± 2	18 ± 4
12/22-12/29	21 ± 2	18 ± 2	19 ± 2	22 ± 2	18 ± 2	17 ± 2	19 ± 2	19 ± 2	19 ± 2	19 ± 2	19 ± 2	19 ± 2	19 ± 3
Quarter Avg. ± 2 s.d.	**20 ± 14**	**19 ± 11**	**20 ± 11**	**22 ± 10**	**20 ± 12**	**22 ± 14**	**20 ± 10**	**22 ± 14**	**20 ± 10**	**22 ± 12**	**21 ± 12**	**21 ± 11**	**21 ± 12**
Annual Avg. ± 2 s.d.	**18 ± 11**	**16 ± 9**	**17 ± 10**	**19 ± 10**	**17 ± 10**	**19 ± 12**	**18 ± 9**	**18 ± 12**	**17 ± 9**	**19 ± 11**	**18 ± 10**	**18 ± 9**	**18 ± 10**

(a) Low sample volume due to sampler not running; volume estimated.

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

North Anna Power Station, Louisa County, Virginia - 1999

1.0 E-03 pCi/m^3 ± 2 Sigma

Station	Nuclide	First Quarter 12/30-03/31	Second Quarter 03/31-06/30	Third Quarter 06/30-09/29	Fourth Quarter 09/29-12/29	Average
STA-01	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	68.4 ± 6.8	99.8 ± 10	83.1 ± 8.3	70.7 ± 7.1	80.5 ± 28.8
	K-40	< 7	< 6	< 5	< 4	-
	Co-60	< 0.2	< 0.4	< 0.3	< 0.3	-
	Ru-103	< 0.4	< 0.4	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.2	-
	Th-228	< 0.4	< 0.5	< 0.5	< 0.4	-
STA-02	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	63.4 ± 6.3	96.3 ± 9.6	78.4 ± 7.8	54.9 ± 5.5	73.3 ± 36.4
	K-40	< 9	< 5	< 4	4.56 ± 1.65	4.56 ± 1.65
	Co-60	< 0.3	< 0.3	< 0.3	< 0.2	-
	Ru-103	< 0.4	< 0.4	< 0.5	< 0.3	-
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.2	-
	Th-228	< 0.3	< 0.5	< 0.4	< 0.3	-
STA-03	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	78.0 ± 7.8	90.1 ± 9	72.3 ± 7.2	74.6 ± 7.5	78.8 ± 15.8
	K-40	< 5	5.85 ± 2.43	7.40 ± 2.33	< 4	6.63 ± 2.19
	Co-60	< 0.2	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.4	< 0.4	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.2	-
	Th-228	< 0.5	< 0.4	< 0.3	< 0.4	-
STA-04	Sr-89	(a)	< 3	(a)	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	74.8 ± 7.5	92.6 ± 9.3	74.9 ± 7.5	66.6 ± 6.7	77.2 ± 21.9
	K-40	< 5	< 10	< 10	< 4	-
	Co-60	< 0.2	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.3	< 0.5	< 0.5	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.2	-
	Th-228	< 0.3	< 0.4	< 0.4	< 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 - 1999

1.0 E-03 pCi/m^3 ± 2 Sigma

Station	Nuclide	First Quarter 12/30-03/31	Second Quarter 03/31-06/30	Third Quarter 06/30-09/29	Fourth Quarter 09/29-12/29	Average
STA-05	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	86.7 ± 8.7	117 ± 12	78.3 ± 7.8	62.8 ± 6.3	86.2 ± 45.6
	K-40	< 4	4.89 ± 2.04	< 3	3.77 ± 1.59	4.33 ± 1.58
	Co-60	< 0.3	< 0.3	< 0.3	< 0.3	-
	Ru-103	< 0.4	< 0.4	< 0.4	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.3	-
	Th-228	< 0.5	< 0.5	< 0.4	1.35 ± 0.32	1.35 ± 0.32
STA-05A	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	68.4 ± 6.8	107 ± 11	88.0 ± 8.8	64.7 ± 6.5	82.0 ± 39.1
	K-40	< 4	< 6	< 6	< 5	-
	Co-60	< 0.2	< 0.2	< 0.2	< 0.2	-
	Ru-103	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.2	-
	Th-228	< 0.4	< 0.4	< 0.3	< 0.3	-
STA-06	Sr-89	(a)	< 2	(a	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	78.5 ± 7.8	107 ± 11	82.0 ± 8.2	63.3 ± 6.3	82.7 ± 36.2
	K-40	< 4	6.46 ± 2.82	3.99 ± 1.68	< 10	5.23 ± 3.49
	Co-60	< 0.2	< 0.3	< 0.2	< 0.3	-
	Ru-103	< 0.3	< 0.5	< 0.4	< 0.4	-
	Cs-134	< 0.2	< 0.3	< 0.2	< 0.3	-
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.3	-
	Th-228	< 0.4	< 0.5	< 0.4	< 0.5	-
STA-07	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	66.4 ± 6.6	105 ± 11	79.5 ± 7.9	77.1 ± 7.7	82.0 ± 32.7
	K-40	< 7	< 5	< 4	< 5	-
	Co-60	< 0.2	< 0.2	< 0.2	< 0.3	-
	Ru-103	< 0.3	< 0.4	< 0.3	< 0.4	-
	Cs-134	< 0.2	< 0.2	< 0.2	< 0.3	-
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.3	-
	Th-228	< 0.3	< 0.5	< 0.4	< 0.5	-

* 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 - 1999

1.0 E-03 pCi/m^3 ± 2 Sigma

Station	Nuclide	First Quarter 12/30-03/31	Second Quarter 03/31-06/30	Third Quarter 06/30-09/29	Fourth Quarter 09/29-12/29	Average
STA-21	Sr-89	(a)	< 1	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	56.5 ± 5.7	89.1 ± 8.9	74.2 ± 7.4	66.6 ± 6.7	71.6 ± 27.5
	K-40	< 4	< 8	< 4	< 6	-
	Co-60	< 0.3	< 0.3	< 0.2	< 0.2	-
	Ru-103	< 0.4	< 0.4	< 0.4	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
	Th-228	< 0.4	< 0.4	< 0.4	< 0.5	-
STA-22	Sr-89	(a)	< 2	(a)	(a)	-
	Sr-90	(a)	< 0.3	(a)	(a)	-
	Be-7	58.9 ± 5.9	94.6 ± 9.5	88.6 ± 8.9	76.1 ± 7.6	79.6 ± 31.6
	K-40	< 5	< 10	< 5	< 4	-
	Co-60	< 0.2	< 0.3	< 0.2	< 0.2	-
	Ru-103	< 0.3	< 0.4	< 0.4	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.2	-
	Th-228	< 0.3	< 0.4	< 0.3	< 0.4	-
STA-23	Sr-89	(a)	< 3	(a	(a)	-
	Sr-90	(a)	< 0.4	(a)	(a)	-
	Be-7	74.6 ± 7.5	119 ± 12	72.3 ± 7.2	72.5 ± 7.3	84.6 ± 45.9
	K-40	< 3	4.52 ± 2.15	< 10	3.44 ± 1.52	3.98 ± 1.53
	Co-60	< 0.2	< 0.2	< 0.3	< 0.2	-
	Ru-103	< 0.3	< 0.3	< 0.6	< 0.3	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.2	-
	Th-228	< 0.3	< 0.4	< 0.5	< 0.3	-
STA-24	Sr-89	(a)	< 1	(a)	(a)	-
	Sr-90	(a)	< 0.2	(a)	(a)	-
	Be-7	72.9 ± 7.3	102 ± 10	90.0 + 9.0	71.7 ± 7.2	84.2 ± 29.1
	K-40	< 10	< 6	< 4	< 4	-
	Co-60	< 0.3	< 0.3	< 0.2	< 0.2	-
	Ru-103	< 0.5	< 0.3	< 0.4	< 0.3	-
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.2	-
	Th-228	< 0.5	< 0.4	< 0.4	< 0.4	-

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

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

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

Station 01A -- (On Site)

North Anna Power Station, Louisa County, Virginia - 1999

pCi/l ± 2 Sigma Page 1 of 1

Collection Dates	Gross Beta	Rainfall (inches)
12/30/98-01/27/99	2.6 ± 0.6	4.40
01/27/99-02/24/99	(a)	
02/24/99-03/31/99	2.8 ± 0.8	4.85
03/31/99-04/28/99	6.5 ± 0.9	1.36
04/28/99-05/26/99	3.5 ± 0.7	1.27
05/26/99-06/30/99	1.8 ± 0.6	1.34
06/30/99-07/28/99	3.4 ± 0.7	1.55
07/28/99-08/25/99	5.3 ± 0.8	1.48
08/25/99-09/29/99	2.1 ± 0.6	8.11
09/29/99-10/27/99	1.6 ± 0.6	4.77
10/27/99-11/24/99	1.4 ± 0.7	0.82
11/24/99-12/29/99	1.9 ± 0.6	3.39
Average ± 2 s.d.	**3.0 ± 3.2**	

(a) Sample not received.

SEMI-ANNUAL PRECIPITATION COMPOSITES

12/30/98-06/24/99	06/30/99-12/29/99
Be-7 = < 30	Be-7 = < 30
H3 = < 200	H3 = < 200

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

TABLE B-5

NORTH ANNA - 1999

CONCENTRATIONS OF GAMMA EMITTERS* IN SOIL

pCi/kg ± 2 Sigma

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

Soil samples are collected every three years. Since they were collected in 1998, they will not be collected during 1999.

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

North Anna Power Station, Louisa County, Virginia - 1999

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								
03/31/99	(a)	(a)	< 200	< 30	< 50	< 0.4	< 4	< 6
06/30/99	< 3.0	< 0.3	< 200	< 40	< 50	< 0.3	< 7	< 7
09/29/99	(a)	(a)	< 300	< 30	< 50	< 8 (b)	< 6	< 6
12/29/99	(a)	(a)	< 200	< 40	< 90	< 10	< 8	< 6
Average ± 2 sd.								

* All gamma emitters other than those listed were <LLD.
(a) Strontium-89/90 analyses performed only on second quarter sample.
(b) I-131 results by Gamma. More sensitive method by radiochemistry not requested.

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

North Anna Power Station, Louisa County, Virginia - 1999

pCi/l ± 2 Sigma Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - 11										
01/13/99	(a)	(a)	3000 ± 200	< 30	< 50	< 0.3	< 4	< 6	< 60	< 5
02/11/99	(a)	(a)	(b)	< 30	< 100	< 0.4	< 4	< 7	< 70	< 6
03/15/99	(a)	(a)	(b)	< 30	< 90	< 0.3	< 4	< 5	< 70	< 6
04/12/99	< 4.0	< 0.3	3000 ± 200	< 30	< 40	< 0.2	< 3	< 4	< 70	< 6
05/17/99	(a)	(a)	(b)	< 30	< 60	< 0.3	< 3	< 6	< 60	< 6
06/14/99	(a)	(a)	(b)	< 30	< 60	< 0.3	< 3	< 6	< 80	< 7
07/09/99	(a)	(a)	3800 ± 300	< 30	< 90	< 0.7	< 4	< 7	< 70	< 6
08/16/99	(a)	(a)	(b)	< 40	< 50	< 20 (c)	< 4	< 10	< 70	< 6
09/13/99	(a)	(a)	(b)	< 30	< 50	< 0.3	< 3	< 10	< 60	< 6
10/15/99	(a)	(a)	3600 ± 200	< 40	< 60	< 20 (c)	< 4	< 10	< 90	< 8
11/12/99	(a)	(a)	(b)	< 50	< 100	< 20 (c)	< 4	< 10	< 80	< 7
12/13/99	(a)	(a)	(b)	< 30	< 50	< 10 (c)	< 4	< 7	< 70	< 6
Average ± 2 sd			**3350 ± 825**							

(a) Sr-89/90 analyses performed only on second quarter samples.
(b) Tritium analysis performed on quarterly composite.
(c) I-131 results by gamma. More sensitive results by radiochemistry not requested nor performed by vendor.

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

North Anna Power Station, Louisa County, Virginia - 1999

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										
01/13	(a)	(a)	3300 ± 200	< 30	< 50	< 0.4	< 4	< 7	< 70	< 6
02/11	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 6	< 80	< 7
03/15	(a)	(a)	(b)	< 30	< 50	< 0.3	< 3	< 5	< 80	< 6
04/12	< 8.0	< 0.6	3500 ± 200	< 30	< 50	< 0.3	< 3	< 7	< 80	< 6
05/17	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 4	< 70	< 6
06/14	(a)	(a)	(b)	< 20	< 40	< 0.4	< 3	< 4	< 60	< 5
07/09	(a)	(a)	4900 ± 300	< 30	< 50	< 0.6	< 3	< 7	< 90	< 7
08/16	(a)	(a)	(b)	< 30	< 50	< 20 (c)	< 3	< 10	< 70	< 6
09/13	(a)	(a)	(b)	< 30	< 80	< 0.4	< 3	< 6	< 60	< 5
10/15	(a)	(a)	4200 ± 200	< 30	< 50	< 20 (c)	< 4	< 10	< 70	< 6
11/12	(a)	(a)	(b)	< 30	< 50	< 20 (c)	< 3	< 10	< 70	< 7
12/13	(a)	(a)	(b)	< 40	< 60	< 10 (c)	< 4	< 9	< 90	< 7
Average ± 2 sd			**3975 ± 1455**							
STATION - 09A										
01/13	(a)	(a)	< 200	< 30	< 60	< 0.3	< 4	< 7	< 60	< 5
02/11	(a)	(a)	(b)	< 30	< 40	< 0.4	< 3	< 6	< 70	< 6
03/15	(a)	(a)	(b)	< 30	< 40	< 0.3	< 3	< 4	< 70	< 6
04/12	< 4.0	< 0.3	< 200	< 30	< 50	< 0.2	< 4	< 6	< 80	< 7
05/17	(a)	(a)	(b)	< 30	< 90	< 0.4	< 4	< 6	< 70	< 6
06/14	(a)	(a)	(b)	< 40	<100	< 0.3	< 5	< 7	< 80	< 7
07/09	(a)	(a)	< 300	< 30	< 50	< 0.6	< 3	< 5	< 70	< 6
08/16	(a)	(a)	(b)	< 30	< 70	< 20 (c)	< 3	< 10	< 60	< 6
09/13	(a)	(a)	(b)	< 30	< 50	< 0.4	< 3	< 7	< 70	< 6
10/15	(a)	(a)	< 200	< 40	< 60	< 20 (c)	< 4	< 10	< 70	< 7
11/12	(a)	(a)	(b)	< 40	< 90	< 20 (c)	< 4	< 10	< 70	< 6
12/13	(a)	(a)	(b)	< 30	< 40	< 10 (c)	< 3	< 6	< 80	< 6

* All gamma emitters other than those listed were <LLD.
** I-131 by radiochemistry
(a) Analysis performed only with second quarter.
(b) Tritium analysis performed on quarterly composite.
(c) I-131 results by gamma. More sensitive method by radiochemistry not requested nor performed by vendor.

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

State-Split Samples

North Anna Power Station, Louisa County, Virginia - 1999

pCi/l ± 2 Sigma Page 1 of 1

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

State sampling was discontinued in the third quarter 1998.

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

North Anna Power Station, Louisa County, Virginia - 1999

pCi/kg ± 2 Sigma Page 1 of 1

Nuclide	STA-08 02/11	STA-09A 02/11	STA-11 02/11	STA-08 08/16	STA-09A 08/16	STA-11 08/16	Average ± 2 s.d.
Sr-89	(a)	(a)	(a)	< 2000	< 2000	< 2000	--
Sr-90	(a)	(a)	(a)	4600 ± 600	4800 ± 600	5800 ± 600	5067 ± 1286
Be-7	< 200	< 300	< 200	< 400	< 300	< 300	--
K-40	20800 ± 2100	10700 ± 1100	14400 ± 1400	16500 ± 1600	12900 ± 1300	13200 ± 1300	14750 ± 7044
Mn-54	< 30	< 30	< 20	< 40	< 30	< 30	--
Co-58	< 30	< 30	< 20	< 40	< 30	< 30	--
Co-60	< 30	< 40	< 20	< 40	< 30	< 30	--
Cs-134	< 30	< 30	< 30	< 40	< 40	< 40	--
Cs-137	< 30	< 40	< 30	< 40	142 ± 34	< 30	142 ± 34
Ra-226	2410 ± 440	< 700	1930 ± 360	1530 ± 630	1850 ± 460	1980 ± 420	1940 ± 632
Th-228	1890 ± 190	593 ± 61	1130 ± 110	1730 ± 170	1040 ± 100	966 ± 97	1225 ± 983

* 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 - 1999

pCi/kg ± 2 Sigma Page 1 of 1

Nuclide	Station-08 02/11/99	Station-08 08/16/99	Average ± 2 Sigma
Sr-89	(a)	< 2000	--
Sr-90	(a)	2300 ± 500	2300 ± 500
Be-7	< 300	< 200	--
K-40	895 ± 251	2270 ± 230	1583 ± 1945
Mn-54	< 30	< 10	--
Co-58	< 20	< 10	--
Co-60	< 20	< 10	--
Cs-134	< 30	< 20	--
Cs-137	< 30	< 20	--
Ra-226	< 600	692 ± 236	692 ± 236

* 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 - 1999

pCi/l ± 2 Sigma

MONTH	NUCLIDE	STATION-12	STATION-13
JANUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1300 ± 130	1110 ± 110
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
FEBRUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1450 ± 140	1310 ± 130
	Cs-137	< 3	< 4
	I-131	< 0.3	< 0.3
MARCH	Sr-89	< 4	< 6
	Sr-90	0.99 ± 0.25	1.3 ± 0.4
	K-40	1330 ± 130	1350 ± 140
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.3
APRIL	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1470 ± 150	1240 ± 120
	Cs-137	< 3	< 4
	I-131	< 0.3	< 0.2
MAY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1370 ± 140	1160 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.3
JUNE	Sr-89	< 7	< 4
	Sr-90	2.4 ± 0.5	0.96 ± 0.27
	K-40	1360 ± 140	1300 ± 130
	Cs-137	< 3	< 4
	I-131	< 0.4	< 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-12: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

North Anna Power Station, Louisa County, Virginia - 1999

pCi/l ± 2 Sigma

MONTH	NUCLIDE	STATION-12	STATION-13
JULY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1250 ± 120	1400 ± 140
	Cs-137	< 4	< 3
	I-131	< 0.2	< 0.3
AUGUST	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1370 ± 140	1180 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
SEPTEMBER	Sr-89	< 3	< 4
	Sr-90	1.3 ± 0.3	1.1 ± 0.3
	K-40	1210 ± 120	1120 ± 110
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.2
OCTOBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1390 ± 140	1240 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.3	< 0.3
NOVEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1160 ± 120	1270 ± 130
	Cs-137	< 4	< 3
	I-131	< 0.3	< 0.3
DECEMBER	Sr-89	< 4	< 3
	Sr-90	1.1 ± 0.3	1.1 ± 0.2
	K-40	1320 ± 130	1330 ± 130
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.3
Average ± 2 s.d.	**Sr-89**	-	-
	Sr-90	**1.45 ± 1.3**	**1.12 ± 0.28**
	K-40	**1332 ± 183**	**1251 ± 186**
	Cs-137	-	-
	I-131		-

* 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 - 1999

pCi/kg ± 2 Sigma Page 1 of 1

Collection Date	Station	Sample Type	K-40	Co-58	Cs-134	Cs-137
02/09	08	Fish (a)	1800 ± 210	< 10	< 20	48.7 ± 14.4
02/09	25	Fish (a)	1430 ± 150	< 10	< 10	< 10
02/09	08	Catfish (b)	1360 ± 160	< 20	< 20	42.0 ± 12.3
02/09	25	Catfish (b)	1110 ± 110	< 10	< 10	< 10
08/18	08	Fish (a)	1020 ± 160	< 10	< 10	30.5 ± 12.8
08/16	25	Fish (a)	1560 ± 170	< 10	< 10	< 10
08/18	08	Catfish (b)	1030 ± 130	< 10	< 10	30.0 ± 12.2
08/16	25	Catfish (b)	1000 ± 140	< 20	< 20	< 20
Avg. ± 2 s.d.			**1289 ± 593**			**37.8 ± 18.3**

* 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 - 1999

pCi/kg ± 2 Sigma

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 14								
04/21	2400 ± 240	19200 ± 1900	< 30	< 20	< 20	22.4 ± 10.9	548 ± 176	276 ± 28
05/19	469 ± 195	26300 ± 2600	< 40	< 30	< 30	< 30	< 400	< 40
06/16	722 ± 170	19900 ± 2000	< 40	< 30	< 20	27.4 ± 14.6	< 400	< 40
07/21	447 ± 121	21300 ± 2100	< 40	< 20	< 20	< 10	< 300	< 20
08/18	609 ± 78	27200 ± 2700	< 20	< 10	< 10	< 10	< 200	< 10
09/22	9100 ± 910	19000 ± 1900	< 50	< 40	< 40	57.6 ± 26.1	< 700	129 ± 31
10/20	582 ± 128	15100 ± 1500	< 20	< 20	< 20	< 20	< 300	< 30
STATION 15								
04/21	2860 ± 290	21500 ± 2200	< 30	< 20	< 20	< 20	323 ± 170	< 20
05/19	1100 ± 210	31700 ± 3200	< 30	< 30	< 30	< 30	< 400	< 50
06/16	956 ± 181	19300 ± 1900	< 40	< 20	< 20	< 20	< 400	< 40
07/21	2450 ± 250	31600 ± 3200	< 30	< 30	< 30	< 30	< 400	< 40
08/18	568 ± 78	18500 ± 1900	< 20	< 10	< 10	< 10	< 200	20.7 ± 11.3
09/22	6980 ± 700	14200 ± 1400	< 50	< 50	< 40	< 40	< 700	< 60
10/20	4080 ± 410	17800 ± 1800	< 20	< 20	< 20	< 20	384 ± 202	121 ± 21
STATION 16								
04/21	3280 ± 330	26600 ± 2700	< 30	< 10	< 10	< 10	< 200	58.4 ± 10.9
05/19	1310 ± 250	30900 ± 3100	< 40	< 30	< 30	< 30	< 600	< 50
06/16	948 ± 192	23800 ± 2400	< 40	< 30	< 30	50.5 ± 20.4	< 500	< 40
07/21	761 ± 176	21000 ± 2100	< 20	< 30	< 20	< 20	< 400	< 30
08/18	1340 ± 160	29400 ± 2900	< 20	< 20	< 20	< 20	416 ± 242	< 30
09/22	5960 ± 600	21600 ± 2200	< 50	< 30	< 30	< 30	< 500	< 50
10/20	3240 ± 320	18600 ± 1900	< 30	< 20	< 10	< 10	< 200	< 20

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

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

North Anna Power Station, Louisa County, Virginia - 1999

pCi/kg ± 2 Sigma

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 21								
04/21	2260 ± 230	14700 ± 1500	< 30	< 10	< 10	< 10	< 200	90.3 ± 14.7
05/19	1260 ± 360	28500 ± 2800	< 30	< 60	< 50	< 50	< 700	< 70
06/16	828 ± 220	20600 ± 2100	< 40	< 30	< 30	42.8 ± 20.5	< 500	< 50
07/21	2650 ± 260	34500 ± 3400	< 40	< 20	< 20	< 20	450 ± 238	146 ± 18
08/18	2530 ± 250	28600 ± 2900	< 20	< 20	< 20	< 20	< 300	58.7 ± 16.7
09/22	9910 ± 990	10700 ± 1100	< 60	< 40	< 40	< 40	< 600	246 ± 47
10/20	8020 ± 800	11100 ± 1100	< 30	< 20	< 20	< 20	648 ± 255	64.0 ± 21.9
STATION 23								
04/21	1940 ± 190	15200 ± 1500	< 40	< 10	< 10	< 10	225 ± 123	73.9 ± 12.7
05/19	1650 ± 390	36500 ± 3700	< 30	< 70	< 60	< 50	< 800	< 80
06/16	3360 ± 340	8270 ± 830	< 50	< 40	< 30	< 30	< 600	< 50
07/21	5820 ± 580	18500 ± 1900	< 40	< 30	< 30	< 30	< 500	< 50
08/18	1420 ± 150	30000 ± 3000	< 20	< 20	< 20	< 20	< 300	< 30
09/22	7190 ± 720	17700 ± 1800	< 50	< 30	< 30	< 30	965 ± 357	218 ± 37
10/20	4330 ± 430	14800 ± 1500	< 40	< 20	< 20	< 20	1090 ± 200	710 ± 71
Average ± 2 s.d.	**2952 ± 5273**	**21833 ± 14163**				**40.1 ± 29.9**	**561 ± 585**	**170 ± 360**

* 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 - 1999

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

Station Number	First Qtr 01/13/99 03/31/99	Second Qtr 03/31/99 06/30/99	Third Qtr 06/30/99 10/05/99	Fourth Qtr 10/05/99 01/06/00	Quarterly Average	Annual TLD 07/01/98 06/30/99
01	8.2 ± 0.1	8.1 ± 0.9	7.5 ± 1.1	6.7 ± 1.1	7.6 ± 1.4	8.2 ±0.5
02	4.6 ± 0.4	4.6 ± 0.3	4.3 ± 0.1	3.9 ± 0.3	4.4 ± 0.7	5.0 ±0.7
03	4.5 ± 0.3	4.7 ± 0.4	4.2 ± 0.2	3.6 ± 0.2	4.3 ± 1.0	4.9 ±0.9
04	4.8 ± 0.2	5.1 ± 0.4	4.3 ± 0.1	3.7 ± 0.5	4.5 ± 1.2	5.0 ±0.3
05	5.6 ± 0.7	6.3 ± 0.4	5.6 ± 0.2	5.3 ± 0.1	5.7 ± 0.8	6.6 ±0.7
05A	5.4 ± 0.3	5.3 ± 0.4	5.1 ± 0.2	4.6 ± 0.2	5.1 ± 0.7	5.4 ±1.0
06	6.8 ± 0.6	7.3 ± 1.1	6.6 ± 0.3	6.5 ± 0.7	6.8 ± 0.7	7.8 ±1.1
07	5.6 ± 0.2	5.7 ± 0.5	5.0 ± 0.2	4.7 ± 0.4	5.3 ± 1.0	5.8 ±0.3
21	5.5 ± 0.3	5.7 ± 0.7	5.0 ± 0.1	4.6 ± 0.3	5.2 ± 1.0	5.7 ±0.7
22	6.9 ± 0.2	7.4 ± 0.8	6.1 ± 0.7	6.0 ± 0.6	6.6 ± 1.3	7.5 ±1.2
23	7.6 ± 0.1	7.7 ± 1.0	6.9 ± 0.2	6.7 ± 0.2	7.2 ± 1.0	7.7 ±0.4
24	6.1 ± 0.2	5.6 ± 0.2	5.2 ± 0.1	4.6 ± 0.2	5.4 ± 1.3	6.2 ±0.9
Average ± 2 s.d.	**6.0 ± 2.4**	**6.1 ± 2.4**	**5.5 ± 2.2**	**5.1 ± 2.3**	**5.7 ± 2.4**	**6.3 ± 2.4**

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

North Anna Power Station, Louisa County, Virginia - 1999

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

Station Number	First Qtr. 01/07-04/02	Second Qtr. 03/31-06/30	Third Qtr. 06/30-10/05	Fourth Qtr. 10/05-01/06	Average ± 2 s.d.
N-1	6.8 ± 0.4	6.3 ± 0.4	6.1 ± 0.4	5.8 ± 0.4	6.3 ± 0.8
N-2	5.2 ± 0.1	4.7 ± 0.3	4.8 ± 0.4	4.3 ± 0.6	4.8 ± 0.7
NNE-3	9.5 ± 0.5	8.8 ± 0.9	9.0 ± 0.9	8.1 ± 1.0	8.9 ± 1.2
NNE-4	6.2 ± 0.4	5.9 ± 0.3	5.7 ± 0.5	5.5 ± 0.1	5.8 ± 0.6
NE-5	7.8 ± 0.1	7.8 ± 0.1	7.2 ± 0.5	5.8 ± 2.8	7.2 ± 1.9
NE-6	5.6 ± 0.2	5.5 ± 0.5	5.3 ± 0.4	5.3 ± 0.8	5.4 ± 0.3
ENE-7	7.0 ± 0.3	6.8 ± 0.5	6.5 ± 0.2	6.3 ± 0.3	6.7 ± 0.6
ENE-8	4.6 ± 0.1	4.2 ± 0.3	4.0 ± 0.1	3.6 ± 0.4	4.1 ± 0.8
E-9	7.2 ± 0.4	7.1 ± 0.7	6.7 ± 1.1	6.4 ± 0.1	6.9 ± 0.7
E-10	6.2 ± 0.3	6.1 ± 0.3	5.8 ± 0.4	5.6 ± 0.5	5.9 ± 0.6
ESE-11	6.1 ± 0.3	6.2 ± 0.4	5.8 ± 0.4	5.5 ± 0.3	5.9 ± 0.6
ESE-12	6.7 ± 0.2	6.7 ± 0.2	6.7 ± 0.2	6.5 ± 0.4	6.7 ± 0.2
SE-13	6.3 ± 0.6	6.0 ± 0.9	6.2 ± 0.1	6.1 ± 0.7	6.2 ± 0.3
SE-14	8.7 ± 0.3	8.1 ± 1.0	7.6 ± 2.0	8.0 ± 0.7	8.1 ± 0.9
SSE-15	7.3 ± 0.3	6.8 ± 0.4	6.9 ± 0.3	6.4 ± 0.2	6.9 ± 0.7
SSE-16	5.2 ± 0.5	5.3 ± 0.7	4.8 ± 0.2	5.0 ± 0.1	5.1 ± 0.4
S-17	8.8 ± 0.4	9.4 ± 0.4	8.9 ± 0.4	8.9 ± 0.2	9.0 ± 0.5
S-18	4.4 ± 0.5	4.1 ± 0.6	4.1 ± 0.2	3.9 ± 0.3	4.1 ± 0.4
SSW-19	8.0 ± 0.5	7.7 ± 0.8	7.5 ± 1.1	8.2 ± 0.5	7.9 ± 0.6
SSW-20	4.4 ± 0.1	4.1 ± 0.5	4.1 ± 0.1	3.7 ± 0.0	4.1 ± 0.6
SW-21	5.5 ± 0.3	5.5 ± 0.4	5.5 ± 0.3	4.8 ± 0.9	5.3 ± 0.7
SW-22	6.3 ± 0.5	6.2 ± 0.5	6.2 ± 0.4	6.3 ± 0.3	6.3 ± 0.1
WSW-23	7.7 ± 0.4	7.3 ± 0.6	7.5 ± 0.1	6.8 ± 0.7	7.3 ± 0.8
WSW-24	6.2 ± 0.3	6.4 ± 0.5	6.2 ± 0.3	6.2 ± 0.3	6.3 ± 0.2
W-25	8.2 ± 1.1	7.7 ± 0.6	7.8 ± 0.4	8.1 ± 1.2	8.0 ± 0.5
W-26	5.3 ± 0.5	4.9 ± 0.3	4.9 ± 0.1	4.3 ± 0.2	4.9 ± 0.8
WNW-27	5.1 ± 0.3	4.6 ± 0.4	5.0 ± 0.3	4.4 ± 0.5	4.8 ± 0.7
WNW-28	5.4 ± 0.3	4.9 ± 0.3	4.9 ± 0.2	4.6 ± 0.7	5.0 ± 0.7
NW-29	8.4 ± 0.2	8.0 ± 1.0	8.2 ± 0.2	7.8 ± 0.3	8.1 ± 0.5
NW-30	4.7 ± 0.1	4.2 ± 0.3	4.6 ± 0.2	4.0 ± 0.3	4.4 ± 0.7
NNW-31	5.8 ± 0.2	5.4 ± 0.2	5.2 ± 0.2	5.0 ± 0.6	5.4 ± 0.7
NNW-32	6.2 ± 0.3	5.8 ± 0.4	5.5 ± 0.4	5.1 ± 0.3	5.7 ± 0.9
N-33	6.5 ± 0.3	5.9 ± 0.2	6.2 ± 0.3	5.9 ± 0.1	6.1 ± 0.6
N-34	5.0 ± 0.3	4.6 ± 0.4	4.7 ± 0.2	4.3 ± 0.4	4.7 ± 0.6
NNE-35	9.2 ± 0.3	8.5 ± 0.4	8.5 ± 0.4	8.4 ± 0.4	8.7 ± 0.7
NNE-36	6.1 ± 0.1	5.7 ± 0.7	6.0 ± 0.2	5.3 ± 0.2	5.8 ± 0.7
NE-37	7.9 ± 0.5	7.3 ± 0.6	7.2 ± 0.4	7.0 ± 0.4	7.4 ± 0.8
NE-38	5.7 ± 0.3	5.3 ± 0.6	5.4 ± 0.3	4.9 ± 0.4	5.3 ± 0.7

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

North Anna Power Station, Louisa County, Virginia - 1999

mR/Std. Month (30.4 days) ± 2 Sigma

Station Number	First Qtr 01/13-03/31	Second Qtr 03/31-06/30	Third Qtr 06/30-10/05	Fourth Qtr 10/05-01/06	Average ± 2 S.d.
ENE-39	6.9 ± 0.3	6.5 ± 0.8	6.9 ± 0.4	6.4 ± 0.4	6.7 ± 0.5
ENE-40	5.0 ± 0.1	4.7 ± 0.0	4.1 ± 0.2	4.0 ± 0.4	4.5 ± 1.0
E-41	7.1 ± 0.2	7.1 ± 0.5	7.1 ± 0.2	6.8 ± 0.4	7.0 ± 0.3
E-42	6.3 ± 0.4	6.2 ± 0.2	6.3 ± 0.4	5.4 ± 0.4	6.1 ± 0.9
ESE-43	6.3 ± 0.3	6.0 ± 0.6	5.9 ± 0.3	5.3 ± 0.7	5.9 ± 0.8
ESE-44	6.8 ± 0.3	7.0 ± 0.4	6.6 ± 0.3	6.5 ± 1.2	6.7 ± 0.4
SE-45	6.9 ± 0.3	6.3 ± 0.7	6.4 ± 0.3	5.8 ± 0.2	6.4 ± 0.9
SE-46	9.2 ± 0.0	8.6 ± 1.0	8.4 ± 0.2	8.6 ± 0.9	8.7 ± 0.7
SSE-47	7.1 ± 0.3	7.3 ± 0.7	6.9 ± 0.3	6.6 ± 0.4	7.0 ± 0.6
SSE-48	5.5 ± 0.1	5.0 ± 0.6	5.1 ± 0.1	4.8 ± 0.3	5.1 ± 0.6
S-49	9.3 ± 0.6	9.4 ± 0.4	9.2 ± 0.4	8.7 ± 1.3	9.2 ± 0.6
S-50	4.5 ± 0.1	4.3 ± 0.4	4.1 ± 0.3	3.8 ± 0.1	4.2 ± 0.6
SSW-51	8.4 ± 0.4	8.2 ± 0.4	8.3 ± 0.5	7.7 ± 1.3	8.2 ± 0.6
SSW-52	4.6 ± 0.4	4.2 ± 0.6	4.2 ± 0.2	3.7 ± 0.1	4.2 ± 0.7
SW-53	6.0 ± 0.3	6.1 + 1.1	5.4 ± 0.4	4.6 ± 0.7	5.5 ± 1.4
SW-54	7.1 ± 0.3	7.1 ± 0.2	6.3 ± 0.2	6.2 ± 0.4	6.7 ± 1.0
WSW-55	8.4 ± 0.3	8.2 ± 1.0	7.5 ± 0.2	6.9 ± 0.5	7.8 ± 1.4
WSW-56	6.8 ± 0.1	6.8 ± 0.7	6.3 ± 0.6	6.1 ± 0.5	6.5 ± 0.7
W-57	9.1 ± 0.1	9.0 ± 0.5	8.1 ± 0.4	7.9 ± 0.5	8.5 ± 1.2
W-58	5.5 ± 0.2	5.2 + 0.5	4.9 ± 0.1	4.2 ± 0.2	5.0 ± 1.1
WNW-59	5.3 ± 0.4	5.5 ± 1.3	4.8 ± 0.2	4.4 ± 0.3	5.0 ± 1.0
WNW-60	5.6 ± 0.2	5.8 ± 0.4	4.9 ± 0.3	5.0 ± 0.5	5.3 ± 0.9
NW-61	8.6 ± 0.4	9.3 ± 1.3	8.1 ± 0.4	7.4 ± 0.3	8.4 ± 1.6
NW-62	5.0 ± 0.1	5.1 + 0.5	4.3 ± 0.3	4.0 ± 0.4	4.6 ± 1.1
NNW-63	6.1 ± 0.1	5.5 ± 0.6	5.4 ± 0.2	5.1 ± 0.2	5.5 ± 0.8
NNW-64	6.4 ± 0.2	6.3 ± 0.8	5.8 ± 0.3	4.9 ± 0.7	5.9 ± 1.4
C-1	5.6 ± 0.3	5.6 ± 0.9	4.8 ± 0.2	4.4 ± 0.2	5.1 ± 1.2
C-2	5.6 ± 0.3	5.6 ± 1.1	4.9 ± 0.1	4.5 ± 0.7	5.2 ± 1.1
C-3	5.7 ± 0.1	5.7 ± 1.0	5.1 ± 0.4	4.1 ± 0.5	5.2 ± 1.5
C-4	5.4 ± 0.3	5.7 ± 0.6	4.9 ± 0.2	4.5 ± 0.1	5.1 ± 1.1
C-5	4.7 ± 0.3	4.6 ± 0.6	4.0 ± 0.3	3.4 ± 0.7	4.2 ± 1.2
C-6	4.7 ± 0.2	5.1 + 1.4	4.0 ± 0.2	3.4 ± 0.2	4.3 ± 1.5
C-7	6.6 ± 0.3	6.7 ± 1.1	5.9 ± 0.2	5.3 ± 0.9	6.1 ± 1.3
C-8	6.6 ± 0.4	7.1 ± 0.9	6.1 ± 0.2	5.8 ± 1.3	6.4 ± 1.1
Average	**6.5 ± 2.7**	**6.3 ± 2.8**	**6.0 ± 2.8**	**5.7 ± 2.9**	**6.1 ± 2.8**

APPENDIX C
LAND USE CENSUS - 1999

VIRGINIA POWER
NORTH ANNA POWER STATION
Annual Radiological Environmental Land Use Census Data for 1999
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	2.4	1.4		3.5		3.2
NNE	1.4	1.4		2.3		2.5
NE	1.5	1.3		2.3		1.5
ENE	3.4	1.3		4.0		3.4
E	2.1	1.3		5.7		2.1
ESE	2.7	1.4		NONE		5.3
SE	2.3	1.4		2.3		2.3
SSE	1.6	1.5		4.5		1.6
S	1.7	1.5		2.4		2.1
SSW	1.9	1.6		3.1		4.6
SW	5.0	1.7		NONE		5.0
WSW	2.7	1.8		2.7		2.7
W	2.4	1.7		7.1		8.0
WNW	1.8	1.6		6.5		4.2
NW	1.7	1.6		NONE		1.9
NNW	1.6	1.4		3.2		1.9

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

VIRGINIA POWER

NORTH ANNA POWER STATION

Annual Radiological Environmental Land Use Census Data for 1999

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	1.5	0.9		2.2		2.0
NNE	0.9	0.9		1.5		1.5
NE	0.9	0.8		1.4		0.9
ENE	2.1	0.8		2.5		2.1
E	1.3	0.8		3.5		1.3
ESE	1.7	0.9		NONE		3.3
SE	1.4	0.9		1.4		1.4
SSE	1.0	0.9		2.8		1.0
S	1.1	0.9		1.5		1.3
SSW	1.2	1.0		2.0		2.9
SW	3.1	1.1		NONE		3.1
WSW	1.7	1.1		1.7		1.7
W	1.5	1.1		4.4		5.0
WNW	1.1	1.0		4.1		2.6
NW	1.0	1.0		NONE		1.2
NNW	1.0	0.9		2.0		1.2

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

VIRGINIA POWER

NORTH ANNA POWER STATION

COMPARISON OF THE 1999 TO 1998 LAND USE CENSUS

I. No changes were observed in the nearest resident status.

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

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

IV. The following change was observed in the nearest vegetable garden as compared to the previous year.

   a. SectorSSW 4.8 kM to 4.6 kM

V. No change was observed in the nearest milk cow/goat status.

VI. The following change was observed to the nearest meat animal status as compared to the previous year.

   a. ESE Sector 7.7 kM to None

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

(Liquid Scintillation)

Water

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

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

RESULT		=	$(N-B)/(2.22\ V\ E)$
TWO SIGMA ERROR		=	$2((N + B)/\bullet t)^{1/2}/\,(2.22\ V\ E)$
LLD		=	$4.66\ (B/\bullet t)^{1/2}/(2.22\ V\ E\ )$
where:	N	=	the gross cpm of the sample
	B	=	the background of the detector in cpm
	2.22	=	conversion factor changing dpm to pCi
	V	=	volume of the sample in ml
	E	=	efficiency of the detector
	•t	=	counting time for the sample

ANALYSIS OF SAMPLES
FOR STRONTIUM-89 AND -90

Water

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ 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	$= 2((N/Dt+B_C+B_A)/\bullet t)^{1/2}/(2.22\ V\ Y_S\ DF_{SR-89}\ E_{SR-89})$
LLD Sr-89	$= 4.66((B_C+B_A)/\bullet t)^{1/2}/(2.22\ V\ YS\ DF_{SR-89}\ E_{SR-89})$
RESULT Sr-90	$= (N/\bullet t - B)/(2.22\ V\ Y_1\ Y_2\ DF\ IF\ E)$
TWO SIGMA ERROR Sr-90	$= 2((N/\bullet t+B)/\bullet t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ DF\ E\ IF))$

LLD Sr-90 $= 4.66(B/\bullet t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ IF\ DF\ E)$

WHERE:	N	=	total counts from sample (counts)
	$\bullet t$	=	counting time for sample (min)
	B_C	=	background rate of counter (cpm) using absorber configuration
	2.22	=	dpm/pCi
	V	=	volume or weight of sample analyzed
	B_A	=	background addition from Sr-90 and ingrowth of Y-90
	B_A	=	$0.016\ (K) + (K)\ E_{Y/abs})\ (IG_{Y\text{-}90})$
	Y_S	=	chemical yield of strontium
	$DF_{SR\text{-}89}$	=	decay factor from the mid collection date to the counting date for SR-89
	$E_{SR\text{-}89}$	=	efficiency of the counter for SR-89 with the 80 mg/cm.sq. aluminum absorber
	K	=	$(N\bullet t - B_C)_{Y\text{-}90}/(E_{Y\text{-}90}\ IF_{Y\text{-}90}\ DF_{Y\text{-}90} Y_1)$
	$DF_{Y\text{-}90})$	=	the decay factor for Y-90 from the "milk" time to the mid count time
	$E_{Y\text{-}90}$	=	efficiency of the counter for Y-90
	$IF_{Y\text{-}90}$	=	ingrowth factor for Y-90 from scavenge time to milking time
	$IG_{Y\text{-}90}$	=	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/•t-B)/(2.22 E V Y DF)
TWO SIGMA ERROR	=	$2((N/\bullet t+B)/\bullet t)^{1/2}/(2.22\ E\ V\ Y\ DF)$
LLD	=	$= 4.66(B/\bullet t)^{1/2}/(2.22\ E\ V\ Y\ DF)$

where:	N	=	total counts from sample (counts)
	•t	=	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 $Pd1_2$ 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

The US Environmental Protection Agency (EPA) discontinued their Interlaboratory Comparison Program in December 1998.

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

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

The EPA Interlaboratory Comparison and Analytics tables for 1997 and 1998 have been included with this report since there were investigations still in progress when the REMP report for 1998 was submitted to the NRC.

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

VEPCO - NORTH ANNA
EPA INTERLABORATORY COMPARISON PROGRAM 1997
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)	
01/17/97	Water	Sr-89	12.0 ±	5.0	10.00 ±	1.00	-0.69	
		Sr-90	25.0 ±	5.0	25.00 ±	1.00	0.00	
01/31/97	Water	Gross Alpha	5.2 ±	5.0	8.10 ±	0.89	1.00	
		Gross Beta	14.7 ±	5.0	15.00 ±	1.00	0.10	
02/07/97	Water	I-131	86.0 ±	9.0	106.00 ±	4.36	3.85	(d)
02/14/97	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	Water	H-3	7900.0 ±	790.0	7366.67 ±	378.59	-1.17	
04/15/97	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	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	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	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	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	Water	H-3	11010 ±	1101.0	12000.00 ±	0.00	1.56	
09/12/97	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	Water	I-131	10.0 ±	6.0	11.00 ±	0.00	0.29	

VEPCO - NORTH ANNA
EPA INTERLABORATORY COMPARISON PROGRAM 1997
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)
10/21/97	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	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	Water	Co-60	27.0 ±	5.0	25.00 ±	1.00	-0.69
		Zn-65	75.0 ±	8.0	71.00 ±	3.61	-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) EPA Results-Expected laboratory precision (1 sigma). Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(b) Teledyne Results - Average ± one sigma. Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(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. Additional in-house analyses performed after retraining have been acceptable.

(g) No apparent cause for the discrepancy could be identified. Equipment calibrations and efficiencies for this analysis were within expected normal ranges.

VEPCO NORTH ANNA
EPA INTERLABORATORY COMPARISON PROGRAM 1998
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Normal Dev. Known(c)	
01/16/98	Water	Sr-89	8.0 ±	5.0	5.00 ±	1.73	-1.04	
		Sr-90	32.0 ±	5.0	31.67 ±	0.58	-0.12	
01/30/98	Water	Gr-Alpha	30.5 ±	7.6	33.00 ±	2.65	0.57	
		Gr-Beta	3.9 ±	5.0	5.60 ±	0.90	0.59	
02/06/98	Water	I-131	104.9 ±	10.5	110.00 ±	0.00	0.84	
02/13/98	Water	Ra-226	16.0 ±	2.4	14.67 ±	0.58	-0.96	
		Ra-228	33.3 ±	8.3	32.00 ±	2.00	-0.27	
03/13/98	Water	H-3	2155.0 ±	348.0	1833.33 ±	57.74	-1.60	
04/21/98	Water	Gr-Alpha	54.4 ±	13.6	50.00 ±	1.73	-0.56	
		Ra-226	15.0 ±	2.3	15.00 ±	0.00	0.00	
		Ra-228	9.3 ±	2.3	8.50 ±	0.20	-0.60	
		Gr-Beta	94.7 ±	10.0	102.00 ±	6.56	1.26	
		Sr-89	6.0 ±	5.0	4.67 ±	1.15	-0.46	
		Sr-90	18.0 ±	5.0	21.67 ±	1.15	1.27	
		Co-60	50.0 ±	5.0	52.33 ±	1.53	0.81	
		Cs-134	22.0 ±	5.0	21.00 ±	1.00	-0.35	
		Cs-137	10.0 ±	5.0	11.67 ±	0.58	0.58	
06/05/98	Water	Co-60	12.0 ±	5.0	13.00 ±	1.00	0.35	
		Zn-65	104.0 ±	10.0	111.67 ±	2.52	1.33	
		Cs-134	31.0 ±	5.0	32.33 ±	0.58	0.46	
		Cs-137	35.0 ±	5.0	37.67 ±	2.08	0.92	
		Ba-133	40.0 ±	5.0	35.00 ±	2.65	-1.73	
06/12/98	Water	Ra-226	4.9 ±	0.7	4.47 ±	0.85	-1.07	
		Ra-228	2.1 ±	0.5	1.93 ±	0.21	-0.58	
07/17/98	Water	Sr-89	21.0 ±	5.0	21.00 ±	1.00	0.00	
		Sr-90	7.0 ±	5.0	6.33 ±	0.58	-0.23	
07/24/98	Water	Gr-Alpha	7.2 ±	5.0	5.43 ±	0.64	-0.61	
		Gr-Beta	12.8 ±	5.0	14.67 ±	2.08	0.65	
08/07/98	Water	H-3	17996.0 ±	1800.0	16000.00 ±	0.00	-1.92	
09/11/98	Water	I-131	6.1 ±	2.0	5.93 ±	0.55	-0.14	
09/18/98	Water	Ra-226	1.7 ±	0.3	1.53 ±	0.46	-0.96	
		Ra-228	5.7 ±	1.4	6.70 ±	0.35	1.24	
10/20/98	Water	Gr-Beta	94.0 ±	10.0	74.67 ±	7.64	-3.35	(d)
		Sr-89	19.0 ±	5.0	18.33 ±	1.53	-0.23	
		Sr-90	8.0 ±	5.0	8.33 ±	1.15	0.12	
		Co-60	21.0 ±	5.0	22.33 ±	1.15	0.46	
		Cs-134	6.0 ±	5.0	6.67 ±	0.58	0.23	
		Cs-137	50.0 ±	5.0	56.33 ±	3.79	2.19	(e)

VEPCO NORTH ANNA
EPA INTERLABORATORY COMPARISON PROGRAM 1998
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Normal Dev. Known(c)
10/20/98	Water	Gr-Alpha	30.1 ±	7.5	21.67 ±	2.31	-1.95
		Ra-226	4.5 ±	0.7	4.67 ±	0.25	0.41
		Ra-228	1.5 ±	0.4	1.9 ±	0.20	1.73
11/06/98	Water	Co-60	38.0 ±	5.0	39.67 ±	2.52	0.58
		Zn-65	131.0 ±	13.0	140.67 ±	10.97	1.29
		Cs-134	105.0 ±	5.0	103.00 ±	2.00	-0.69
		Cs-137	111.0 ±	6.0	115.33 ±	1.53	1.25
		Ba-133	56.0 ±	6.0	46.33 ±	2.52	-2.79 (f)

Footnotes:

(a) EPA Results-Expected laboratory precision (1 sigma). Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(b) Teledyne Results - Average ± one sigma. Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(c) Normalized deviation from the known.

(d) The special EPA instructions concerning multiple evaporation with concentrated nitric acid (to purge chlorides derived from HCl preservative) were omitted by oversight. The chlorides cause greater self absorption and lead to lower results. Two additional aliquots using two evaporations with concentrated nitric acid were analyzed. The results, when corrected for decay of Gr-Beta, were 87 and 83 pCi/liter which compare favorably with the EPA result.

(e) Weekly efficiency checks for the sample collect date (10/20/98) counted in December 1998, indicate that detectors were in compliance during that period of time. All detectors are calibrated using NIST traceable mixed gamma standards containing Cs137. The Branching Intensity value used in the calculation by the EPA is not available for cross-reference checks.

(f) The results of the EPA Interlaboratory Comparison Program, sample collect date 11/06/98, indicate a low bias for the Ba-133 result. Weekly efficiency counts for our detectors were found to be in compliance during that period of time. One possible cause for the low bias may be the Branching Intensity value used in the calculation. The EPA does not supply their values used to calculate activity. If the Brookhaven or RadDecay Data Tables are used to supply the B.I. and Half-Life, the calculated results will fall within the acceptable range:

TBEES (Atomic Data and Nuclear Data Tables Vol 13 Nos 2-3 1974)

	Branching Intensity	Half-Life	Calculated Activity
TBEES	0.670	10.9 years	46.33
Brookhaven Tables	0.6205	10.52 years	50.04
RadDecay Tables	0.605	10.5 years	51.31

VEPCO – NORTH ANNA
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 TI #57517 09/18/97	Milk	Sr-89	14 ± 1	15 ± 1	0.93
		Sr-90	18 ± 1	14 ± 1	1.29

Footnotes:

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

(b) Ratio of Teledyne Brown Engineering 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.

---- Ce-141 was identified by gamma spectrometry system (232 ± 23 pCi/l) for the 3/20/97 milk sample, but was not reported to Analytics.

ANALYTICS CROSS CHECK COMPARISON PROGRAM 1998

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b)
E1346-396 TI #71657 03/12/98	Milk	I-131	87 ± 9	82 ± 4	1.06
		Ce-141	66 ± 7	70 ± 4	0.94
		Cr-51	220 ± 30	201 ± 10	1.09
		Cs-134	85 ± 9	84 ± 4	1.01
		Cs-137	180 ± 20	161 ± 8	1.12
		Mn-54	130 ± 10	133 ± 7	0.98
		Fe-59	110 ± 10	95 ± 5	1.16
		Zn-65	160 ± 20	142 ± 7	1.13
		CO-60	82 ± 8	85 ± 4	0.96
E1460-396 TI #78921 06/11/98	Milk	I-131	68 ± 7	67 ± 3	1.01
		Ce-141	94 ± 9	99 ± 5	0.95
		Cr-51	97 ± 31	132 ± 7	0.73
		Cs-134	101 ± 10	95 ± 5	1.06
		Cs-137	79 ± 8	70 ± 4	1.13
		Mn-54	112 ± 11	106 ± 5	1.06
		Fe-59	58 ± 9	45 ± 2	1.29
		Zn-65	143 ± 14	122 ± 6	1.17
		CO-60	157 ± 16	143 ± 7	1.10
E1630-396 TI #94881 12/14/98	Milk	I-131	65 ± 1	71 ± 4	0.92
		Ce-141	647 ± 65	746 ± 37	0.87
		Cr-51	900 ± 90	979 ± 49	0.92
		Cs-134	200 ± 20	220 ± 11	0.91
		Cs-137	177 ± 18	183 ± 9	0.97
		Mn-54	136 ± 14	142 ± 7	0.96
		Fe-59	156 ± 16	148 ± 7	1.05
		Zn-65	132 ± 14	140 ± 7	0.94
		CO-60	169 ± 17	178 ± 9	0.95
		Sr-89	20 ± 2	69 ± 3	0.29 (c)
		Sr-90	16 ± 1	41 ± 2	0.39 (c)
E1631-396 TI #94882 12/14/98	Filter	Ce-141	566 ± 57	524 ± 26	1.08
		Cr-51	800 ± 80	687 ± 49	1.16
		Cs-134	147 ± 15	154 ± 8	0.95
		Cs-137	158 ± 16	128 ± 6	1.23
		Mn-54	122 ± 12	100 ± 5	1.22
		Fe-59	134 ± 13	104 ± 5	1.29
		Zn-65	129 ± 13	98 ± 5	1.32
		CO-60	134 ± 13	125 ± 6	1.07
E1632-396 TI #94883 12/14/98	Water	H-3	5500 ± 200	5980 ± 299	0.92
E1633-396 TI #94884 12/14/98	Water	Am-241	8.3 ± 1.5	7.9 ± 0.4	1.05
		Pu-239	9.8 ± 1.8	8.9 ± 0.4	1.10

Footnotes:

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

(b) Ratio of Teledyne Brown Engineering to Analytics results. Acceptance criteria are based on USNRC acceptance criteria described in USNRC Procedure 84750 dated March 15, 1994.

(c) The original and repeat analysis data sheets for Sr-89 and Sr-90 have been reconstructed from information in the laboratory notebook and the counter printouts. This sample was originally analyzed in January 1999 (login L4004) and produced unacceptable radiostrontium results. The analysis was repeated in April 1999 using a smaller aliquot of 500 ml because 1000 ml was no longer available. The repeat analysis produced good results:

Result	Analytics value		ratio
Sr-89	74 +- 8	69 +- 3	1.07
Sr-90	37 +- 1	41 +- 2	0.90

A problem such as sample identity is suspected for the first analysis.

VEPCO - NORTH ANNA
ANALYTICS CROSS CHECK COMPARISON PROGRAM 1999

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result(b)	Ratio (c)
E1823-396 TI #09576 06/24/99	Water	Sr-89	60 ± 5	69 ± 3	0.87
		Sr-90	35 ± 2	46 ± 2	0.76
E1824-396 TI #09577 06/24/99	Water	Gr-A	160 ± 10	98 ± 5	1.63 (d)
		Gr-B	300 ± 10	290 ± 15	1.03
E1825-396 TI #09578 06/24/99	Water	I-131	77 ± 13	68 ± 3	1.13
		Ce-141	139 ± 14	134 ± 7	1.04
		Cr-51	162 ± 42	172 ± 9	0.94
		Cs-134	86 ± 9	92 ± 5	0.93
		Cs-137	167 ± 17	151 ± 8	1.11
		Mn-54	77 ± 8	68 ± 3	1.13
		Fe-59	40 ± 9	38 ± 2	1.05
		Zn-65	113 ± 12	98 ± 5	1.15
		Co-60	179 ± 18	171 ± 9	1.05
E1826-396 TI #09579 06/24/99	Filter	Ce-141	169 ± 17	162 ± 8	1.04
		Cr-51	241 ± 24	208 ± 10	1.16
		Cs-134	105 ± 10	111 ± 6	0.95
		Cs-137	211 ± 21	182 ± 9	1.16
		Mn-54	96 ± 10	82 ± 4	1.17
		Fe-59	55 ± 8	46 ± 2	1.20
		Zn-65	144 ± 14	118 ± 6	1.22
		Co-60	214 ± 21	206 ± 10	1.04
E1827-396 TI #09580 06/24/99	Soil	Ce-141	0.274 ± 0.027	0.269 ± 0.013	1.02
		Cr-51	0.374 ± 0.103	0.345 ± 0.017	1.08
		Cs-134	0.200 ± 0.020	0.184 ± 0.009	1.09
		Cs-137	0.450 ± 0.045	0.429 ± 0.021	1.05
		Mn-54	0.153 ± 0.015	0.136 ± 0.007	1.13
		Fe-59	0.118 ± 0.022	0.077 ± 0.004	1.53 (e)
		Zn-65	0.206 ± 0.021	0.196 ± 0.010	1.05
		Co-60	0.351 ± 0.035	0.343 ± 0.017	1.02

Footnotes:

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters. Units are pCi/gram for Soil, which has been added to the program for 1999.

(b) Analytics Result - Average ± 3 sigma

(c) Ratio of Teledyne Brown Engineering to Analytics results. Acceptance criteria are based on USNRC acceptance criteria described in USNRC Procedure 84750 dated March 15, 1994.

(d) A high Gross Alpha result was obtained because the calculation was mistakenly performed using Th-230 counting efficiency. If our normal Am-241 calibration were used, we would have reported *110 +- 10 pCi/L*, which is an acceptable value.

(e) Random or coincidental summing caused the problem. Two other energy lines can sum a peak on the same energy band causing more counts to be thrown in. The key line was changed and the resulting value was 0.079, which is in agreement with Analytics.

VEPCO – NORTH ANNA
ERA STATISTICAL SUMMARY
PROFICIENCY TESTING (PT) PROGRAM – 1999
SAMPLE TYPE: WATER

TI #s	DATE	NUCLIDE	ERA Known Value (pCi/l)(a)	TBE Result (b) (pCi/l)	Expected Dev. Known (c) (pCi/l)	Control Limits (d) (pCi/l)	Warning Limits (e) (pCi/l)	Performance Evaluation (f)
11811-11813	8/23/99	U(NAT)	12.4	13.0	3.00	7.20-17.6	8.94-15.9	A
11811-11813	8/20/99	Ra-226	7.21	7.37	1.08	5.34-9.08	5.96-8.46	A
11811-11813	8/23/99	Ra-228	4.51	7.17	1.13	2.57-6.45	3.21-5.81	NA (g)
11808-11810	8/24/99	Sr-89	26.6	25.0	5.00	17.9-35.3	20.8-32.4	A
11808-11810	8/24/99	Sr-90	40.2	39.7	5.00	31.5-48.9	34.4-46.0	A
13058-13060	9/15/99	Gr-A	48.6	30.3	12.2	27.7-69.5	34.6-62.6	CE (h)
13061-13063	9/14/99	Gr-B	20.0	22.0	5.00	11.3-28.7	14.2-25.8	A
14425-14427	9/01/99	H-3	6130	5530	613	5090-7170	5420-6840	A

Footnotes:

(a) The ERA Known Value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.
(b) Average ± 1 sigma.
(c) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
(d) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
(e) Established per the guidelines contained in the EPA's National Standards for Water Proficiency Testing Criteria Document, December 1998, as applicable.
(f) A= Acceptable. Reported Result falls within the Warning Limits.
NA = Not Acceptable. Reported Result falls outside of the Control Limits.
CE = Check for Error. Reported Result falls within the Control Limits and outside of the Warning Limits.
(g) A calculation error was made by not correcting for Ra-226 content. If this correction is made, an average result of 5.7 pCi/l is obtained which is in the acceptance region.
(h) The low value is attributed to greater self-absorption characteristics of the sample matrix compared to those of the calibration matrix. This source of bias is often observed in gross alpha measurements, nevertheless, the average result is within the control region (but also in the warning region).

Interlaboratory Comparison Program

1997 – 1998 – 1999

ADDENDUM

1. **Analysis of milk samples for Potassium (K) in the Interlaboratory Comparison Program (ICP) (1997-1999).**
   The Offsite Dose Calculation Manual lists the analyses to be performed for the Interlaboratory Comparison Program. The requirement for Milk – "K" cannot be met. The EPA deleted the analysis of Milk samples from the Cross-Check program in 1996. Teledyne Brown Engineering Environmental Services (TBEES) contracted with Analytics, Inc., to provide milk samples spiked with Sr-89/90, I-131, and other gamma emitters. Although the results reported to Analytics included K-40, this radionuclide was not evaluated by Analytics. Subsequent analyses of Analytics milk samples were not evaluated for K-40 also. Analytics has indicated that the accuracy of the potassium measurement cannot be determined with a sufficiently high degree of integrity to permit its' use as a proficiency test radionuclide.

2. **Analysis of milk samples for Strontium (Sr) 89 and 90 (1998).**
   The VEPCO contract requires TBE to perform interlaboratory crosschecks of these analyses. TBE presumed, erroneously, that we were meeting the requirements of the contract.

3. **Analysis of air filter samples for Strontium 90, Gross Beta (1998 - 1999).**
   The VEPCO contract requires TBEES to perform interlaboratory crosschecks of these analyses. TBEES erroneously presumed they were meeting the requirements of the contract.

4. **Analysis for Milk - I-131, Gamma, Strontium 89 and 90 (1999).**
   The VEPCO contract requires TBE to perform interlaboratory crosschecks of these analyses. TBEES erroneously presumed they were meeting the requirements of the contract.

5. **Methodology and results of the ICP – Analytics (vendor) not in TBEES QC Manual.**
   This requires documentation revision. This issue will be addressed in the year 2000 with the entire implementation of the National Environmental Laboratory Accreditation Program (NELAP). Revisions of controlled documentation will be distributed to the appropriate control officers at the power plant stations as outlined in the contract.

6. **Trend Data of Cross-Check Program (ICP) (1997-1999)**
   Graphs of data have been updated in the report. Data in which there is only one data point have not been graphed, since there are no trends apparent to the upper and lower control limits. Therefore, one-point data information has no real value.

7. **Corrective Actions to prevent non-compliance of the Interlaboratory Comparison Program (1999).**

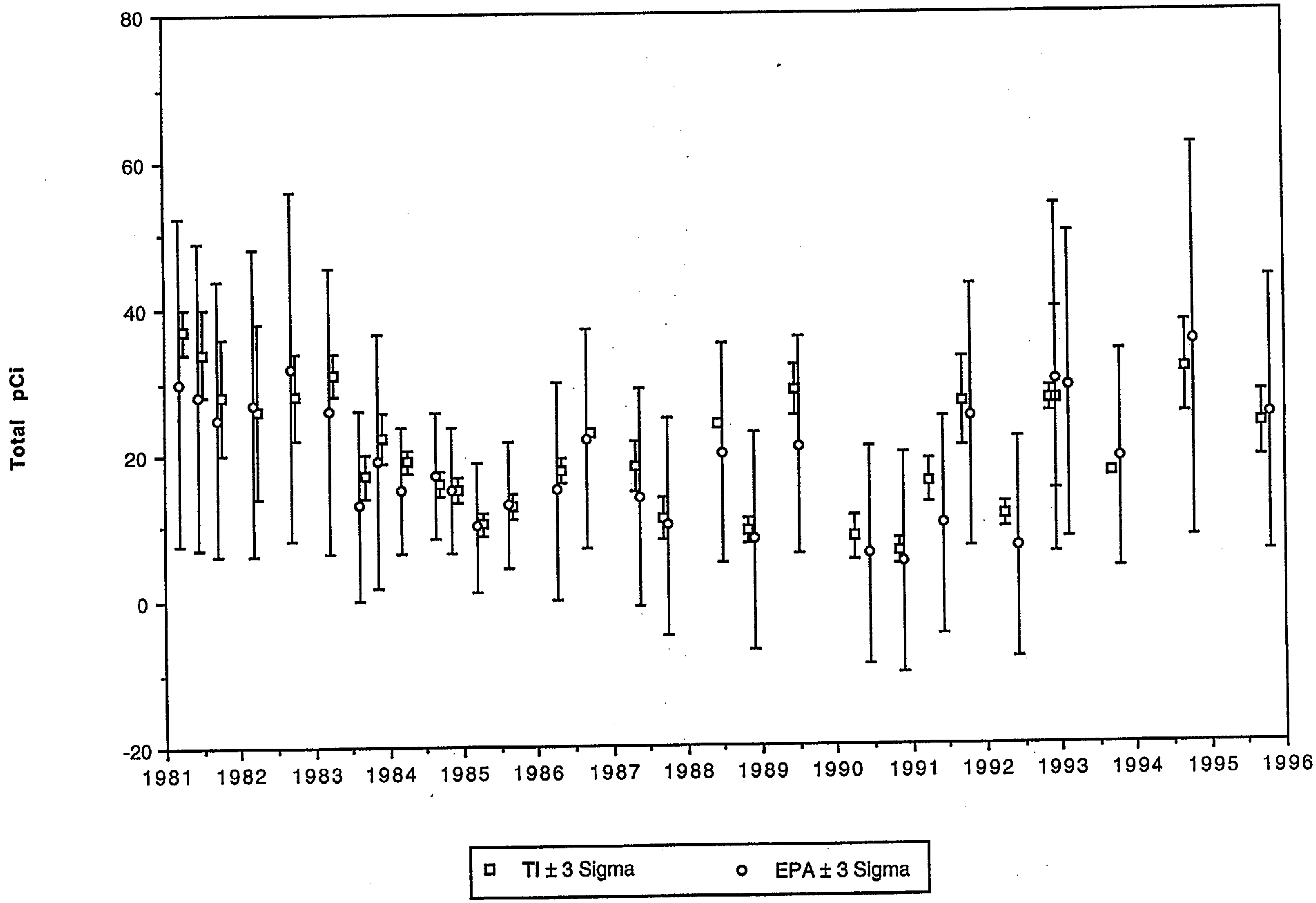
The remaining requirements for Water and Air Filters were supported by TBEES' Vendor Interlaboratory Comparison Program. Analyses of Air Filters for Sr-90 and Gross Beta analyses were not performed in the 1999 Analytics studies. TBEES ordered ICP studies based on workload for the entire laboratory operations and did not take into account the specific contract requirements for VEPCO. Corrective actions include the following:

- The VEPCO contract with TBEES was revised to include the specific media and analysis requirements for the ICP.
- TBEES' 2000 Performance Testing (PT) Programs will meet the VEPCO contract requirements. Vendor (Analytics and Environmental Resource Associates) contracts have been revised and implemented for the year 2000.
- The potassium analysis requirement for milk was eliminated from the ICP since it is a primordial element and not associated with nuclear power plant effluents.
- An ICP checklist has been included in the North Anna Power Station procedure for generating the Radiological Environmental Operating Report (REOR). This checklist ensures all ICP elements are assessed prior to submitting the REOR to the NRC.
- The requirement to maintain the methodology and results of the ICP in a QC manual has been eliminated as it is not a requirement of Branch Technical Position, November 1979, Revision 1, An Acceptable Radiological Environmental Monitoring Program.
- VEPCO will perform an audit of TBEES in the year 2000.

APPENDIX E
INTERLABORATORY COMPARISON PROGRAM

EPA CROSS CHECK PROGRAM

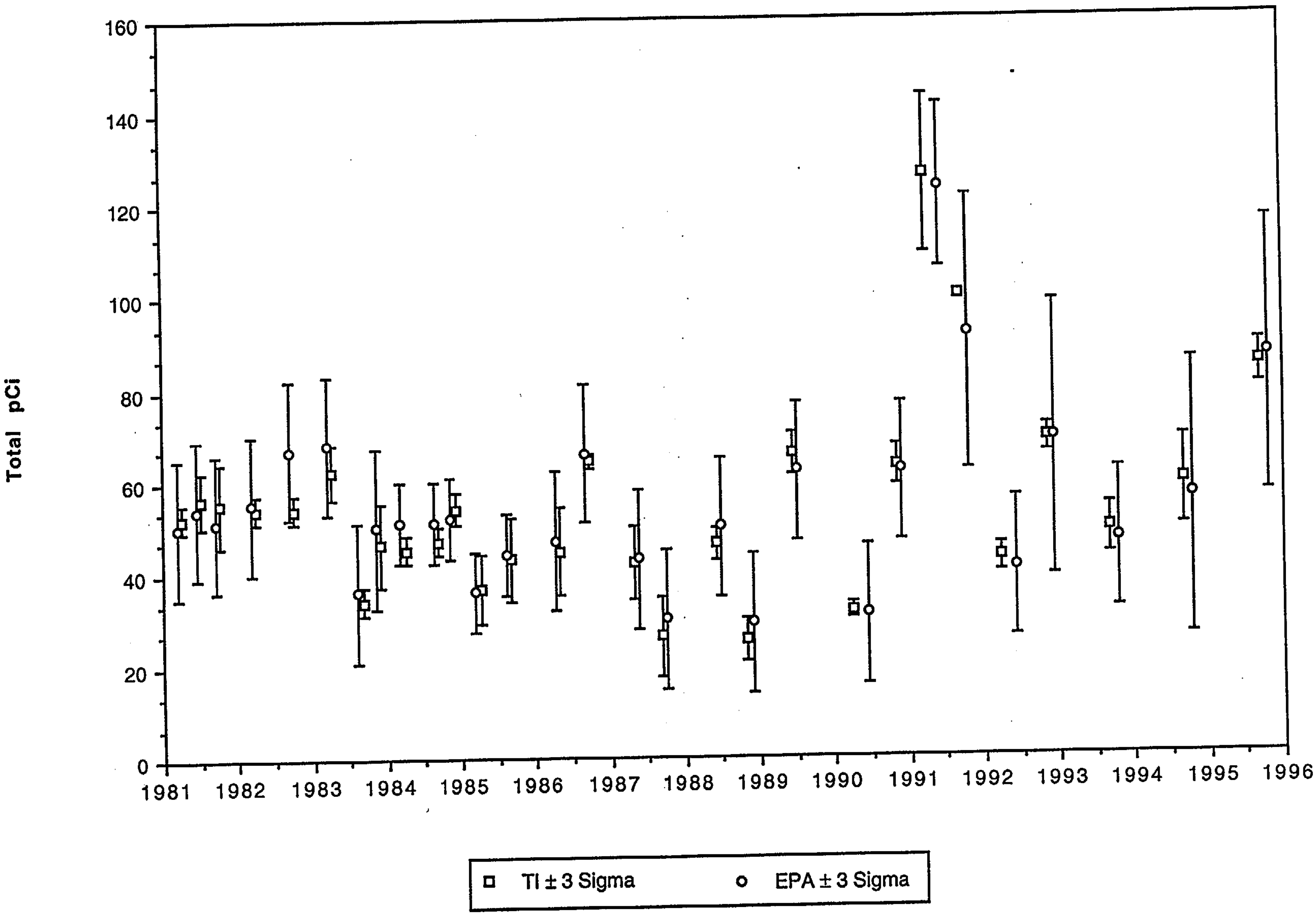
GROSS ALPHA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

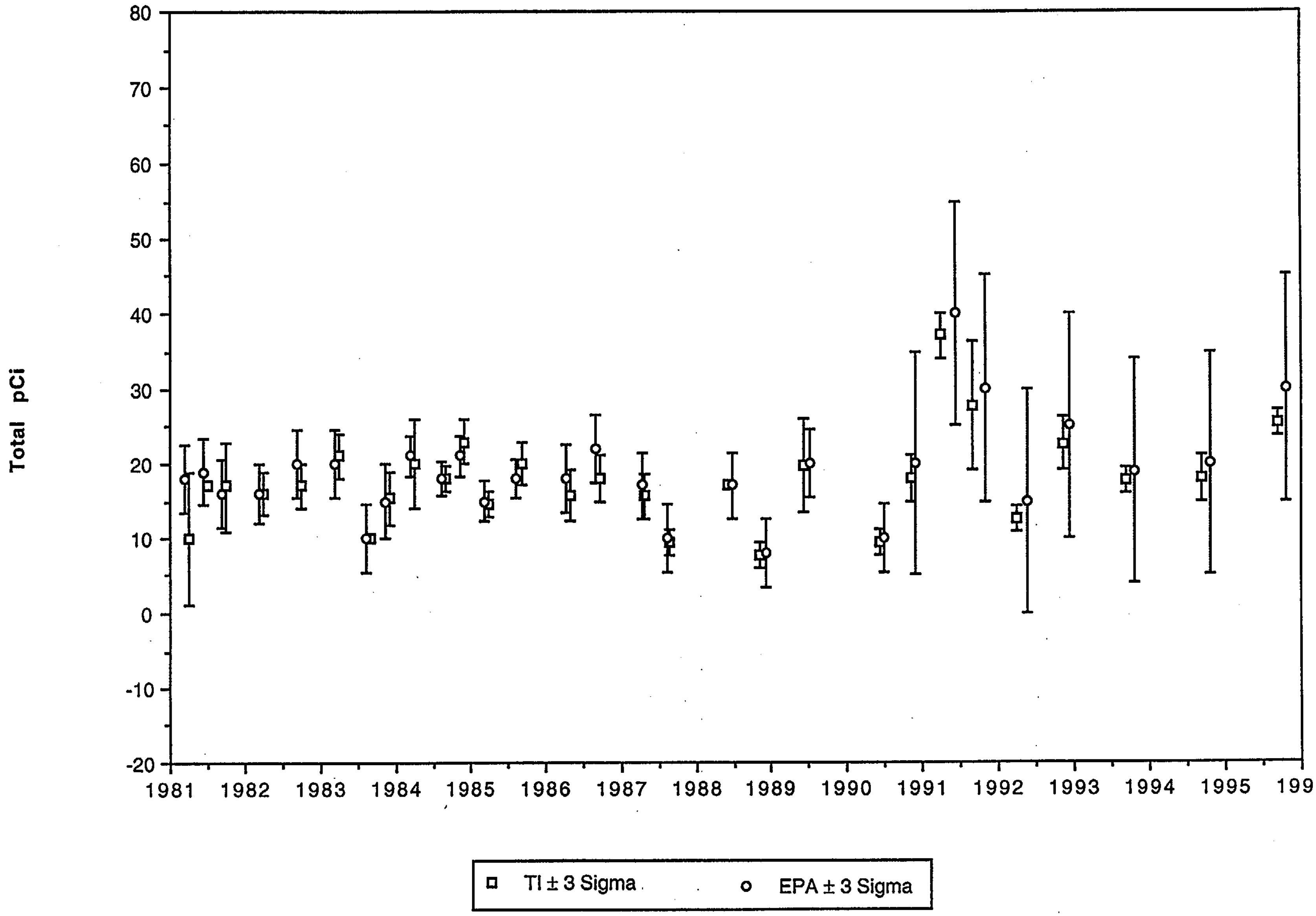
GROSS BETA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

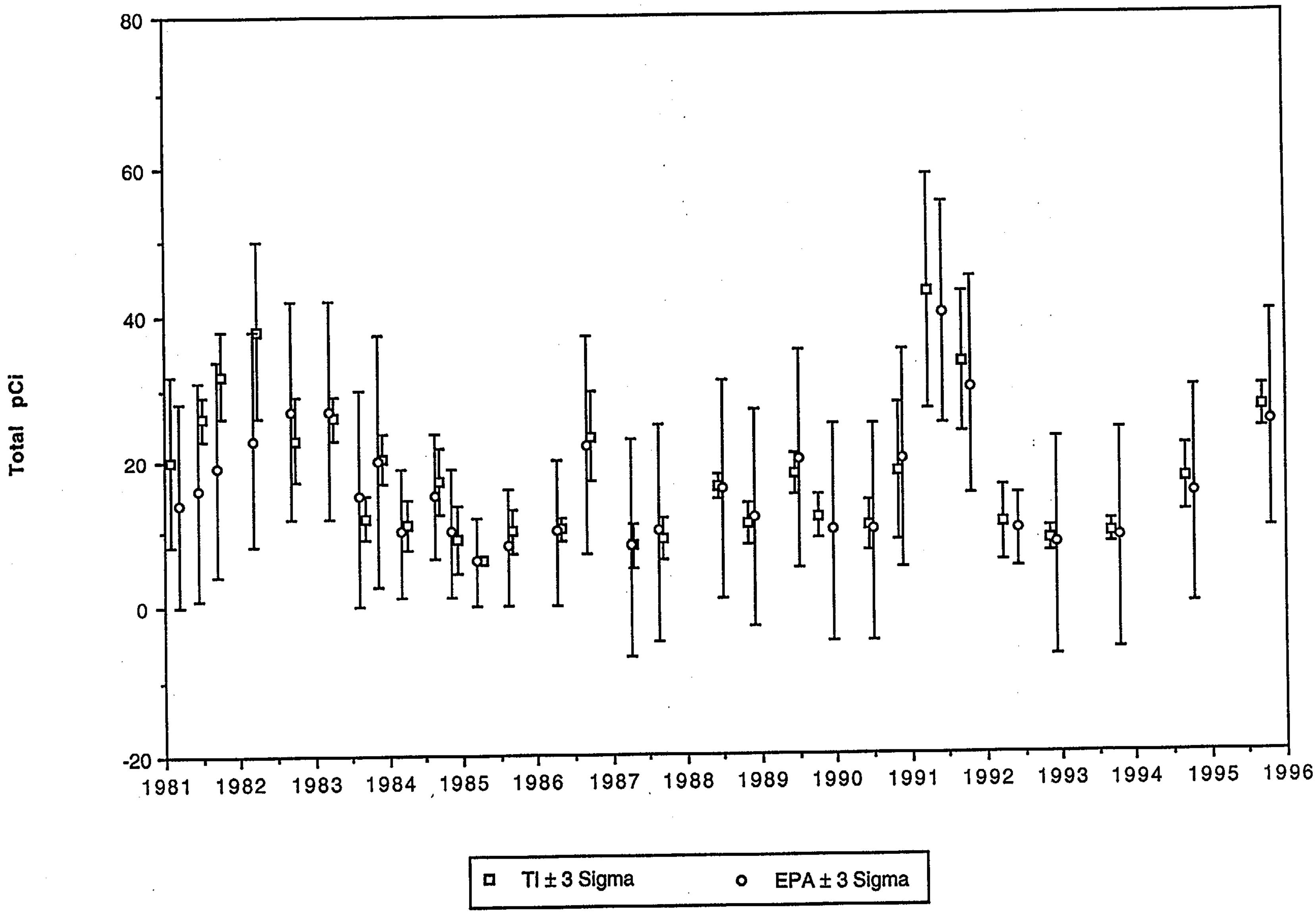
STRONTIUM-90 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

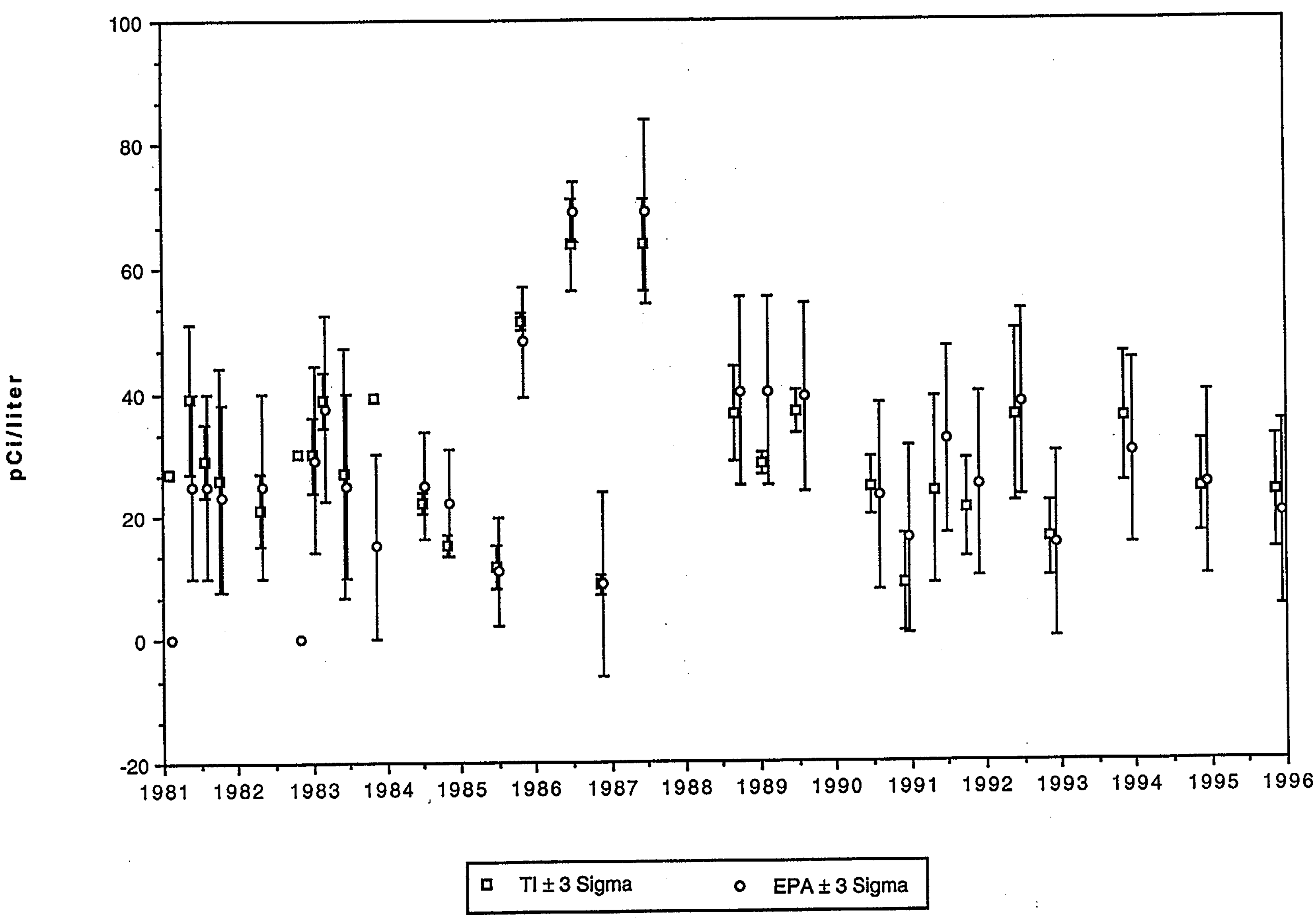
CESIUM-137 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

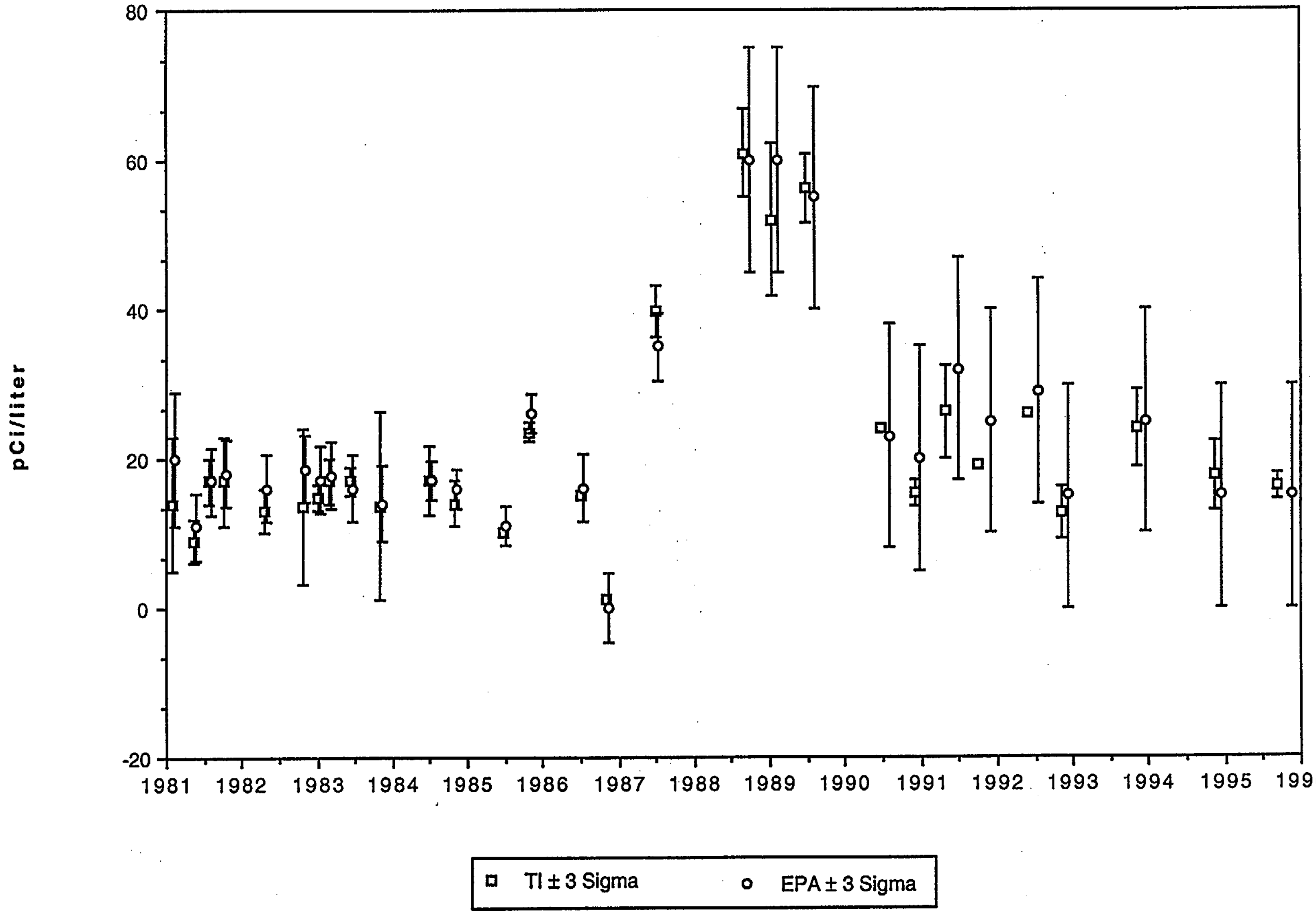
STRONTIUM-89 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

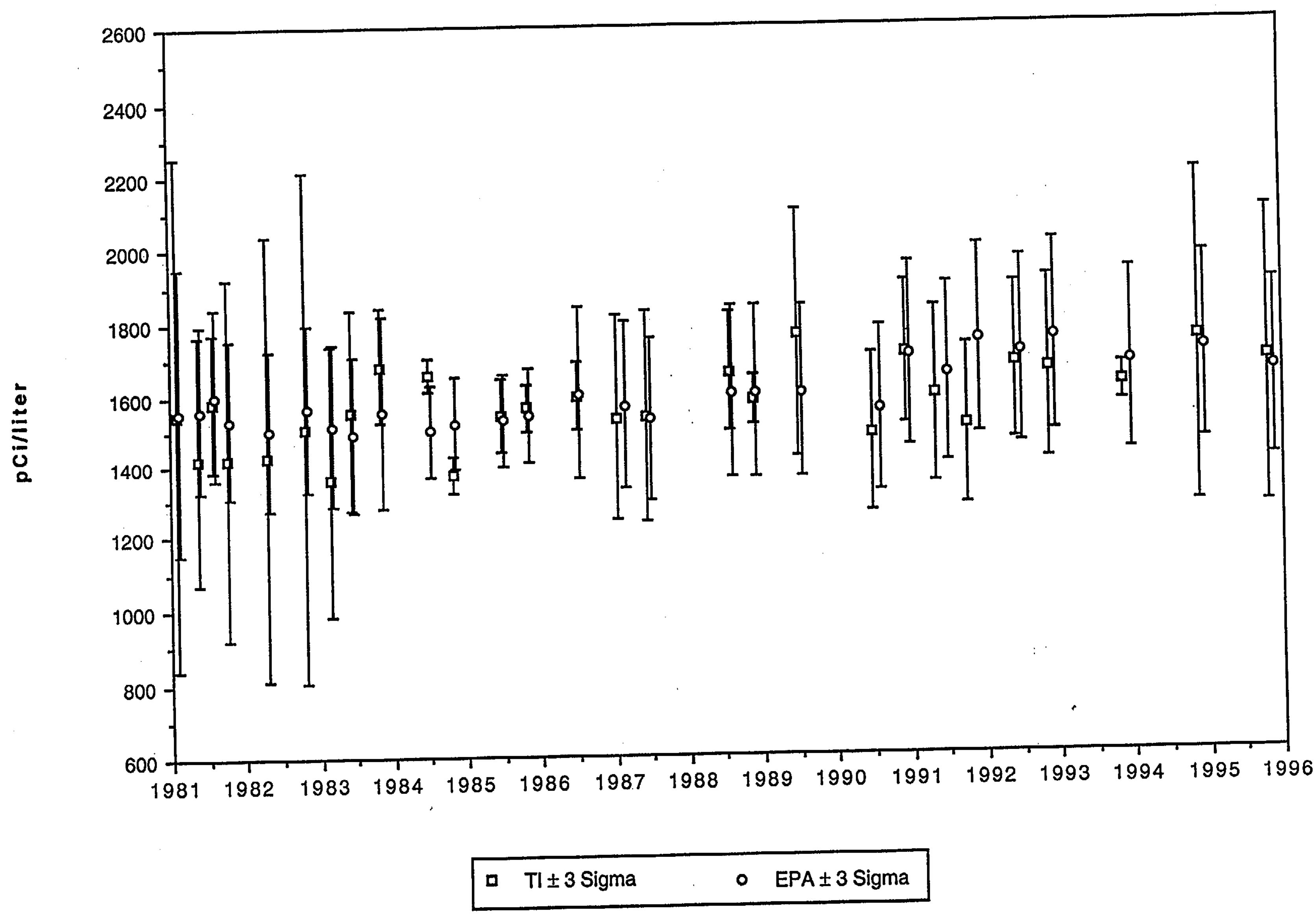
STRONTIUM-90 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

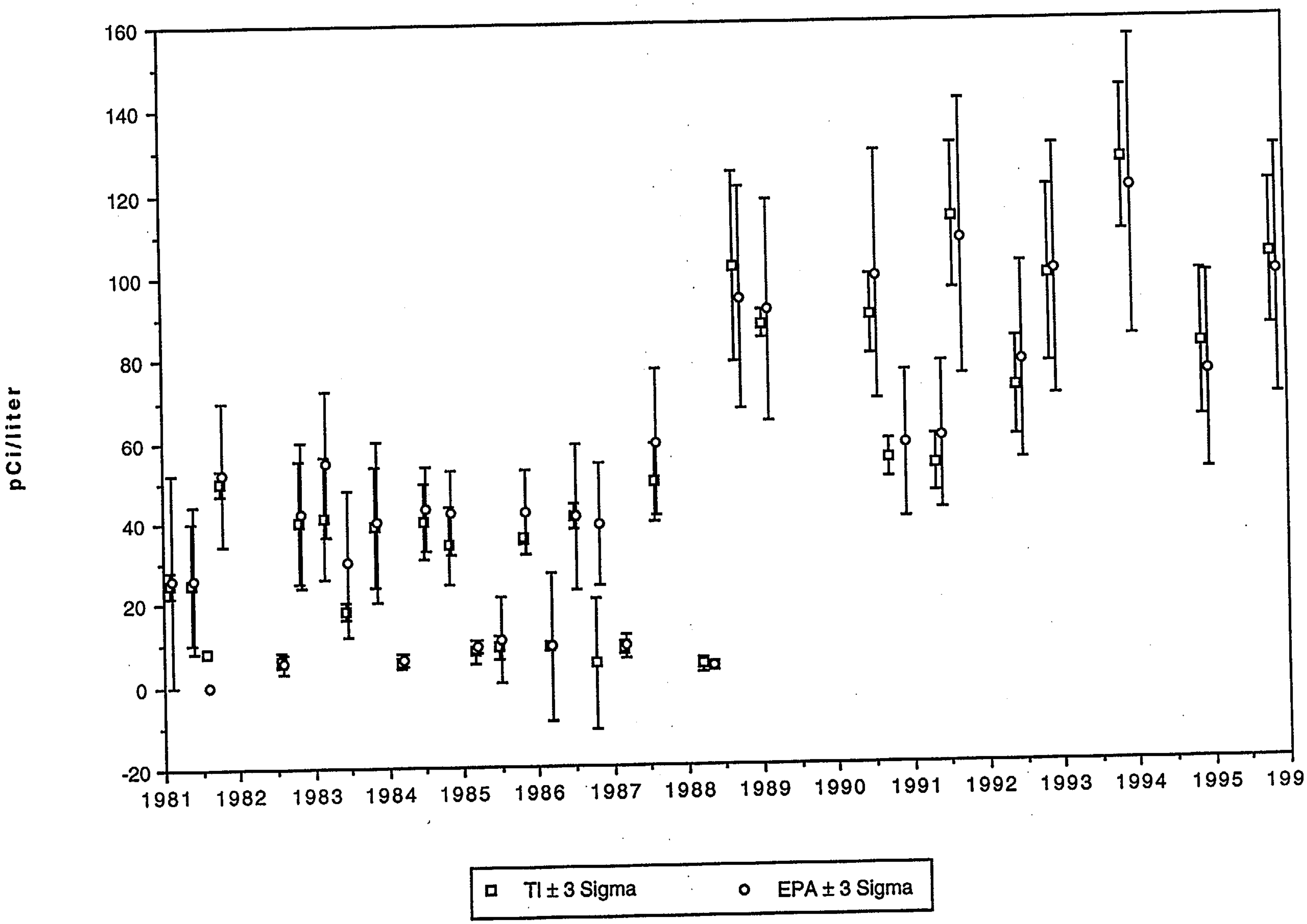
POTASSIUM-40 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

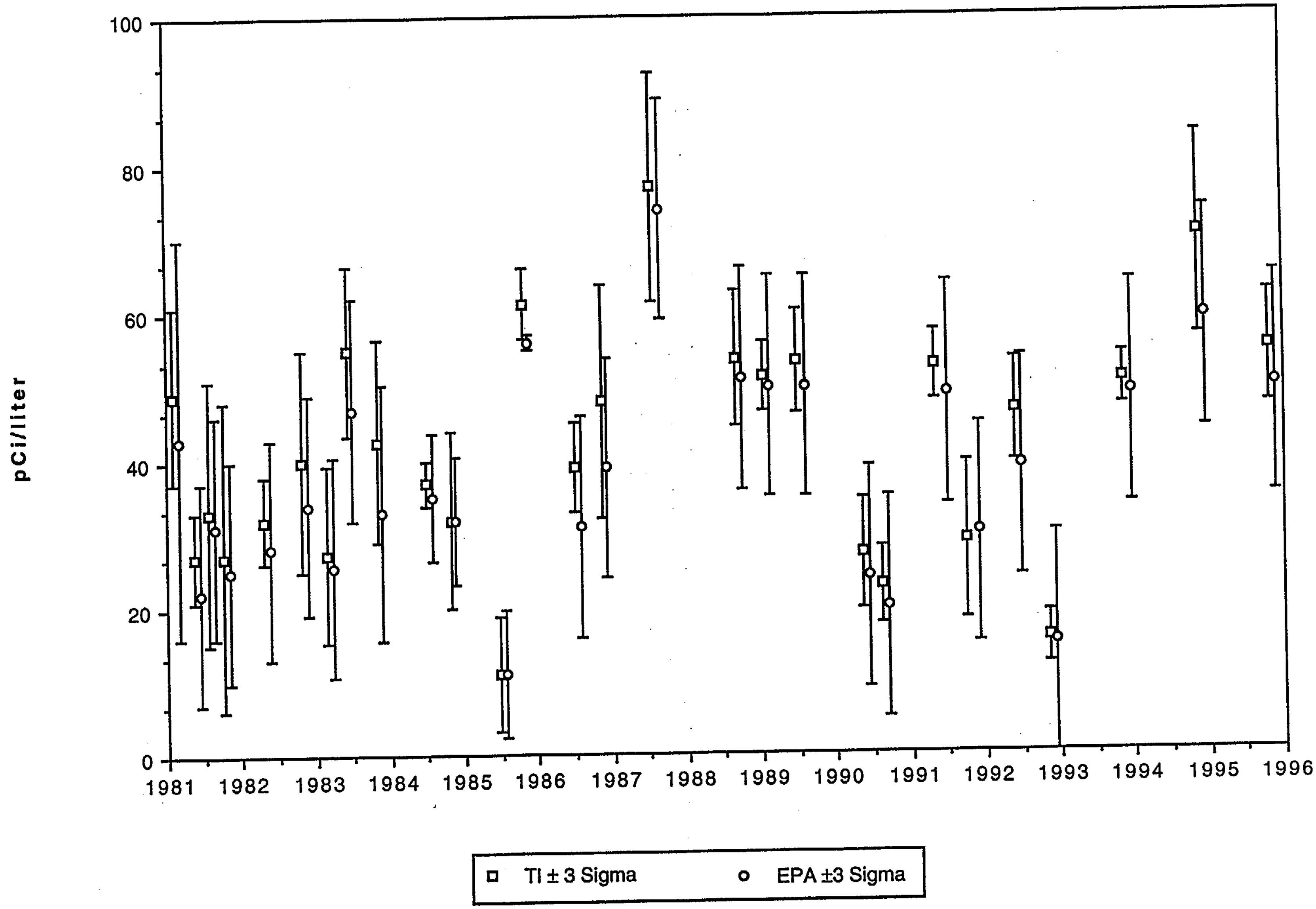
IODINE-131 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

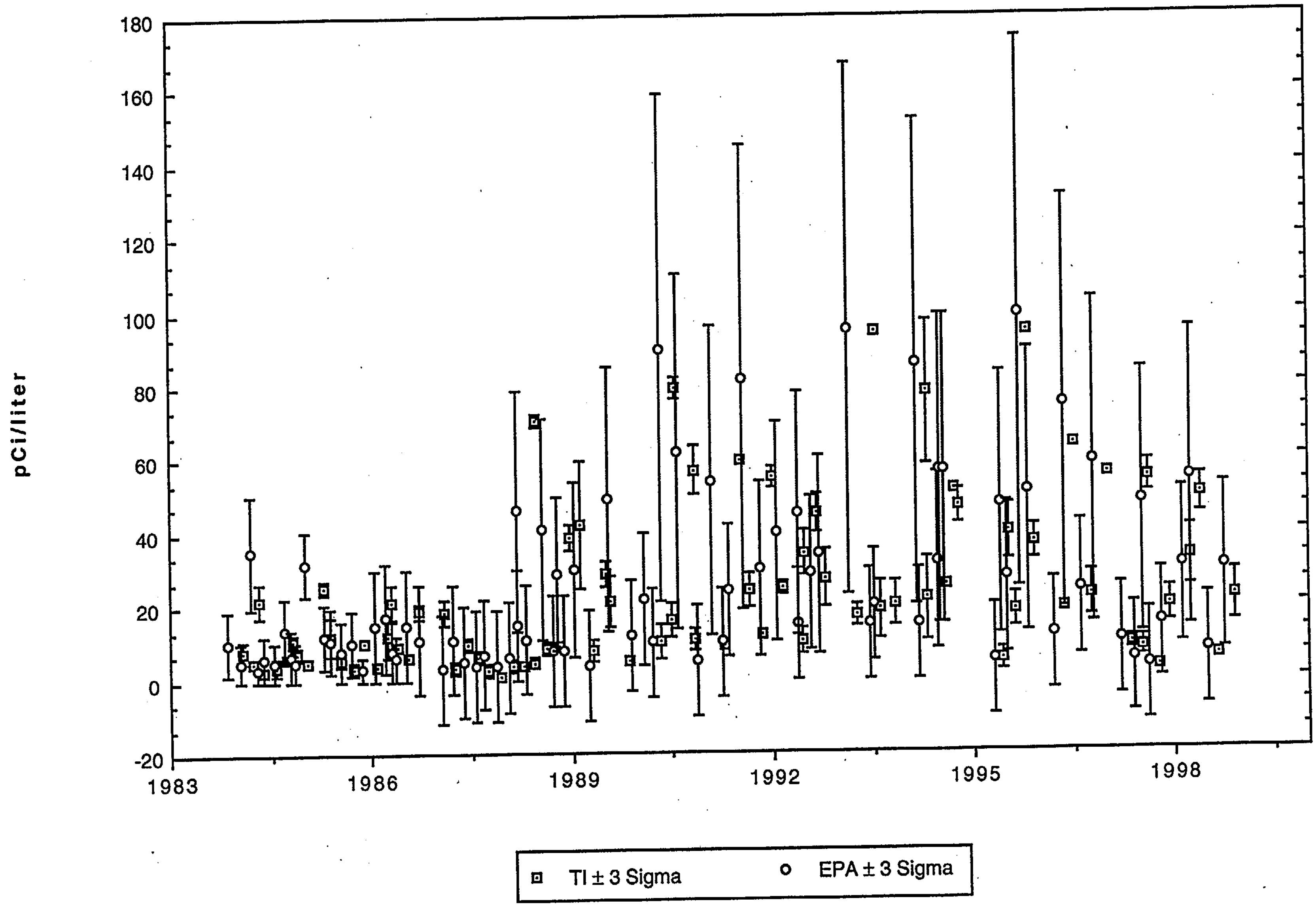
CESIUM-137 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

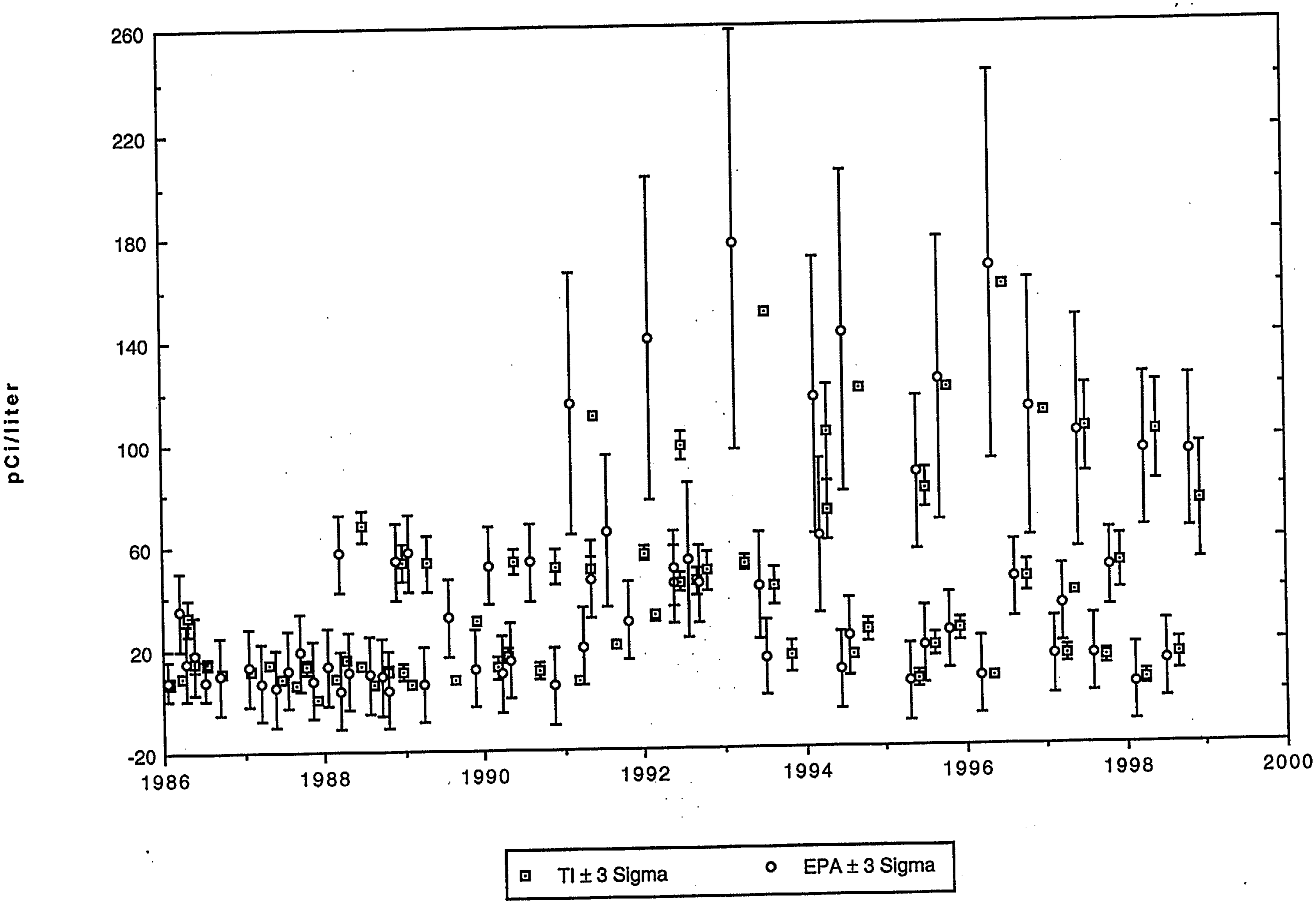
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)



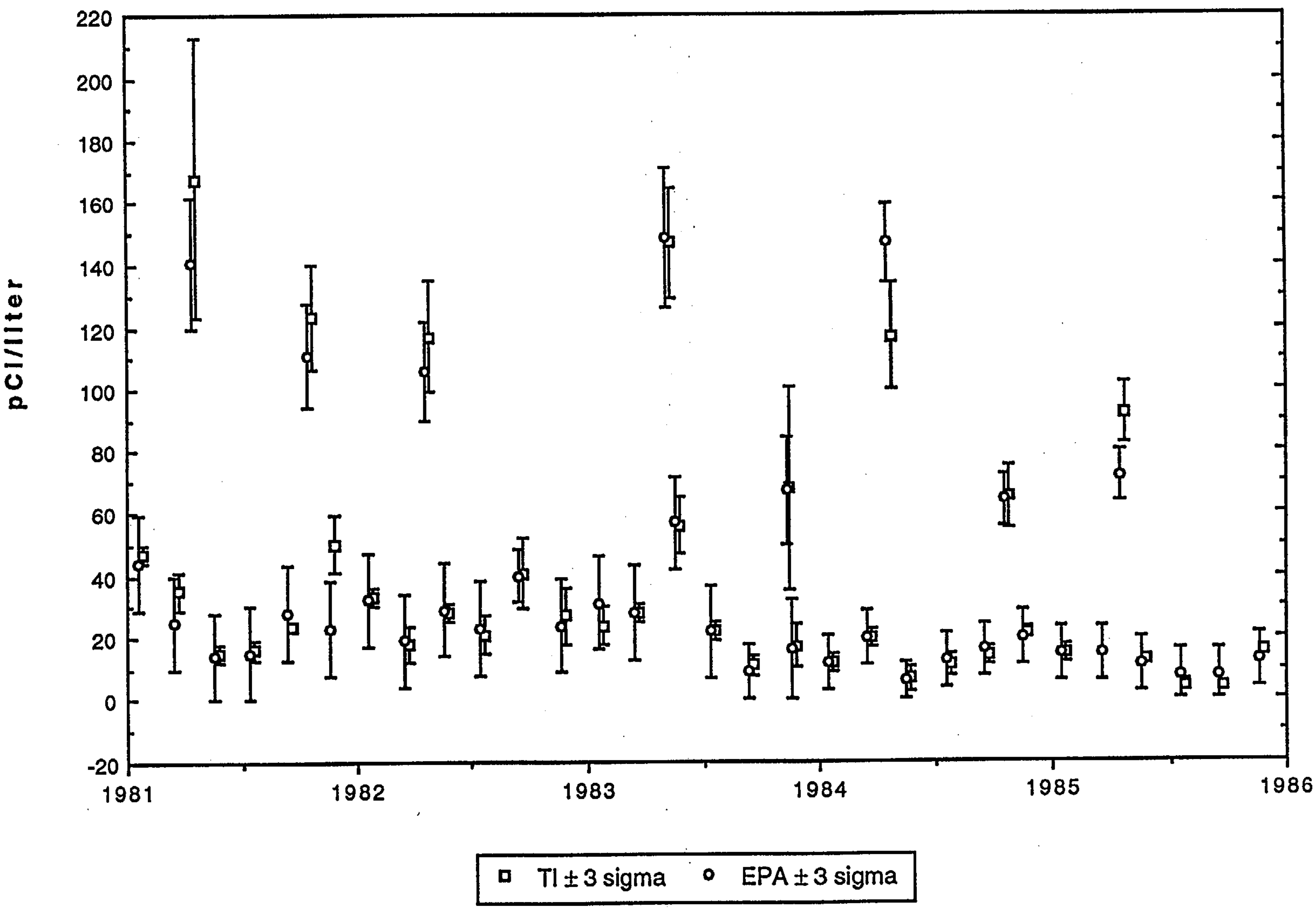
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 2 of 2)



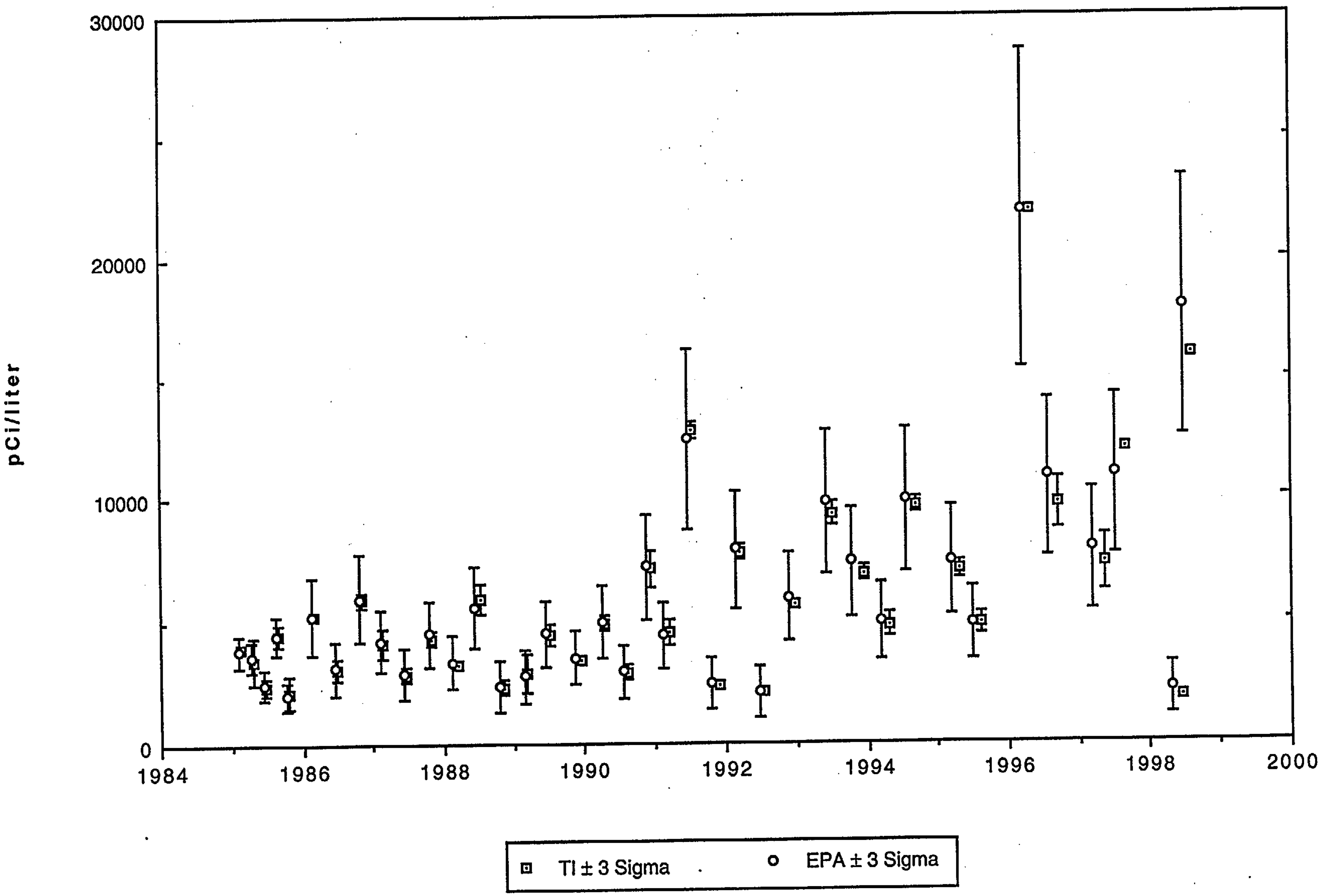
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)



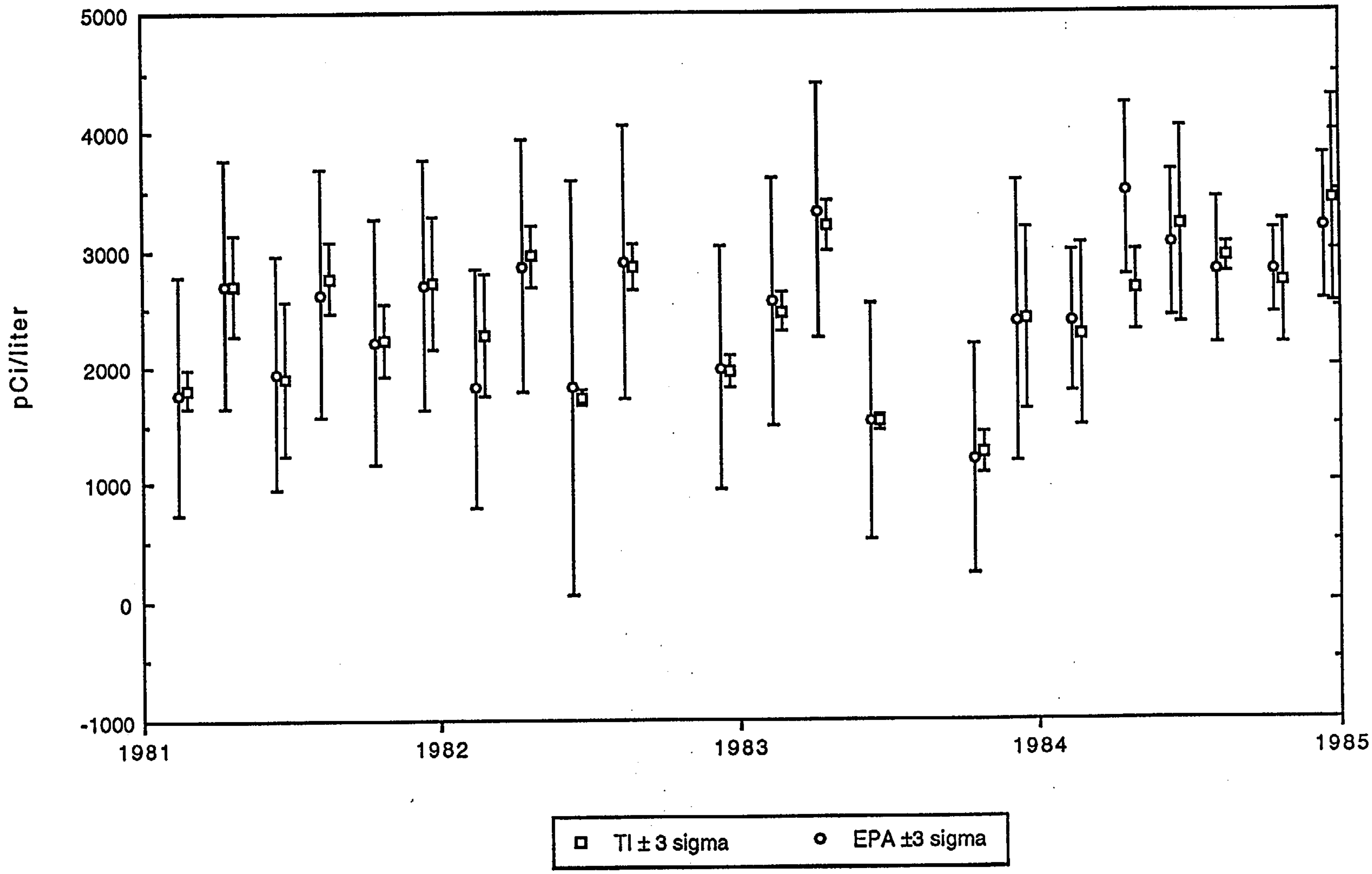
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 2 of 2)



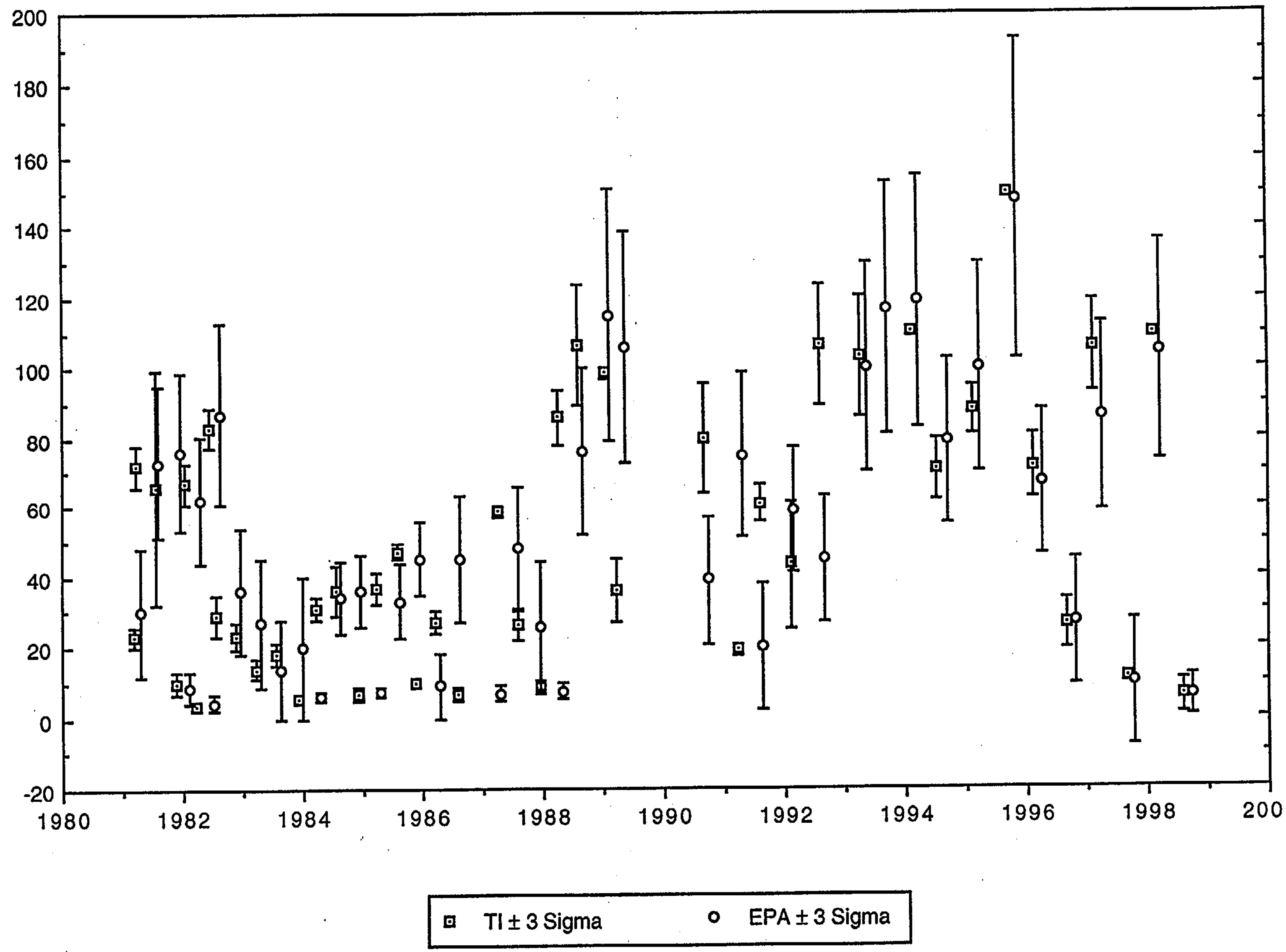
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



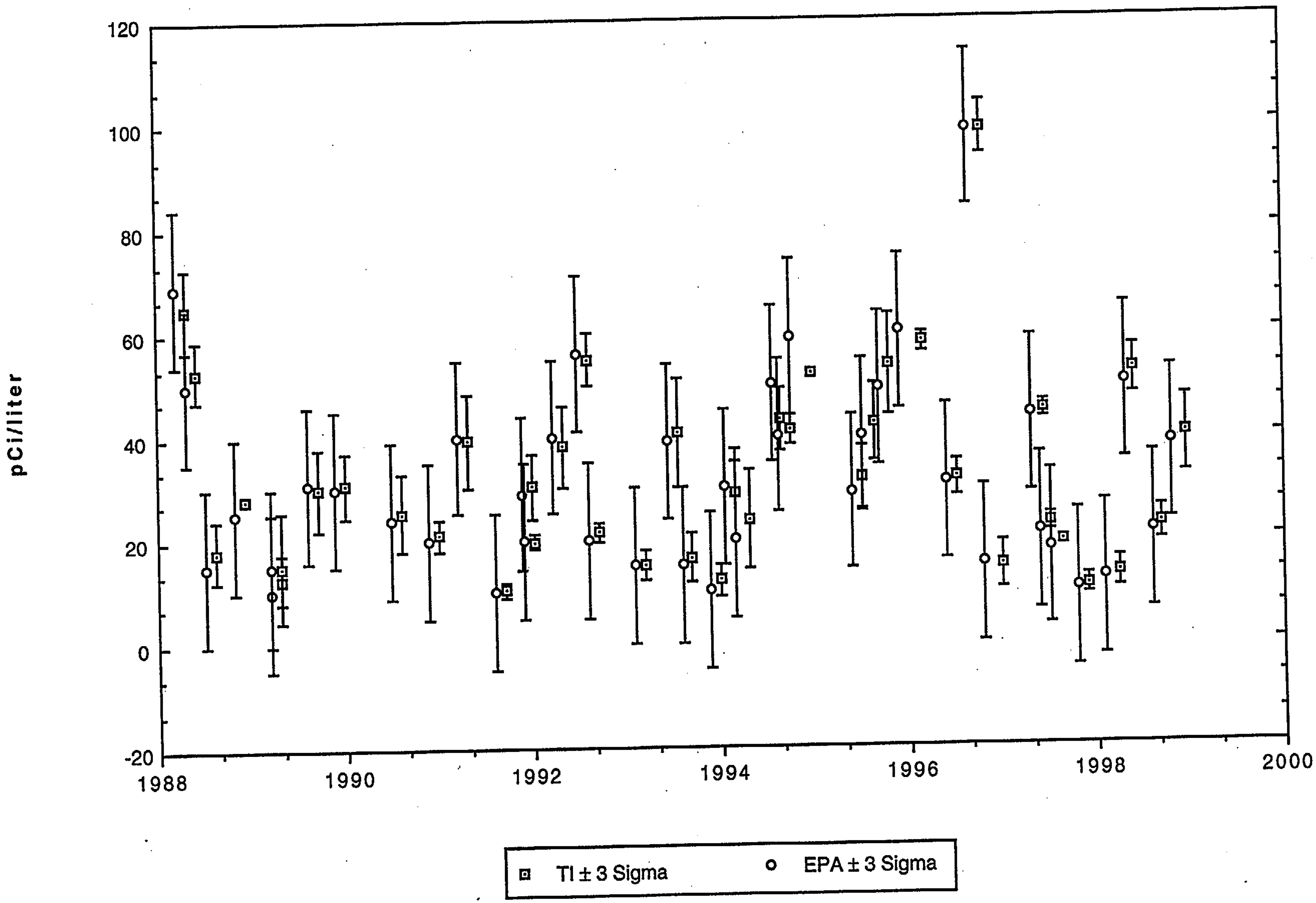
EPA CROSS CHECK PROGRAM

IODINE IN WATER (pg. 1 of 1)



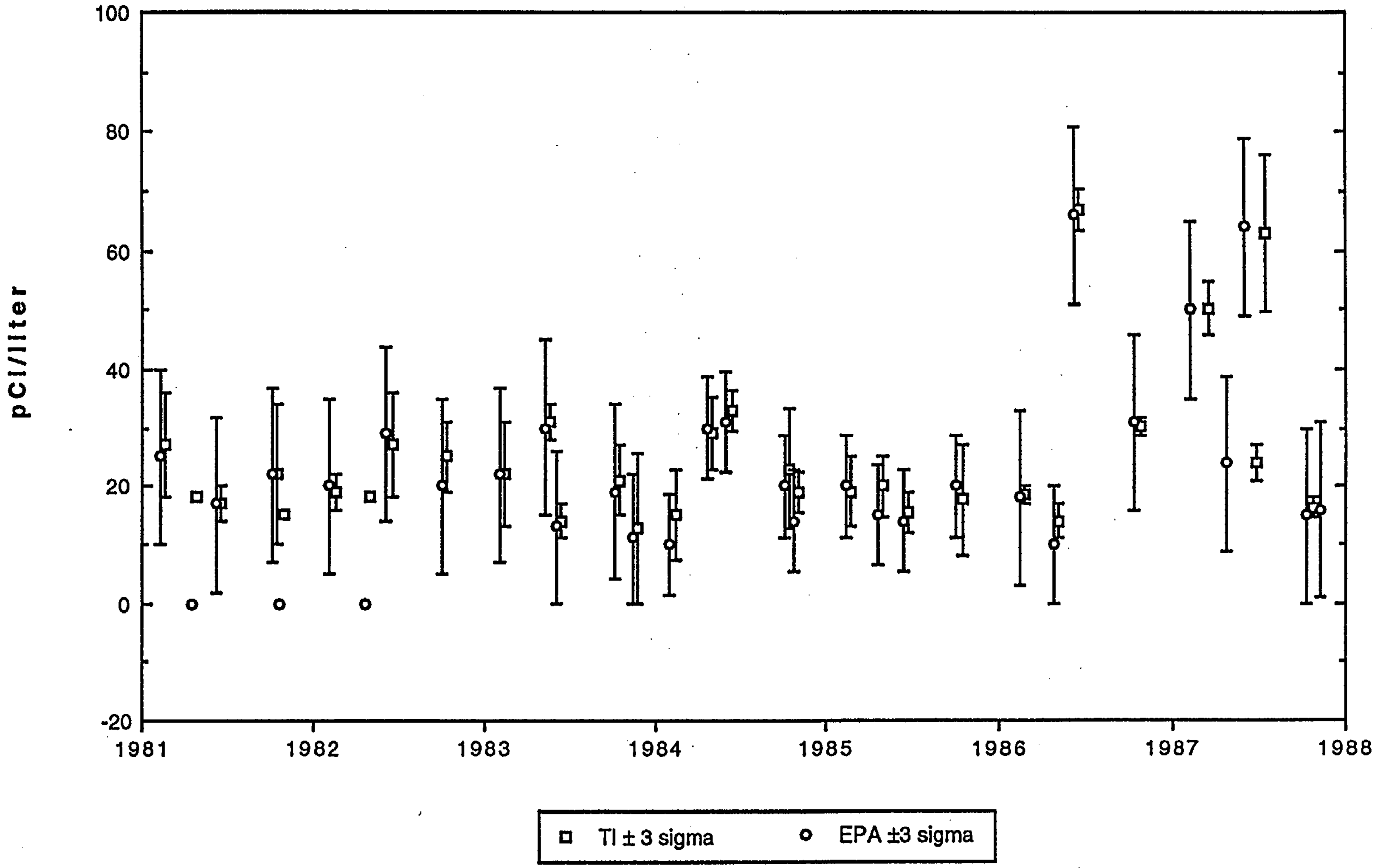
EPA CROSS CHECK PROGRAM

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



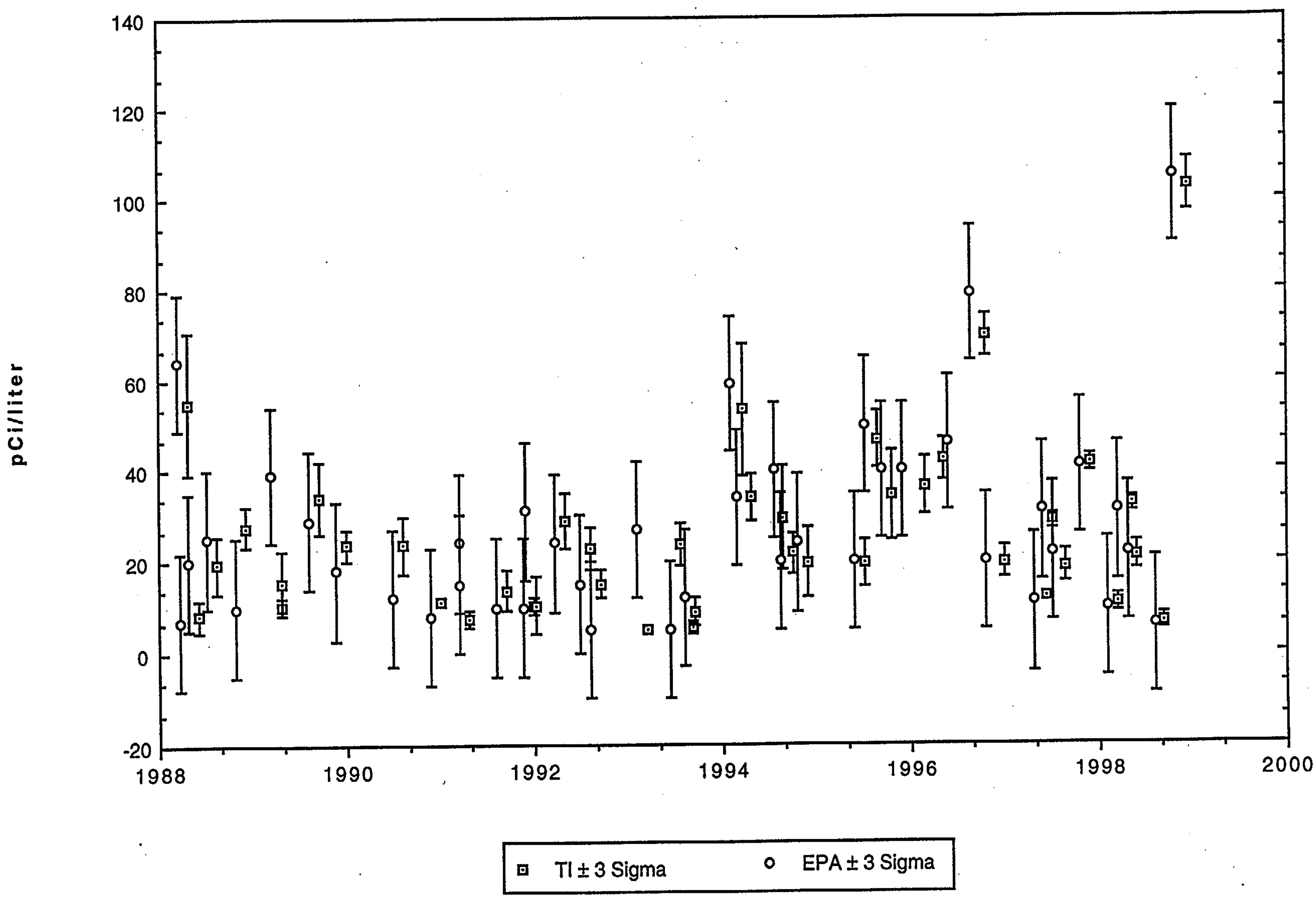
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



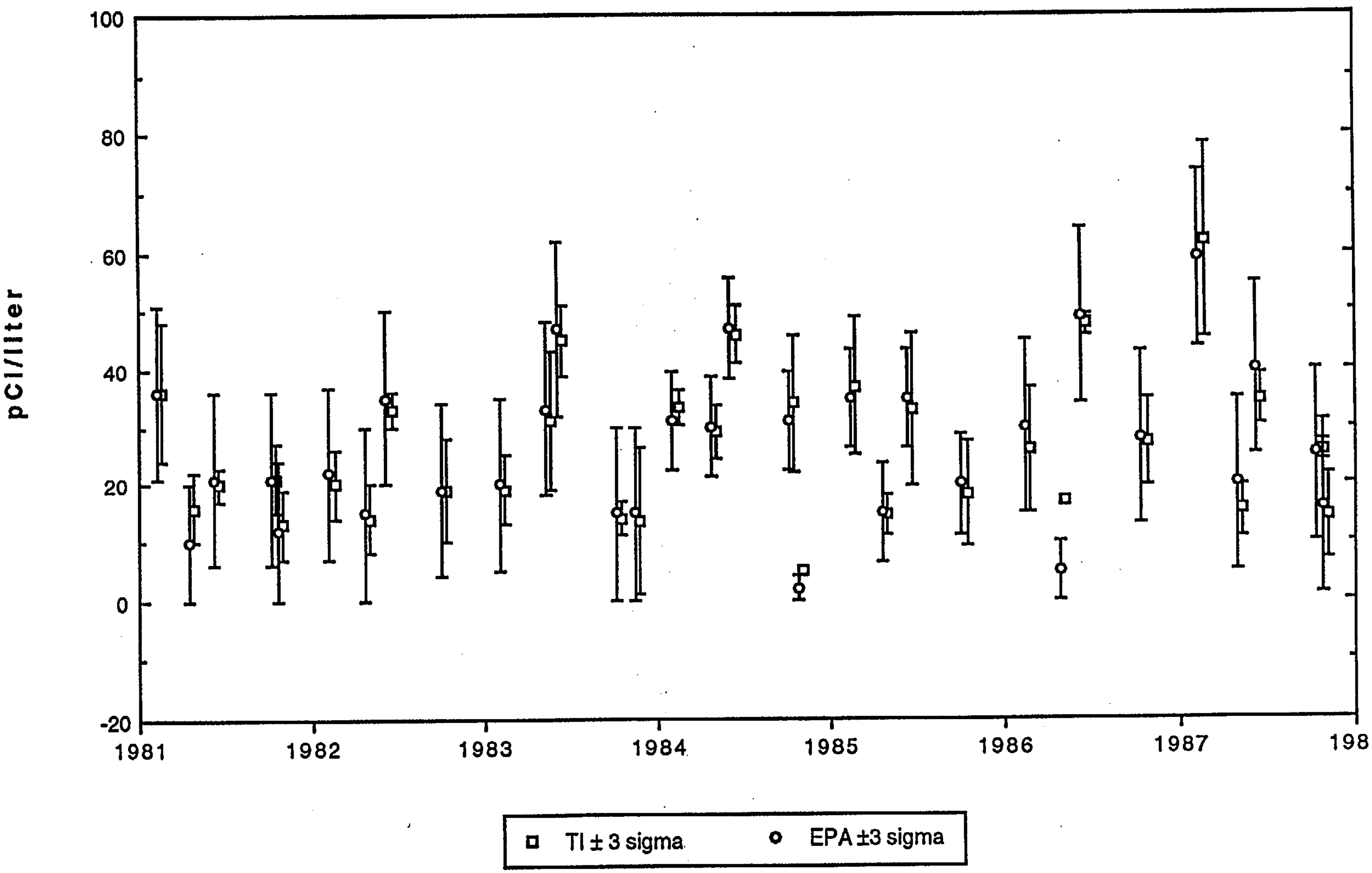
EPA CROSS CHECK PROGRAM

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



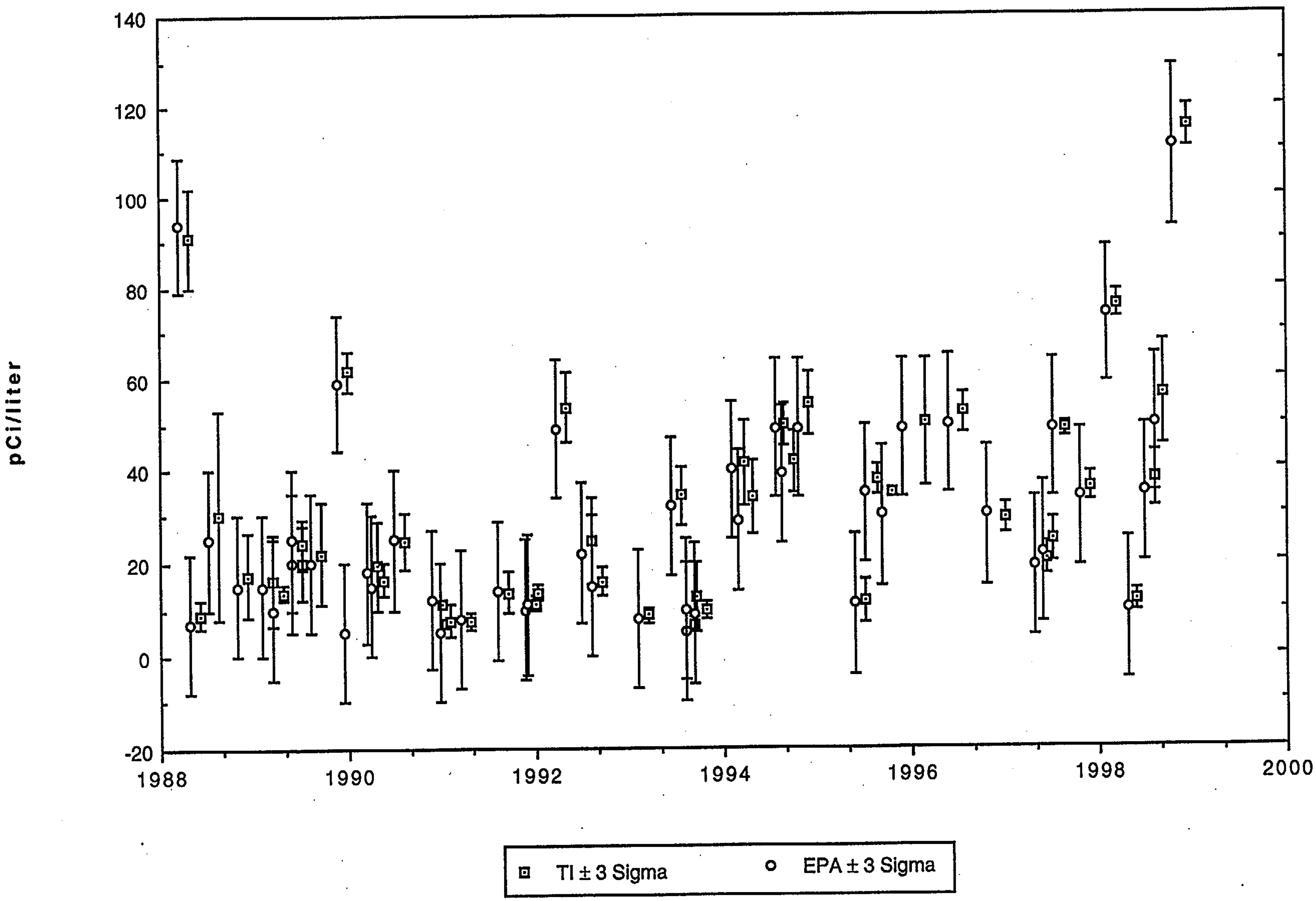
EPA CROSS CHECK PROGRAM

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



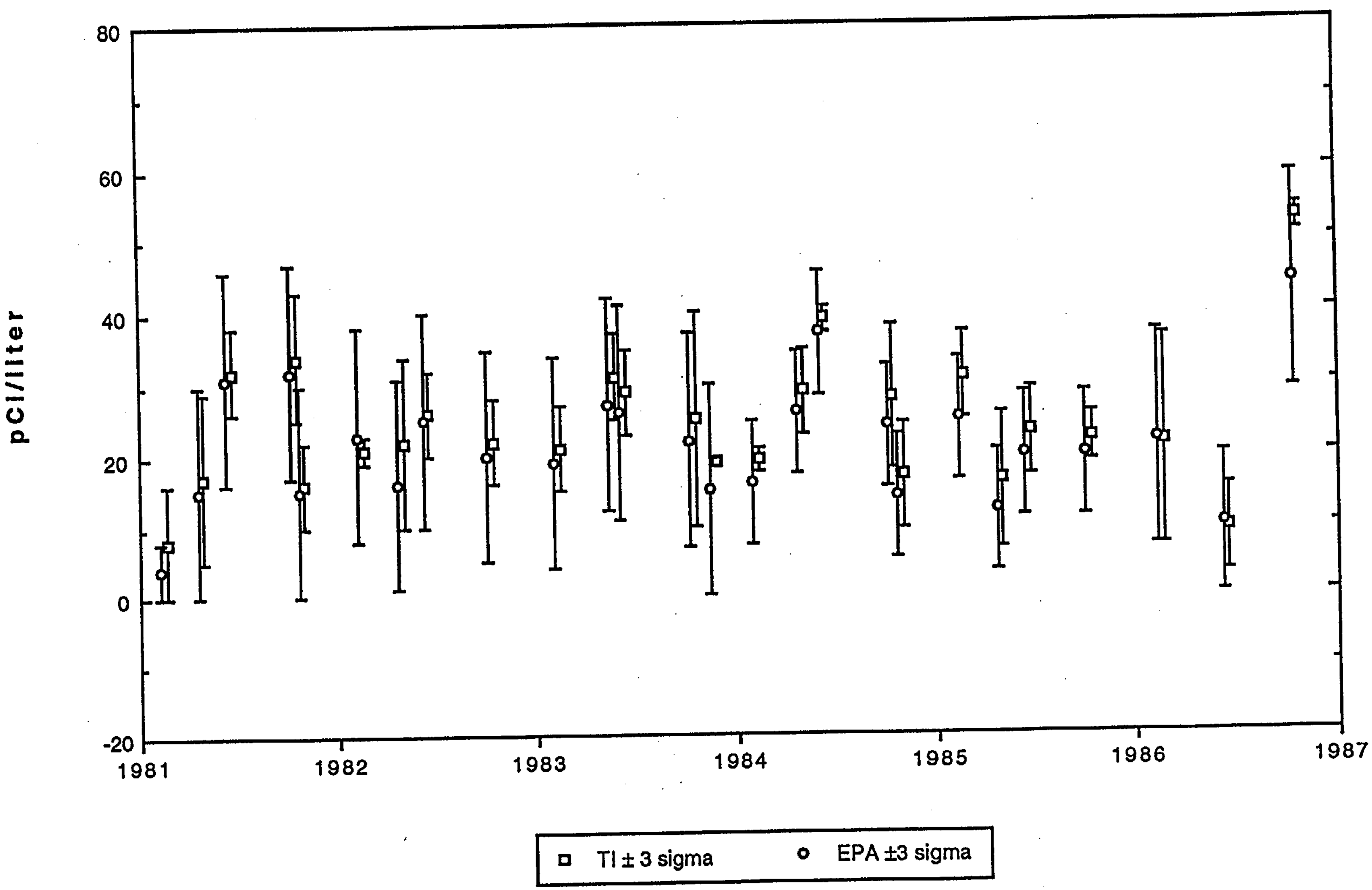
EPA CROSS CHECK PROGRAM

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



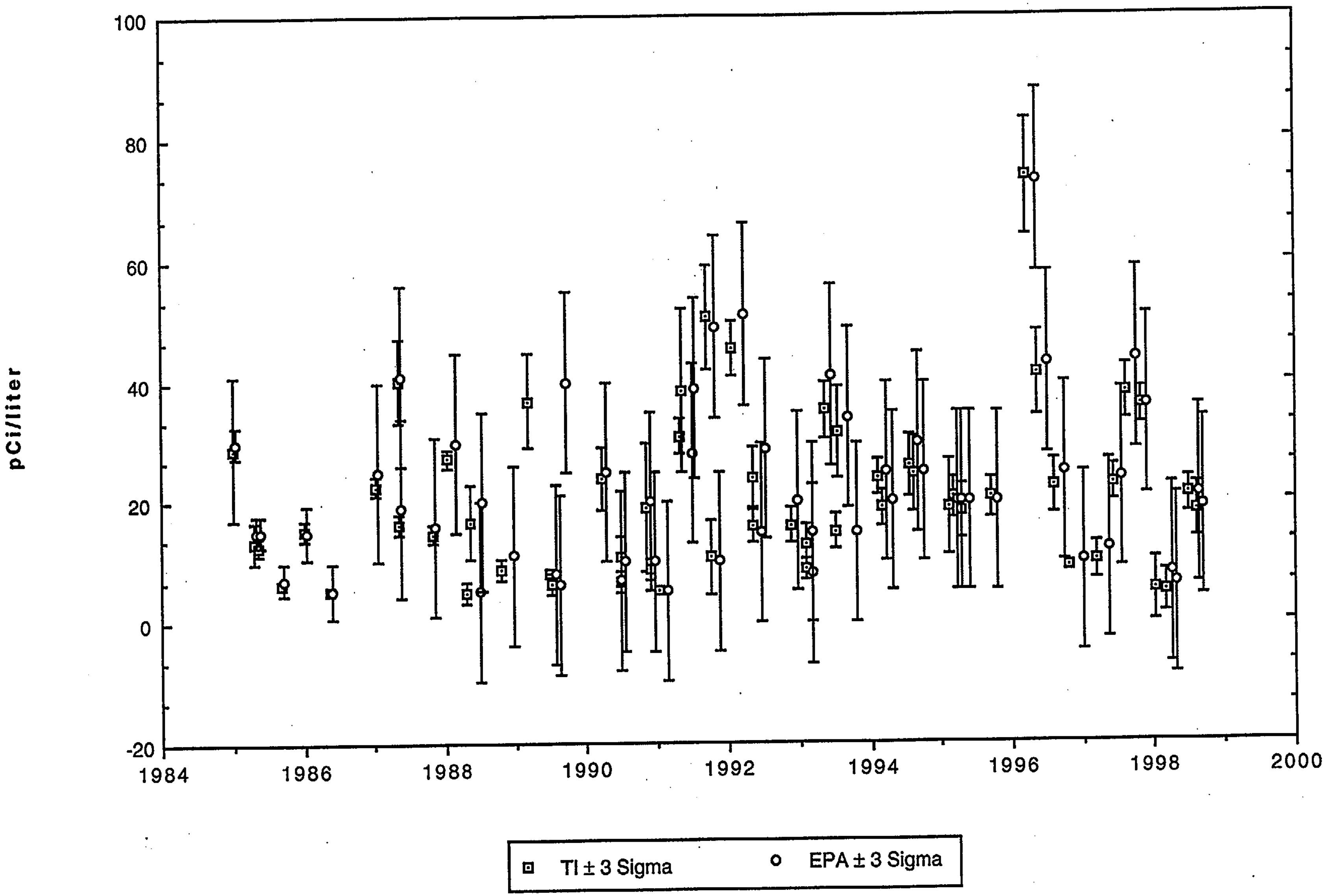
EPA CROSS CHECK PROGRAM

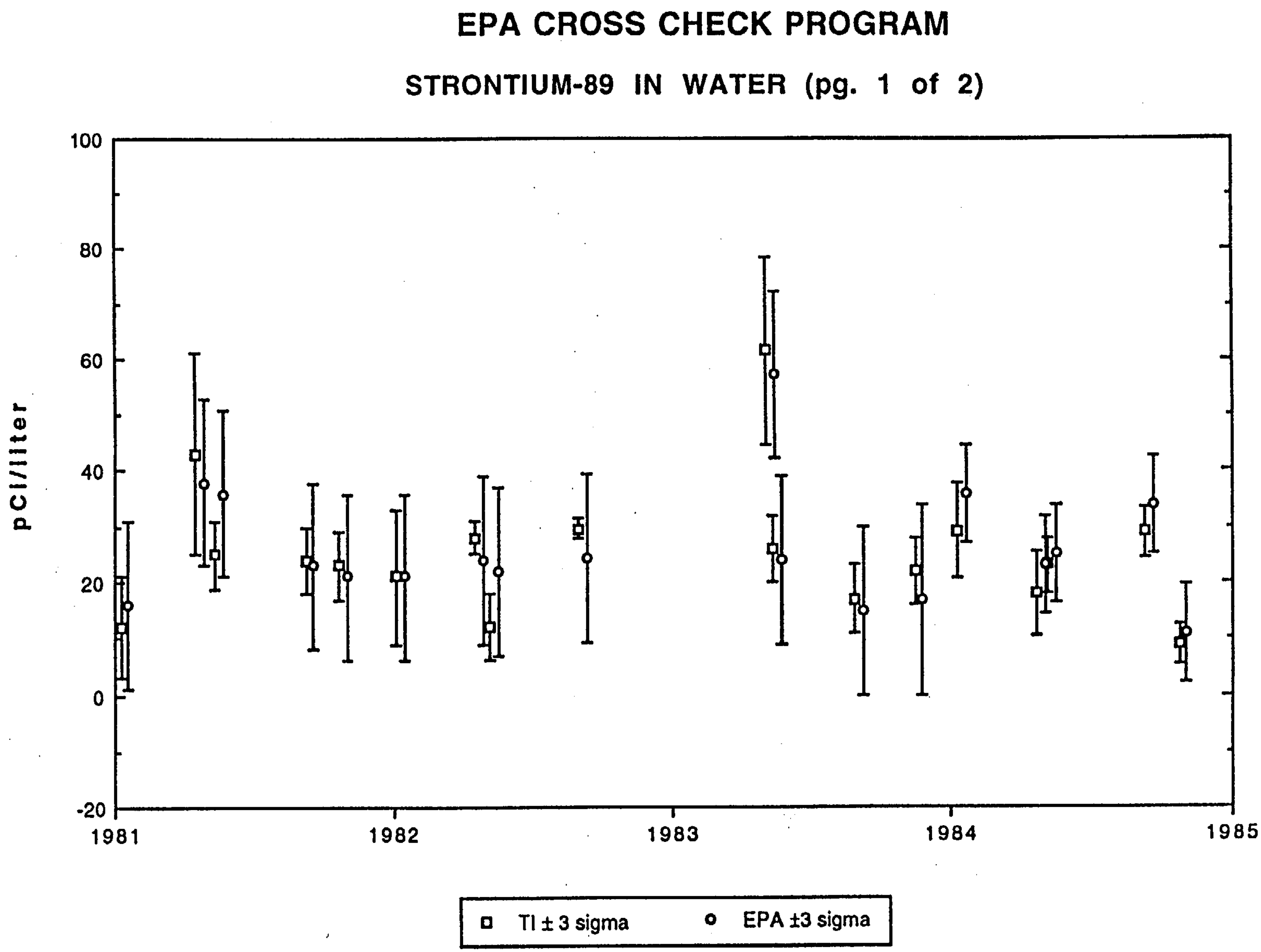
CESIUM-137 IN WATER (pg. 1 of 2)



EPA CROSS CHECK PROGRAM

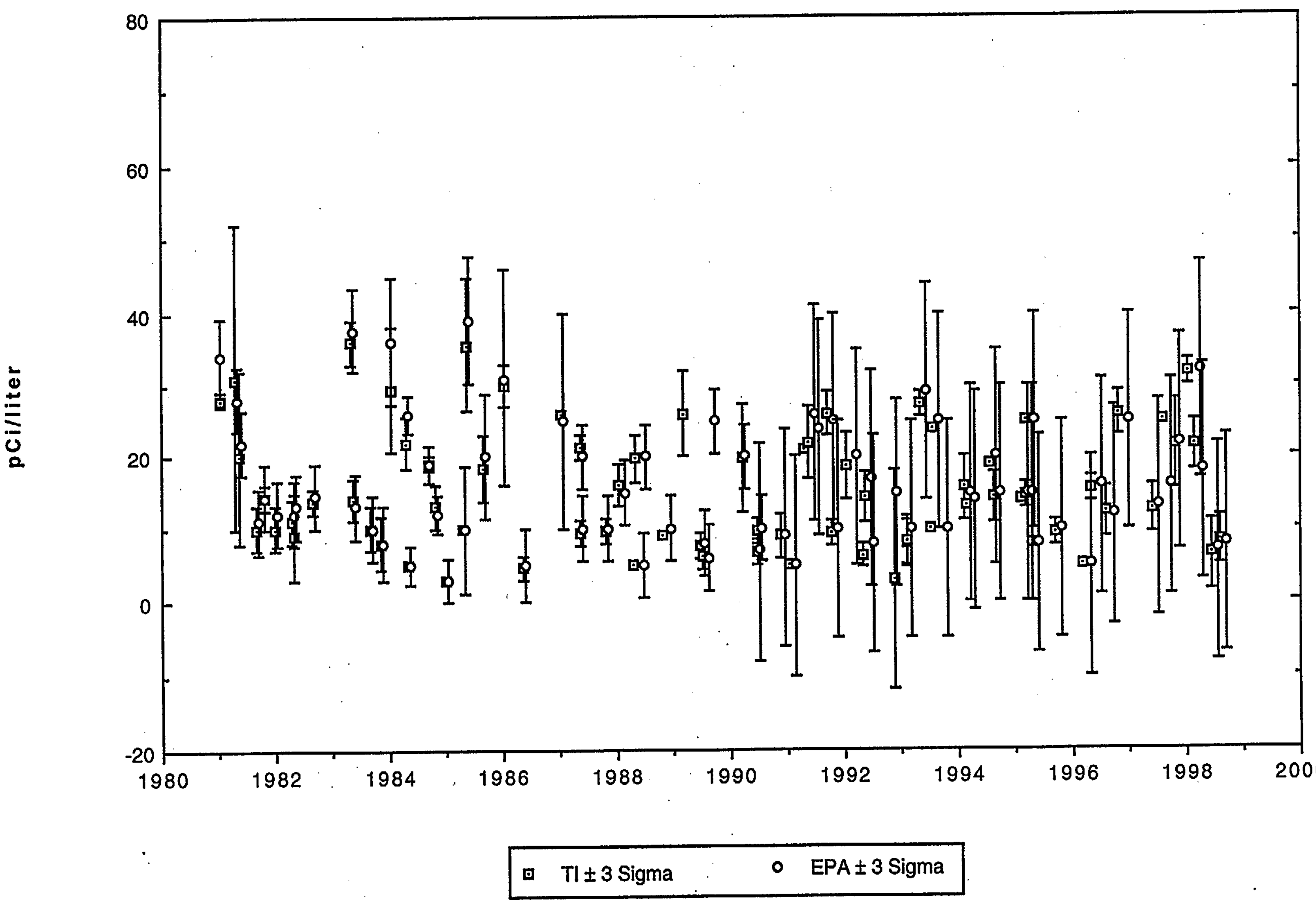
STRONTIUM-89 IN WATER (pg. 2 of 2)




EPA CROSS CHECK PROGRAM
STRONTIUM-89 IN WATER (pg. 1 of 2)
pCi/liter
100
80
60
40
20
0
-20
1981
1982
1983
1984
1985
TI ± 3 sigma
EPA ±3 sigma

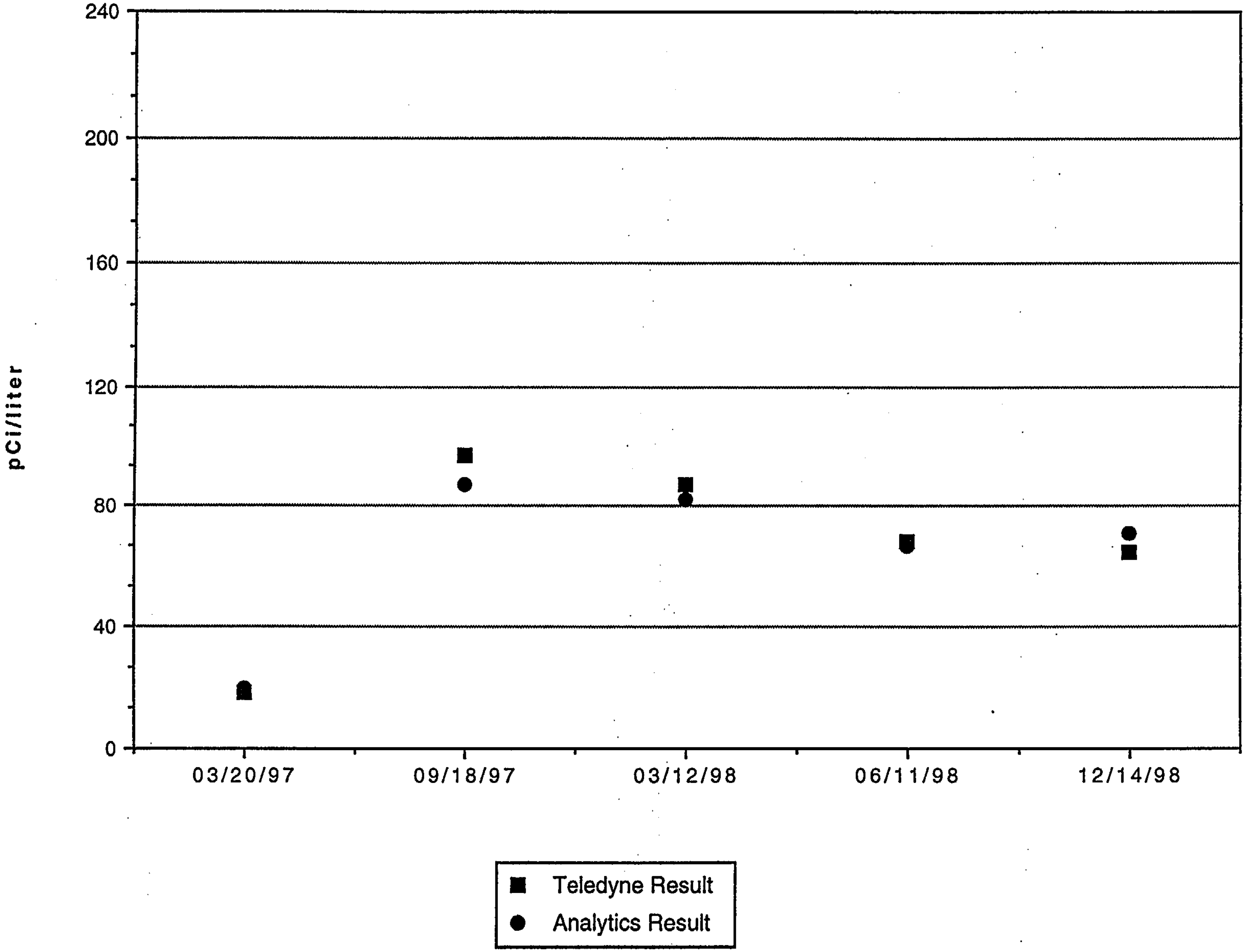
EPA CROSS CHECK PROGRAM

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



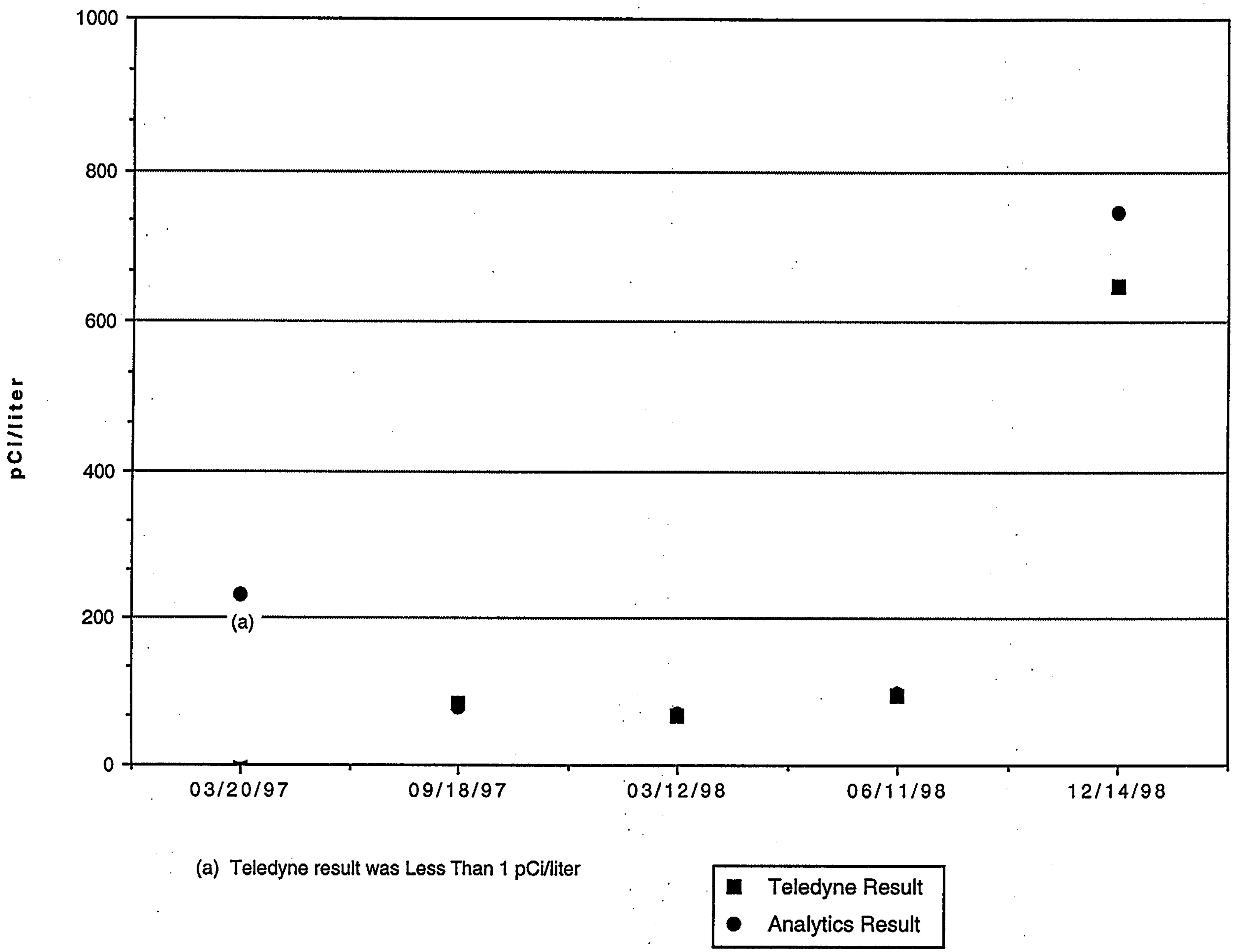
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

IODINE-131 IN MILK



ANALYTICS INTERLABORATORY COMPARISON PROGRAM

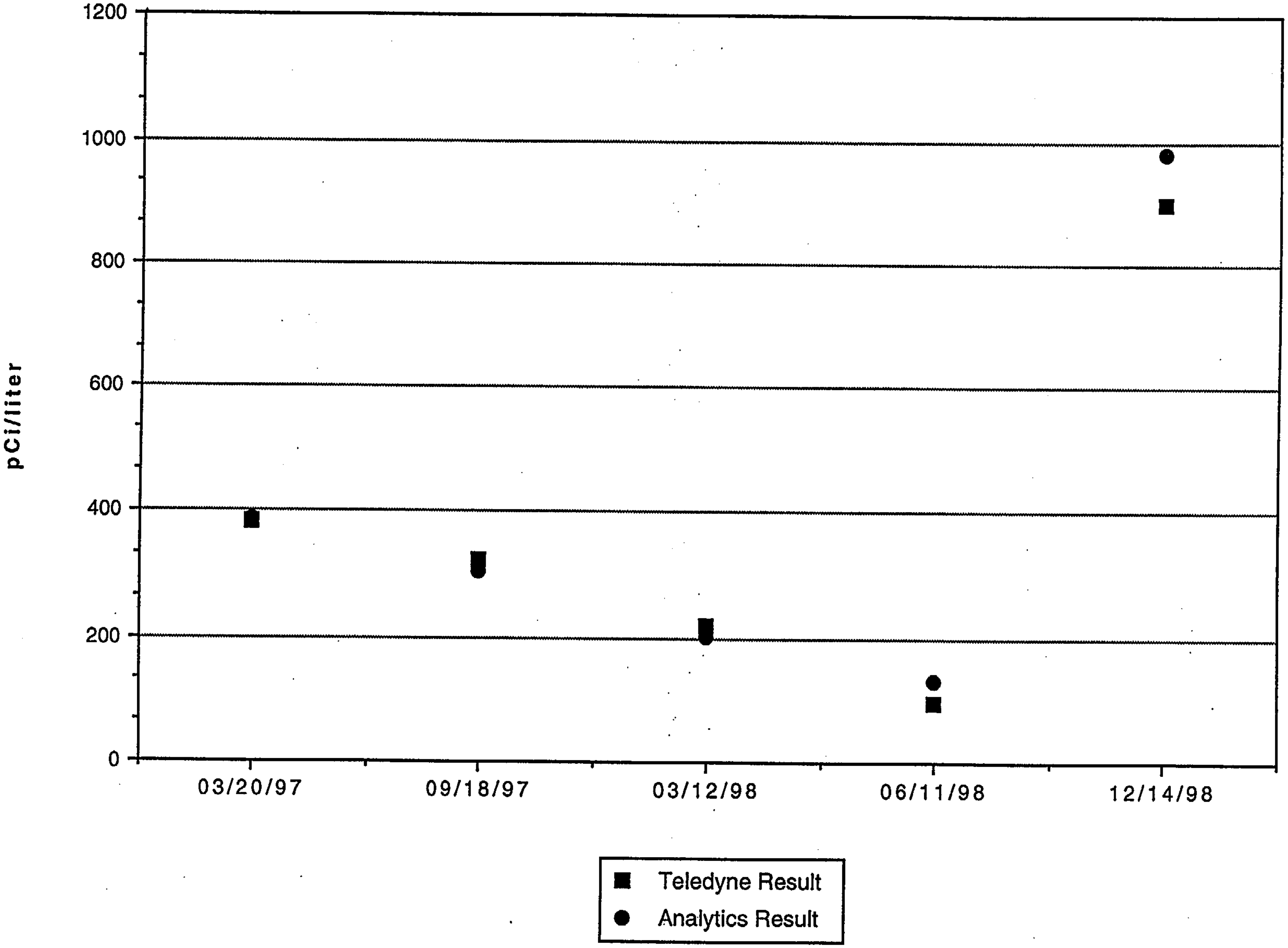
CERIUM-141 IN MILK



(a) Teledyne result was Less Than 1 pCi/liter

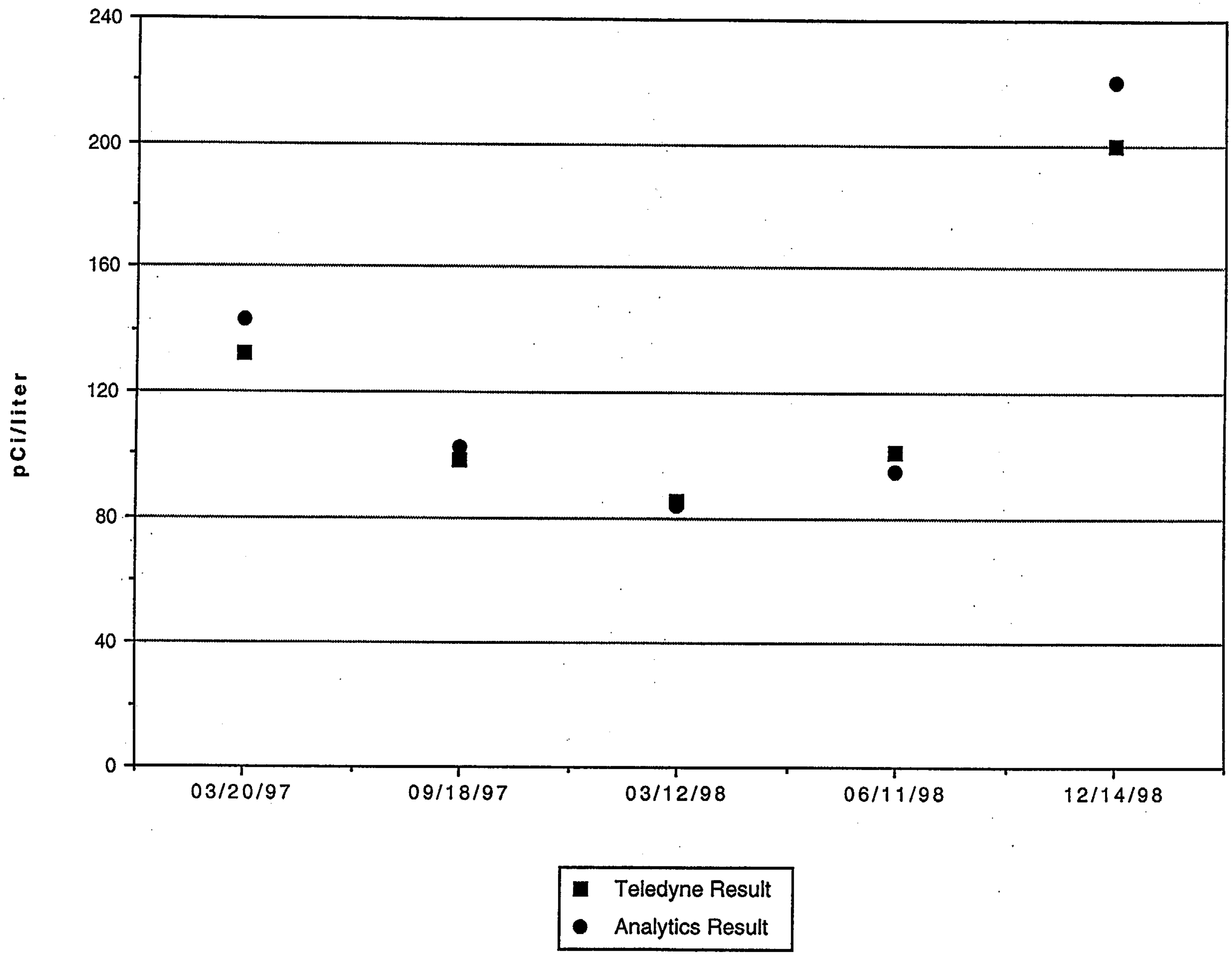
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CHROMIUM-51 IN MILK



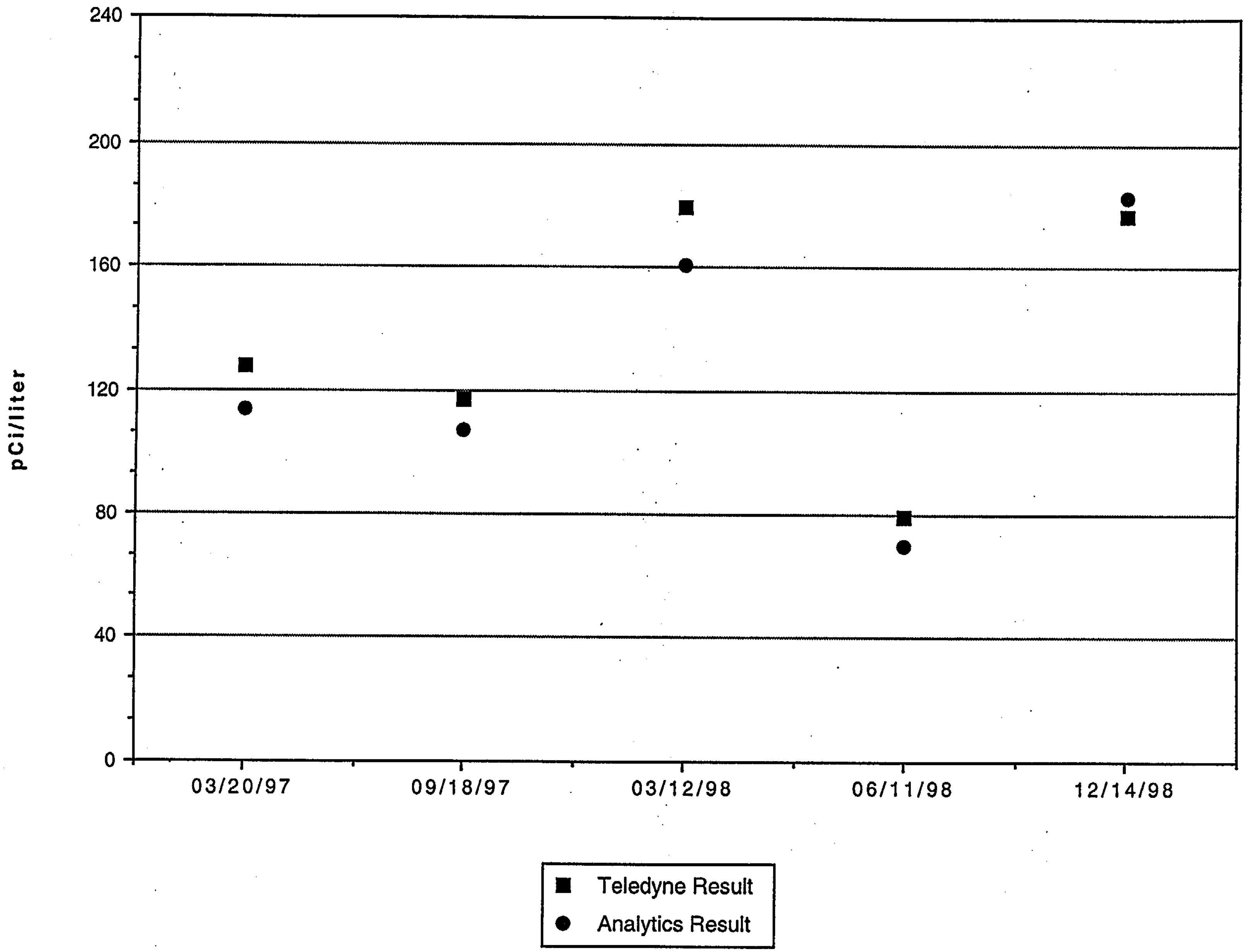
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CESIUM-134 IN MILK



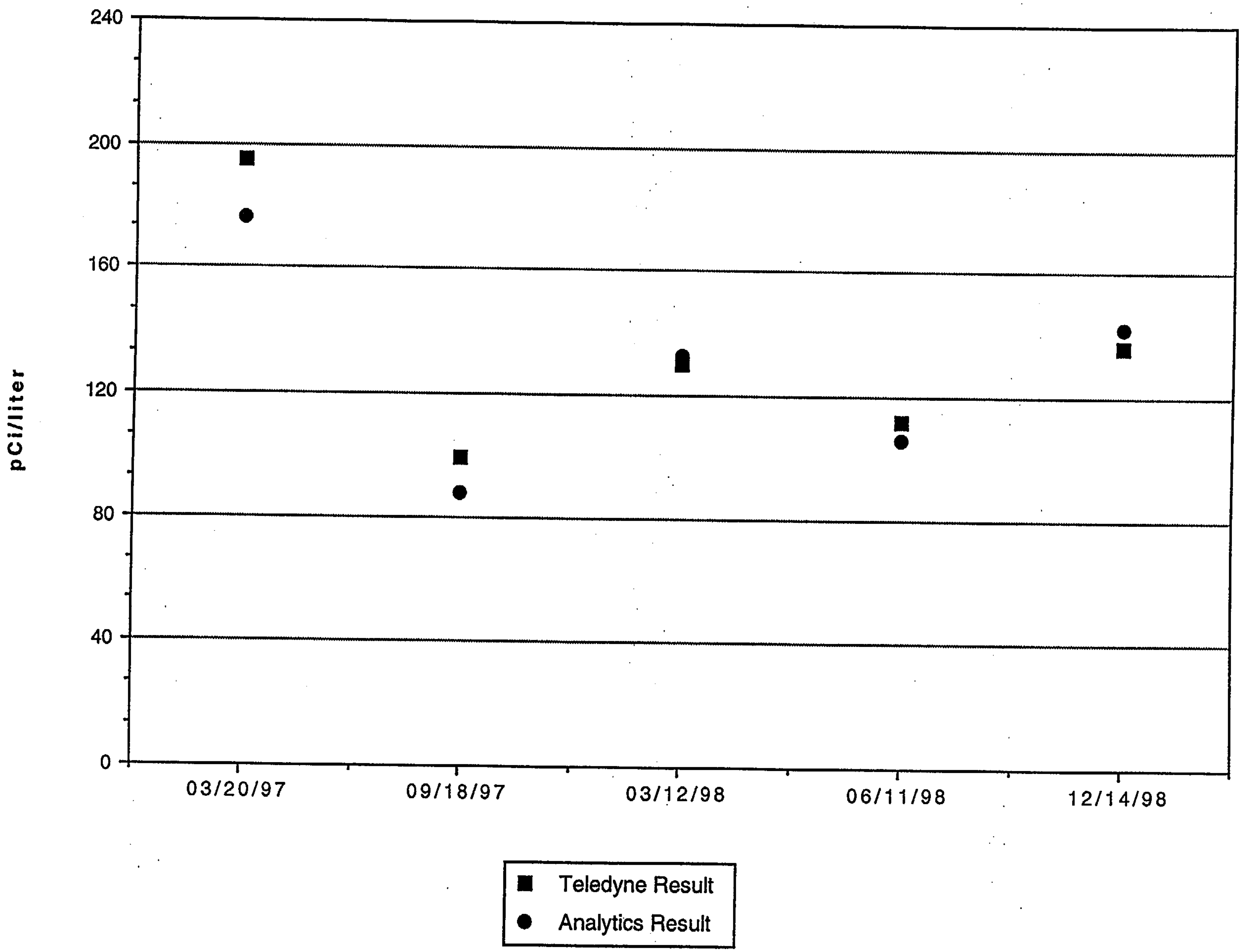
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CESIUM-137 IN MILK



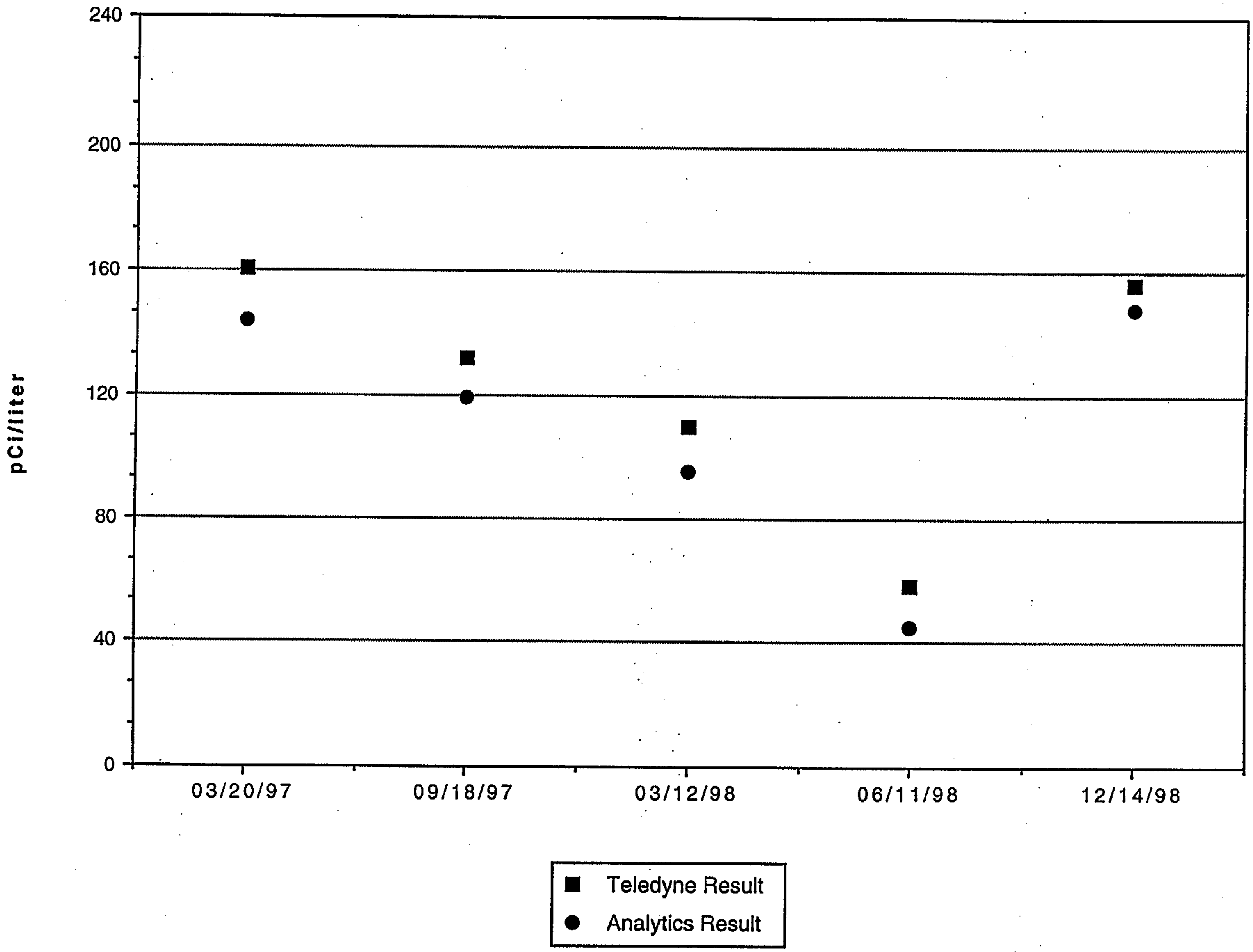
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

MANGANESE-54 IN MILK



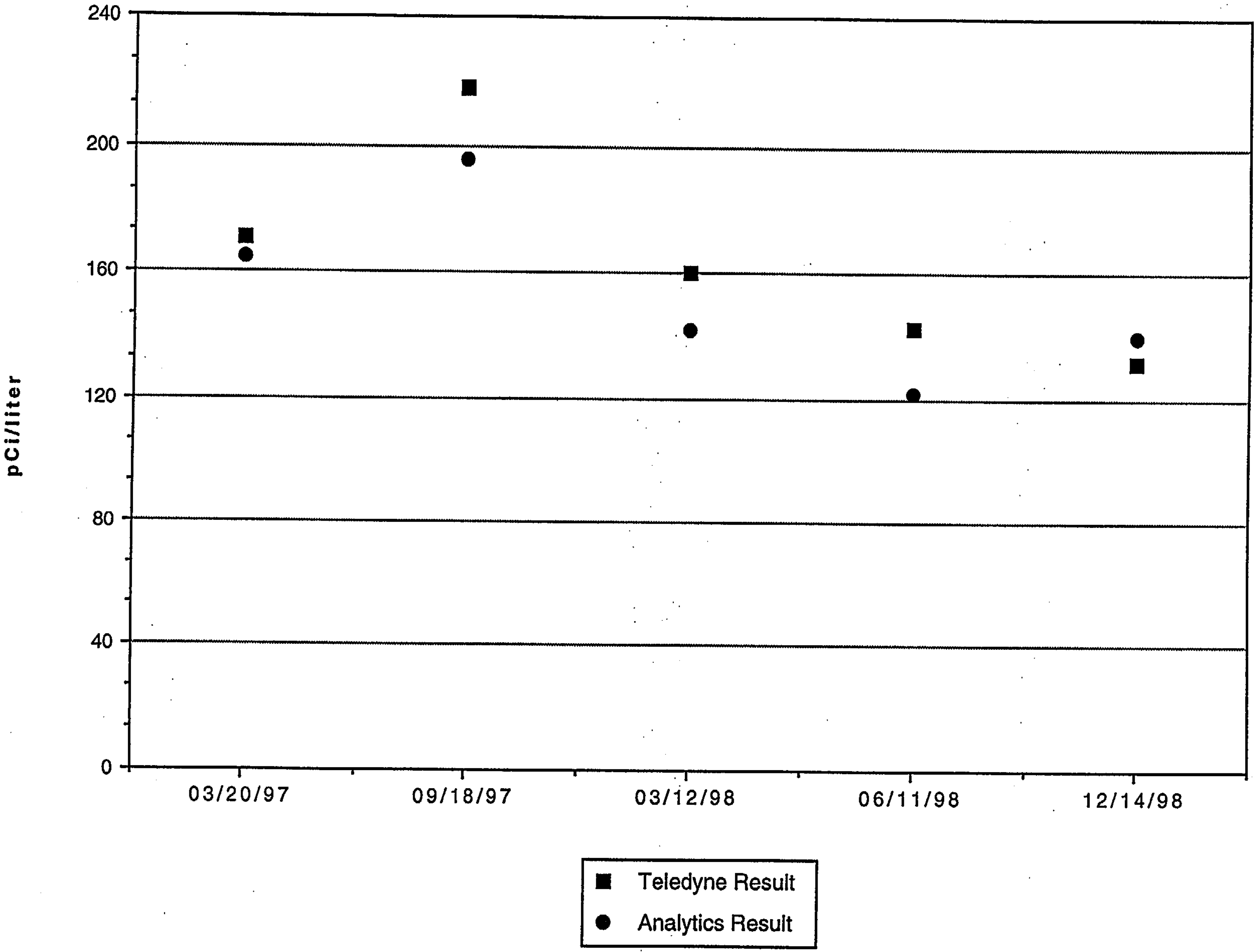
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

IRON-59 IN MILK



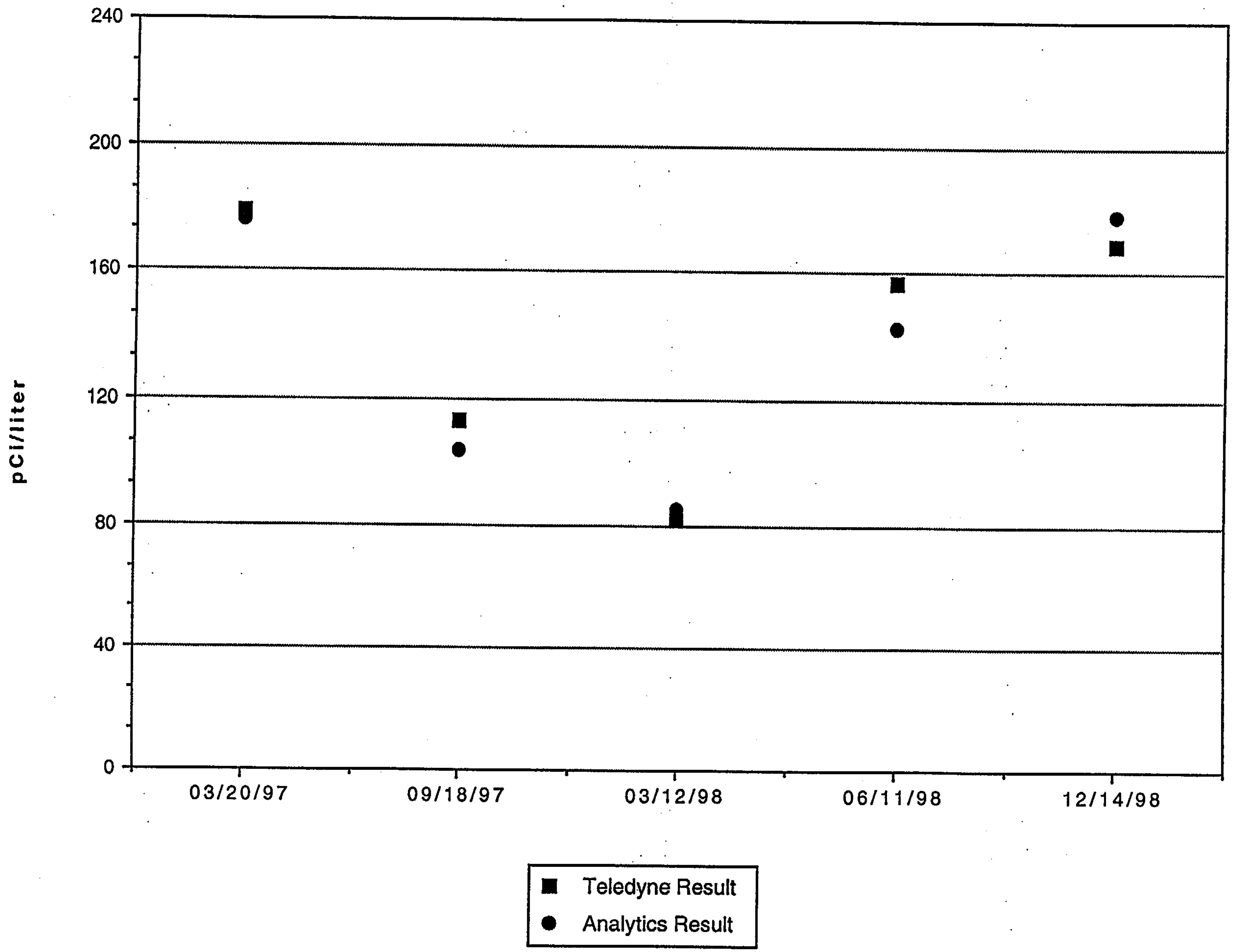
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

ZINC-65 IN MILK



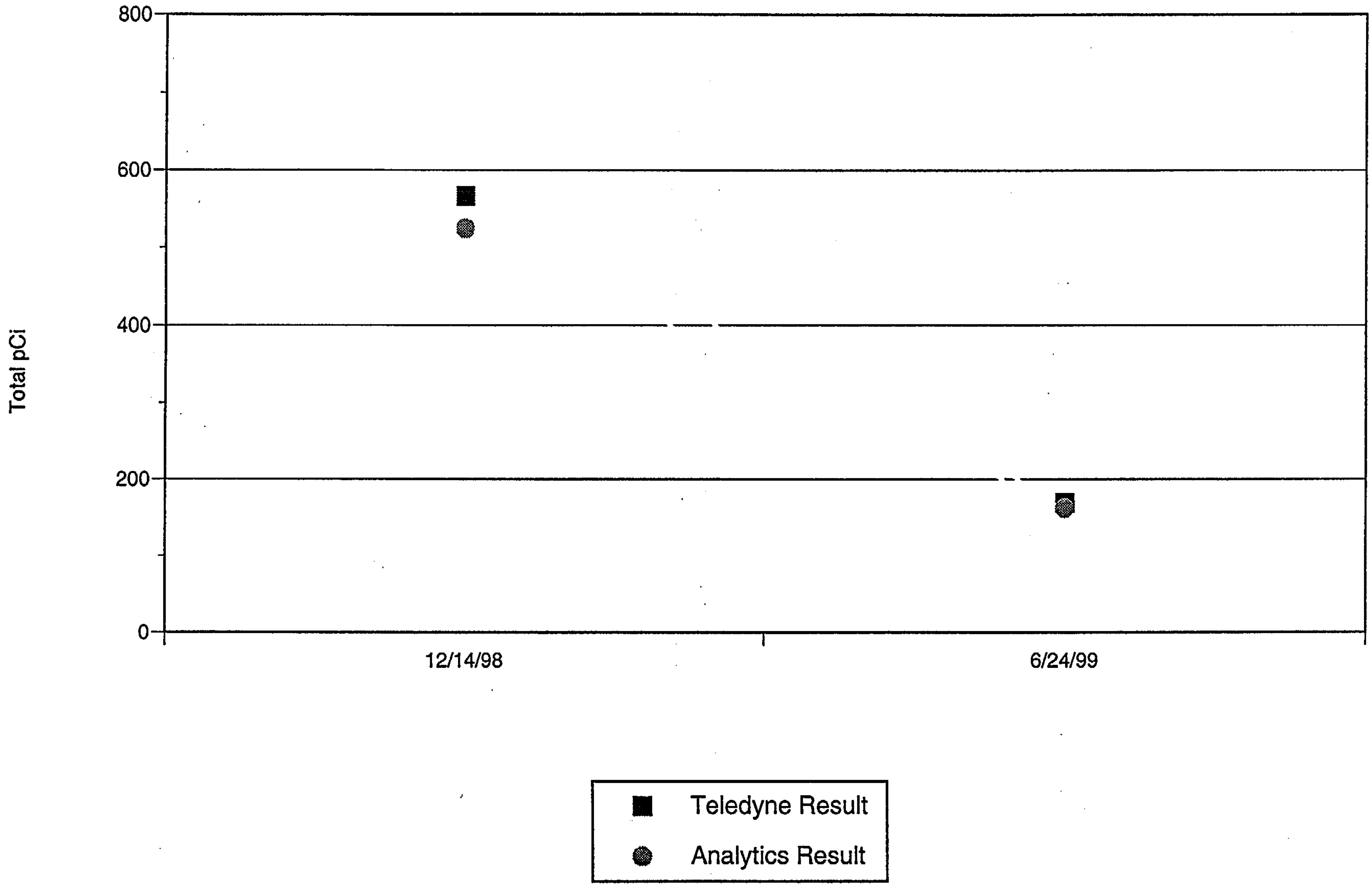
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

COBALT-60 IN MILK



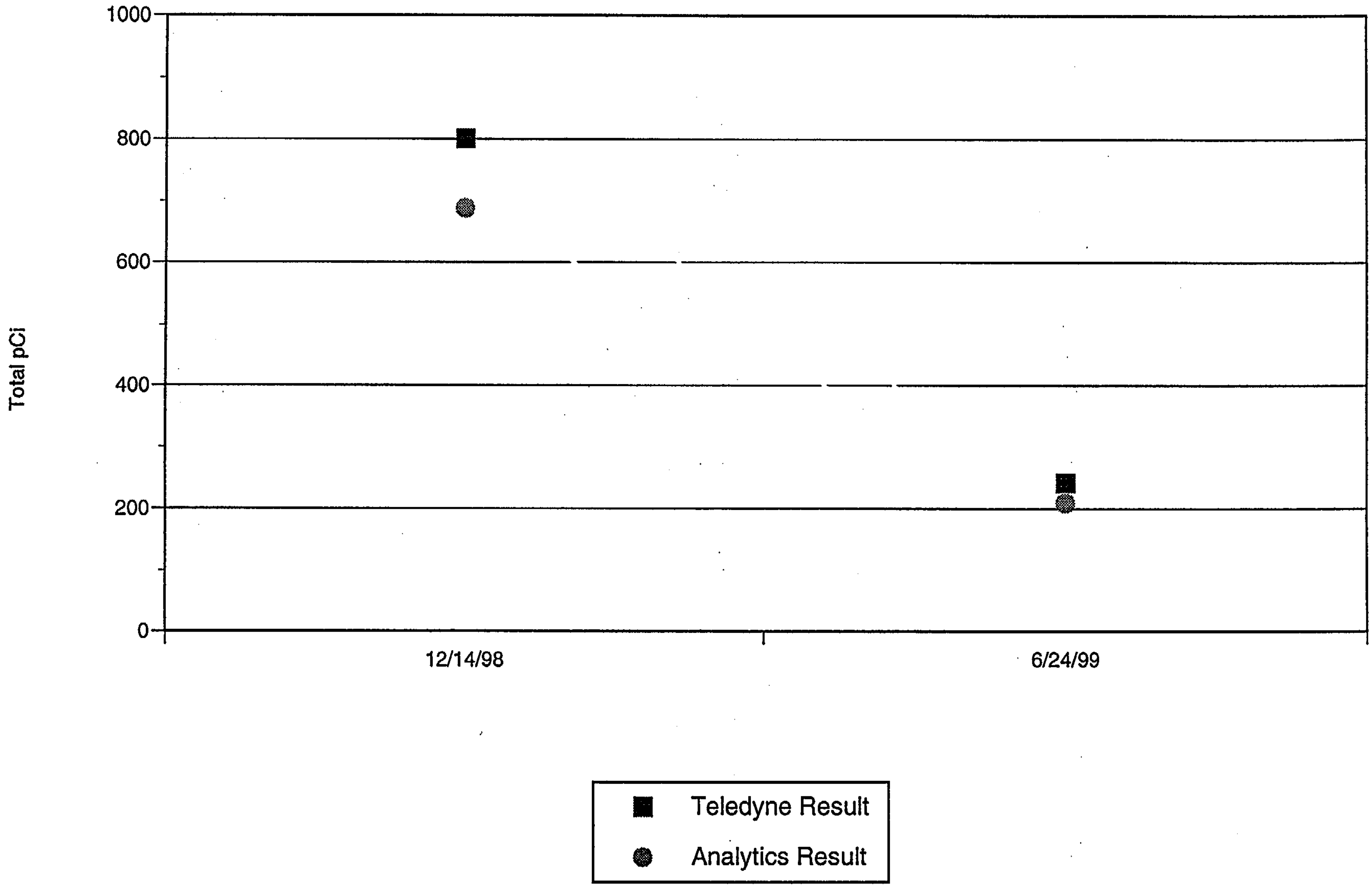
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CERIUM-141 IN AIR FILTERS



ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CHROMIUM-51 IN AIR FILTERS



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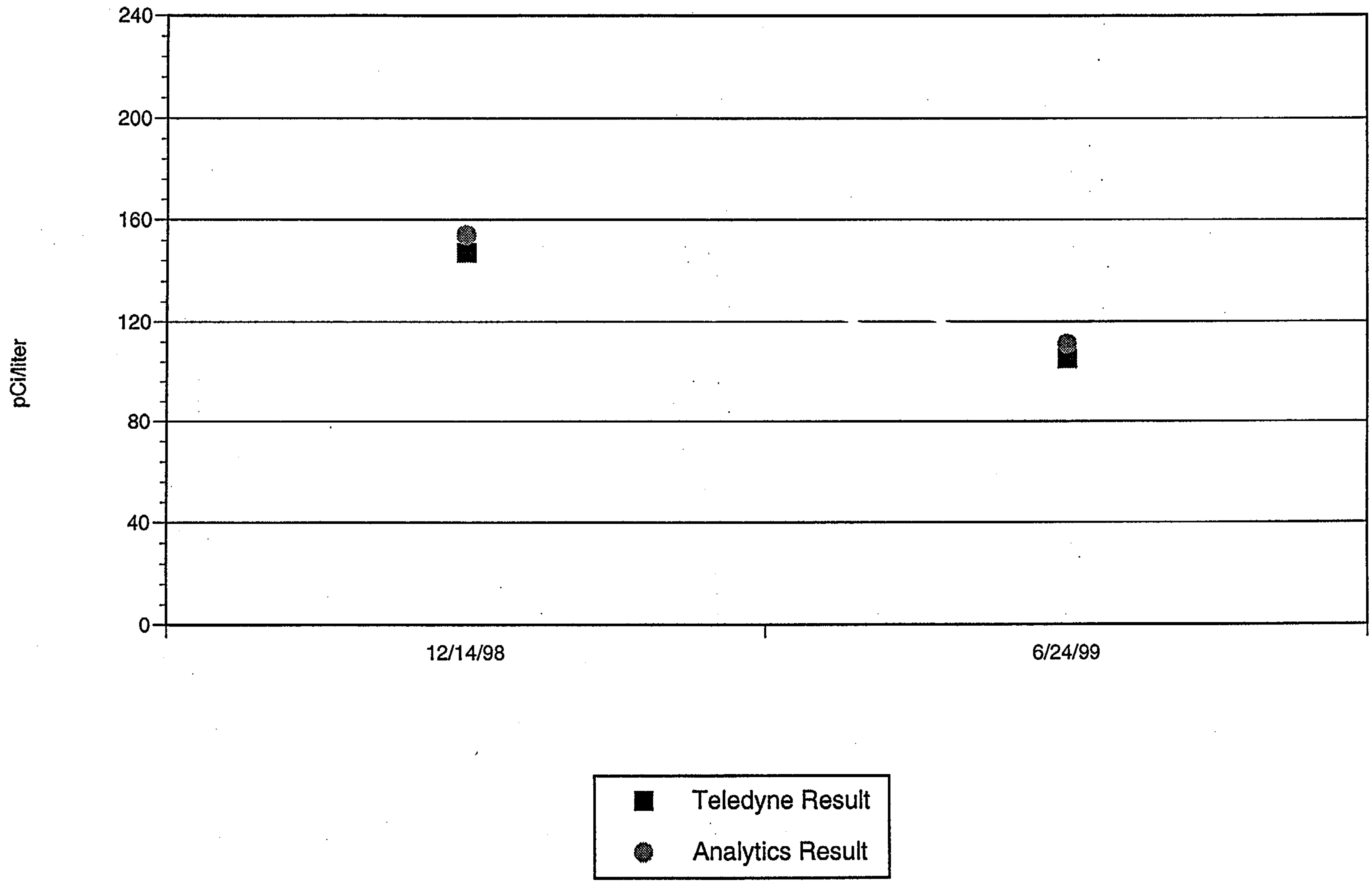
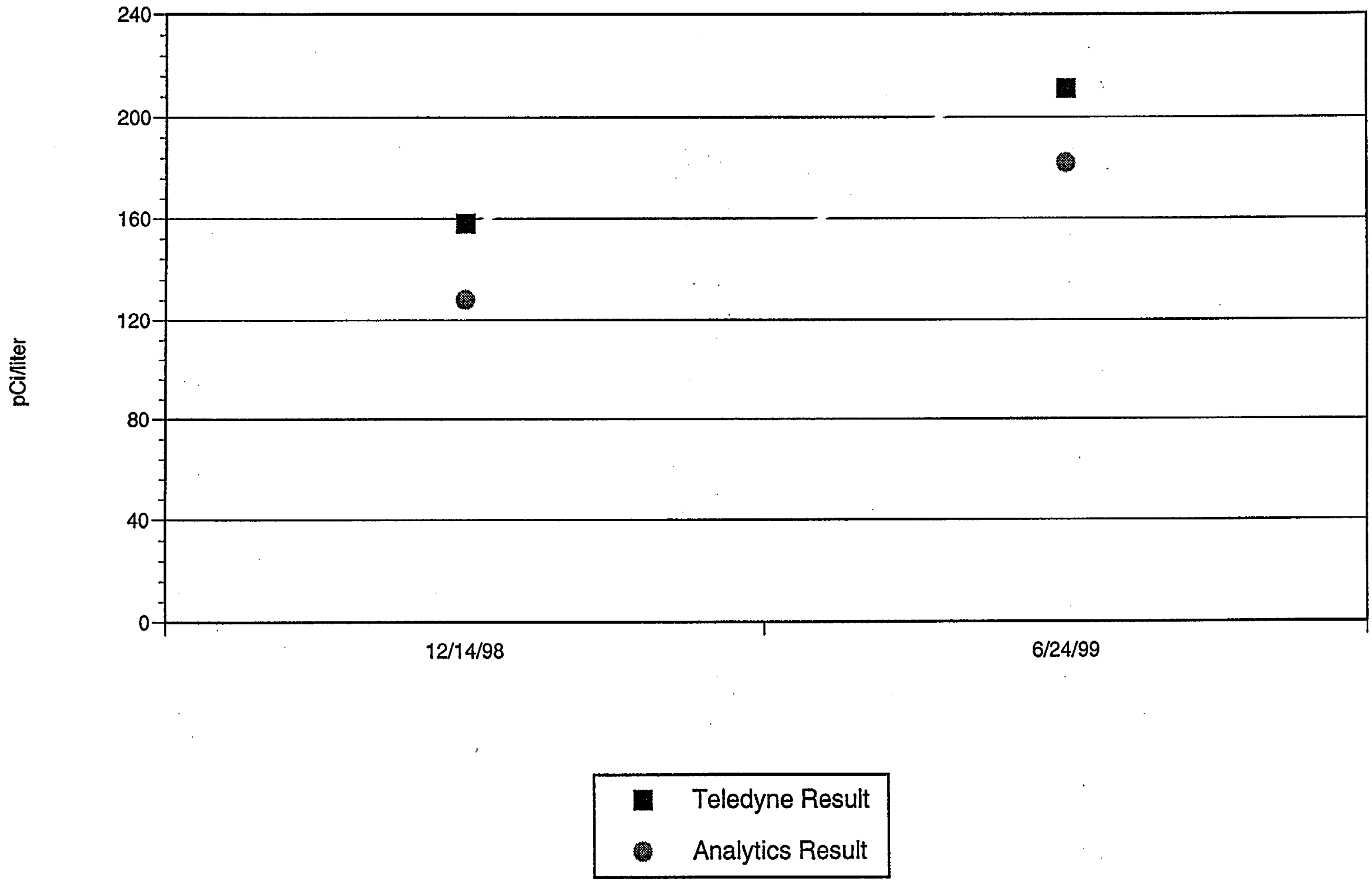
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CESIUM-134 IN AIR FILTERS



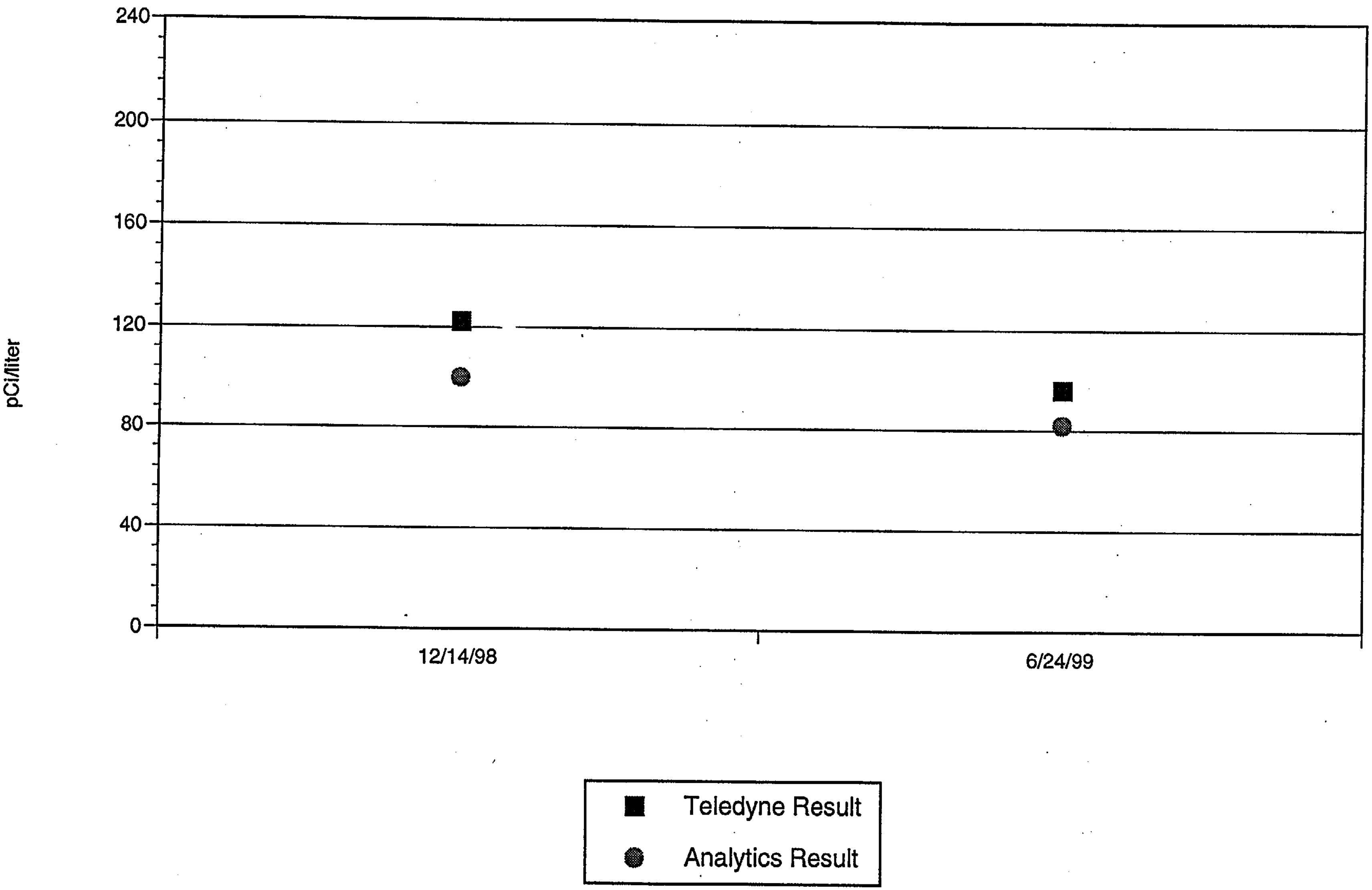
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

CESIUM-137 IN AIR FILTERS



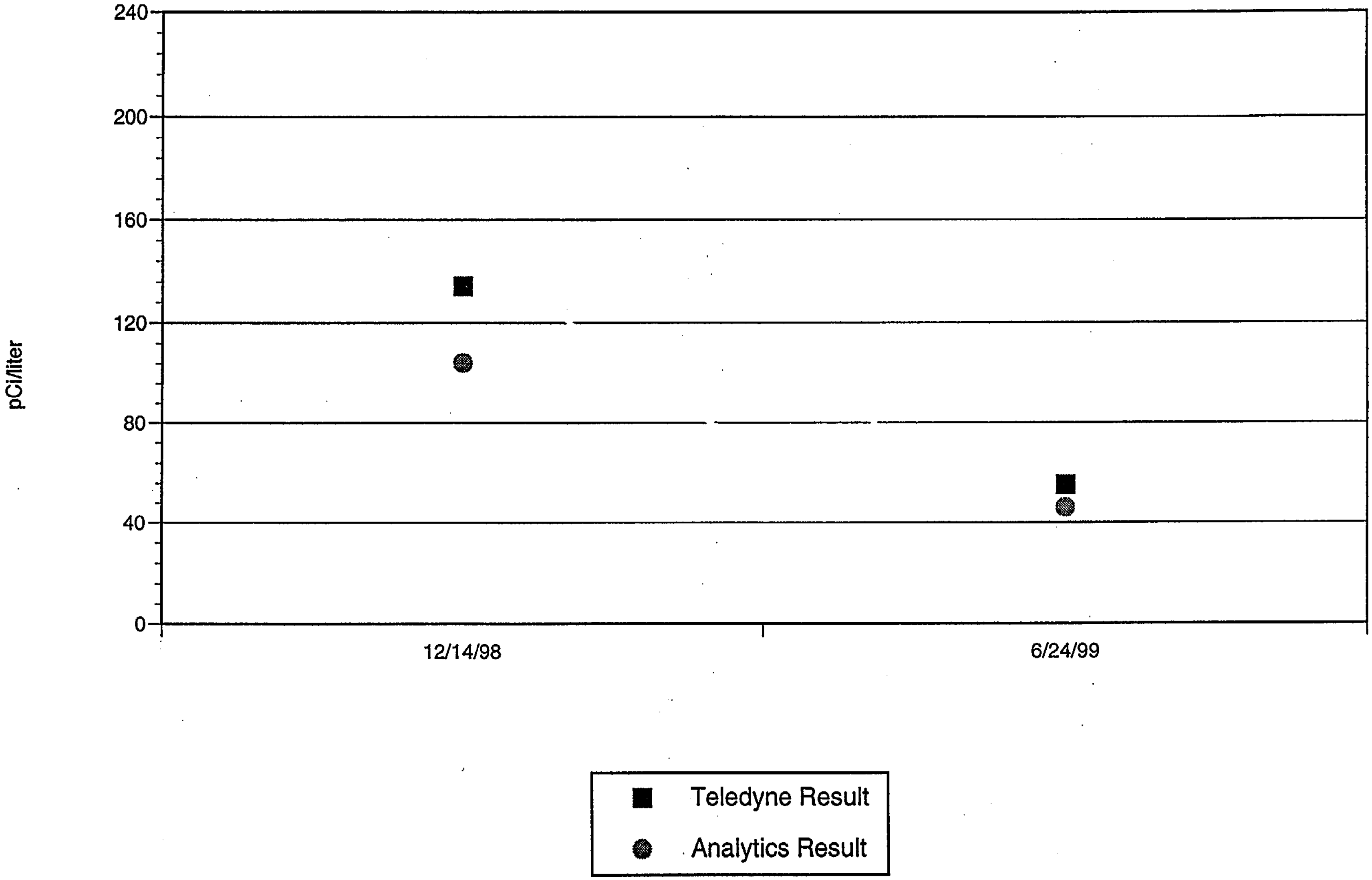
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

MANGANESE-54 IN AIR FILTERS



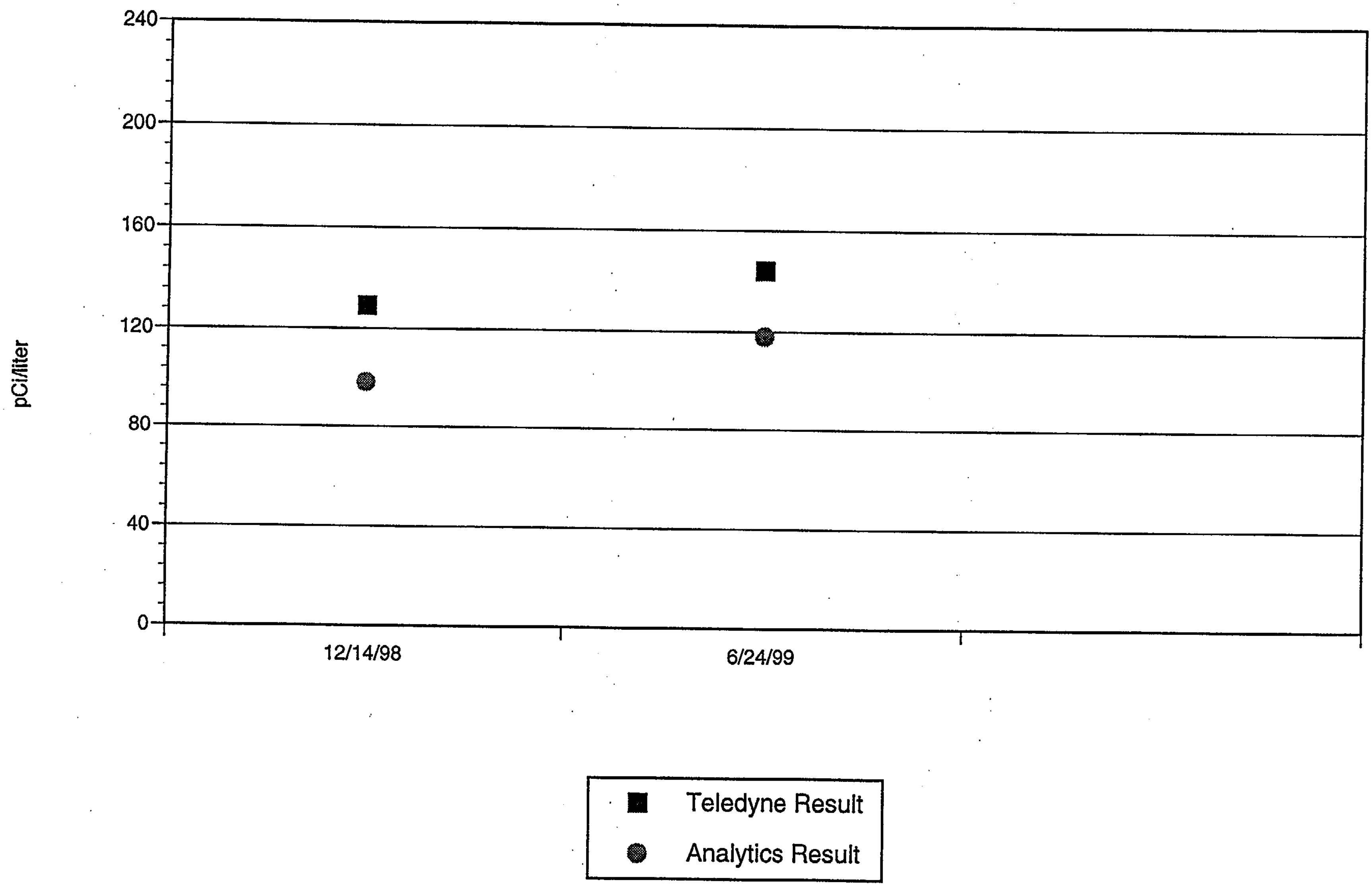
ANALYTICS INTERLABORATORY COMPARISON PROGRAM

IRON-59 IN AIR FILTERS



ANALYTICS INTERLABORATORY COMPARISON PROGRAM

ZINC-65 IN AIR FILTERS



ANALYTICS INTERLABORATORY COMPARISON PROGRAM

COBALT-60 IN AIR FILTERS