VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 30, 1987

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

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DPR-37

Gentlemen:

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

Attached is the Annual Radiological Environmental Operating Report for Surry Power Station for the calendar year 1986 as required by Technical Specification 6.6.B.2.

Very truly yours,

W. L. Stewart

Attachment

cc: U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N. W.
Suite 2900
Atlanta, Georgia 30323

Mr. W. E. Holland
NRC Senior Resident Inspector
Surry Power Station

Mr. Charles Price
Department of Health
109 Governor Street
Richmond, Virginia 23219

Carolyn Schreider
Department of Health
109 Governor Street
Richmond, Virginia 23219

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
1986

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR 1986

Prepared by

VIRGINIA ELECTRIC AND POWER COMPANY

and

TELEDYNE ISOTOPES

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

SURRY POWER STATION

January 1, 1986 through December 31, 1986

Reviewed by: _____
Health Physcist

Reviewed by: _____
Health Physcist

Reviewed by: _____
Superintendent Health Physics

Approved by: _____
Station Manager

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VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

I. INTRODUCTION

The operational radiological environmental monitoring program conducted for the year 1986 for the Surry Power Station is provided in this report. The results of measurements and analyses of data obtained from samples collected from January 1, 1986 through December 31, 1986 is summarized.

A. The Surry Power Station of Virginia Electric and Power Company is located on the Gravel Neck peninsula adjacent to the James River, approximately 25 miles upstream of the Chesapeake Bay. The site consists of two units, each with 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 822.6 megawatts electric (MWe). Unit 1 achieved commercial operation on December 22, 1972, and Unit 2 on May 1, 1973.

B. The United States Nuclear Regulatory Commission (USNRC) regulations (10CFR50.34a) require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). To ensure these criteria are met, the operating license for Surry Power Station includes Technical Specifications which govern the release of radioactive effluents. Inplant monitoring is used to determine that these predetermined release limits are not exceeded. As a precaution against unexpected or undefined

environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in Surry Power Station Technical Specifications.

C. Virginia Electric and Power Company is responsible for collecting the various indicator and control (background) environmental samples. Teledyne Isotopes is responsible for sample analysis and the submission of reports of radioanalyses. The results are used to determine if changes in radioactivity levels could be attributable to station operations. Measured values are compared with background levels, which vary with time due to such external events as cosmic ray bombardment, weapons test fallout, and seasonal variations of naturally occurring isotopes. Data collected prior to the plant operation is used to indicate the degree of natural variation to be expected. This preoperational data is compared with data collected during the operational phase to assist in evaluating the radiological impact of the plant operation.

D. Occasional samples of environmental media show the presence of man-made isotopes. As a method of referencing the measured radionuclide concentrations in the sample media to a dose consequence to man, the data may be compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8 and Table 4.9-4 of Surry Power Station's Technical Specifications. These concentrations are based upon the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion of "As Low As Is Reasonably Achievable".

E. This report documents the results of the Radiological Environmental Monitoring Program for 1986 and satisfies the following objectives of the program.

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

2. To supplement the radiological effluent monitoring program by verifying that radioactive releases are within allowable limits.

3. To identify changes of radioactivity in the environment.

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

II. SAMPLING AND ANALYSIS PROGRAM

A. Sampling Program

1. Table 1 summarizes the sampling program for Surry Power Station during 1986. The symbols on this table refer to the sample locations shown on Figures 1 through 3. Figure 1 indicates the locations of the land based samples while Figure 2 shows the locations of the river based samples. The small triangles in Figure 3 designate the position of environmental thermoluminescent dosimeters (TLDs) at the site boundary.

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. These are indicated as "co-location" samples.

3. In addition to the Radiological Environmental Monitoring Program required by Surry Technical Specifications, Virginia Electric and Power Company splits samples with the Commonwealth of Virginia. All samples listed in Table 1 are collected by Vepco personnel except for those labeled state split. All samples are shipped to Teledyne Isotopes in Westwood, New Jersey.

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

B. Analysis Program

1. Table 2 summarizes the analysis program conducted by Teledyne Isotopes for Surry Power Station during 1986.

TABLE 1

VIRGINIA POWER - SURRY - 1986

RADIOLOGICAL SAMPLING STATION

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Environmental (TLD's) △	Control	(00)	-	-	-	Quarterly	Onsite*
	West North West	(02)	0.17	WNW	292°	Quarterly	Site Boundary
	Surry Station Discharge	(03)	0.6	NW	309°	Quarterly	Site Boundary
	North North West	(04)	0.4	NNW	330°	Quarterly	Site Boundary
	North	(05)	0.33	N	357°	Quarterly	Site Boundray
	North North East	(06)	0.28	NNE	22°	Quarterly	Site Boundary
	North East	(07)	0.31	NE	45°	Quarterly	Site Boundary
	East North East	(08)	0.43	ENE	68°	Quarterly	Site Boundary
	East (Exclusion)	(09)	0.31	E	90°	Quarterly	Onsite
	West	(10)	0.40	W	270°	Quarterly	Site Boundary
	West South West	(11)	0.45	WSW	250°	Quarterly	Site Boundary
	South West	(12)	0.30	SW	225°	Quarterly	Site Boundary
	South South West	(13)	0.43	SSW	203°	Quarterly	Site Boundary
	South	(14)	0.48	S	180°	Quarterly	Site Boundary
	South South East	(15)	0.74	SSE	157°	Quarterly	Site Boundary
	South East	(16)	1.00	SE	135°	Quarterly	Site Boundary
	East	(17)	0.57	E	90°	Quarterly	Site Boundary
	Station Intake	(18)	1.23	ESE	113°	Quarterly	Site Boundary
	Hog Island Reserve	(19)	1.94	NNE	26°	Quarterly	Near Resident, co-location
	Bacons Castle	(20)	4.45	SSW	202°	Quarterly	Apx. 5 mile TLD, co-location
	Route 633	(21)	3.5	SW	224°	Quarterly	Apx. 5 mile TLD
	Alliance	(22)	5.1	WSW	248°	Quarterly	Apx. 5 mile TLD, co-location
	Surry	(23)	8.0	WSW	250°	Quarterly	Population Center
	Route 636 and 637	(24)	4.0	W	270°	Quarterly	Apx. 5 mile TLD
	Scotland Wharf	(25)	5.0	WNW	285°	Quarterly	Apx. 5 mile TLD, co-location
	Jamestown	(26)	6.3	NW	310°	Quarterly	Apx. 5 mile TLD, co-location
	Colonial Parkway	(27)	3.7	NNW	330°	Quarterly	Apx. 5 mile TLD
	Route 617 and 618	(28)	5.2	NNW	340°	Quarterly	Apx. 5 mile TLD
	Kingsmill	(29)	4.8	N	2°	Quarterly	Apx. 5 mile TLD
	Williamsburg	(30)	7.8	N	0°	Quarterly	Population Center, co-location
	Kingsmill North	(31)	5.6	NNE	14°	Quarterly	Apx. 5 mile TLD
	Budweiser	(32)	5.7	NNE	27°	Quarterly	Population Center

* Located onsite in a lead shield.

TABLE 1 (Cont.)

VIRGINIA POWER - SURRY - 1986

RADIOLOGICAL SAMPLING STATION

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	STATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Environmental TLD's (Cont.) △	Water Plant	(33)	4.8	NE	41°	Quarterly	Apx. 5 mile TLD
	Dow	(34)	5.1	ENE	70°	Quarterly	APX. 5 mile TLD
	Lee Hall	(35)	7.1	ENE	73°	Quarterly	Population Center, co-location
	Goose Island	(36)	5.0	E	88°	Quarterly	Apx. 5 mile TLD
	Fort Eustis	(37)	4.8	ESE	107°	Quarterly	Apx. 5 mile, TLD co-location
	Newport News	(38)	16.5	ESE	102°	Quarterly	Population Center
	James River Bridge	(39)	14.8	SSE	147°	Quarterly	Control Location
	Benn's Church	(40)	14.5	S	175°	Quarterly	Control Location
	Smithfield	(41)	11.5	S	176°	Quarterly	Population Center
	Rushmere	(42)	5.2	SSE	156°	Quarterly	Apx. 5 mile TLD
	Rt. 628	(43)	5.0	S	177°	Quarterly	Apx. 5 mile, TLD co-location
Air Charcoal and Particulate □	Surry Station	(SS)	.37	NNE	15°	Weekly	Site boundary location with Highest D/Q
	Hog Island Reserve	(HIR)	2.0	NNE	26°	Weekly	Co-location
	Bacons Castle	(BC)	4.5	SSW	202°	Weekly	
	Alliance	(ALL)	5.1	WSW	248°	Weekly	Co-location
	Collonial Parkway	(CP)	3.7	NNW	330°	Weekly	
	Dow Chemical	(DOW)	5.1	ENE	70°	Weekly	
	Fort Eustis	(FE)	4.8	ESE	107°	Weekly	
	Newport News	(NN)	16.5	ESE	122°	Weekly	Control Location
River Water (W)	Surry Discharge		0.17	NW	325°	Monthly	State Split
	Scotland Wharf		5.0	WNW	285°	Monthly	Control Location/State Split
	Surry Station Intake		1.9	ESE	77°	Bi-monthly	
	Hog Island Point		2.4	NE	52°	Bi-monthly	
	Newport News		12.0	SE	140°	Bi-monthly	
	Chickahominy River		11.2	WNW	300°	Bi-monthly	Control Location
	Surry Station Discharge		0.17	NW	325°	Bi-monthly	
	Scotland Wharf		5.0	WNW	285°	Bi-monthly	

TABLE 1 (Cont.)

VIRGINIA POWER - SURRY - 1986

RADIOLOGICAL SAMPLING STATION

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Well Water	Surry Station	-	-	-	Quarterly	Onsite*
	Hog Island Reserve	2.0	NNE	27°	Quarterly	
	Bacons Castle	4.5	SSW	203°	Quarterly	
	Jamestown	6.3	NW	309°	Quarterly	
Shoreline Sediment	Hog Island Reserve	0.8	N	5°	Semi-Annually	
	Burwell's Bay	7.76	SSE	167°	Semi-Annually	
Silt	Chickahominy River	11.2	WNW	300°	Semi-Annually	Control Location
	Surry Station Intake	1.9	ESE	77°	Semi-Annually	
	Hog Island Point	2.4	NE	52°	Semi-Annually	
	Point of Shoals	6.4	SSE	157°	Semi-Annually	
	Newport News	12.0	SE	140°	Semi-Annually	
	Surry Station Discharge	0.5	NNW	341°	Semi-Annually	
Milk	Lee Hall	7.1	ENE	64°	Monthly	State Split
	Epps	4.8	SSW	201°	Monthly	State Split
	Colonial Parkway	3.7	NNW	337°	Monthly	
	Judkins	6.2	SSW	211°	Monthly	
	Williams	22.5	S	182°	Monthly	Control Location
Oysters	Deep Water Shoals	3.9	ESE	105°	Bi-Monthly	
	Point of Shoals	6.4	SSE	157°	Bi-Monthly	
	Newport News	12.0	SE	140°	Bi-Monthly	State Split
Clams	Chickahominy River	11.2	WNW	300°	Bi-Monthly	Control Location
	Surry Power Discharge	1.3	NNW	341°	Bi-Monthly	State Split
	Hog Island Point	2.4	NE	52°	Bi-Monthly	
	Jamestown	5.1	WNW	300°	Bi-Monthly	
	Lawnes Creek	2.4	SE	131°	Bi-Monthly	

* Well water sample taken onsite at Surry Environmental Building.

TABLE 1 (Cont.)

VIRGINIA POWER - SURRY - 1986

RADIOLOGICAL SAMPLING STATION

DISTANCE AND DIRECTION FROM UNIT NO. 1

SAMPLE MEDIA	LOCATION	DISTANCE MILES	DIRECTION	DEGREES	COLLECTION FREQUENCY	REMARKS
Crabs (CR)	Surry Station Discharge	0.6	NW	312°	July/August September	
Fish (F)	Surry Station Discharge	0.6	NW	312°	Semi-Annually	
Crops (Corn, Peanuts, Soybeans)	Brock's Farm	3.8	S	188°	Annually	State Split
	Slade's Farm	2.4	S	177°	Annually	State Split
(Cabbage, Kale)	Pool's Garden	2.3	S	182°	Annually	State Split
	Carter's Grove Garden	4.8	NE	56°	Annually	State Split
	Ryan's Garden	-	-	-	Annually	State Split/Control Location (Chester, Va.)

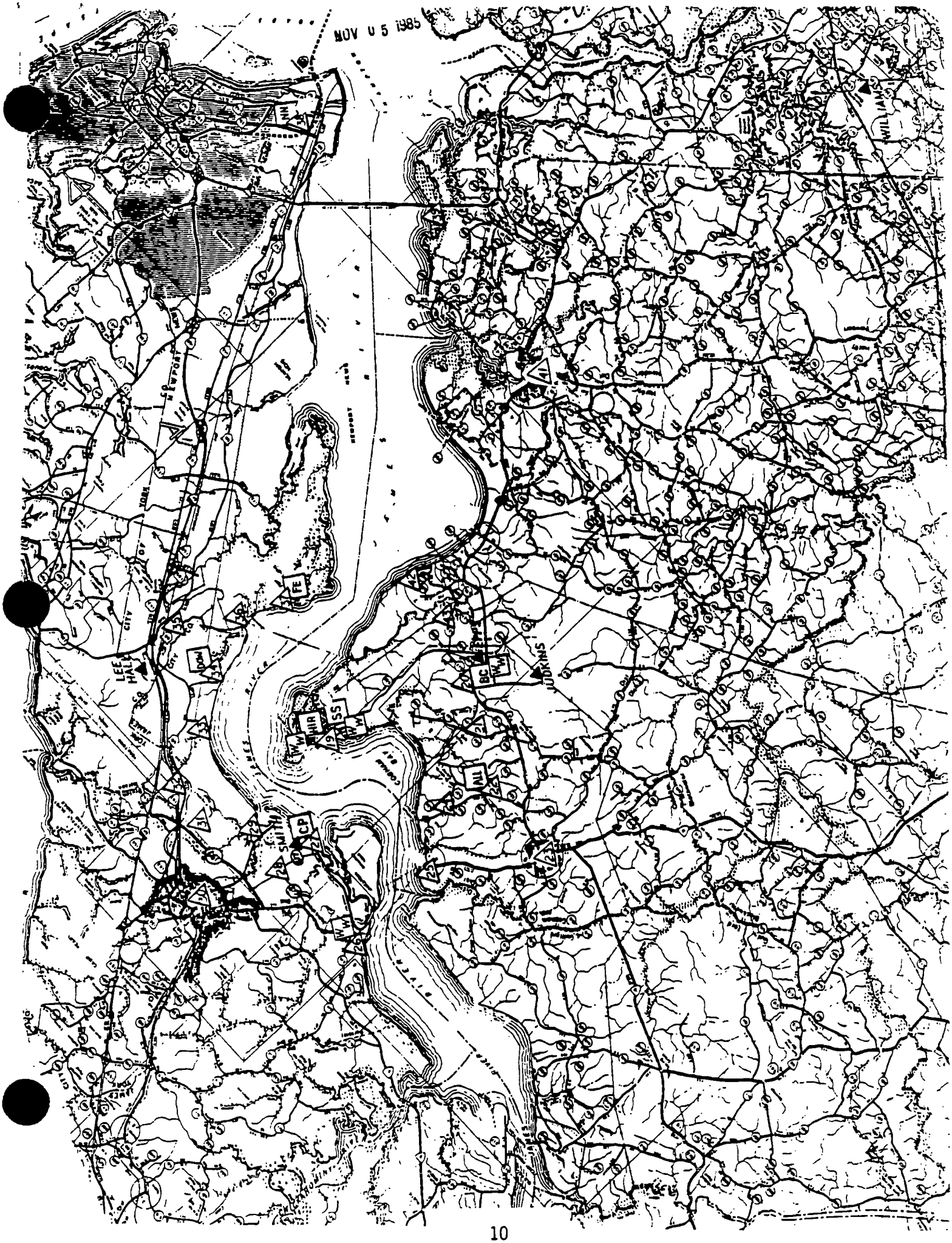
NOV 0 5 1985
LEE HALL
SMITH
CP
FE
NM
NJ
SS
WHR
BC
HW
JUDKINS
WILLIAMS
YORK
RIVER

FIGURE 2 RIVER

FEB 6 1986

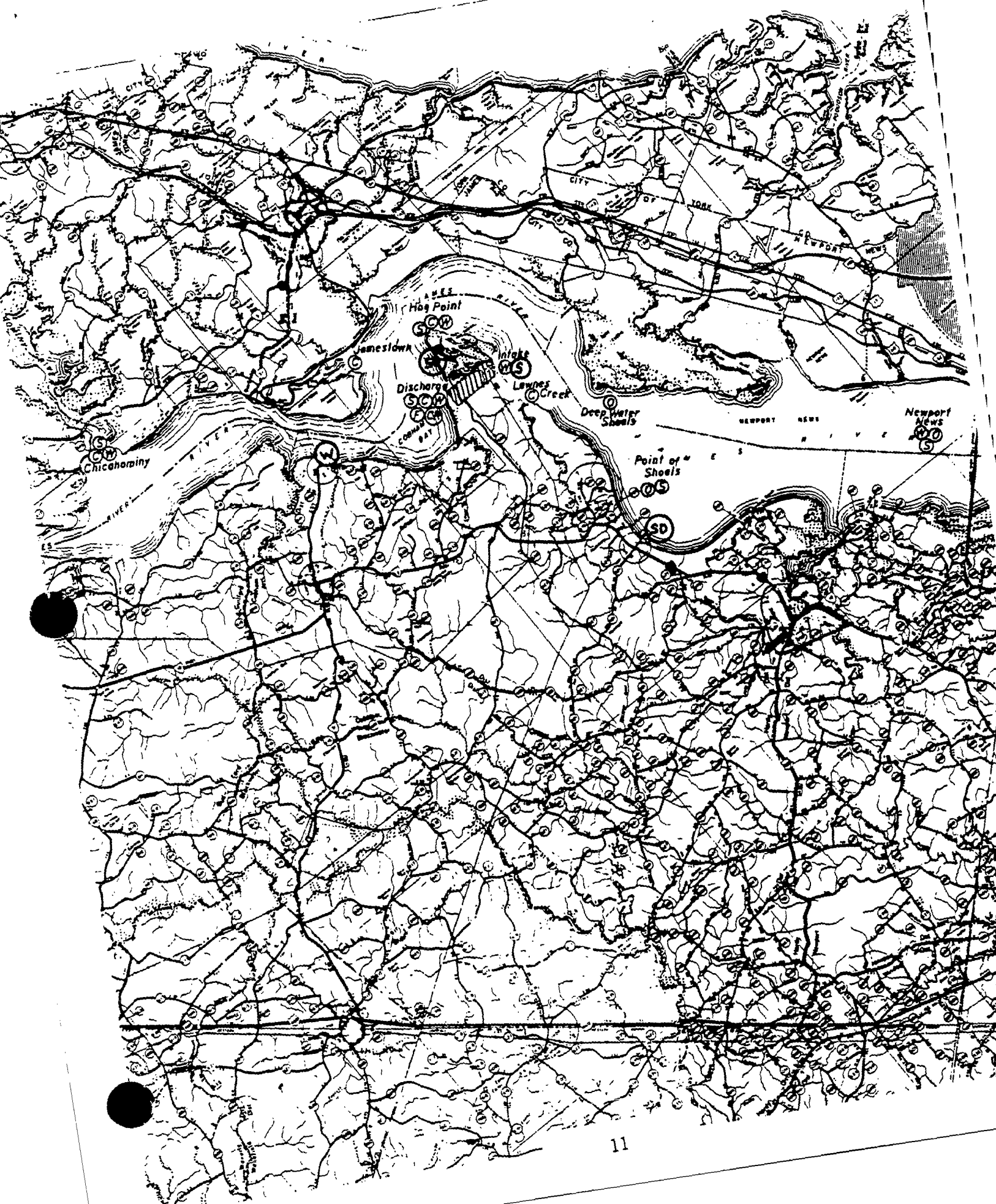

FIGURE 3 SITE BOUNDR's

NOV 0 5 1985

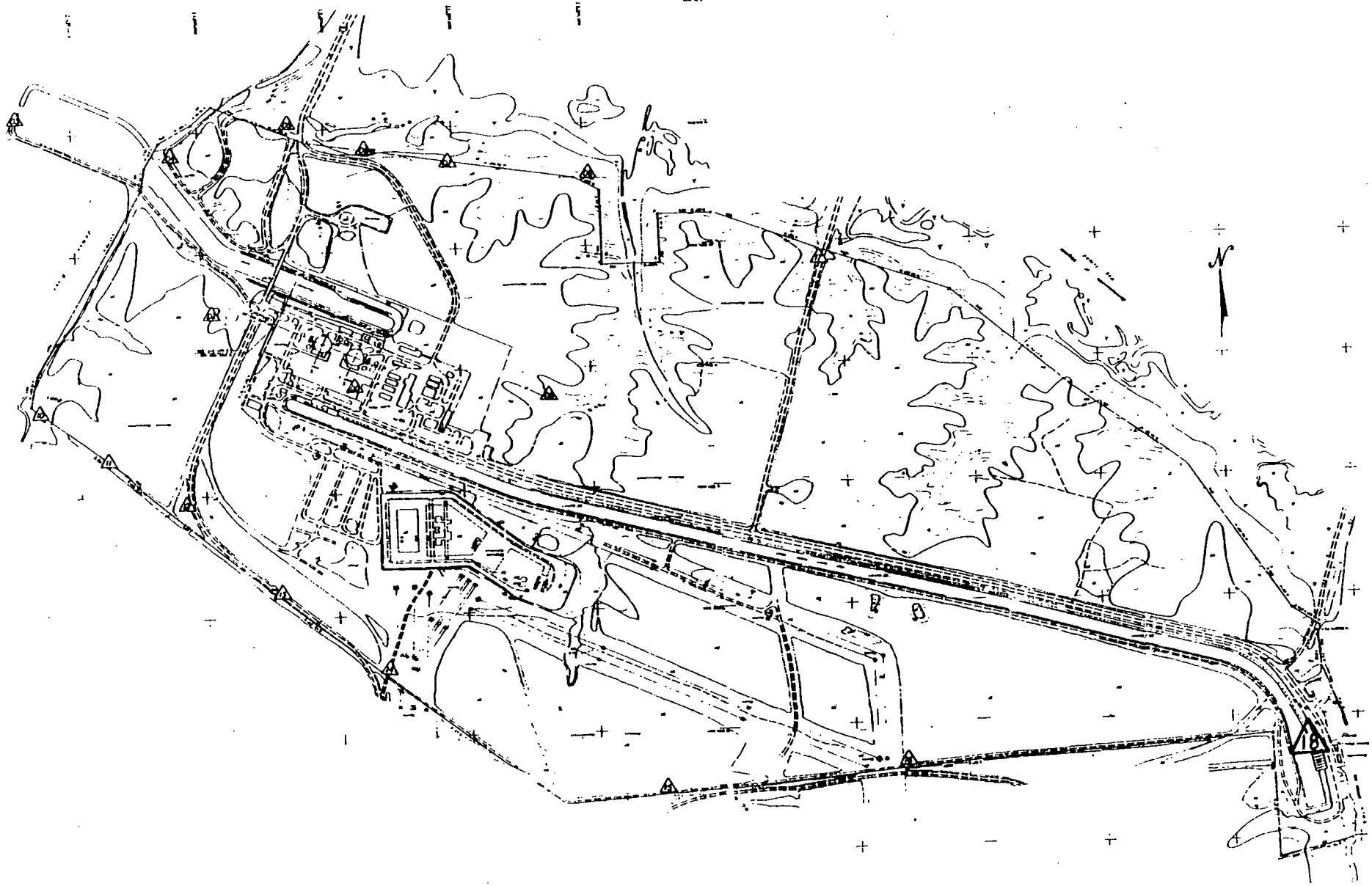

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TABLE 2

SURRY POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Thermoluminescent Dosimetry (TLD)	Quarterly	Gamma Dose		mR/month
Air Iodine	Weekly	I-131	0.07	pCi/m^3
Air Particulate	Weekly	Gross Beta	0.01	pCi/m^3
	Quarterly (1)	Gamma Isotopic		pCi/m^3
		Cs-134	0.05	
		Cs-137	0.06	
River Water	Quarterly composite of monthly sample	Tritium	2000	pCi/ℓ
	Monthly and Bi-monthly	Gamma Isotopic		pCi/ℓ
		Mn-54	15	
		Fe-59	30	
		Co-58, 60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		I-131	10	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
Well Water	Quarterly	Tritium	2000	pCi/ℓ
		Gamma Isotopic		pCi/ℓ
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		I-131	1	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	

(1) Quarterly composites of each locations's weekly air particulate samples will be analysed for Gamma Emitters.

TABLE 2 (Cont.)

SURRY POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Shoreline Sediment	Semi-Annual	Gamma Isotopic		pCi/kg-dry
		Cs-134	150	
		Cs-137	180	
Silt	Semi-Annual	Gamma Isotopic		pCi/kg-dry
		Cs-134	150	
		Cs-137	180	
Milk	Monthly	I-131	1	pCi/ℓ
		Gamma Isotopic		pCi/ℓ
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
Oyster	Bi-Monthly	Gamma Isotopic		pCi/kg-wet
		Mn-54	130	
		Fe-59	260	
		Co-58, 60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
Clams	Bi-Monthly	Gamma Isotopic		pCi/kg-wet
		Mn-54	130	
		Fe-59	260	
		Co-58, 60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
Crabs	3 Summer Months	Gamma Isotopic		pCi/kg-wet
		Mn-54	130	
		Fe-59	260	
		Co-58, 60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	

TABLE 2 (Cont.)

SURRY POWER STATION

SAMPLE ANALYSIS PROGRAM

SAMPLE MEDIA	FREQUENCY	ANALYSIS	LLD*	REPORT UNITS
Fish	Semi-Annual	Gamma Isotopic		pCi/kg-wet
		Mn-54	130	
		Fe-59	260	
		Co-58, 60	130	
		Zn-65	260	
		Cs-134	130	
		CS-137	150	
Crops	Annually	Gamma Isotopic		pCi/kg-wet
		I-131	60	
		Cs-134	60	
		Cs-137	80	

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

* LLD's indicate those levels that the environmental samples should be analyzed to, in accordance with the Surry Radiological Environmental Program. Actual analysis of the samples by Teledyne Isotopes may be lower than those listed.

III. EXCEPTIONS

REMP EXCEPTIONS FOR SCHEDULED SAMPLING AND ANALYSIS PROGRAM DURING 1986

During the environmental reporting period, several samples were not available, the analysis of the samples did not meet the required sensitivity (LLD) or the sample was not collected in the usual sampling frequency. In addition to the loss of some samples currently in the Radiological Environmental Monitoring Program, several sample locations and/or types of analysis included in the 1985 REMP but not required by Station Technical Specifications, were deleted from the 1986 REMP. The following is a discussion of the exceptions and actions taken to limit reoccurrence.

Four direct radiation TLD's were vandalized during the reporting period. The current program requires two sets of TLD's at each sample location, thus the backup TLD set provided readings for two of the four TLD stations. All TLD sample locations are visually checked once per month to eliminate loss of data.

TLD sample location #01 along with an air iodine/particulate station were located onsite during 1985. In September 1985, these sample stations were moved to the site boundary because of onsite construction. TLD location #01 was deleted from the 1986 REMP because there are TLD sample locations in the site boundary sectors on either side of the site boundary air iodine/particulate sampling station.

Two air iodine/particulate samples were lost because of failure of the carbon vanes in the sample pumps. The air sampling equipment was replaced with new equipment early in 1986. Sampler failure rate has decreased dramatically as compared with 1985 failure rate.

The analysis of gross alpha activity was eliminated from the 1986 REMP because it is not required by Station Technical Specifications. The

weekly analysis of gross beta, weekly analysis of iodine and the quarterly gamma analysis of composite particulate filters will continue to monitor possible radiological releases from the power station.

River water samples are collected and composited at the Surry Discharge Canal (downstream location) and at Scotland Wharf (upstream control location) by the State of Virginia. These samples are split with VEPCO on a monthly basis. The analysis for barium/lanthanum-140 and iodine-131 failed to meet the required Lower Limit of Detection (LLD) in many of these samples because of delay in receipt of composite samples from the State of Virginia. To satisfy the Technical Specification requirements of upstream and downstream river water samples, a monthly grab sample was taken by VEPCO at approximately the same locations.

The analysis of the river water grab samples for the Hog Island Point (HIP), Newport News (NN) and Scotland Wharf (SW) failed to meet the LLD for lanthanium-140 because of delay in analysis by the vendor lab.

Gross alpha/beta analysis on all well water samples were deleted during 1986. Current Technical Specifications require only gamma analysis to be performed on well water samples.

Elemental calcium analysis and strontium analysis on milk samples were deleted during 1986. Current Technical Specifications require only gamma and iodine analysis. The State Split samples from Lee Hall and Epps were analyzed for strontium during 1986 and will continue as a quarterly composite analysis in 1987.

Fish samples were taken in accordance with the required sampling program during 1986. The sample taken for the Station Discharge on 9/2/86 did not meet the LLD for cesium because of its small size. After VEPCO was notified of the LLD problem, several attempts were made to acquire another sample.

A sample was collected in January 1987 and sent to the vendor lab. The results of this sample are included in this report.

Precipitation samples requiring gross beta and tritium analysis, were deleted from the sampling program in 1986. These samples are not required by the current Technical Specifications.

REMP EXCEPTIONS FOR SCHEDULED

SAMPLING AND ANALYSIS DURING 1986

Location	Description	Date of Sampling	Reason(s) for Loss/ Exception
01	Direct Radiation	All 1986	Not required by current REMP.
03	Direct Radiation	First Quarter	TLD Vandalized
05	Direct Radiation	First Quarter	TLD Vandalized
18	Direct Radiation	Third Quarter	TLD Vandalized; back-up TLD available for analysis.
35	Direct Radiation	First Quarter	TLD Vandalized; replaced 2/12/86; back-up TLD available for analysis.
SS	Air Particulate/ Air Iodine	01/20/86-01/29/86	Malfunction of carbon vanes in sample pump.
Alliance	Air Particulate/ Air Iodine	03/25/86-04/01/86	Malfunction of carbon vanes in sample pump.
All Stations	Gross Alpha/ Air Particulate	All 1986	Analysis not required by current Technical Specifications.
SW, SD (State Split)	River Water Ba/La-140 I-131	03/15/86-12/15/86 05/15/86-08/15/86	LLD's not met due to late receipt from State of Virginia.
HIP, NN, SW	River Water La-140	07/14/86	LLD not met due to delay in analysis by vendor lab.

REMP EXCEPTIONS FOR SCHEDULED

SAMPLING AND ANALYSIS DURING 1986

Location	Description	Date of Sampling	Reason(s) for Loss/ Exception
SW, SD (VEPCO)	Monthly Analysis of River Water Tritium	All 1986	Monthly samples composited for quarterly analysis as required by Technical Specification.
CHIC, HIP, SI, NN	Bi-monthly Analysis of River Water Tritium	All 1986	Analysis not required by current Technical Specifications.
BC, HIR, JMTN, SS	Well Water Gross Alpha/Beta	All 1986	Gross alpha/beta analysis not required by current Technical Specifications; gamma analysis performed on all samples.
All Stations	Calcium Analysis on Milk	All 1986	Calcium analysis not required by current Technical Specifications.
CP, JDKS, WMS	Strontium-89, 90 Analysis on Milk	All 1986	Strontium analysis not required by current Technical Specifications.
SD	Gamma Analysis in Fish Sample	9/2/86	Cesium LLD not met due to small volume sent to vendor lab; re-sample taken.
SS, NN	Gross Beta and Tritium in Precipitation	All 1986	Precipitation sampling not required by current Technical Specifications.
Ryan's Garden	Gamma Analysis of Kale Sample	6/1986	Sample lost in transfer from State of Virginia to VEPCO.

V. SUMMARY AND DISCUSSION OF 1986 ANALYTICAL RESULTS

IV. SUMMARY AND DISCUSSION OF 1986 ANALYTICAL RESULTS

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

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

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

A. Airborne Exposure Pathway

1. Air Iodine/Air Particulates

On April 25, 1986 at 1725 hours EST there was a nuclear accident at a Russian reactor at Chernobyl. Sufficient quantities of radioactivity were released into the atmosphere so that various radioisotopes were

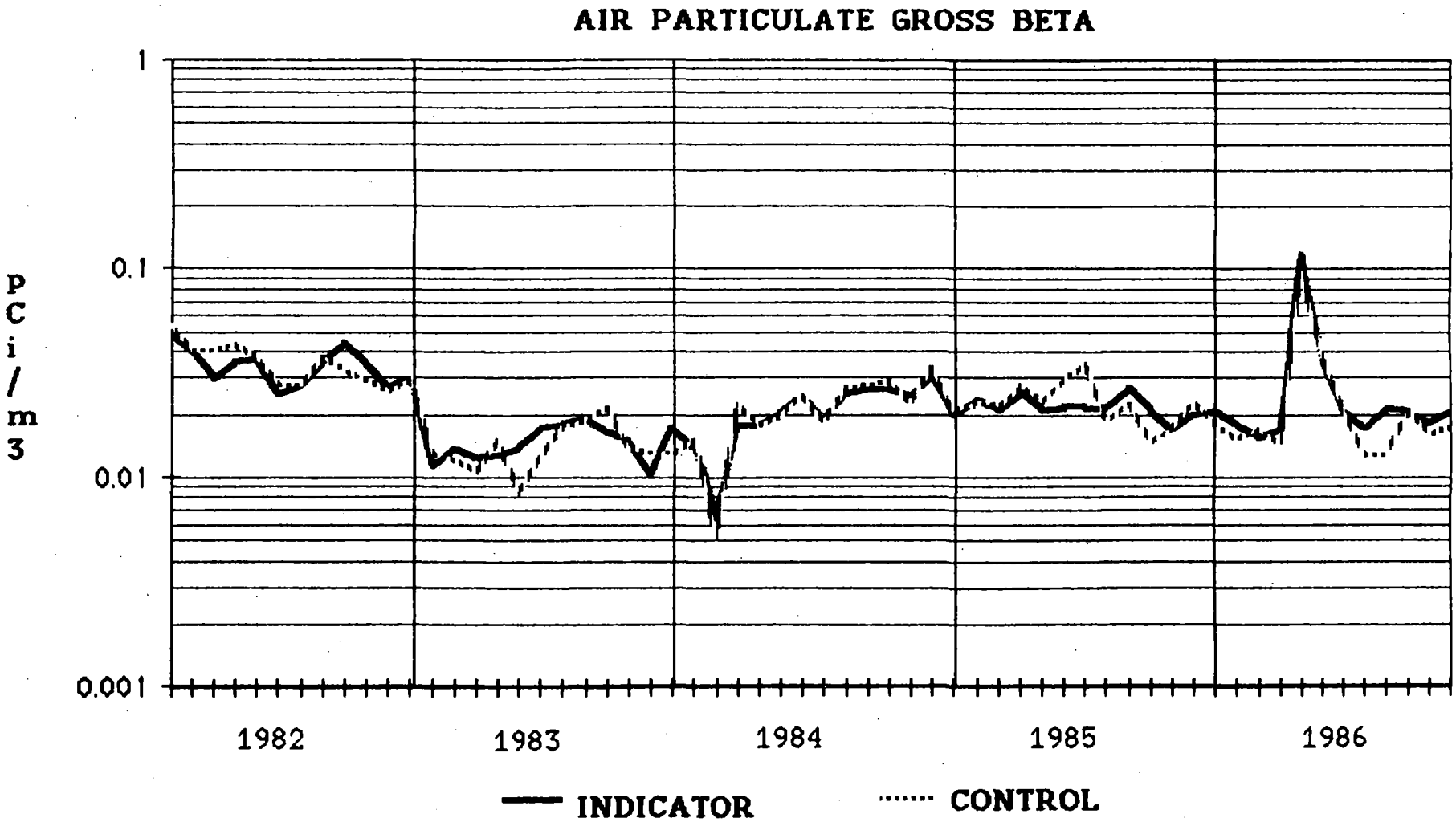
were measured in certain sample media collected at all the commercial nuclear utilities in the U.S. for which Teledyne Isotopes provides environmental analytical services. At the Surry Power Station the radioactivity was first detected during the week beginning May 5, 1986. Elevated gross beta activity levels in weekly air particulates were measured from May 5 through June 10. The second quarter composite (by sampling location) of air particulates analyzed by gamma ray spectroscopy had measurable levels of ruthenium-103, cesium-134 and cesium-137. Iodine-131 was measured in weekly charcoal cartridges from May 5 through June 10.

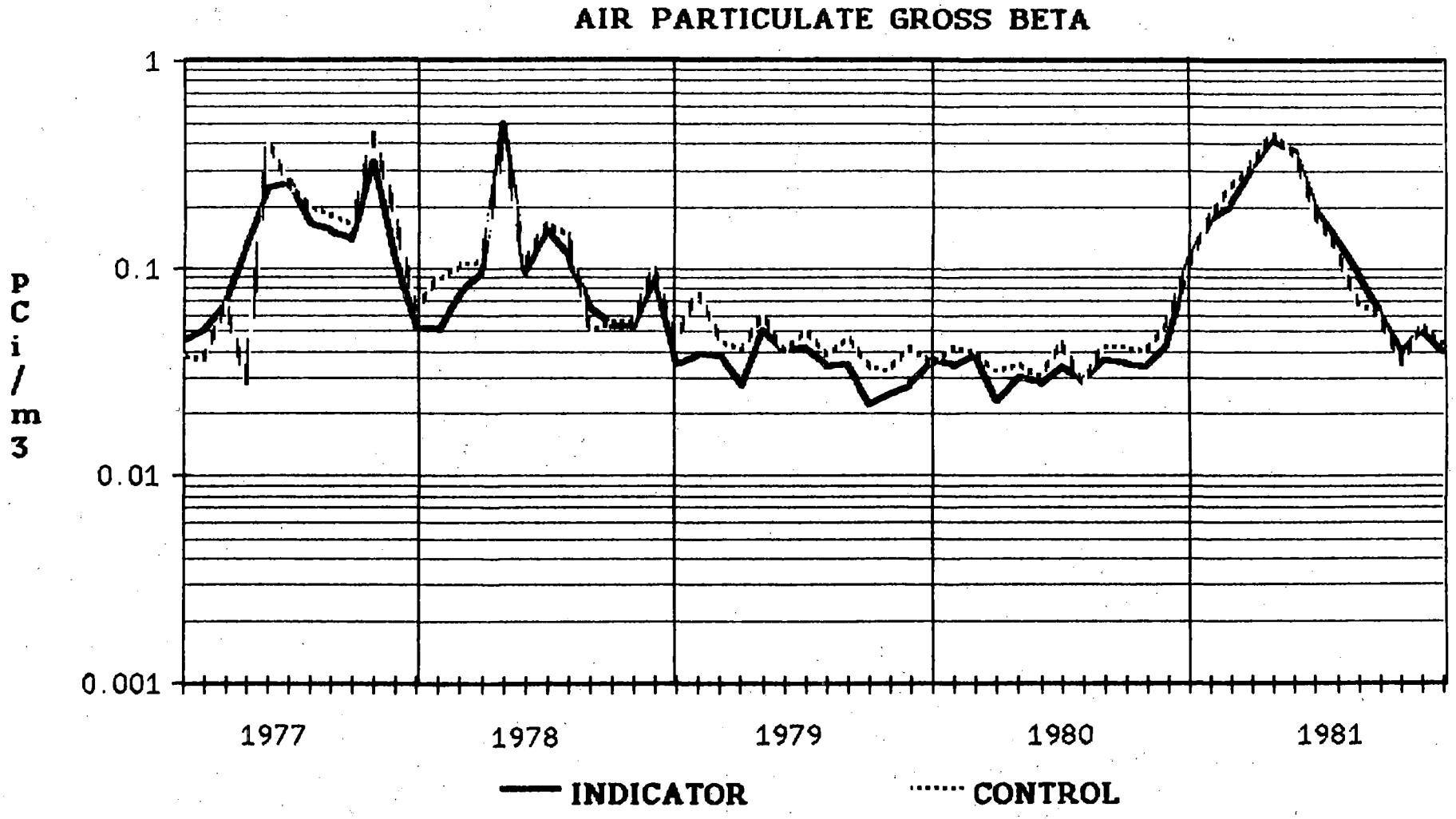
Results of airborne iodine-131 analyses of charcoal cartridges are presented in Table 4. Iodine-131 attributable to the Chernobyl accident, was detected in all eight sampling locations during the three week period May 6 through May 27. The average concentration per week was 0.94, 0.30, and 0.20 pCi/m^3. In subsequent weeks as the iodine-131 continued to decrease due to radioactive decay and atmospheric mixing, the concentrations dropped below the detection limit. During the week of May 27 to June 3, iodine-131 was detected in six sampling locations with an average activity of 0.062 pCi/m^3. During the week of June 3 to June 10, iodine-131 was detected in only three sampling locations with an average activity of 0.056 pCi/m^3. There was no statistical difference of the average of the weekly iodine-131 results of the seven indicator locations compared to the control location.

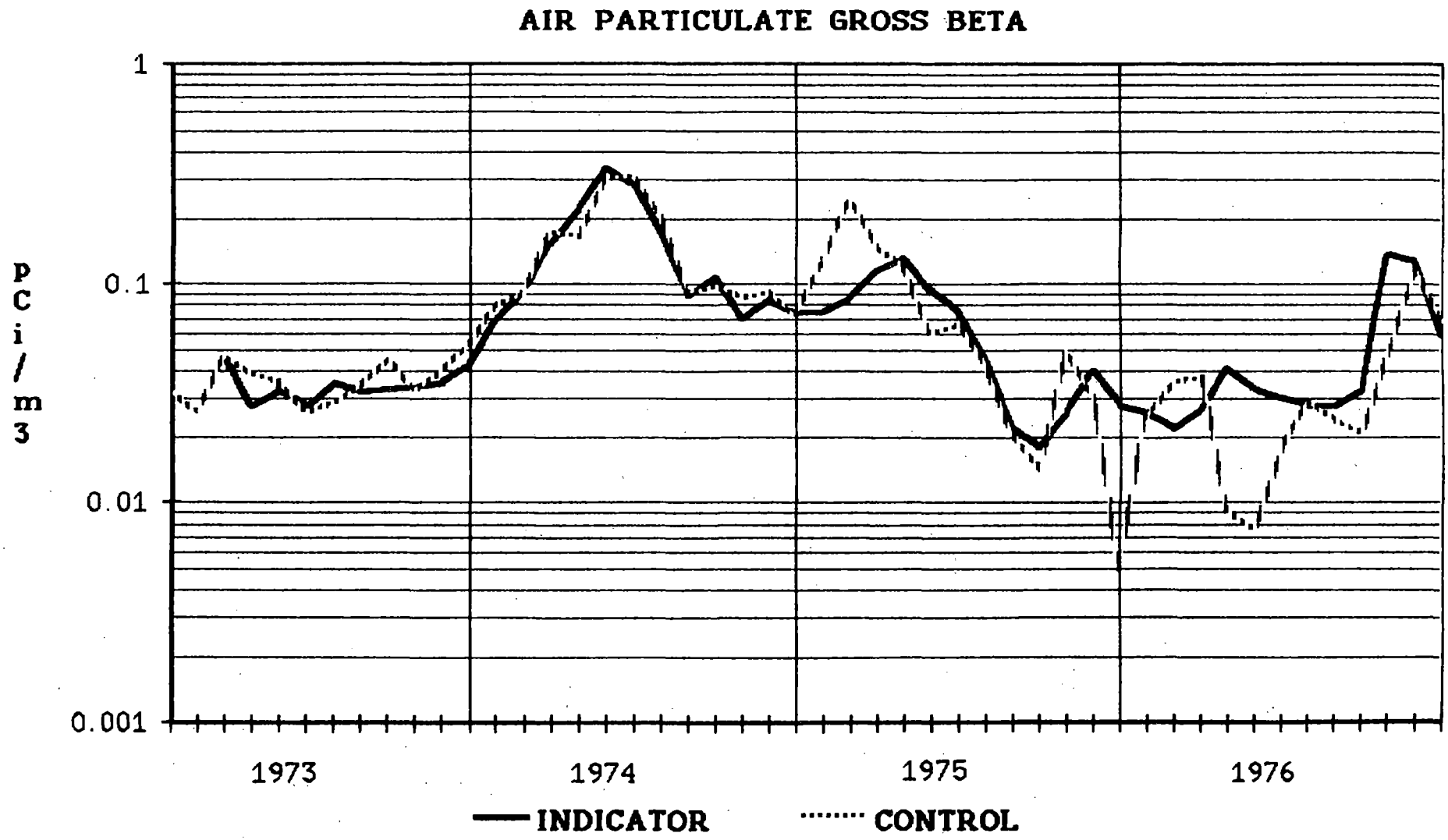
During the same five week period of May 6 through June 10 elevated gross beta activities of all eight sampling locations were measured with weekly average concentrations of 0.226, 0.143, 0.107, 0.070, and 0.092 pCi/m^3. For the week of highest gross beta activity the individual

sampling locations had a range of 0.19 to 0.32 pCi/m^3. During the remaining 47 weeks of 1986 the gross beta activity was measured in all of the 375 samples collected with an average concentration of 0.017 pCi/m^3 and a range from 0.0076 to 0.035 pCi/m^3. The results of the gross beta activities are listed in Table 5. The monthly averages of the gross beta concentrations for the seven indicator locations and the control locations are plotted for 1969 through 1986. With the exception of the five week period influenced by the Chernobyl accident, the gross beta activities were comparable to levels in the 1982-1985 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing by other countries.

Air particulate filters were composited by locations on a quarterly basis and were analyzed by gamma ray spectroscopy. The results are listed in Table 6. Cosmogenically produced beryllium-7 was measured in all 32 composite samples with an average activity of 0.094 pCi/m^3 and a range between 0.056 and 0.163 pCi/m^3. Naturally occurring potassium-40 was detected in four samples with an average activity of 0.012 pCi/m^3 and a range from 0.0054 to 0.027 pCi/m^3. In the second quarter composites, three fission-produced isotopes, ruthenium-103, cesium-134 and cesium-137 were measured in the eight samples. These isotopes are attributed to the Chernobyl accident; there was no statistical significance to the average concentrations in the seven indicator locations compared to the control location. The average activity of ruthenium-103 was 0.0085 pCi/m^3 and the range was from 0.0072 to 0.0109 pCi/m^3. The average activity of cesium-134 was 0.0070 pCi/m^3 and the range was 0.0052 to 0.0082 pCi/m^3. The average activity of cesium-137 was 0.0148 pCi/m^3 and the range was 0.0129 to 0.0196 pCi/m^3.


AIR PARTICULATE GROSS BETA
1
0.1
0.01
0.001
pCi/m3
1982
1983
1984
1985
1986
INDICATOR
CONTROL


AIR PARTICULATE GROSS BETA
1
0.1
0.01
0.001
pCi/m3
1977
1978
1979
1980
1981
INDICATOR
CONTROL


AIR PARTICULATE GROSS BETA
1
0.1
0.01
0.001
pCi/m3
1973
1974
1975
1976
INDICATOR
CONTROL

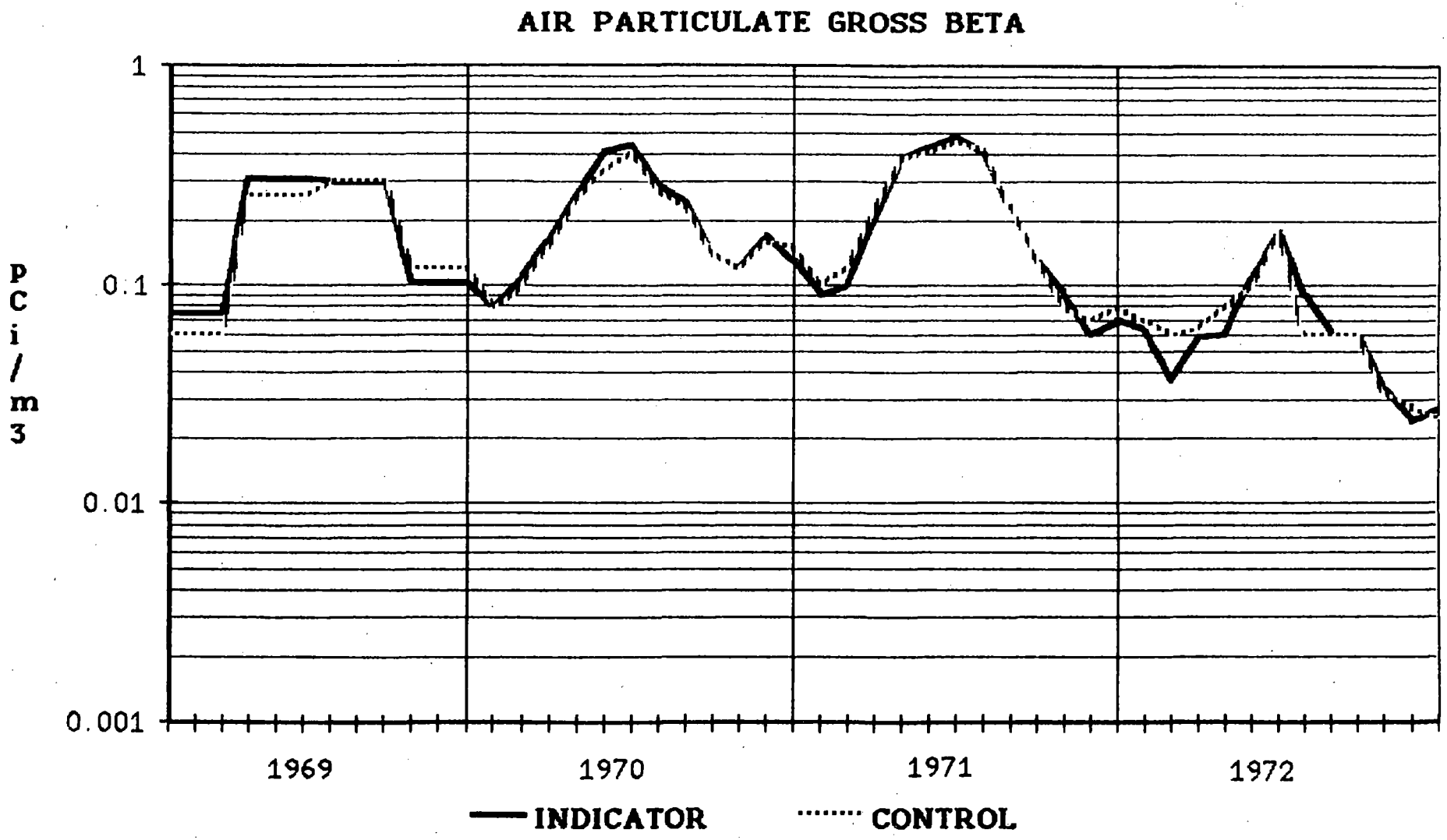

AIR PARTICULATE GROSS BETA
1
0.1
0.01
0.001
PCi/m3
1969
1970
1971
1972
INDICATOR
CONTROL

TABLE 3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Iodine (pCi/m^3)	I-131	414	0.07	0.37(29/362) (0.04-1.27)	CP	0.60(3/52) (0.17-1.27)	0.30(4/52) (0.06-0.74)	0
Airborne Particulates (1E-03 pCi/m^3)	Gross Beta	414	2	30(362/362) (7.6-320)	CP	32(52/52) (8-320)	26(52/52) (9.1-210)	0
	Gamma Spec Quarterly	32						
	Be-7	32		96.4(28/28) (56.4-138)	ALL	108.3(4/4) (67.9-163)	77(4/4) (59.6-90.7)	0
	K-40	32		11.8(4/28) (5.4-26.9)	FE	26.9(1/4) -	-(0/4) -	0
	Ru-103	32		8.6(7/28) (7.2-10.9)	ALL	10.9(1/4) -	7.7(1/4) -	0
	Cs-134	32	0.6	7.3(7/28) (6.1-8.2)	CP	8.2(1/4) -	5.2(1/4) -	0
	Cs-137	32	0.7	15.1(7/28) (12.9-19.6)	ALL	19.6(1/4) -	13.0(1/4) -	0

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

TABLE 4

(Page 1 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN
JANUARY								
12/31/85-01/07/86	<.01	<.02	<.03	<.03	<.03	<.03	<.03	<.02
01/07/86-01/13/86	<.02	<.03	<.05	<.05	<.03	<.03	<.03	<.02
01/13/86-01/20/86	<.03	<.03	<.05	<.06	<.03	<.03	<.03	<.02
01/20/86-01/29/86	(a)	<.02	<.01	<.03	<.02	<.02	<.02	<.007
01/29/86-02/05/86	<.03	<.03	<.05	<.05	<.04	<.07	<.07	<.04
FEBRUARY								
02/05/86-02/12/86	<.03	<.05	<.06	<.06	<.05	<.04	<.04	<.03
02/12/86-02/18/86	<.04	<.04	<.06	<.07	<.04	<.04	<.04	<.02
02/18/86-02/25/86	<.02	<.02	<.03	<.03	<.04	<.04	<.04	<.03
02/25/86-03/04/86	<.02	<.02	<.04	<.04	<.02	<.03	<.03	<.02
MARCH								
03/04/86-03/11/86	<.01	<.01	<.02	<.03	<.02	<.02	<.02	<.01
03/11/86-03/18/86	<.02	<.02	<.03	<.04	<.02	<.02	<.02	<.01
03/18/86-03/25/86	<.01	<.01	<.02	<.02	<.02	<.01	<.02	<.01
03/25/86-04/01/86	<.02	<.02	<.04	(a)	<.03	<.02	<.02	<.01
APRIL								
04/01/86-04/08/86	<.02	<.02	<.03	<.04	<.03	<.03	<.03	<.02
04/08/86-04/15/86	<.02	<.02	<.04	<.05	<.03	<.03	<.03	<.02
04/15/86-04/22/86	<.02	<.02	<.03	<.05	<.04	<.03	<.03	<.02
04/22/86-04/29/86	<.02	<.02	<.02	<.03	<.04	<.03	<.03	<.02

(a) Sampler malfunction; no sample available.

TABLE 4

(Page 2 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN
MAY								
04/29/86-05/06/86	<.02	<.02	<.02	<.02	<.03	<.03	<.03	<.02
05/06/86-05/13/86	.737 ±.081	.948 ±.100	.769 ±.077	1.02 ±0.10	1.27 ±.021	.769 ±.131	1.26 ±.015	.741 ±.074
05/13/86-05/20/86	.361 ±.064	.344 ±.061	.313 ±.031	.375 ±.038	.354 ±.035	.222 ±.022	.308 ±.033	.147 ±.015
05/20/86-05/27/86	.157 ±.019	.122 ±.012	.224 ±.022	.190 ±.019	.173 ±.022	.151 ±.039	.303 ±.040	.244 ±.055
05/27/86-06/03/86	.046 ±.022	.057 ±.012	.068 ±.020	.077 ±.015	<.05	.060 ±.014	<.02	.061 ±.016
JUNE								
06/03/86-06/10/86	.074 ± .011	.054 ± .011	<.04	<.04	<.05	<.05	.039 ± .019	<.04
06/10/86-06/17/86	<.03	<.03	<.03	<.03	<.05	<.03	<.03	<.03
06/17/86-06/24/86	<.02	<.02	<.02	<.02	<.03	<.02	<.02	<.02
06/24/86-07/01/86	<.02	<.01	<.02	<.01	<.02	<.01	<.01	<.01
JULY								
07/01/86-07/08/86	<.02	<.02	<.02	<.02	<.05	<.02	<.02	<.02
07/08/86-07/14/86	<.03	<.03	<.03	<.03	<.05	<.02	<.02	<.02
07/14/86-07/22/86	<.02	<.02	<.02	<.02	<.03	<.02	<.02	<.02
07/22/86-07/29/86	<.01	<.01	<.01	<.01	<.04	<.009	<.009	<.009
AUGUST								
07/29/86-08/05/86	<.01	<.01	<.02	<.01	<.02	<.01	<.01	<.01
08/05/86-08/12/86	<.02	<.02	<.02	<.02	<.04	<.02	<.02	<.02
08/12/86-08/19/86	<.02	<.02	<.02	<.02	<.03	<.01	<.02	<.02
08/19/86-08/26/86	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
08/26/86-09/02/86	<.02	<.02	<.03	<.02	<.01	<.01	<.03	<.02

TABLE 4

(Page 3 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN
SEPTEMBER								
09/02/86-09/09/86	<.02	<.02	<.02	<.02	<.02	<.02	<.03	<.02
09/09/86-09/16/86	<.02	<.02	<.02	<.01	<.01	<.01	<.01	<.01
09/16/86-09/22/86	<.02	<.02	<.02	<.03	<.02	<.02	<.02	<.02
09/22/86-09/29/86	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
OCTOBER								
09/29/86-10/07/86	<.01	<.01	<.01	<.01	<.008	<.008	<.008	<.009
10/07/86-10/14/86	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
10/14/86-10/21/86	<.02	<.01	<.01	<.01	<.03	<.03	<.02	<.03
10/21/86-10/28/86	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
NOVEMBER								
10/28/86-11/04/86	<.01	<.01	<.01	<.01	<.02	<.02	<.02	<.02
11/04/86-11/11/86	<.03	<.02	<.02	<.02	<.02	<.02	<.02	<.02
11/11/86-11/18/86	<.04	<.03	<.03	<.03	<.02	<.02	<.02	<.02
11/18/86-11/25/86	<.03	<.03	<.03	<.03	<.02	<.02	<.02	<.02
11/25/86-12/02/86	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.01
DECEMBER								
12/02/86-12/09/86	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.01
12/09/86-12/16/86	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.01
12/16/86-12/22/86	<.04	<.04	<.03	<.04	<.03	<.03	<.03	<.03
12/22/86-12/30/86	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02

TABLE 5

(Page 1 of 4)

VIRGINIA POWER - SURRY 1986

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

10^{-3} pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN	Average ± 2 s.d
JANUARY									
12/31/85-01/07/86	21 ± 2	21 ± 2	26 ± 3	13 ± 2	28 ± 3	25 ± 3	24 ± 3	23 ± 2	23 ± 9.1
01/07/86-01/13/86	18 ± 2	21 ± 2	28 ± 4	31 ± 4	30 ± 4	24 ± 3	26 ± 3	22 ± 2	25 ± 9.1
01/13/86-01/20/86	17 ± 2	14 ± 2	17 ± 3	17 ± 3	9 ± 2	19 ± 3	18 ± 3	13 ± 2	16 ± 6.6
01/20/86-01/29/86	(a)	16 ± 2	16 ± 2	18 ± 3	17 ± 2	19 ± 2	15 ± 2	15 ± 2	17 ± 3.0
01/29/86-02/05/86	21 ± 2	20 ± 2	18 ± 3	28 ± 3	23 ± 3	26 ± 3	26 ± 3	18 ± 2	23 ± 7.7
FEBRUARY									
02/05/86-02/12/86	14 ± 2	13 ± 2	24 ± 3	14 ± 3	13 ± 2	17 ± 3	18 ± 3	12 ± 2	16 ± 7.9
02/12/86-02/18/86	28 ± 3	21 ± 2	13 ± 3	30 ± 4	30 ± 4	17 ± 3	19 ± 3	17 ± 2	22 ± 13.2
02/18/86-02/25/86	15 ± 2	16 ± 2	18 ± 3	19 ± 3	17 ± 3	21 ± 3	11 ± 2	17 ± 2	17 ± 5.9
02/25/86-03/04/86	15 ± 2	16 ± 2	15 ± 2	17 ± 3	8 ± 2	19 ± 2	15 ± 2	15 ± 2	15 ± 6.3
MARCH									
03/04/86-03/11/86	16 ± 2	14 ± 2	16 ± 3	23 ± 3	20 ± 3	17 ± 3	15 ± 3	20 ± 2	18 ± 6.1
03/11/86-03/18/86	12 ± 2	13 ± 2	16 ± 2	10 ± 2	14 ± 2	16 ± 2	11 ± 2	15 ± 2	13 ± 4.5
03/18/86-03/25/86	17 ± 2	24 ± 2	12 ± 2	15 ± 3	9 ± 2	16 ± 2	10 ± 2	14 ± 2	15 ± 9.4
03/25/86-04/01/86	20 ± 2	15 ± 2	21 ± 3	(a)	15 ± 2	11 ± 2	21 ± 3	19 ± 2	17 ± 7.6
Quarter Average ± 2 s.d.	18 ± 8	17 ± 7	18 ± 10	20 ± 14	18 ± 16	19 ± 8	18 ± 11	17 ± 7	18 ± 7

(a) Sampler malfunction; no sample available.

TABLE 5

(Page 2 of 4)

VIRGINIA POWER - SURRY 1986

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

10^{-3} pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN	Average ± 2 s.d
APRIL									
04/01/86-04/08/86	16 ± 2	14 ± 2	21 ± 3	19 ± 3	21 ± 3	13 ± 2	23 ± 3	15 ± 2	18 ± 7.5
04/08/86-04/15/86	14 ± 2	15 ± 2	16 ± 3	18 ± 3	16 ± 3	17 ± 3	16 ± 3	16 ± 2	16 ± 2.4
04/15/86-04/22/86	8.4± 1.4	7.6± 1.2	24 ± 3	14 ± 3	20 ± 3	15 ± 2	18 ± 2	9.6± 1.4	15 ± 11.8
04/22/86-04/29/86	16 ± 2	15 ± 2	18 ± 2	15 ± 2	29 ± 3	24 ± 3	20 ± 3	18 ± 2	19 ± 10
MAY									
04/29/86-05/06/86	24 ± 2	20 ± 2	23 ± 2	18 ± 2	24 ± 3	26 ± 3	24 ± 3	22 ± 2	23 ± 5.1
05/06/86-05/13/86	230 ± 10	200 ± 10	220 ± 10	190 ± 10	320 ± 10	220 ± 10	220 ± 10	210 ± 10	226 ± 80
05/13/86-05/20/86	130 ± 10	150 ± 10	160 ± 10	180 ± 10	160 ± 10	140 ± 10	150 ± 10	71 ± 4	143 ± 65.1
05/20/86-05/27/86	95 ± 4	100 ± 10	130 ± 10	120 ± 10	99 ± 6	90 ± 4	110 ± 10	110 ± 10	107 ± 26.8
05/27/86-06/03/86	63 ± 4	64 ± 4	67 ± 4	86 ± 4	86 ± 6	55 ± 3	69 ± 5	69 ± 4	70 ± 21.8
JUNE									
06/03/86-06/10/86	85 ± 4	100 ± 10	100 ± 10	100 ± 10	85 ± 5	80 ± 4	91 ± 4	91 ± 4	92 ± 15.7
06/10/86-06/17/86	25 ± 3	11 ± 2	17 ± 2	23 ± 3	9.6± 3.2	16 ± 2	15 ± 2	16 ± 2	17 ± 10.6
06/17/86-06/24/86	23 ± 2	23 ± 2	23 ± 2	22 ± 2	13 ± 3	20 ± 2	21 ± 2	26 ± 3	21 ± 7.6
06/24/86-07/01/86	16 ± 2	17 ± 2	18 ± 2	19 ± 2	15 ± 3	13 ± 2	18 ± 2	18 ± 2	17 ± 4.0
Quarter Average ± 2 s.d.	57 ± 129	57 ± 125	64 ± 135	63 ± 130	69 ± 176	56 ± 126	62 ± 130	53 ± 116	60 ± 131

TABLE 5

(Page 3 of 4)

VIRGINIA POWER - SURRY 1986

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

10^{-3} pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN	Average ± 2 s.d
JULY									
07/01/86-07/08/86	22 ± 2	21 ± 2	22 ± 2	20 ± 2	19 ± 3	21 ± 2	25 ± 2	21 ± 2	21 ± 3.5
07/08/86-07/14/86	24 ± 3	19 ± 2	22 ± 2	20 ± 2	19 ± 4	21 ± 2	23 ± 2	23 ± 2	21 ± 3.8
07/14/86-07/22/86	17 ± 2	21 ± 2	18 ± 2	18 ± 2	25 ± 3	19 ± 2	21 ± 2	19 ± 2	20 ± 5.1
07/22/86-07/29/86	19 ± 2	23 ± 2	16 ± 2	19 ± 2	35 ± 6	16 ± 2	16 ± 2	21 ± 2	21 ± 12.7
AUGUST									
07/29/86-08/05/86	24 ± 2	23 ± 2	27 ± 2	19 ± 2	22 ± 3	21 ± 2	25 ± 2	12 ± 2	22 ± 9.2
08/05/86-08/12/86	20 ± 2	21 ± 2	26 ± 2	18 ± 2	22 ± 3	20 ± 2	17 ± 2	17 ± 2	20 ± 6.0
08/12/86-08/19/86	8.7± 1.5	11 ± 2	11 ± 2	11 ± 2	13 ± 3	11 ± 2	12 ± 2	10 ± 2	11 ± 2.5
08/19/86-08/26/86	11 ± 2	13 ± 2	17 ± 2	14 ± 2	14 ± 3	12 ± 2	12 ± 2	11 ± 2	13 ± 4.0
08/26/86-09/02/86	18 ± 2	15 ± 2	22 ± 3	16 ± 2	19 ± 2	13 ± 2	16 ± 3	14 ± 2	17 ± 5.8
SEPTEMBER									
09/02/86-09/09/86	21 ± 2	17 ± 2	15 ± 2	17 ± 2	19 ± 2	15 ± 2	18 ± 3	9.1± 1.7	16 ± 7.1
09/09/86-09/16/86	29 ± 3	24 ± 2	23 ± 2	28 ± 7	28 ± 2	21 ± 2	25 ± 2	14 ± 2	24 ± 9.8
09/16/86-09/22/86	24 ± 2	21 ± 2	16 ± 2	23 ± 3	26 ± 3	15 ± 2	19 ± 2	18 ± 2	20 ± 7.8
09/22/86-09/29/86	28 ± 3	22 ± 2	22 ± 2	20 ± 2	22 ± 2	22 ± 2	24 ± 2	11 ± 2	21 ± 9.6
Quarter Average ± 2 s.d.	20 ± 12	19 ± 8	20 ± 9	19 ± 8	22 ± 12	18 ± 8	20 ± 10	15 ± 9	19 ± 7

TABLE 5

(Page 4 of 4)

VIRGINIA POWER - SURRY 1986

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

10^{-3} pCi/m3 ± 2 Sigma

STATION COLLECTION DATE	SS	HIR	BC	ALL	CP	DOW	FE	NN	Average ± 2 s.d
OCTOBER									
09/29/86-10/07/86	14 ± 2	20 ± 2	16 ± 2	18 ± 2	19 ± 2	16 ± 2	19 ± 2	21 ± 2	18 ± 4.7
10/07/86-10/14/86	15 ± 2	14 ± 2	14 ± 2	15 ± 2	14 ± 2	16 ± 2	17 ± 2	14 ± 2	15 ± 2.3
10/14/86-10/21/86	19 ± 2	19 ± 2	18 ± 2	21 ± 2	23 ± 2	19 ± 2	19 ± 2	18 ± 2	20 ± 3.4
10/21/86-10/28/86	31 ± 2	32 ± 2	33 ± 2	30 ± 2	32 ± 2	22 ± 2	25 ± 2	30 ± 2	29 ± 7.7
NOVEMBER									
10/28/86-11/04/86	20 ± 2	20 ± 2	13 ± 2	19 ± 2	15 ± 2	14 ± 2	19 ± 2	16 ± 2	17 ± 5.7
11/04/86-11/11/86	19 ± 3	17 ± 2	17 ± 2	17 ± 2	15 ± 2	15 ± 2	19 ± 2	14 ± 2	17 ± 3.7
11/11/86-11/18/86	20 ± 2	18 ± 2	12 ± 2	20 ± 2	21 ± 2	17 ± 2	20 ± 2	20 ± 2	19 ± 5.9
11/18/86-11/25/86	20 ± 2	19 ± 2	12 ± 2	22 ± 2	22 ± 2	17 ± 2	19 ± 2	15 ± 2	18 ± 6.9
DECEMBER									
11/25/86-12/02/86	19 ± 2	15 ± 2	14 ± 2	20 ± 2	20 ± 2	18 ± 2	20 ± 2	14 ± 2	18 ± 5.5
12/02/86-12/09/86	19 ± 2	18 ± 2	14 ± 2	16 ± 2	18 ± 2	16 ± 2	18 ± 2	16 ± 2	17 ± 3.3
12/09/86-12/16/86	16 ± 2	16 ± 2	15 ± 2	19 ± 2	18 ± 2	14 ± 2	19 ± 2	17 ± 2	17 ± 3.7
12/16/86-12/22/86	30 ± 3	28 ± 3	25 ± 2	32 ± 3	28 ± 3	23 ± 2	27 ± 3	24 ± 3	27 ± 6.1
12/22/86-12/30/86	21 ± 2	23 ± 2	17 ± 2	23 ± 2	23 ± 2	18 ± 2	24 ± 2	16 ± 2	21 ± 6.3
Quarter Average ± 2 s.d.	20 ± 10	20 ± 10	17 ± 12	21 ± 10	21 ± 10	17 ± 6	20 ± 6	18 ± 9	19 ± 8
Annual Average ± 2 s.d.	29 ± 72	28 ± 70	30 ± 77	31 ± 75	32 ± 96	28 ± 70	30 ± 73	26 ± 65	29 ± 4

TABLE 6

(Page 1 of 2)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY AIR PARTICULATES

10^{-3} pCi/m^3 ± 2 sigma

STATION	NUCLIDE	FIRST QUARTER 12/31/85-04/01/86	SECOND QUARTER 04/01/86-07/01/86	THIRD QARTER 07/01/86-09/29/86	FOURTH QUARTER 09/29/86-12/30/86	AVERAGE ± 2.s.d.
SS	Be-7	132 ± 13	88.1 ± 11.4	95.8 ± 9.6	61.2 ± 6.8	94.3 ± 58.4
	K-40	<5	<9	<4	<7	-
	Co-60	<0.3	<0.6	<0.2	<0.4	-
	Ru-103	<0.9	8.13 ± 1.36	<0.3	<0.4	8.13 ± 1.36
	Cs-134	<0.3	6.83 ± 0.94	<0.2	<0.4	6.83 ± 0.94
	Cs-137	<0.3	14.8 ± 1.5	<0.3	<0.4	14.8 ± 1.5
	Th-228	<0.5	<1	<0.4	<0.8	-
HIR	Be-7	133 ± 13	95.8 ± 11.8	93.1 ± 9.3	80.5 ± 10.7	100.6 ± 45.2
	K-40	<3	<8	<10	<20	-
	Co-60	<0.2	<0.6	<0.3	<0.7	-
	Ru-103	<0.7	7.22 ± 1.31	<0.5	<1	7.22 ± 13.1
	Cs-134	<0.2	7.64 ± 1.09	<0.4	<0.7	7.64 ± 1.09
	Cs-137	<0.2	12.9 ± 1.3	<0.3	<0.7	12.9 ± 1.3
	Th-228	<0.5	<0.9	<0.5	<2	-
BC	Be-7	123 ± 12	105 ± 13	60.0 ± 6.0	57.8 ± 8.4	86.5 ± 65.3
	K-40	8.42 ± 3.34	<10	5.41 ± 2.39	<10	6.9 ± 4.3
	Co-60	<0.3	<0.5	<0.3	<0.7	-
	Ru-103	<1	9.87 ± 1.57	<0.3	<0.6	9.87 ± 1.57
	Cs-134	<0.4	7.94 ± 0.99	<0.3	<0.5	7.94 ± 1.0
	Cs-137	<0.4	17.1 ± 1.7	<0.3	<0.7	17.1 ± 1.7
	Th-228	<0.8	<1	<0.4	<1	-
ALL	Be-7	163 ± 22	110 ± 15	92.2 ± 9.2	67.9 ± 7.4	108.3 ± 80.7
	K-40	<20	<10	6.53 ± 2.22	<7	6.53 ± 2.22
	Co-60	<0.7	<0.9	<0.3	<0.4	-
	Ru-103	<3	10.9 ± 1.6	<0.4	<0.6	10.9 ± 1.6
	Cs-134	<0.9	8.21 ± 0.99	<0.3	<0.4	8.21 ± 0.99
	Cs-137	<0.8	19.6 ± 2.0	<0.3	<0.5	19.6 ± 2.0
	Th-228	<2	<1	<0.5	<0.7	-

* All other gamma emitters were <LLD.

TABLE 6

(Page 2 of 2)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY AIR PARTICULATES

10^{-3} pCi/m^3 ± 2 sigma

STATION	NUCLIDE	FIRST QUARTER 12/31/85-04/01/86	SECOND QUARTER 04/01/86-07/01/86	THIRD QARTER 07/01/86-09/29/86	FOURTH QUARTER 09/29/86-12/30/86	AVERAGE ± 2.s.d.
CP	Be-7	105 ± 15	93.4 ± 16.6	104 ± 10	85.5 ± 8.8	97.0 ± 18.6
	K-40	<10	<20	<10	<20	-
	Co-60	<0.6	<1	<0.6	<0.6	-
	Ru-103	<2	7.39 ± 2.07	<0.8	<0.8	7.39 ± 2.07
	Cs-134	<0.5	8.22 ± 1.68	<0.5	<0.6	8.22 ± 1.68
	Cs-137	<0.7	13.9 ± 1.6	<0.5	<0.6	13.9 ± 1.6
	Th-228	<1	<2	<0.9	<0.8	-
DOW	Be-7	138 ± 14	87.5 ± 13.2	60.9 ± 6.1	56.4 ± 5.9	85.7 ± 74.9
	K-40	<6	<10	<4	<6	-
	Co-60	<0.4	<0.7	<0.2	<0.4	-
	Ru-103	<1	7.57 ± 1.45	<0.3	<0.5	7.57 ± 1.45
	Cs-134	<0.4	6.10 ± 1.28	<0.2	<0.3	6.10 ± 1.28
	Cs-137	<0.4	13.6 ± 1.4	<0.2	<0.4	13.6 ± 1.4
	Th-228	<0.7	<1	<0.5	<0.6	-
FE	Be-7	129 ± 13	124 ± 23	83.1 ± 8.3	73.3 ± 7.3	102.4 ± 56.5
	K-40	<20	26.9 ± 12.9	<5	<4	26.9 ± 12.9
	Co-60	<0.5	<1	<0.2	<0.2	-
	Ru-103	<2	9.33 ± 2.34	<0.3	<0.3	9.33 ± 2.34
	Cs-134	<0.6	5.96 ± 1.66	<0.3	<0.2	5.96 ± 1.66
	Cs-137	<0.5	14.1 ± 1.9	<0.2	<0.3	14.1 ± 1.9
	Th-228	<0.8	<2	<0.5	<0.4	-
NN	Be-7	90.7 ± 6.3	88.3 ± 12.8	59.6 ± 6.0	69.5 ± 7.0	77.0 ± 30.0
	K-40	<9	<8	<4	<9	-
	Co-60	<0.3	<0.6	<0.2	<0.3	-
	Ru-103	<0.8	7.70 ± 1.36	<0.2	<0.4	7.70 ± 1.36
	Cs-134	<0.3	5.19 ± 1.12	<0.2	<0.3	5.19 ± 1.12
	Cs-137	<0.3	13.0 ± 1.3	<0.2	<0.3	13.0 ± 1.3
	Th-228	<0.4	<1	<0.3	<0.5	-

* All other gamma emitters were <LLD.

B. Waterborne Exposure Pathway

1. River Water

The James River is an estuary near Surry Power Station and undergoes tidal exchange with the Chesapeake Bay. River water samples thus represent saline bay water. Samples of James River water are collected as both monthly grab samples at the Surry Discharge and Scotland Wharf stations and bi-monthly grab samples at the Hog Island Point, Newport News, Chickahominy River, and Surry Intake stations. All the samples were analyzed for gamma emitting isotopes by gamma spectrometry and for iodine-131 by a radiochemical procedure. In addition, Scotland Wharf and Surry Discharge samples are composited and analyzed for tritium on a quarterly basis. The results are presented in Table 8. Potassium-40 was measured in seventeen of the samples with an average concentration of 103 pCi/ℓ and a range of 11.8 to 173 pCi/ℓ. No other gamma emitters were detected.

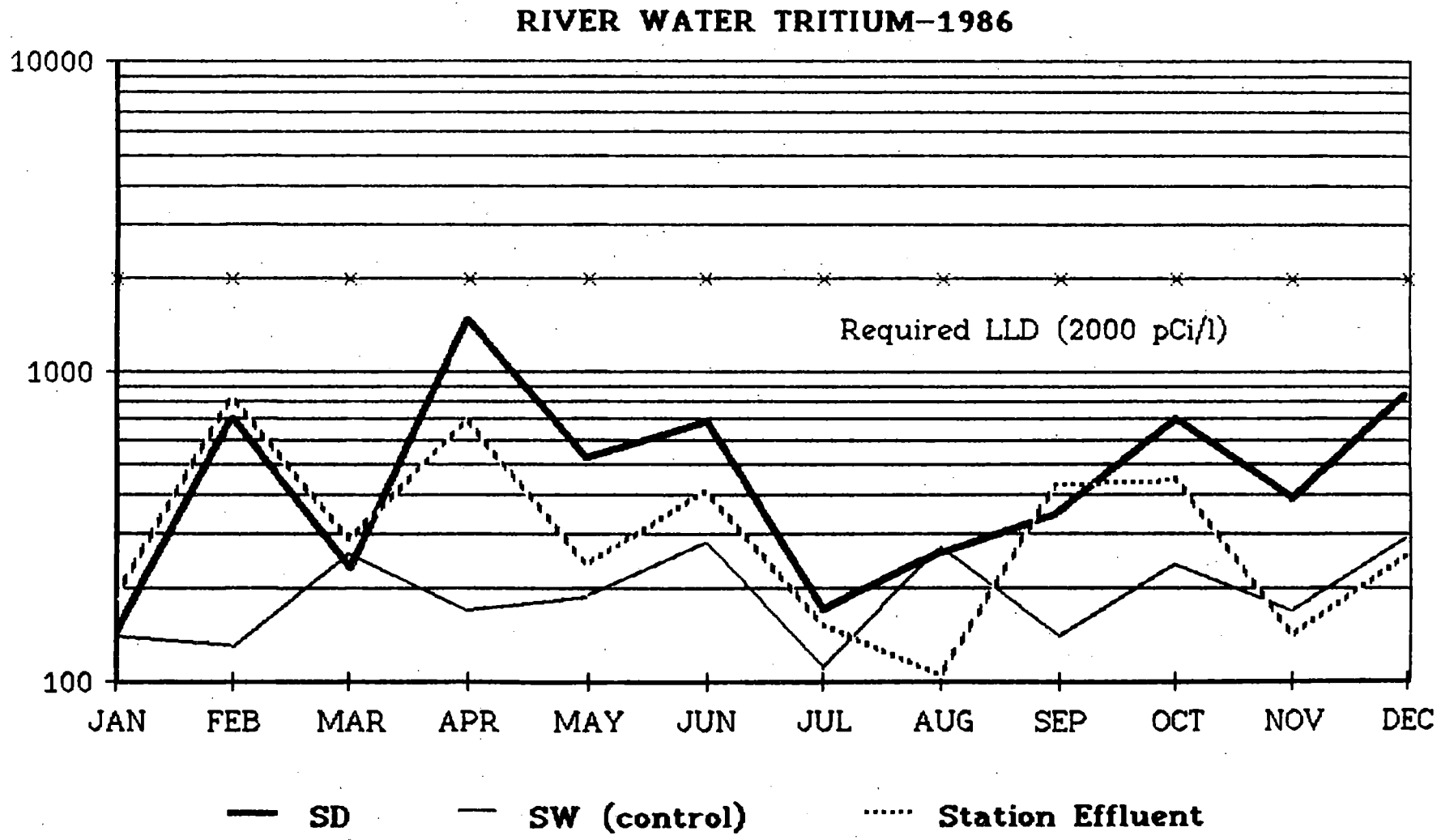
The Surry Discharge and Hog Island Point samples taken on May 15, 1986 had measurable activity with an average of 1.3 pCi/ℓ and a range of 1.2 to 1.3 pCi/ℓ. These samples were taken during the period of measurable airborne iodine-131 resulting from the Chernobyl accident. The activity detected in these samples was slightly above the required LLD of 1 pCi/ℓ.

Tritium was measured in 7 of the 8 composite samples with an average activity of 217 pCi/ℓ for Surry Discharge location and 193 pCi/ℓ for Scotland Wharf (control) location.

Monthly composites of river water are collected by the Commonwealth of Virginia. Results of gamma spectrometry and tritium analyses on these samples are presented in Table 9. Except for naturally occurring potassium-40, all the gamma emitting nuclides were below their respective detection limits. Potassium-40 was measured twelve times with an average activity of

88 pCi/ℓ and a range of 43.7 to 174 pCi/ℓ. The average tritium activity for eleven samples collected at the Surry Discharge location was 578 and the range was from 170 to 1490 pCi/ℓ. At the Scotland Wharf location eleven measured tritium levels had an average activity of 205 pCi/ℓ and a range from 110 to 290 pCi/ℓ. The attached trend graphs provide a comparison of tritium measured in the downstream sample (Surry Discharge), the upstream control location (Scotland Wharf) and the station effluents, sampled prior to discharge. The environmental sample from the Station Discharge indicates good comparison with measured station effluents. The average Station Discharge tritium was measured, as indicated above, at 578 pCi/ℓ and the average station effluents measured 400 pCi/ℓ. Variations between the two samples may be due to the sampling method of the environmental sample. The Station Discharge location is sampled approximately once per 6 hours and composited for monthly analysis.

The trend graphs also indicate that there is no long term build up of tritium in the environment. All gamma emitters were below their lower limit of detection.


RIVER WATER TRITIUM–1986
10000
1000
100
pCi/l
Required LLD (2000 pCi/l)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
SD
SW (control)
Station Effluent

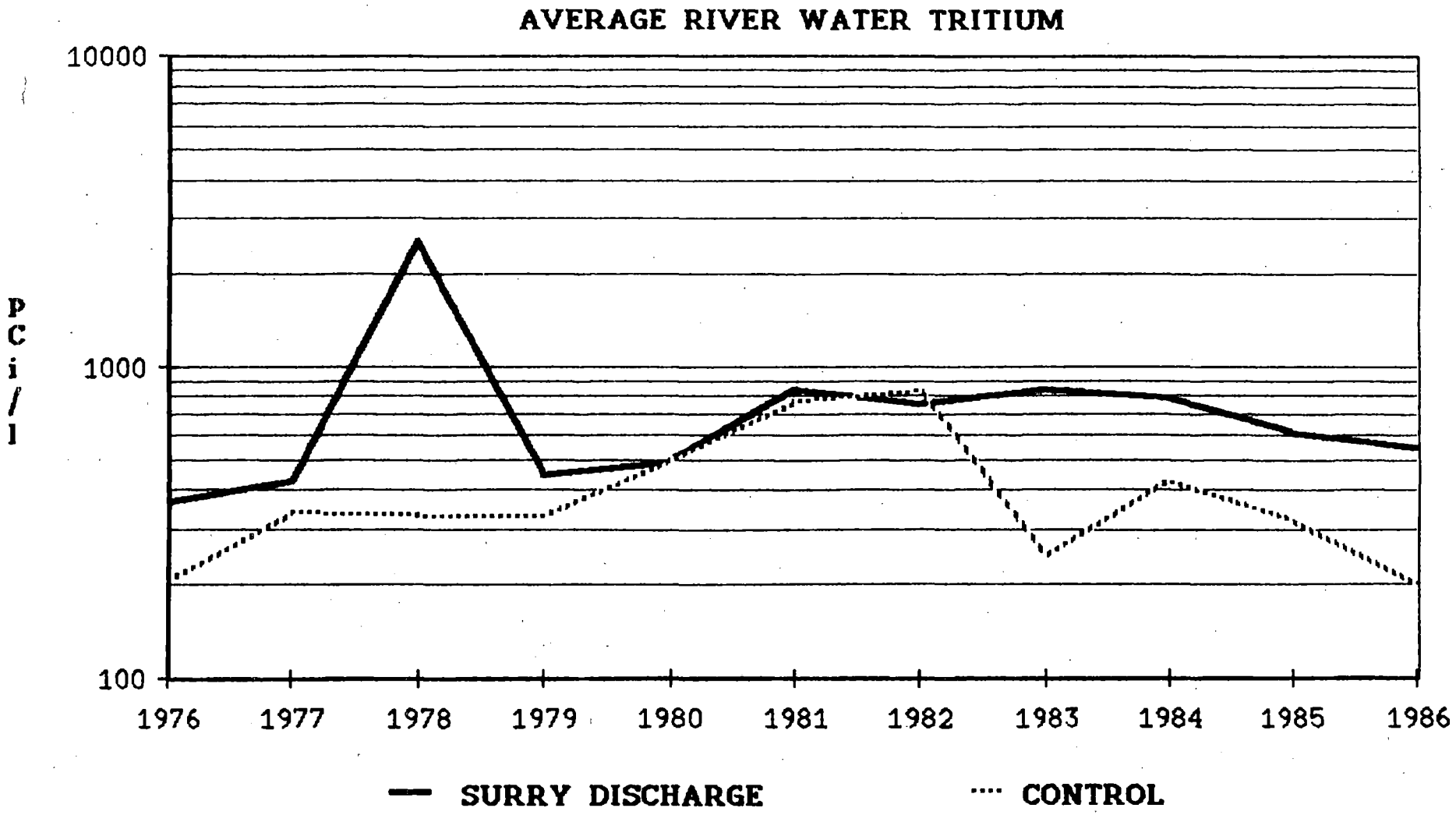

AVERAGE RIVER WATER TRITIUM
10000
1000
100
pCi/l
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
SURRY DISCHARGE
CONTROL

TABLE 7

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
River Water (a) (pCi/ℓ)	Gamma 48						
	K-40 48	60	103(14/36) (27.9-173)	SD	104(5/12) (60.4-144)	64.3(3/12) (11.8-120)	0
	I-131 (b) 48	0.5	1.3(2/36) (1.2-1.3)	SD	1.3(1/12) -	-(0/12) -	0
	Tritium 14	100	254(10/11) (120-660)	SD	397(3/3) (240-660)	230(3/3) (150-380)	0
	Tritium 16 (Quarterly)	100	193(11/12) (81-490)	HIP	235(2/2) (180-290)	193(3/4) (180-220)	0
River Water (c) pCi/ℓ - State Split	Gamma 24						
	K-40 24	60	93.8(9/12) (48.0-174)	SD	93.8(9/12) (48.0-174)	71.7(3/12) (43.7-111)	0
	Tritium 24	100	578(11/12) (170-1490)	SD	578(11/12) (170-1490)	205(11/12) (110-290)	0

(1) LLD is lower limit of detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.
(a) Analyses for monthly and bi-monthly samples listed in Table 8.
(b) Analyses by radiochemistry.
(c) Monthly State Split analyses presented in Table 9.

TABLE 8

(Page 1 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* AND TRITIUM IN RIVER WATER

pCi/ℓ ± 2 Sigma

STATION	DATE	Be-7	K-40	I-131	Cs-137	Ba-140	La-140	TH-228	H-3
JANUARY									
CHIC	01/10/86	<40	<60	<0.5	<4	<20	<6	<7	
HIP	01/10/86	<60	<200	<0.4	<6	<30	<9	<10	
NN	01/10/86	<40	147 ± 41	<0.3	<4	<20	<6	<8	
SD	01/10/86	<30	<40	<0.3	<3	<8	<3	<7	
SI	01/10/86	<40	<100	<0.3	<5	<20	<8	<9	
SW	01/10/86	<30	<50	<0.3	<3	<10	<5	<7	
FEBRUARY									
SD	02/18/86	<30	<40	<0.3	<3	<10	<5	<6	
SW	02/18/86	<30	<50	<0.3	<3	<10	<5	<7	
MARCH									
CHIC	04/01/86 **	<30	<40	<0.5	<3	<10	<5	<6	
HIP	04/01/86	<40	<50	<0.5	<4	<20	<5	<8	
NN	04/01/86	<30	59.7 ± 29.2	<0.5	<4	<10	<6	<7	
SD	04/01/86	<30	<50	<0.5	<3	<10	<6	<7	160 ± 80
SI	04/01/86	<30	<50	<0.4	<3	<10	<6	<7	
SW	04/01/86	<40	<100	<0.4	<4	<20	<7	<8	180 ± 80
APRIL									
SD	04/22/86	<40	109 ± 37	<0.5	<4	<20	<6	<9	
SW	04/22/86	<40	<50	<0.3	<4	<20	<7	<7	

* All other gamma emitters were <LLD.
** Samples collected 04/01/86 for March sample.

TABLE 8

(Page 2 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* AND TRITIUM IN RIVER WATER

pCi/ℓ ± 2 Sigma

STATION	DATE	Be-7	K-40	I-131	Cs-137	Ba-140	La-140	TH-228	H-3
MAY									
CHIC	05/15/86	<40	<50	<0.5	<3	<30	<10	<7	
HIP	05/15/86	<40	57.9 ± 29.2	1.2 ± 0.3	<4	<30	<10	<8	
NN	06/02/86**	<30	112 ± 18	<0.9	<2	<40	<10	<5	
SD	05/15/86	<40	60.4 ± 30.8	1.3 ± 0.3	<4	<30	<10	<7	
SI	06/02/86**	<30	27.9 ± 16.2	<0.3	<2	<30	<10	<4	
SW	05/15/86	<40	<60	<0.3	<4	<30	<10	<8	
JUNE									
SD	06/17/86	<30	<60	<0.6	<4	<20	<9	<9	110 ± 80
SW	06/17/86	<60	<200	<0.3	<5	<40	<10	<10	<110
JULY									
CHIC	07/23/86	<40	<60	<0.5	<4	<30	<10	<8	
HIP	07/14/86	<50	<60	<1	<4	<50	<20 (a)	<8	
NN	07/14/86	<50	134 ± 39	<1	<4	<50	<20 (a)	<8	
SD	07/23/86	<40	85.1 ± 34.1	<0.5	<4	<30	<10	<8	
SI	07/29/86	<40	173 ± 40	<0.5	<4	<30	<10	<8	
SW	07/14/86	<40	61.1 ± 31.5	<1	<4	<50	<20 (a)	<7	
AUGUST									
SD	08/19/86	<40	144 ± 29	<0.3	<3	<20	<8	<7	
SW	08/19/86	<30	11.8 ± 4.6	<0.5	<3	<20	<7	<6	

* All other gamma emitters were <LLD.
** Samples collected 06/02/86 for May sample.
(a) LLD analysis not met because of delay in analysis at vendor lab.

TABLE 8

(Page 3 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* AND TRITIUM IN RIVER WATER

pCi/ℓ ± 2 Sigma

STATION	DATE	Be-7	K-40	I-131	Cs-137	Ba-140	La-140	TH-228	H-3
SEPTEMBER									
CHIC	09/10/86	<40	<100	<0.5	<4	<30	<10	<8	
HIP	09/10/86	<60	<200	<0.5	<5	<40	<10	<10	
NN	09/10/86	<70	<100	<0.5	<5	<40	<10	<10	
SD	09/10/86	<50	<100	<0.5	<5	<30	<10	<9	110 ± 80
SI	09/10/86	<50	101 ± 33	<0.5	<5	<30	<10	<8	
SW	09/10/86	<40	<60	<0.5	<5	<30	<10	<8	180 ± 80
OCTOBER									
SD	10/21/86	<40	122 ± 31	<0.3	<4	<20	<7	<8	
SW	10/21/86	<50	<200	<0.4	<6	<30	<10	<10	
NOVEMBER									
CHIC	11/25/86	<40	<60	<0.4	<4	<20	<9	<7	
HIP	11/25/86	<40	115 ± 45	<0.3	<4	<20	<10	<8	
NN	11/25/86	<70	<200	<0.4	<7	<40	<10	<10	
SD	11/25/86	<60	<100	<0.4	<6	<30	<9	<10	
SI	11/25/86	<80	<200	<0.4	<7	<40	<10	<20	
SW	11/25/86	<50	120 ± 39	<0.3	<5	<30	<9	<9	
DECEMBER									
SD	12/22/86	<50	<80	<0.3	<5	<20	<6	<10	490 ± 70
SW	12/22/86	<50	<200	<0.4	<5	<30	<10	<10	220 ± 90
Average ± 2 s.d.			103 ± 82	1.3 ± 0.1					206 ± 264

* All other gamma emitters were <LLD.

TABLE 9

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* AND TRITIUM IN RIVER WATER

pCi/ℓ ± 2 Sigma - STATE SPLIT

MONTH	COLL. DATES 1986	Be-7	K-40	I-131	Cs-137	Ba-140	La-140	Th-228	H-3
SCOTLAND WH. (SW)									
January	01/01-01/31	<40	<40	<1	<3	<40	<10	<6	<140
February	02/01-02/28	<30	<40	<1	<3	<30	<10	<6	130 ± 80
March	03/15/86	<30	<20	(b)	<2	<90 (a)	<40 (a)	<4	260 ± 80
April	04/01-04/30	<70	<100	<0.3	<5	<100 (a)	<30 (a)	<10	170 ± 80
May	05/15/86	<100	<50	<200(a)	<4	<2000(a)	<800(a)	<9	190 ± 80
June	06/15/86	<70	<50	<30 (a)	<4	<300 (a)	<100(a)	<7	280 ± 80
July	07/15/86	<60	43.7 ± 23.6	<60 (a)	<4	<100 (a)	<50 (a)	<7	110 ± 80
August	08/15/86	<60	<60	<20 (a)	<4	<300 (a)	<100(a)	<7	270 ± 90
September	09/15/86	<50	<50	<0.3	<3	<70 (a)	<30 (a)	<7	140 ± 100
October	10/01-10/31	<50	60.5 ± 34.8	<2	<4	<70 (a)	<30 (a)	<7	240 ± 100
November	11/15/86	<50	111 ± 35	<0.8	<4	<60 (a)	<20 (a)	<9	170 ± 100
December	12/15/86	<60	<50	<7	<4	<100 (a)	<60 (a)	<7	290 ± 90
Average ± 2 s.d.			71.7 ± 70						205 ± 131
SURRY DIS. (SD)									
January	01/01-01/31	<40	59.1 ± 27.6	<1	<3	<40	<15	<7	<140
February	02/01-02/28	<40	48.0 ± 28.2	<1	<3	<30	<10	<7	700 ± 90
March	03/15/86	<30	<50	(b)	<2	<100 (a)	<50 (a)	<4	230 ± 80
April	04/01-04/30	<50	<50	<0.5	<4	<70 (a)	<30 (a)	<8	1490 ± 120
May	05/15/86	<100	61.1 ± 32.4	<200(a)	<4	<2000(a)	<700(a)	<8	530 ± 90
June	06/15/86	<100	92.2 ± 45.9	<20 (a)	<5	<500 (a)	<200(a)	<10	690 ± 90
July	07/15/86	<50	119 ± 36	<50 (a)	<3	<100 (a)	<60 (a)	<6	170 ± 80
August	08/15/86	<80	<50	<20 (a)	<4	<400 (a)	<100(a)	<9	260 ± 90
September	09/15/86	<40	104 ± 28	<0.3	<3	<70 (a)	<30 (a)	<7	350 ± 110
October	10/01-10/31	<60	108 ± 40	<1	<4	<80 (a)	<30 (a)	<9	700 ± 100
November	11/15/86	<50	174 ± 30	<1	<4	<80 (a)	<30 (a)	<7	390 ± 100
December	12/15/86	<70	78.6 ± 31.2	<10	<4	<200 (a)	<50 (a)	<9	850 ± 100
Average ± 2 s.d.			93.8 ± 77						578 ± 755

* All other gamma emitters were <LLD.
(a) LLD not met because of late receipt of sample from the State of Virginia.
(b) I-131 analysis not performed since samples received 54 days after collection and I-131 was not requested on the sample receipt form.

2. Well Water

The results of analyses of well water samples are presented in Table 11. Well water was collected from four indicator locations during March, June, September and December. Tritium was measured in ten of the sixteen samples with an average activity of 230 pCi/ℓ and a range of 90 to 560 pCi/ℓ. Each well water sample was also analyzed for gamma emitters and the results are presented in Table 11. All gamma emitters that may result from releases from the power station were below the detection limits.

TABLE 10

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Well Water (pCi/ℓ)	Tritium	16	100	220(10/16) (90-560)	SS	320(4/4) (170-560)	NONE	0
	Th-228	16	-	10.7(1/16) -	HIR	10.7(1/4) -	NONE	0

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

TABLE 11

VIRGINIA POWER - SURRY-1986

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN WELL WATER

pCi/ℓ ± 2 Sigma

DATE	STATION	Be-7	K-40	I-131	Cs-137	Ba-140	La-140	Th-228	H-3
FIRST QUARTER									
03/18/86	BC	<40	<70	<0.2	<6	<20	<7	<9	130 ± 80
03/18/86	HIR	<40	<100	<0.2	<5	<10	<6	10.7 ± 4.2	90 ± 10
03/18/86	JMTN	<40	<60	<0.2	<5	<10	<5	<7	220 ± 80
03/18/86	SS	<30	<50	<0.2	<3	<10	<4	<7	240 ± 80
SECOND QUARTER									
06/17/86	BC	<50	<100	<0.3	<5	<30	<10	<9	<110
06/17/86	HIR	<30	<50	<0.3	<3	<20	<9	<8	<110
06/17/86	JMTN	<40	<60	<0.3	<3	<20	<10	<7	190 ± 80
06/17/86	SS	<40	<50	<0.4	<4	<20	<9	<8	310 ± 80
THIRD QUARTER									
09/16/86	BC	<30	<40	<0.4	<3	<20	<8	<6	<140
09/16/86	HIR	<40	<50	<0.3	<3	<20	<9	<7	130 ± 100
09/16/86	JMTN	<40	<50	<0.4	<3	<20	<10	<7	<140
09/16/86	SS	<30	<40	<0.3	<3	<20	<8	<6	560 ± 120
FOURTH QUARTER									
12/16/86	BC	<50	<80	<0.3	<6	<20	<6	<10	<130
12/16/86	HIR	<40	<70	<0.4	<6	<10	<7	<10	160 ± 100
12/16/86	JMTN	<70	<200	<0.3	<7	<20	<8	<20	<130
12/16/86	SS	<50	<200	<0.5	<5	<20	<7	<10	170 ± 100

* All other gamma emitters were <LLD.

C. Aquatic Exposure Pathway

1. Silt

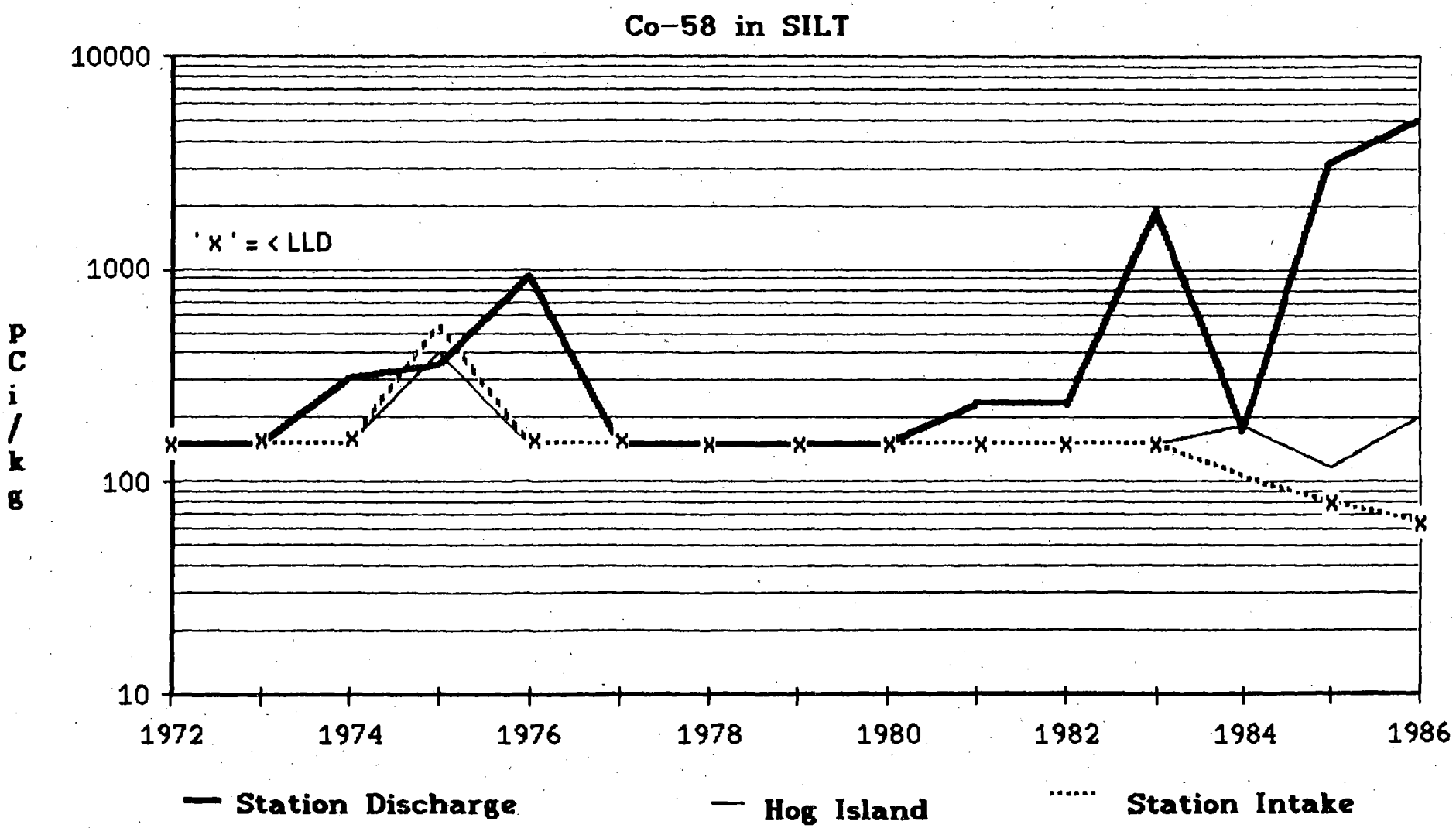
Sediment samples were collected in April and September from each of six locations and were analyzed by gamma spectroscopy. The results are presented in Table 13. A number of man-made and naturally occurring radioisotopes were measured in five samples from three locations. The Surry Discharge location measured cobalt-58 activity with an average of 5124 pCi/kg (dry weight) with a range of 839 to 9410 pCi/kg (dry weight). These results were slightly higher than samples taken at the same location in 1985 and the previous years samples. Cobalt-58 results from Hog Island Point and Point of Shoals were comparable to results from 1985 and remain close to the Lower Level of Detection (LLD).

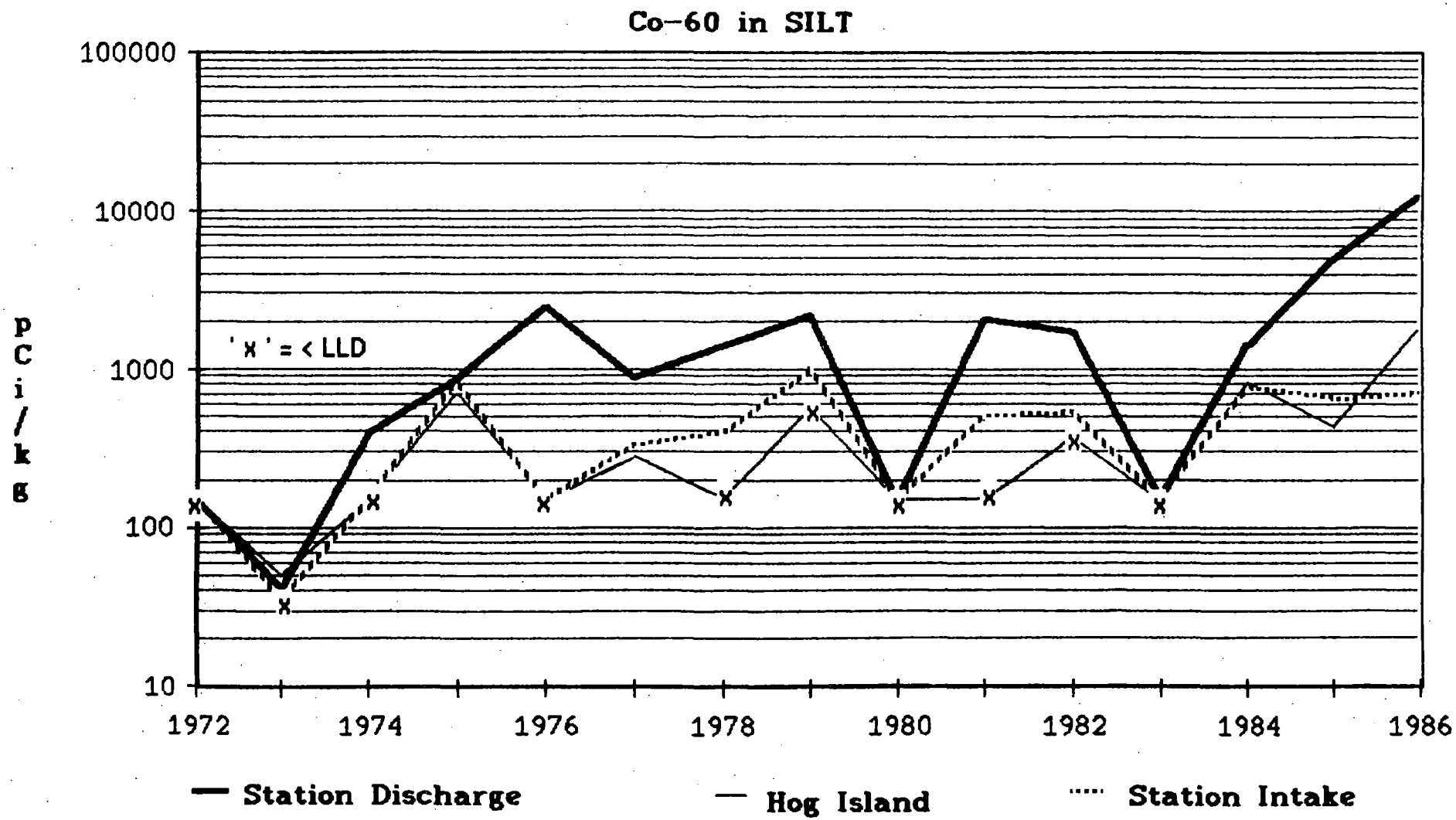
Cobalt-60 was measured in all twelve samples including the control location (CHIC). Surry Discharge was, as expected, the location with the highest activity measuring an average of 12535 pCi/kg (dry weight) with a range of 8070 to 17000 pCi/kg (dry weight). Samples taken at downstream location Hog Island Point, Surry Intake, Point of Shoals and Newport News indicate the dilution provided by the James River. Cobalt-60 was also detected at the control location (CHIC) in both samples. All samples were generally higher than in previous years.

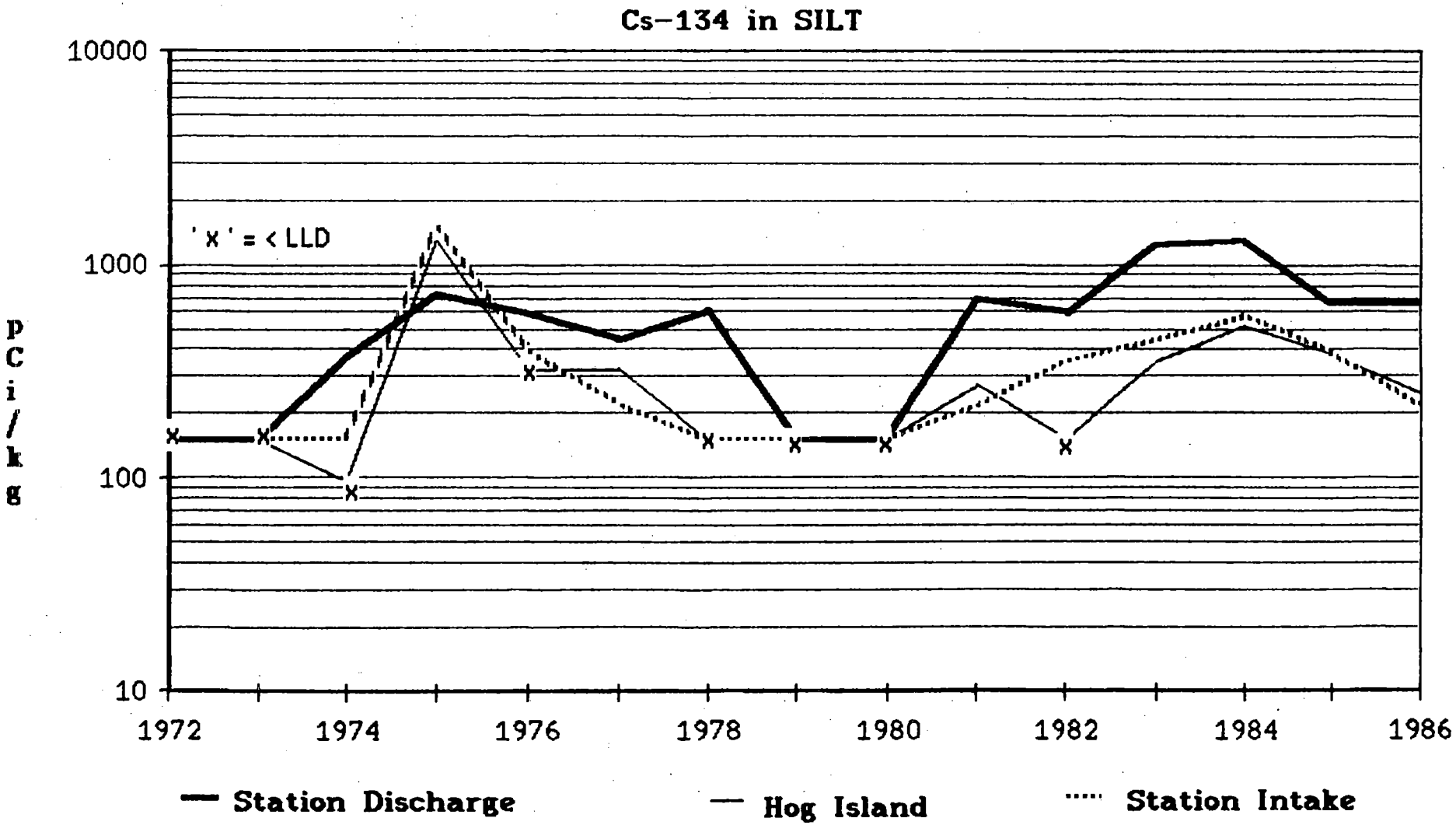
Cesium-134 was measured in all locations except Newport News with the highest location at Surry Discharge. This location measured an average activity of 671 pCi/kg (dry weight) with a range of 599 to 743 pCi/kg (dry weight). The trend graphs indicate decreasing activity as compared to previous years.

Cesium-137 was measured in all samples, again with the highest at Surry Discharge location. The average at Surry Discharge was 2935

pCi/kg (dry weight) and a range of 2440 to 3430 pCi/kg (dry weight). The average from all other sample locations was 923 pCi/kg (dry weight) and a range of 223 to 1550 pCi/kg (dry weight). The average from the control location (CHIC) was 943 pCi/kg (dry weight) and a range of 877 to 1010 pCi/kg (dry weight). The trend graphs generally indicate no long term increases in cesium-137 activity.


Co-58 in SILT
10000
1000
100
10
'X' = < LLD
pCi/kg
1972
1974
1976
1978
1980
1982
1984
1986
Station Discharge
Hog Island
Station Intake


Co-60 in SILT
100000
10000
1000
100
10
pCi/kg
'x' = < LLD
1972
1974
1976
1978
1980
1982
1984
1986
Station Discharge
Hog Island
Station Intake


Cs-134 in SILT
10000
1000
100
10
'x' = < LLD
pCi/kg
1972
1974
1976
1978
1980
1982
1984
1986
Station Discharge
Hog Island
Station Intake

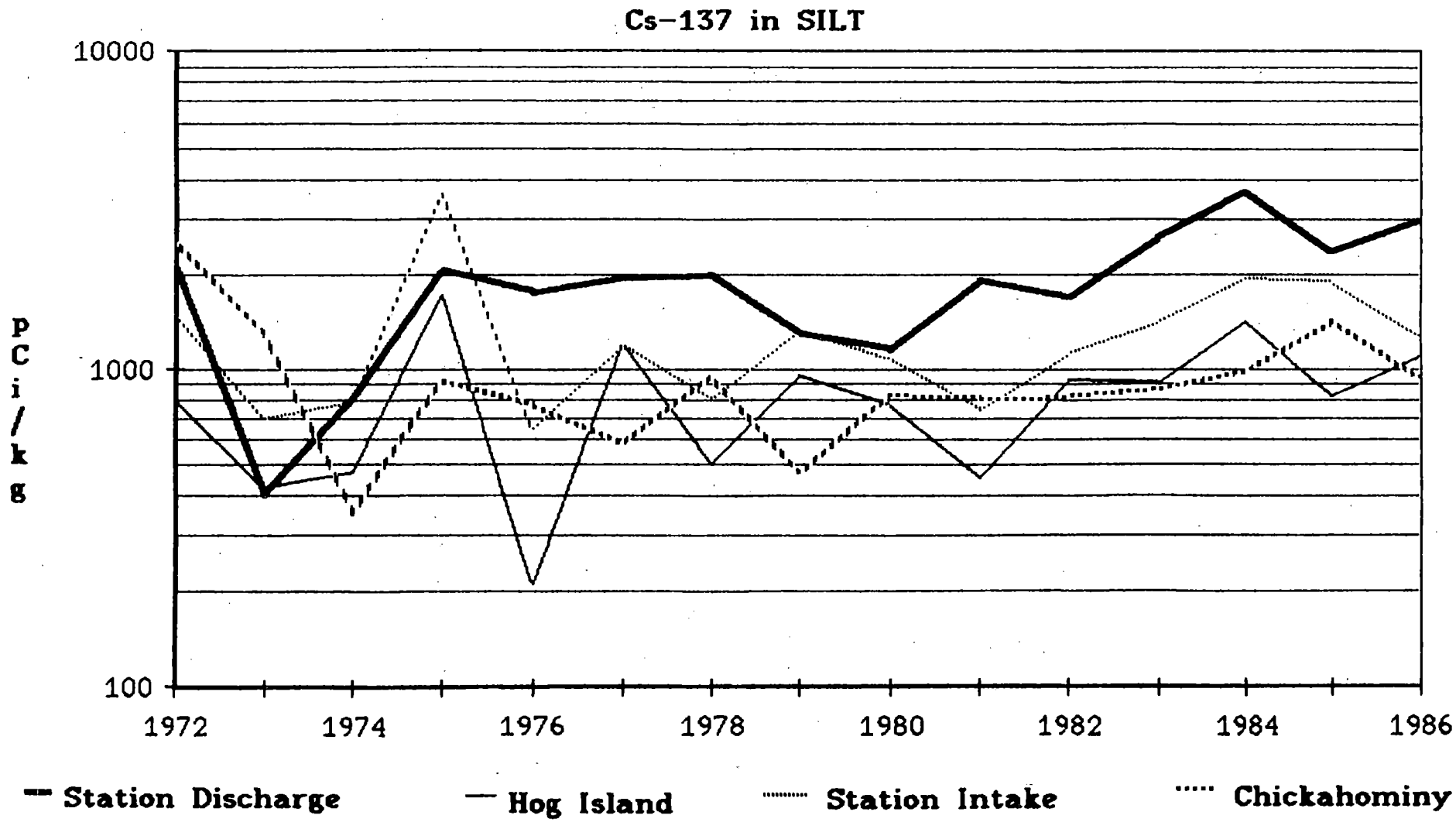

Cs-137 in SILT
10000
1000
100
pCi/kg
1972
1974
1976
1978
1980
1982
1984
1986
Station Discharge
Hog Island
Station Intake
Chickahominy

TABLE 12

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Silt (pCi/kg dry)	Gamma Spec 12						
	Be-7 12		1330(2/10) (1040-1620)	POS	1620(1/2) -	595(1/2) -	0
	K-40 12		16420(10/10) (13800-22800)	POS	18350(2/2) (13900-22800)	15650(2/2) (15500-15800)	0
	Cr-51 12		1430(1/10) -	SD	1430(1/2) -	-(0/2) -	0
	Mn-54 12		269(2/10) (210-328)	SD	269(2/2) (210-328)	-(0/2) -	0
	Co-58 12		2160(5/10) (96.3-9410)	SD	5125(2/2) (839-9410)	-(0/2) -	0
	Co-60 12		3228(10/10) (136-17000)	SD	12535(2/2) (8070-17000)	223(2/2) (160-285)	0
	Cs-134 12	150	326((8/10) (123-599)	SD	671(2/2) (599-743)	186(1/2) -	0
	Cs-137 12	180	1177(10/10) (223-3430)	SD	2935(2/2) (2440-3430)	944(2/2) (877-1010)	0
	Ra-226 12		2064(10/10) (1400-2580)	HIP	2450(2/2) (2320-2580)	2855(2/2) (2750-2960	0
	Th-228 12		1295(10/10) (835-1520)	SD	1435(2/2) (1430-1440)	1470(2/2) (1380-1560)	0

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

TABLE 13

(Page 1 of 2)

VIRGINIA POWER - SURRY-1986

CONCENTRATIONS OF GAMMA* EMITTERS IN SILT

pCi/kg (dry) ± 2 Sigma

STATION COLLECTION DATE	CHIC 04/01/86	HIP 04/01/86	NN 04/01/86	POS 04/01/86	SD 04/01/86	SI 04/01/86
Be-7	<500	<500	<300	1620 ± 510	<700	<600
K-40	15500 ± 1600	14600 ± 1500	15600 ± 1600	22800 ± 2300	17100 ± 1700	16900 ± 1700
Mn-54	<50	<40	<20	<50	210 ± 72	<50
Co-58	<50	96.3 ± 44.6	<30	141 ± 49	839 ± 92	<60
Co-60	160 ± 44	2400 ± 240	64.4 ± 19.7	1050 ± 110	8070 ± 810	873 ± 57
Cs-134	<60	160 ± 45	<30	202 ± 47	599 ± 82	299 ± 49
Cs-137	877 ± 88	825 ± 83	223 ± 28	1270 ± 130	2440 ± 240	1550 ± 160
Ra-226	2750 ± 800	2320 ± 640	1400 ± 370	1910 ± 520	2150 ± 800	2280 ± 710
Th-228	1380 ± 140	1450 ± 150	835 ± 84	1470 ± 150	1430 ± 140	1520 ± 150

* All other gamma emitters were <LLD.

TABLE 13

(Page 2 of 2)

VIRGINIA POWER - SURRY-1986

CONCENTRATIONS OF GAMMA* EMITTERS IN SILT

pCi/kg (dry) ± 2 Sigma

STATION COLLECTION DATE	CHIC 09/10/86	HIP 09/10/86	NN 09/10/86	POS 09/10/86	SD 09/10/86	SI 09/10/86	Average ± 2 s.d
Be-7	595 ± 230	<700	<500	<400	1040 ± 450	<700	818 ± 629
K-40	15800 ± 1600	15300 ± 1500	16700 ± 1700	13900 ± 1400	17600 ± 1800	13800 ± 1400	15517 ± 3024
Cr-51	<400	<1000	<600	<600	1430 ± 520	<1000	1430 ± 520
Mn-54	<30	<70	<50	<50	328 ± 60	<60	328 ± 60
Co-58	<30	312 ± 74	<50	<50	9410 ± 940	<70	4861 ± 12867
Co-60	285 ± 29	1270 ± 130	136 ± 40	286 ± 48	17000 ± 1700	548 ± 69	3254 ± 13492
Cs-134	186 ± 28	340 ± 59	<60	123 ± 46	743 ± 74	142 ± 60	307 ± 517
Cs-137	1010 ± 100	1380 ± 140	427 ± 51	674 ± 67	3430 ± 340	998 ± 100	1320 ± 2167
Ra-226	2960 ± 470	2580 ± 740	1540 ± 640	2580 ± 620	2400 ± 720	1480 ± 620	2257 ± 1214
Th-228	1560 ± 160	1420 ± 140	1090 ± 110	1330 ± 130	1440 ± 140	961 ± 96	1300 ± 457

* All other gamma emitters were <LLD.

2. Shoreline Sediment

Four shoreline sediment samples were collected in April and November from two indicator locations and were analyzed by gamma spectrometry. The results are presented in Table 15. Naturally occurring potassium-40 was observed in all samples with an average of 4423 pCi/kg (dry) and a range of 2340 to 7060 pCi/kg (dry). Two samples measured cesium-137 with an average activity of 82 pCi/kg (dry) and a range of 80.2 to 84.5 pCi/kg (dry). Thorium-228 was observed in three samples with an average concentration of 93 pCi/kg (dry) and a range of 68.8 to 106 pCi/kg (dry). Radium-226 was observed in one sample with an activity of 391 pCi/kg (dry).

TABLE 14

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Shoreline Sediment (pCi/kg dry)	Gamma Spec	4						
	K-40	4		4423(4/4) (2340-7060)	HIR	6455(2/2) (5850-7060)	NONE	0
	Cs-137	4	180	82.4(2/2) (80.2-84.5)	HIR	82.4(2/2) (80.2-84.5)	NONE	0
	Ra-226	4		391(1/4) -	HIR	391(1/2) -	NONE	0
	Th-228	4		92.9(3/4) (68.8-106)	BURWELL'S	106(1/2) -	NONE	0

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

TABLE 15

VIRGINIA POWER - SURRY-1986

CONCENTRATIONS OF GAMMA EMITTERS* IN SHORELINE SEDIMENT

pCi/kg (dry) ± 2 Sigma

STATION COLLECTION DATE	HIR 04/08/86	BURWELL'S 04/08/86	HIR 11/18/86	BURWELL'S 11/18/86	AVERAGE ± 2.s.d.
Be-7	<100	<200	<200	<200	-
K-40	5850 ± 590	2340 ± 230	7060 ± 710	2440 ± 240	4423 ± 4797
Co-60	<20	<20	<20	<20	-
Cs-134	<10	<20	<20	<20	-
Cs-137	84.5 ± 13.1	<20	80.2 ± 15.0	<20	82 ± 6.1
Ra-226	<300	<400	391 ± 221	<400	391 ± 221
Th-228	68.8 ± 11.1	106 ± 18	104 ± 12	<40	93 ± 42

* All other gamma emitters searched for were <LLD.

D. Ingestion Exposure Pathway

1. Milk

The results of iodine-131 and gamma analysis of milk samples are presented in Table 17. A total of 60 analyses were performed, 48 from indicator locations and 12 from the control location. Iodine-131, attributed to the Chernobyl accident was detected in six indicator locations and one control location during the months of May and June. The activities ranged from 0.63 to 61.2 pCi/ℓ with each result referenced for radioactive decay to the collection date. From the remainder of the samples, 42 from indicator locations and 10 from the control location, no iodine-131 was detected. A lower limit of detection 0.5 pCi/ℓ or better was achieved in those 52 samples.

Cesium-137, which has been detected occasionally in recent years and attributed then to past atmospheric nuclear weapons testing (global fallout), was not measured in the milk samples, until the Chernobyl accident early in 1986. Beginning in May, cesium-137 was detected in five milk samples; four from indicator locations and one from the control location. The average cesium-137 activity was 10.6 pCi/ℓ with a range between 3.7 and 20.0 pCi/ℓ. The required sensitivities for all other gamma emitting isotopes listed in Table 2 were met.

Milk samples from Lee Hall and Epps locations were also analyzed for strontium-89 and strontium-90 during 1986. Strontium-89 was not detected in any of the samples. Strontium-90 was measured in 23 out of 24 samples with an average of 1.4 pCi/ℓ and a range of 0.81 pCi/ℓ to 2.2 pCi/ℓ. For four months before radioactivity from Chernobyl reached the eastern U.S. the average strontium-90 of eight samples was 1.5 pCi/ℓ as

compared to 1.3 pCi/ℓ for the remainder of the year. Therefore, the Chernobyl accident did not increase the strontium-90 activity in milk samples. The strontium-90 activity is attributed to global fallout from past weapons tests. During the preoperational radiological monitoring program for Surry Power Station, strontium-90 was detected in milk samples in the range of 5.2 to 13 pCi/ℓ.

TABLE 16

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1, to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Milk (pCi/ℓ)	Gamma Spec	60						
	K-40	60	100	1283(48/48) (916-1510)	CP	1358(12/12) (1230-1470)	1305(12/12) (1160-1460)	0
	Cs-137	60	18	6.8(4/48) (9.1-20.0)	JDKS	20.0(1/12) -	3.7(1/12) -	0
	I-131	60	0.5	22.7(6/48) (1.4-61.2)	JDKS	34.8(2/12) (8.4-61.2)	4.7(1/12) -	0
	Sr-89	27	5	-(0/26) -	NA	NA	-(0/1) -	0
	Sr-90	27	1	1.6(25/26) (0.81-3.7)	CP	3.7(1/1) -	0.86(1/1) -	0

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

TABLE 17

(Page 1 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF STRONTIUM-89 AND -90 AND GAMMA EMITTERS** IN MILK

pCi/ℓ ± 2 sigma

MONTH	NUCLIDE	LEE HALL*	EPPS*	CP	WMS	JDKS
JANUARY	Sr-89	<1	<1			
	Sr-90	1.5 ± 0.5	2.2 ± 0.5			
	K-40	1300 ± 130	1280 ± 130	1380 ± 140	1270 ± 130	1260 ± 130
	Cs-137	<7	<4	<7	<4	<8
	I-131	<0.3	<0.3	<0.3	<0.2	<0.3
FEBRUARY	Sr-89	<1	<1			
	Sr-90	1.8 ± 0.5	1.7 ± 0.6			
	K-40	1300 ± 130	1350 ± 140	1280 ± 130	1300 ± 130	1240 ± 120
	Cs-137	<5	<4	<4	<5	<3
	I-131	<0.3	<0.4	<0.5	<0.2	<0.4
MARCH	Sr-89	<2	<2	<1	<1	<2
	Sr-90	1.4 ± 0.6	1.2 ± 0.7	3.7 ± 0.7	0.86 ± 0.48	3.2 ± 0.7
	K-40	1340 ± 130	1300 ± 130	1380 ± 140	1370 ± 140	1200 ± 120
	Cs-137	<4	<6	<4	<4	<4
	I-131	<0.4	<0.5	<0.4	<0.2	<0.3
APRIL	Sr-89	<1	<1			
	Sr-90	1.3 ± 0.6	1.1 ± 0.5			
	K-40	1370 ± 140	1260 ± 130	1300 ± 130	1460 ± 150	1340 ± 130
	Cs-137	<4	<4	<4	<4	<4
	I-131	<0.3	<0.3	<0.3	<0.4	<0.3

* State split
** All other gamma emitters were LLD.

TABLE 17

(Page 2 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF STRONTIUM-89 AND -90 AND GAMMA EMITTERS** IN MILK

pCi/ℓ ± 2 sigma

MONTH	NUCLIDE	LEE HALL*	EPPS*	CP	WMS	JDKS
MAY	Sr-89	<3	<3			
	Sr-90	1.6 ± 0.8	0.96 ± 0.34			
	K-40	1420 ± 140	1200 ± 120	1470 ± 150	1270 ± 130	1050 ± 110
	Cs-137	<5	<4	6.82 ± 3.64	<5	<6
	I-131	<0.5	1.4 ± 0.6	50.1 ± 8.9	4.7 ± 0.4	61.2 ± 11.1
JUNE	Sr-89	<2	<1			
	Sr-90	1.5 ± 0.6	1.1 ± 0.7			
	K-40	1380 ± 140	1270 ± 130	1240 ± 120	1340 ± 130	956 ± 96
	Cs-137	<5	<4	13.2 ± 6.4	<4	20.0 ± 6.3
	I-131	0.63 ± 0.31	2.0 ± 0.3	3.2 ± 0.3	<0.3	8.4 ± 0.5
JULY	Sr-89	<1	<1			
	Sr-90	1.2 ± 0.6	1.2 ± 0.6			
	K-40	916 ± 92	1300 ± 130	1230 ± 120	1180 ± 120	1070 ± 110
	Cs-137	<8	<6	<8	<4	<7
	I-131	<0.5	<0.5	<0.4	<0.3	<0.5
AUGUST	Sr-89	<2	<1			
	Sr-90	0.99 ± 0.63	0.81 ± 0.43			
	K-40	1510 ± 150	1260 ± 130	1470 ± 150	1370 ± 140	1170 ± 120
	Cs-137	<4	<4	<6	<7	<5
	I-131	<0.4	<0.5	<0.4	<0.4	<0.5

* State split
** All other gamma emitters were LLD.

TABLE 17

(Page 3 of 3)

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF STRONTIUM-89 AND -90 AND GAMMA EMITTERS** IN MILK

pCi/ℓ ± 2 sigma

MONTH	NUCLIDE	LEE HALL*	EPPS*	CP	WMS	JOKS
SEPTEMBER	Sr-89	<2	<1			
	Sr-90	1.2 ± 0.7	1.1 ± 0.7			
	K-40	1450 ± 150	1180 ± 120	1420 ± 140	1270 ± 130	1110 ± 110
	Cs-137	9.08 ± 3.77	<4	<4	<4	<5
	I-131	<0.4	<0.4	<0.5	<0.3	<0.4
OCTOBER	Sr-89	<4	<3			
	Sr-90	1.9 ± 0.7	1.8 ± 0.7			
	K-40	1310 ± 130	1150 ± 120	1300 ± 130	1320 ± 130	1300 ± 130
	Cs-137	<5	<4	<7	<4	<7
	I-131	<0.3	<0.3	<0.3	<0.3	<0.3
NOVEMBER	Sr-89	<4	<5			
	Sr-90	1.6 ± 0.9	<0.7			
	K-40	1360 ± 140	1280 ± 130	1410 ± 140	1160 ± 120	1140 ± 110
	Cs-137	<8	<6	<5	<7	<5
	I-131	<0.2	<0.3	<0.5	<0.4	<0.5
DECEMBER	Sr-89	<5	<5			
	Sr-90	1.5 ± 0.8	1.2 ± 0.8			
	K-40	1390 ± 140	1360 ± 140	1420 ± 140	1350 ± 140	1210 ± 120
	Cs-137	<5	<4	<6	3.71 ± 1.95	<4
	I-131	<0.4	<0.4	<0.4	<0.3	<0.3

* State Split

** All other gamma emitters were <LLD.

2. Aquatic Biota

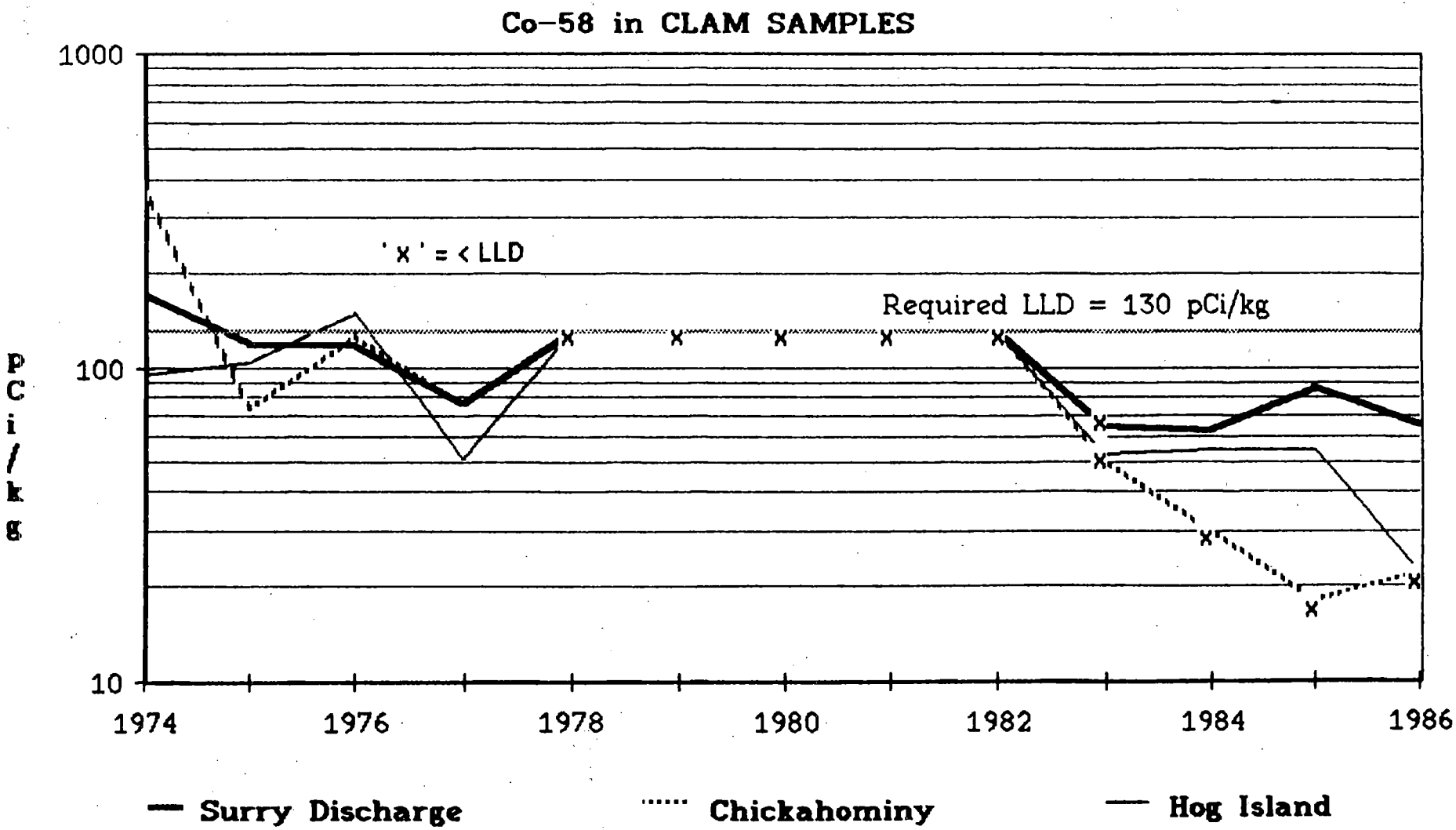
Marine biota can be sensitive indicators of radionuclide accumulation in the environment because of their ability to concentrate certain chemical elements which have radioactive isotopes. Gamma spectrometry was performed on bi-monthly samples of clams and oysters from the James River. The results are shown in Table 19 for clams and Table 20 for oysters. As expected, naturally occurring potassium-40 was the nuclide most frequently detected.

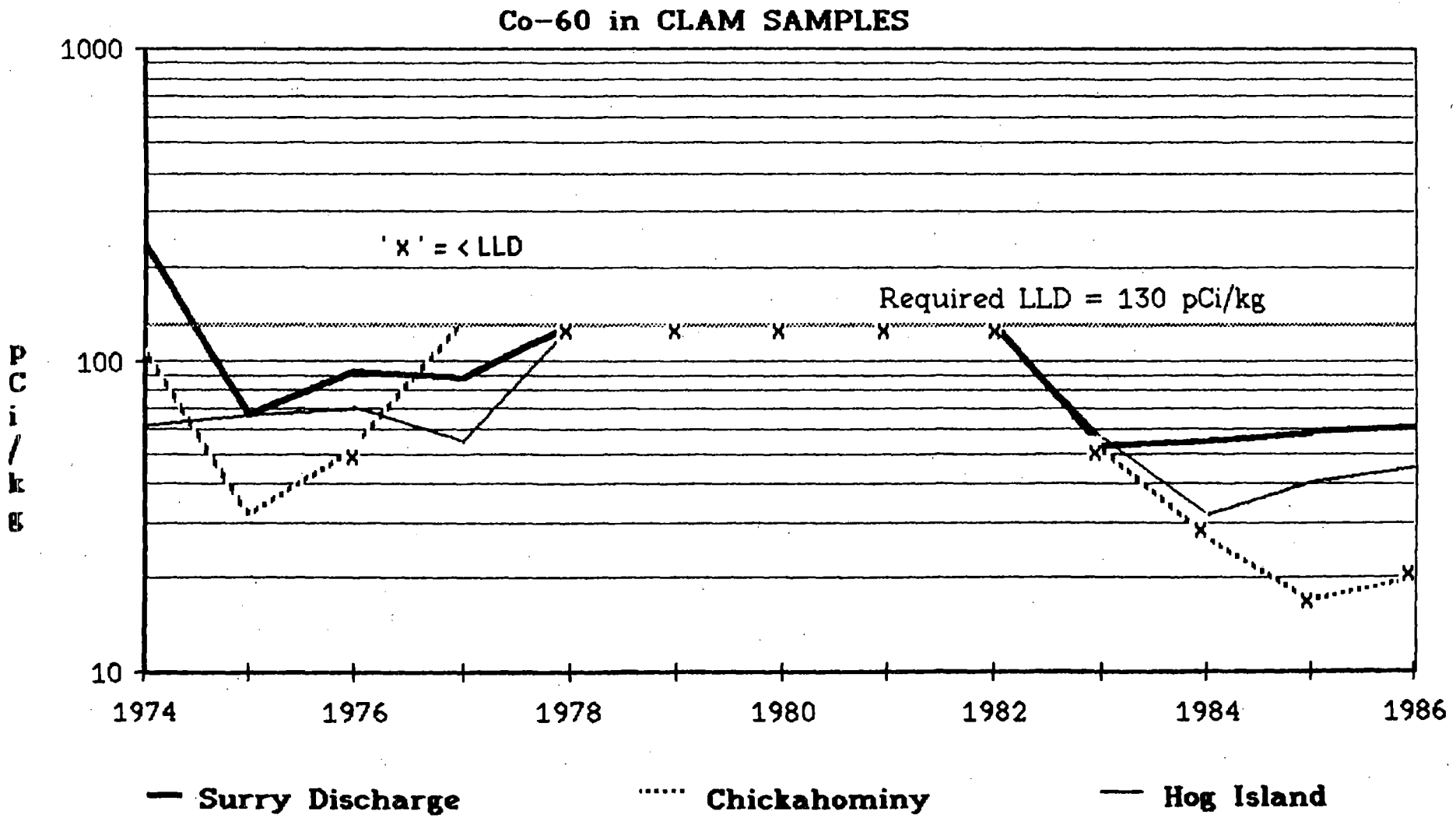
For the clam samples the average potassium-40 activity was 575 pCi/kg (wet weight) with a range from 246 to 1010 pCi/kg (wet weight). Thorium-228, also naturally occurring, was measured in one sample from the Chickahominy River location (CHIC) with an activity of 97.5 pCi/kg (wet weight). Cobalt-58 was measured in two samples at the Surry Discharge (SD) location with an average activity of 65 pCi/kg (wet weight) and a range of 61.8 to 69 pCi/kg (wet weight). Cobalt-60 was measured in five samples from Surry Discharge with an average of 60.7 pCi/kg (wet weight) and a range of 52.0 to 74.2 pCi/kg (wet weight); and four samples from Hog Island Point measured an average of 46.2 pCi/kg (wet weight) with a range of 32.0 to 59.7 pCi/kg (wet weight). Cobalt-60 activity measured in the 1986 clam samples indicated a similar range as the activity measured in the 1985 clam samples taken at the same locations. Cesium-137 was also measured in five samples from one control location and three indicator locations with an average of 26.8 pCi/kg (wet weight) and a range of 21.1 to 36.7 pCi/kg (wet weight). All positive results showed activity to be present in quantities well below the required sensitivities as listed in Table 2.

For oyster samples the average potassium-40 activity for 17 of the 18 samples was 1386 pCi/kg (wet weight) with a range of 326 to 11800 pCi/kg (wet weight). Cesium-137 was measured in one sample from the Newport News location with an activity of 30.5 pCi/kg (wet weight). Thorium-228 was also measured in one sample from the Point of Shoals location with an activity of 109 pCi/kg (wet weight).

During July, August, and September, crabs were collected from the Surry Discharge (SD) location and analyzed by gamma spectrometry. Naturally occurring potassium-40 was found in all three samples, with an average activity of 2423 pCi/kg (wet weight) and a range of 2210 to 2760 pCi/kg (wet weight) as presented in Table 21.

Four fish samples (perch and catfish) were collected during February, March, August and September from the same Surry Discharge location (SD). The results of gamma spectrometry on these samples are presented in Table 22. The September, 1986 catfish sample missed the LLD for cesium and was re-sampled on January 27, 1987. The results of this analysis is also presented on Table 22. One sample showed positive results for cesium-137 and was measured at 45.5 pCi/kg (wet weight). In comparison with the 1986 data, all fish samples taken in 1985 measured cesium-137 with an average activity of 87.1 pCi/kg (wet weight).


Co-58 in CLAM SAMPLES
1000
100
10
pCi/kg
'x' = < LLD
Required LLD = 130 pCi/kg
1974
1976
1978
1980
1982
1984
1986
Surry Discharge
Chickahominy
Hog Island


Co-60 in CLAM SAMPLES
1000
100
10
pCi/kg
'x' = < LLD
Required LLD = 130 pCi/kg
1974
1976
1978
1980
1982
1984
1986
Surry Discharge
Chickahominy
Hog Island

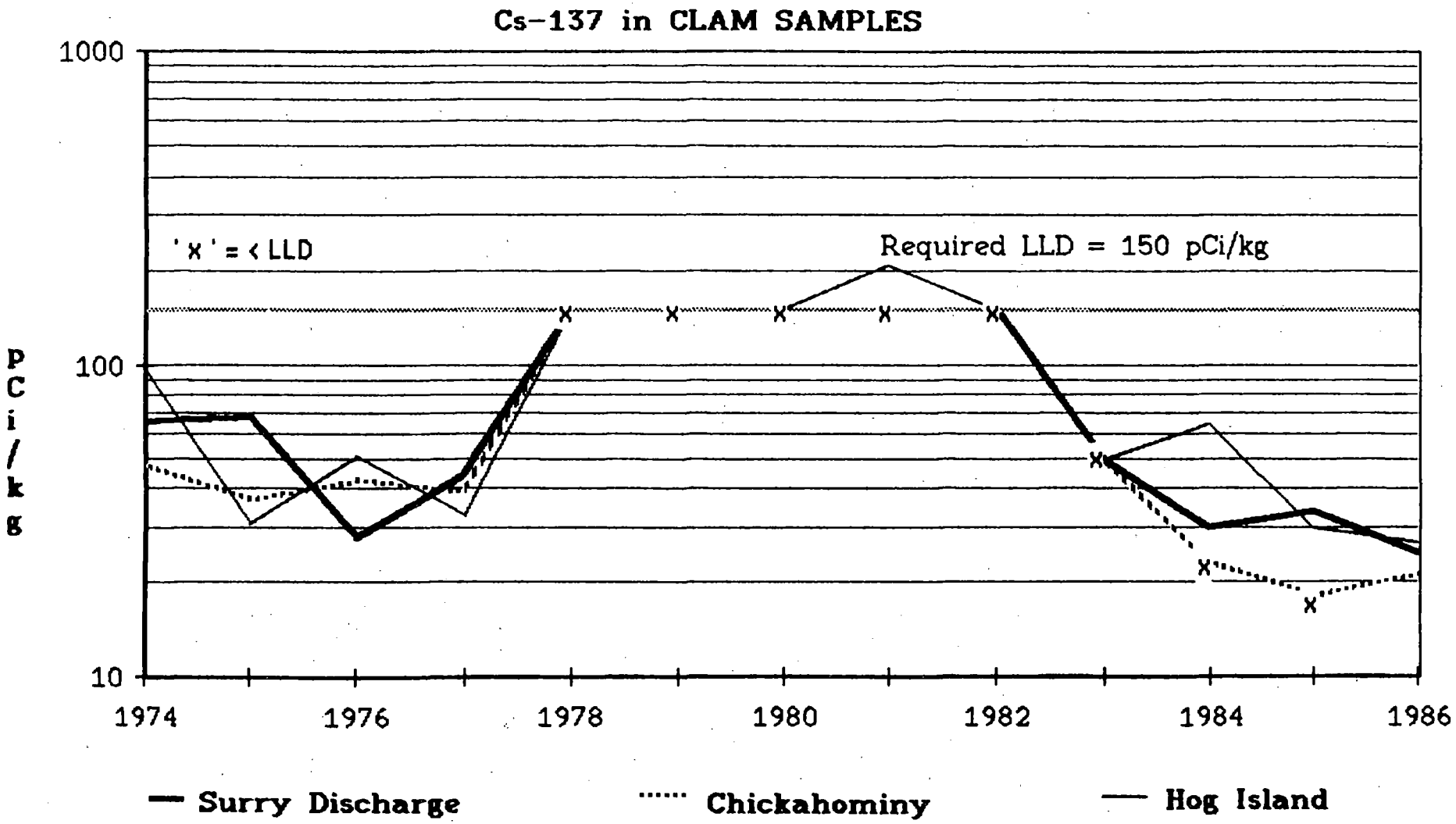

Cs-137 in CLAM SAMPLES
1000
100
10
pCi/kg
'X' = < LLD
Required LLD = 150 pCi/kg
1974
1976
1978
1980
1982
1984
1986
Surry Discharge
Chickahominy
Hog Island

TABLE 18

(Page 1 of 2)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Clams (pCi/kg wet)	Gamma Spec 30						
	K-40	-	588(21/24) (246-1010)	LC	654(5/6) (356-1000)	528(6/6) (387-942)	0
	Co-58	130	65.4(2/24) (61.8-69.0)	SD	65.4(2/6) (61.8-69.0)	-(0/6) -	0
	Co-60	130	54.3(9/24) (32.0-74.2)	SD	60.7(5/6) (52.0-74.2)	-(0/6) -	0
	Cs-137	150	28.3(4/24) (22.3-36.7)	LC	36.7(1/6) -	21.1(1/6) -	0
	Th-228		-(0/24) -	CHIC	97.5(1/6) -	97.5(1/6) -	0
Oysters (pCi/kg wet)	Gamma Spec 18						
	K-40	-	1386(17/18) (326-11800)	NN	3286(5/6) (592-11800)	NONE	0
	Cs-137 18	150	30.5(1/18) -	NN	30.5(1/6) -	NONE	0
	Th-228 18		109(1/18) -	POS	109(1/6) -	NONE	0
Crabs (pCikg wet)	Gamma Spec 3	-	2423(3/3) (2210-2760)	SD	2423(3/3) (2210-2760)	NONE	0
	K-40						

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

TABLE 18

(Page 2 of 2)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Fish (pCi/kg wet)	Gamma Spec	5						
	K-40	5	100	1526(5/5) (791-2850)	SD	1526(5/5) (791-2850)	NONE	0
	Cs-137	5	60	45.5(1/5) -	SD	45.5(1/5) -	NONE	0

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

TABLE 19

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* CLAMS

pCi/kg (wet) ± 2 Sigma

STATION	DATE	SAMPLE TYPE	Be-7	K-40	CO-58	CO-60	CS-137	Ra-226	TH-228
CHIC	01/10/86	Clams	<500	942 ± 301	<40	<30	<30	<400	97.5 ± 39.6
	04/01/86	Clams	<300	388 ± 218	<20	<20	<20	<400	<40
	05/15/86	Clams	<300	481 ± 152	<20	<20	<20	<400	<30
	07/23/86	Clams	<200	387 ± 127	<20	<10	21.1 ± 12.0	<300	<30
	09/10/86	Clams	<200	458 ± 157	<20	<20	<20	<400	<40
	11/25/86	Clams	<100	510 ± 140	<10	<20	<10	<300	<30
JMTN	01/10/86	Clams	<200	330 ± 158	<20	<20	<10	<300	<30
	04/01/86	Clams	<200	469 ± 253	<20	<20	<20	<400	<40
	05/15/86	Clams	<300	540 ± 226	<30	<20	<30	<400	<40
	07/14/86	Clams	<300	500 ± 183	<30	<20	<20	<400	<40
	09/10/86	Clams	<300	853 ± 187	<30	<30	<30	<400	<50
	11/25/86	Clams	<200	<600	<20	<20	<20	<400	<40
SD	01/10/86**	Clams	<200	404 ± 110	<20	68.3 ± 16.7	<20	<400	<30
	02/27/86**	Clams	<300	354 ± 176	<30	56.1 ± 17.4	22.3 ± 10.6	<400	<30
	05/08/86**	Clams	<200	590 ± 141	<20	52.9 ± 14.5	<20	<300	<30
	07/10/86**	Clams	<300	1010 ± 240	<40	<30	<30	<600	<50
	09/02/86**	Clams	<300	642 ± 262	61.8 ± 25.8	52.0 ± 20.5	27.3 ± 13.2	<400	<40
	11/06/86**	Clams	<200	797 ± 153	69.0 ± 19.3	74.2 ± 17.4	<20	<400	<30
HIP	01/10/86	Clams	<200	429 ± 137	<20	32.0 ± 12.1	<20	<300	<30
	04/01/86	Clams	<200	246 ± 119	<20	57.0 ± 18.1	26.7 ± 9.8	<400	<30
	05/15/86	Clams	<200	<300	<20	<10	<20	<300	<30
	07/14/86	Clams	<200	614 ± 179	<20	<20	<20	<300	<30
	09/10/86	Clams	<200	488 ± 216	<30	59.7 ± 23.9	<30	<400	<40
	11/25/86	Clams	<100	814 ± 139	<20	36.3 ± 13.4	<20	<300	<30
LC	01/10/86	Clams	<300	449 ± 165	<30	<30	<20	<400	<40
	04/01/86	Clams	<200	356 ± 141	<20	<20	<20	<400	<40
	06/02/86	Clams	<300	<700	<30	<30	<30	<500	<50
	07/14/86	Clams	<200	900 ± 162	<20	<20	<20	<300	<30
	09/10/86	Clams	<200	1000 ± 210	<20	<20	36.7 ± 15.8	<400	<30
	11/25/86	Clams	<200	564 ± 214	<20	<20	<20	<400	<30

* All other gamma emitters were <LLD.
** State Split

TABLE 20

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* OYSTERS

pCi/kg (wet) ± 2 Sigma

STATION	DATE	SAMPLE TYPE	Be-7	K-40	CO-58	CO-60	CS-137	Ra-226	TH-228
NN	01/10/86**	Oysters	<200	592 ± 134	<20	<10	<10	<300	<30
	02/26/86**	Oysters	<500	2170 ± 300	<40	<30	<30	<400	<50
	05/07/86**	Oysters	<500	<700	<40	<20	<30	<400	<50
	07/09/86**	Oysters	<200	1130 ± 160	<20	<20	<20	<300	<30
	09/11/86**	Oysters	<200	737 ± 127	<10	<10	<10	<300	<30
	11/05/86**	Oysters	<300	11800 ± 1200	<30	<20	30.5 ± 17.7	<400	<40
DWS	01/10/86	Oysters	<200	567 ± 162	<20	<20	<20	<300	<30
	04/01/86	Oysters	<200	394 ± 168	<20	<20	<20	<400	<30
	06/02/86	Oysters	<200	635 ± 175	<30	<20	<20	<400	<40
	07/14/86	Oysters	<200	416 ± 165	<20	<20	<20	<300	<30
	09/10/86	Oysters	<300	1140 ± 240	<30	<30	<30	<500	<50
	11/25/86	Oysters	<100	579 ± 159	<10	<10	<20	<400	<30
POS	01/10/86	Oysters	<200	326 ± 134	<20	<20	<20	<400	109 ± 18
	04/01/86	Oysters	<200	335 ± 166	<20	<10	<10	<300	<30
	06/02/86	Oysters	<200	505 ± 127	<20	<10	<20	<400	<40
	07/14/86	Oysters	<300	540 ± 173	<30	<20	<20	<300	<40
	09/10/86	Oysters	<200	949 ± 150	<20	<20	<20	<300	<30
	11/25/86	Oysters	<200	751 ± 175	<20	<20	<20	<400	<40

* All other gamma emitters were <LLD.
** State split

TABLE 21

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA EMITTERS* IN CRABS

pCi/kg (wet) ± 2 Sigma

STATION	DATE	SAMPLE TYPE	Be-7	K-40	CO-58	CO-60	CS-137	Ra-226	TH-228
SD	07/29/86	Crabs	<300	2210 ± 320	<30	<30	<30	<600	<50
SD	08/27/86	Crabs	<300	2760 ± 310	<40	<30	<30	<500	<60
SD	09/25/86	Crabs	<400	2300 ± 270	<30	<30	<30	<400	<50
Average ± 2 s.d.				2423 ± 590					

* All other gamma emitters were <LLD.

TABLE 22

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA* EMITTERS IN FISH

pCi/kg (wet) ± 2 sigma

COLLECTION DATE	STATION	SAMPLE TYPE	K-40	Co-58	Cs-134	Cs-137
02/24/86	SD	CATFISH	1240 ± 280	<30	<30	45.5 ± 24.1
03/13/86	SD	PERCH	1620 ± 530	<50	<50	<50
08/27/86	SD	PERCH	1130 ± 430	<60	<60	<60
09/02/86	SD	CATFISH	2850 ± 1200	<100	<200 (a)	<200 (a)
01/27/87	SD	CATFISH	791 ± 189	<20	<20	<20
Average ± 2 S.D.			1526 ± 1594			45.5 ± 24.1

* All other gamma emitters were below <LLD.
(a) LLD's not met due to low sample volume of 0.036 Kg available.

3. Food Products

Nine food samples were collected from four locations and analyzed by gamma spectrometry. The samples consisted of kale, cauliflower, cabbage, corn, soybeans and peanuts. Naturally occurring potassium-40 was observed in all samples with an average activity of 6919 pCi/kg (wet weight) and a range of 2840 to 14440 pCi/kg (wet weight). Cosmogenic beryllium-7 was measured in one sample from the Poole's Garden location with an activity of 284 pCi/kg (wet weight). Cesium-137 was measured during June in two samples with an average activity of 17.5 pCi/kg (wet weight) and a range of 15.9 to 19.1 pCi/kg (wet weight). The measurements can be attributed to the Chernobyl accident. All other gamma emitters were below detection limits.

TABLE 23

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION — DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA — JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Vegetation (pCi/kg wet)	Gamma Spec K-40 9	-	6919(9/9) (2840-14400)	SLADE's	8067(3/3) (3000-14400)	NONE	0
	Be-7 9	100	284(1/9) -	POOLE'S	284(1/1) -	NONE	0
	Cs-137 9	20	17.5(2/9) (15.9-19.1)	CARTER'S	19.1(1/2) -	NONE	0

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

TABLE 24

VIRGINIA POWER - SURRY - 1986

CONCENTRATIONS OF GAMMA* EMITTERS IN VEGETATION

pCi/kg (wet) ± 2 sigma

STATION	SAMPLE TYPE	COLLECTION DATE	Be-7	K-40	I-131	Cs-134	Cs-137
Carter's Garden**	Cauliflower	06/24/86	<100	5620 ± 560	<10	<1	<10
Poole's Garden**	Kale	06/24/86	284 ± 73	6430 ± 640	<10	<10	15.9 ± 7.4
Carter's Garden**	Cabbage	06/30/86	<200	2840 ± 280	<6	<10	19.1 ± 10.9
Brock's Garden	Peanut's	10/08/86	<100	5850 ± 590	<20	<10	<10
Brock's Garden	Corn	10/08/86	<100	3330 ± 330	<30	<20	<20
Slade's Garden	Peanuts	10/09/86	<100	6800 ± 680	<20	<10	<10
Slade's Garden	Corn	10/09/86	<200	3000 ± 300	<30	<20	<20
Brock's Garden	Soybeans	12/11/86	<200	14000 ± 1400	<20	<10	<10
Slade's Garden	Soybeans	12/11/86	<100	14400 ± 1400	<20	<10	<10
Average ± 2 s.d.			284 ± 73	6919 ± 8777			17.5 ± 4.5

* All other gamma emitters were <LLD.
** State Split

J. Direct Radiation

Environmental radiation dose rates determined by thermoluminescent dosimeters (TLDs) are given on Table 26 and 27. Two sets of TLD badges of four readout areas each were deployed quarterly at each location. The mean values of four readings (calibrated individually for response to a known dose and for intransit exposure) are reported in this table, unless indicated otherwise.

Table 25 provides a statistical summary of the four quarters 1986 data. Individual measurements of external radiation levels in the environs of the Surry site for stations 02 through 43 had an average dose of 6.7 mR/standard month. The average dose for the control stations (39,40) was 6.1 mR/standard month with a range of 4.9 to 7.5 mR/standard month. The indicator locations had an average activity of 6.7 mR/standard month with a range of 4.1 to 9.2 mR/standard month.

A trend graph is provided indicating a plot of TLDs located at the site boundary and approximately 5 miles from the Station.

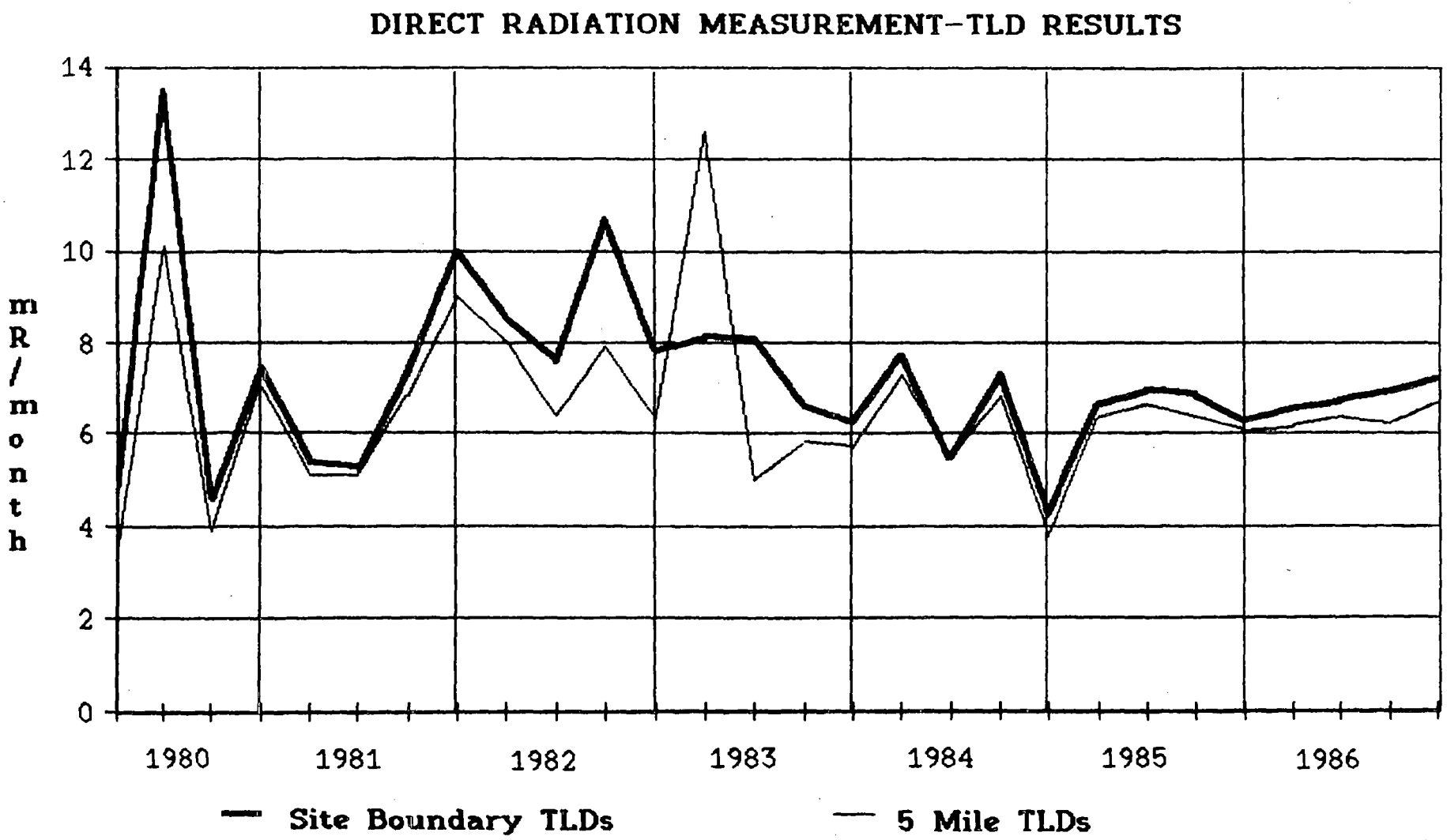

DIRECT RADIATION MEASUREMENT-TLD RESULTS
mR/month
14
12
10
8
6
4
2
0
1980
1981
1982
1983
1984
1985
1986
Site Boundary TLDs
5 Mile TLDs

TABLE 25

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SURRY NUCLEAR POWER STATION DOCKET NO. 5-280-281

SURRY COUNTY, VIRGINIA JANUARY 1 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD)	ALL INDICATOR LOCATIONS MEAN RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
TLDs (mr/std. month)	Gamma Dose 331	2	6.7(315/315) (4.1-9.2)	38	8.6(8/8) (8.1-9.2)	6.1(16/16) (4.9-7.5)	0

TABLE 26

(Page 1 of 2)

VIRGINIA POWER - SURRY - 1986

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS
mR/month ± 2 Sigma - Set 1 - 098

STATION NUMBER	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	AVERAGE ± 2 s.d.
02	7.1 ± 0.5	8.0 ± 0.3	7.9 ± 0.3	8.8 ± 0.2	8.0 ± 1.4
03	(a)	4.6 ± 0.6	4.1 ± 0.4	5.1 ± 0.3	4.6 ± 1.0
04	6.3 ± 0.7	6.9 ± 0.8	6.9 ± 0.4	7.5 ± 0.4	6.9 ± 1.0
05	(a)	6.8 ± 0.5	7.0 ± 0.5	7.2 ± 0.3	7.0 ± 0.4
06	6.1 ± 0.3	7.5 ± 0.1	7.4 ± 0.5	7.8 ± 0.2	7.2 ± 1.5
07	6.0 ± 0.4	7.3 ± 0.4	7.0 ± 0.5	7.2 ± 0.3	6.9 ± 1.2
08	8.4 ± 1.1	6.8 ± 0.3	6.7 ± 0.6	7.2 ± 0.1	7.3 ± 1.6
09	6.6 ± 0.5	6.5 ± 1.2	7.2 ± 1.0	7.4 ± 0.4	6.9 ± 0.9
10	6.8 ± 1.1	7.6 ± 0.4	7.1 ± 0.3	7.0 ± 0.3	7.1 ± 0.7
11	7.6 ± 0.9	6.7 ± 0.9	7.1 ± 0.4	7.1 ± 0.2	7.1 ± 0.7
12	7.0 ± 1.0	6.9 ± 0.6	7.4 ± 0.6	7.2 ± 0.3	7.1 ± 0.4
13	8.0 ± 0.6	7.0 ± 0.6	7.2 ± 0.7	7.5 ± 0.5	7.4 ± 0.9
14	6.8 ± 0.5	7.1 ± 0.8	7.2 ± 0.8	7.3 ± 0.4	7.1 ± 0.4
15	6.3 ± 0.9	6.9 ± 0.6	7.3 ± 2.5	7.0 ± 0.4	6.9 ± 0.8
16	7.1 ± 0.5	7.0 ± 0.3	6.9 ± 0.3	7.0 ± 0.3	7.0 ± 0.2
17	6.8 ± 0.8	6.4 ± 0.2	6.2 ± 0.6	6.3 ± 0.5	6.4 ± 0.5
18	5.6 ± 0.8	5.5 ± 0.3	5.4 ± 0.5	5.9 ± 0.4	5.6 ± 0.4
19	5.3 ± 0.6	6.1 ± 0.5	6.1 ± 0.7	6.6 ± 0.4	6.0 ± 1.1
20	7.0 ± 0.5	5.7 ± 1.1	5.7 ± 0.4	6.1 ± 0.2	6.1 ± 1.2
21	6.5 ± 1.6	6.2 ± 0.5	6.3 ± 0.2	6.6 ± 0.6	6.4 ± 0.4

(a) TLD Vandalized

TABLE 26

(Page 2 of 2)

VIRGINIA POWER - SURRY - 1986

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS
mR/day ± 2 Sigma - Set 1 - 098

STATION NUMBER	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	AVERAGE ± 2 s.d.
22	6.0 ± 0.4	5.8 ± 0.5	6.0 ± 0.7	6.4 ± 0.4	6.1 ± 0.5
23	5.4 ± 0.9	6.2 ± 0.6	7.3 ± 1.1	6.7 ± 0.3	6.4 ± 1.6
24	6.5 ± 0.8	6.6 ± 0.4	6.1 ± 0.5	6.7 ± 0.4	6.5 ± 0.5
25	7.9 ± 0.5	7.7 ± 0.4	6.4 ± 0.6	7.2 ± 0.4	7.3 ± 1.3
26	7.0 ± 1.0	6.4 ± 0.4	6.1 ± 0.6	6.2 ± 0.2	6.4 ± 0.8
27	5.7 ± 0.7	6.3 ± 0.9	5.8 ± 0.8	5.9 ± 0.1	5.9 ± 0.5
28	6.6 ± 0.8	6.3 ± 0.3	6.2 ± 0.2	6.6 ± 0.4	6.4 ± 0.4
29	6.0 ± 0.6	5.9 ± 0.4	5.6 ± 0.4	5.7 ± 0.3	5.8 ± 0.4
30	7.4 ± 1.2	6.0 ± 0.2	6.2 ± 1.4	6.2 ± 0.2	6.5 ± 1.3
31	5.8 ± 0.5	6.2 ± 0.6	5.8 ± 0.2	5.7 ± 0.5	5.9 ± 0.4
32	5.0 ± 0.5	6.0 ± 0.4	6.3 ± 0.5	6.0 ± 0.2	5.8 ± 1.1
33	6.0 ± 0.3	6.8 ± 0.8	6.4 ± 0.7	6.7 ± 0.3	6.5 ± 0.7
34	5.9 ± 0.6	6.8 ± 1.0	6.5 ± 0.4	7.0 ± 0.3	6.6 ± 1.0
35	7.8 ± 0.6	7.3 ± 0.8	7.6 ± 0.7	7.9 ± 0.3	7.7 ± 0.5
36	8.6 ± 1.0	7.0 ± 0.8	7.9 ± 1.1	7.7 ± 0.6	7.8 ± 1.3
37	8.0 ± 0.7	6.7 ± 0.2	6.8 ± 0.4	6.9 ± 0.4	7.1 ± 1.2
38	8.8 ± 1.7	8.4 ± 0.4	8.5 ± 0.7	8.1 ± 0.9	8.5 ± 0.6
39	7.1 ± 1.0	6.8 ± 0.9	6.7 ± 0.7	6.3 ± 0.4	6.7 ± 0.7
40	6.2 ± 0.4	5.3 ± 0.3	4.9 ± 0.3	5.7 ± 0.2	5.5 ± 1.1
41	7.6 ± 1.5	6.3 ± 1.1	7.5 ± 0.7	6.6 ± 0.4	7.0 ± 1.3
42	7.9 ± 1.2	6.7 ± 0.5	6.3 ± 0.8	6.7 ± 0.4	6.9 ± 1.4
43	5.0 ± 0.4	6.2 ± 0.7	5.8 ± 0.1	6.1 ± 0.3	5.8 ± 1.1
Average ± 2 s.d.	6.7 ± 2.0	6.6 ± 1.4	6.6 ± 1.7	6.8 ± 1.5	6.7 ± 0.2

TABLE 27

(Page 1 of 2)

VIRGINIA POWER - SURRY - 1986

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS
mR/month ± 2 Sigma - Set 2 - 099

STATION NUMBER	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	AVERAGE ± 2 s.d.
02	7.2 ± 1.7	8.3 ± 0.7	8.3 ± 0.6	8.7 ± 0.8	8.1 ± 1.3
03	(a)	4.3 ± 0.4	4.3 ± 0.2	5.1 ± 0.6	4.6 ± 0.9
04	5.5 ± 1.2	6.8 ± 0.3	7.6 ± 0.7	7.4 ± 0.1	6.8 ± 1.9
05	(a)	6.7 ± 0.8	7.1 ± 0.3	7.5 ± 0.8	7.1 ± 0.8
06	6.5 ± 0.7	7.1 ± 0.5	7.6 ± 0.6	8.2 ± 0.2	7.4 ± 1.4
07	6.3 ± 1.0	6.9 ± 0.5	6.9 ± 0.4	7.4 ± 0.2	6.9 ± 0.9
08	6.9 ± 2.0	6.8 ± 0.6	6.9 ± 0.4	7.5 ± 0.3	7.0 ± 0.6
09	6.1 ± 0.6	6.3 ± 0.3	7.1 ± 0.6	7.5 ± 0.8	6.8 ± 1.3
10	6.5 ± 0.8	6.5 ± 0.3	7.4 ± 0.5	7.4 ± 0.2	7.0 ± 1.0
11	6.0 ± 1.1	6.4 ± 1.7	7.7 ± 0.5	7.4 ± 1.5	6.9 ± 1.6
12	7.8 ± 0.9	7.2 ± 0.5	7.5 ± 0.5	7.7 ± 0.9	7.6 ± 0.5
13	6.5 ± 0.7	7.0 ± 0.5	7.3 ± 0.5	8.2 ± 0.1	7.3 ± 1.4
14	6.6 ± 0.7	7.7 ± 1.3	7.5 ± 0.4	7.9 ± 0.5	7.4 ± 1.1
15	5.7 ± 0.6	6.4 ± 0.5	6.7 ± 0.9	7.3 ± 0.3	6.5 ± 1.3
16	5.8 ± 0.7	7.2 ± 1.1	7.2 ± 1.1	7.8 ± 0.6	7.0 ± 1.7
17	6.2 ± 0.7	6.4 ± 0.6	6.4 ± 0.4	6.7 ± 0.2	6.4 ± 0.4
18	4.8 ± 1.0	5.5 ± 0.3	(a)	6.1 ± 0.2	5.5 ± 1.3
19	5.5 ± 0.3	6.2 ± 0.3	6.3 ± 0.3	7.0 ± 0.3	6.3 ± 1.2
20	4.7 ± 0.5	5.8 ± 0.2	6.0 ± 0.6	6.5 ± 0.8	5.8 ± 1.5
21	4.8 ± 0.9	6.0 ± 0.5	6.1 ± 0.7	6.8 ± 0.2	5.9 ± 1.7

(a) TLD Vandalized

TABLE 27 (Cont.)

(Page 2 of 2)

VIRGINIA POWER - SURRY - 1986

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS
mR/month ± 2 Sigma - Set 2 - 099

STATION NUMBER	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	AVERAGE ± 2 s.d.
22	5.2 ± 0.7	5.7 ± 0.3	5.8 ± 0.1	6.6 ± 0.3	5.8 ± 1.2
23	5.5 ± 0.3	5.9 ± 0.2	6.4 ± 0.5	6.8 ± 0.4	6.2 ± 1.1
24	6.1 ± 1.5	5.7 ± 0.6	6.6 ± 0.5	6.9 ± 0.2	6.3 ± 1.1
25	6.3 ± 0.4	6.3 ± 0.3	6.5 ± 0.3	7.6 ± 0.9	6.7 ± 1.2
26	4.9 ± 0.4	6.8 ± 0.7	6.2 ± 0.5	6.8 ± 0.7	6.2 ± 1.8
27	5.4 ± 1.2	6.2 ± 0.4	5.6 ± 0.4	6.6 ± 0.2	6.0 ± 1.1
28	5.4 ± 0.7	6.7 ± 0.3	6.5 ± 0.6	7.1 ± 0.4	6.4 ± 1.5
29	4.6 ± 1.4	6.1 ± 0.4	5.8 ± 0.3	6.1 ± 0.1	5.7 ± 1.4
30	5.5 ± 0.5	6.2 ± 0.3	5.7 ± 0.4	6.9 ± 0.4	6.1 ± 1.2
31	5.2 ± 0.7	6.0 ± 0.4	5.6 ± 0.3	6.6 ± 0.1	5.9 ± 1.2
32	5.0 ± 0.9	6.5 ± 0.3	6.1 ± 0.6	6.6 ± 0.2	6.1 ± 1.5
33	5.3 ± 1.0	6.9 ± 0.6	6.8 ± 0.3	7.2 ± 0.5	6.6 ± 1.7
34	6.1 ± 0.8	7.1 ± 0.3	6.4 ± 0.5	7.8 ± 0.3	6.9 ± 1.5
35	8.6 ± 0.7 (a)	7.5 ± 0.2	7.5 ± 0.5	8.2 ± 1.3	8.0 ± 1.1
36	7.5 ± 1.5	7.5 ± 0.3	6.9 ± 0.5	8.7 ± 1.2	7.7 ± 1.5
37	6.6 ± 1.2	6.5 ± 0.6	6.7 ± 0.8	7.2 ± 0.4	6.8 ± 0.6
38	8.7 ± 1.8	8.7 ± 0.5	8.4 ± 1.4	9.1 ± 0.6	8.7 ± 0.6
39	5.5 ± 1.8	6.4 ± 0.4	6.5 ± 0.8	7.0 ± 0.2	6.4 ± 1.2
40	5.5 ± 1.9	5.9 ± 0.3	5.4 ± 0.3	5.9 ± 0.2	5.7 ± 0.5
41	6.5 ± 0.8	6.9 ± 0.8	7.2 ± 0.5	7.6 ± 0.2	7.1 ± 0.9
42	6.6 ± 1.3	6.8 ± 0.4	6.7 ± 0.4	7.0 ± 0.2	6.8 ± 0.3
43	6.5 ± 1.2	6.7 ± 0.4	5.9 ± 0.6	7.0 ± 1.4	6.5 ± 0.9
Average ± 2 s.d.	6.0 ± 2.0	6.6 ± 1.5	6.7 ± 1.6	7.2 ± 1.6	6.6 ± 1.0

(a) TLD vandalized; collection period 02/12/86-04/01/86.

V. CONCLUSIONS

V. CONCLUSIONS

The results of the 1986 Radiological Environmental Monitoring Program for Surry Nuclear Power Station have been presented. The Chernobyl nuclear accident on April 25, 1986 produced fission-related isotopes which were detected in the vicinity of the Surry Nuclear Power Station from May 5 through June 30. During the remainder of the year the results were as expected for normal environmental samples. Naturally occurring activity was observed in sample media in the expected activity ranges.

Occasional samples of nearly all media showed the presence of man-made isotopes. These have been discussed individually in the text. Observed activities were at very low concentrations and had no significant dose consequence.

As a method of referencing the measured radionuclide concentrations in sample media to the dose consequence, the data may be compared to the Reporting Level Concentrations listed in the NRC Regulatory Guide 4.8. These concentrations are based upon 25% of the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion "As Low as is Reasonably Achievable." Specific examples of sample media with positive analysis results are discussed below.

Air particulate gross beta concentrations of all the indicator locations for 1986 appear to follow the gross beta concentrations at the control location. Elevated gross beta concentrations, attributed to Chernobyl, were measured at all locations during the five week period beginning May 6. Gamma isotopic analysis of the particulate samples identified the majority of the gamma emitting isotopes as natural products

(beryllium-7 and potassium-40). The second quarter composites also had measureable concentrations of three fission isotopes (attributed to Chernobyl): ruthenium-103, cesium-134, and cesium-137. These were detected at all locations. No man-made activity was found in the particulate media during the other three quarters.

Iodine-131, attributed to the Chernobyl accident was measured in five milk samples using the radiochemical separation method and in two milk samples analyzed by gamma ray spectroscopy during May and June. Cesium-137 was detected in five milk samples and the most probable source was the Chernobyl accident. Cesium-137 has been detected occasionally in previous years, once in 1985, and then was attributed to past atmospheric nuclear weapons testing. Strontium-90 was measured in all but one of the milk samples. The values were comparable to the levels in 1985 and preoperational years. Strontium-90 from those years is attributed to past atmospheric nuclear weapons testing. The Chernobyl accident does not appear to have affected strontium-90 levels in the environment. 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.

The four well water sample stations for 1986 have environmental concentrations of tritium. The sensitivity of the tritium analysis of well water (<130 pCi/ℓ) is substantially better than the analysis from years prior to 1985 (<330 pCi/ℓ). This makes it difficult to compare and trend the low level results found in 1986 to previous data. Also, there is no preoperational data to compare with for well water tritium. The tritium concentrations in well water are comparable to concentrations found in surface water samples (230 pCi/ℓ vs 220 pCi/ℓ). These concentrations are 1.15% of the reporting level concentrations for drinking water samples.

The river water tritium of the Surry Discharge Canal samples were similar to the measured activity of the Surry effluent samples taken prior to discharge. The average tritium concentration of the environmental discharge sample was 578 pCi/ℓ. The average concentration of Surry discharges, as reported in the 1986 semi-annual reports was 400 pCi/ℓ.

The concentration of tritium in the river water was 2% of the reporting level concentration for non-drinking water. The discharge water is further diluted when mixed with the river water.

Silt is a sensitive indicator of discharges from nuclear power stations. The silt from Surry environmental samples indicates a number of man-made isotopes present as a result of the operation of the power station. The trend graphs indicate the extent and magnitude of the contamination. Cobalt-60 and cesium-137 were detected in the samples from all locations. Cobalt-58 and cesium-134 were detected at several locations. In addition to these isotopes, manganese-54 and chromium-51 were detected in the samples collected at the Surry Discharge.

The preoperational program analyzed silt samples but found no gamma emitting activity above the sensitivity of the analysis (<5000 pCi/kg). The low sensitivity of the preoperational data eliminates the ability to make comparisons to operational data. No reporting level concentrations have been assigned to this media because silt contamination does not provide a direct dose pathway to man.

Activity in clam and fish samples does present a direct dose pathway to man. Clam samples from 1986 indicates the presence of low level man-made activity. This activity was determined at levels well below the required sensitivity. Comparison of the 1986 data to 1983-1985 data and to data prior to 1978, does not indicate increasing trends. Samples taken during

1978-1982 were not analyzed below the required sensitivity level (<130 pCi/kg) and therefore cannot be compared to the low level activity found in the 1983-1986 samples. Preoperational clam samples were analyzed for gross beta and potassium-40 and are not directly comparable to operational data.

The average concentration of positive results from 1986 Surry Discharge clam samples were 2.2% of the reporting level concentrations.

A low level cesium-137 measurement was found in one of the five fish samples. Trends of activity in fish is difficult to establish because previous samples were analyzed only to the required sensitivity (<130 pCi/kg). Preoperational samples were analyzed for gross beta.

The one positive result from 1986 Surry Discharge fish samples was 2.3% of the reporting level concentrations.

Based upon the evidence of the environmental monitoring program the station appears to be operating within regulatory limits. Thus, no unusual radiological characteristics were observed in the environs of the Surry Nuclear Power Station in 1986.

VI. 1986 LAND USE CENSUS RESULTS FOR SURRY POWER STATION

VI. LAND USE CENSUS

Surry Technical Specifications require that a Land Use Census be conducted within a distance of 8 Km (5 miles) from Surry Power Station on an annual basis. This census indentifies, in each of 16 meteorological sectors, the location of the nearest milk cow, the nearest resident and the nearest garden of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation. The census also identifies the nearest milk goat within a distance of 9.7 Km (6 miles) from the station.

The results of the Land Use Census are used to calculate the principal exposure pathway from gaseous effluents. This pathway analysis is compared to previous analysis to determine the requirements for modification of the Radiological Environmental Monitoring Program and/or the calculational model used for determining dose contributions to the unrestricted area.

Based on the results of the 1986 Land Use Census, no change to the Monitoring Program nor calculational model is required.

The results of the Land Use Census are presented in tabular form in Table 28. A map indicating the locations of the nearest resident, nearest milk animal, and the nearest garden greater than 50 m^2 producing broad leaf vegetation is presented on Figure 4.

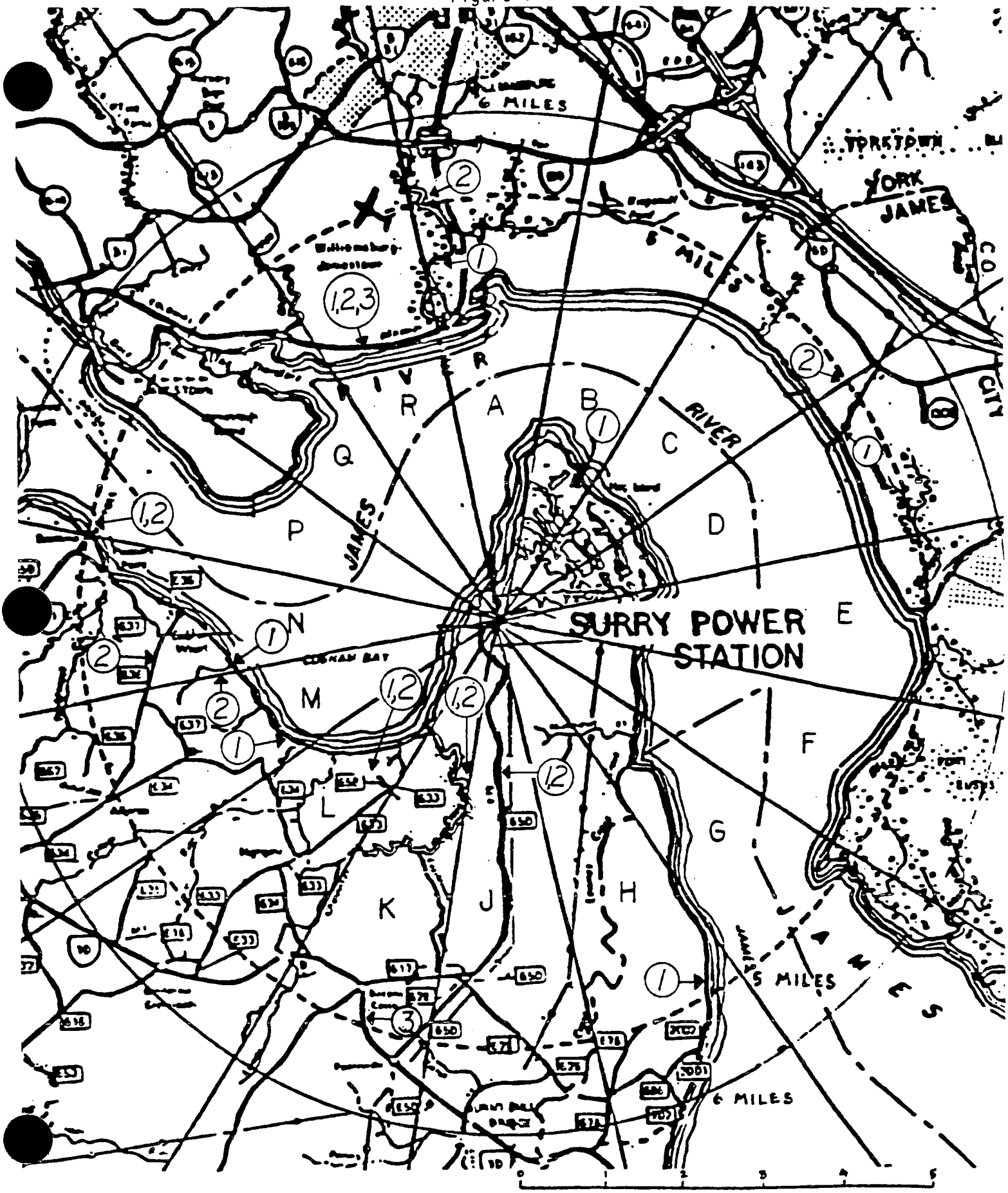
TABLE 28

CENSUS FOR SURRY POWER STATION - 1986

SECTOR	NEAREST RESIDENCE	NEAREST GARDEN	NEAREST COW	NEAREST GOAT
A-(N)	4.75 @ 358°	4.95 @ 356°	*	*
B-(NNE)	1.95 @ 34°	*	*	*
C-(NE)	*	4.90 @ 56°	*	*
D-(ENE)	4.90 @ 63°	*	*	*
E-(E)	*	*	*	*
F-(ESE)	*	*	*	*
G-(SE)	*	*	*	*
H-(SSE)	4.70 @ 152°	*	*	*
J-(S)	1.60 @ 182°	1.86 @ 182°	*	*
K-(SSW)	1.90 @ 193°	1.90 @ 193°	4.75 @ 201°	*
L-(SW)	2.25 @ 220°	2.25 @ 220°	*	*
M-(WSW)	2.80 @ 243°	3.42 @ 258°	*	*
N-(W)	3.20 @ 261°	4.33 @ 262°	*	*
P-(WNW)	4.90 @ 282°	4.90 @ 282°	*	*
Q-(NW)	*	*	*	*
R-(NNW)	3.75 @ 339°	4.90 @ 341°	3.65 @ 337°	*

*** None**

Figure 4



LAND USE CENSUS LOCATION MAP, YEAR 1986 .

1 = NEAREST RESIDENT 2= NEAREST GARDEN 3= NEAREST COW 4= NEAREST GOAT

VII. SYNOPSIS OF ANALYTICAL PROCEDURES

VII. ANALYTICAL PROCEDURES SYNOPSIS

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

GROSS BETA AND GROSS ALPHA ANALYSIS OF AIR PARTICULATE SAMPLES

After a delay of five or more days, allowing for the radon-222 and radon-220 (thoron) daughter products to decay, the filters are counted in a gas-flow proportional counter. The sample is counted at one operating voltage for gross beta and then changed to a second operating voltage for gross alpha.

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

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

where:

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

GROSS BETA ANALYSIS OF WATER SAMPLES

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

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

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

where:

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

ANALYSIS OF SAMPLES FOR TRITIUM

Water

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

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

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

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

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

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

where:

T_N = tritium units of the standard

3.234 = conversion factor changing tritium units to pCi/ℓ

V_N = volume of the standard used to calibrate the efficiency of the detector in psia

V_S = volume of the sample loaded into the detector in psia

C_N = the cpm activity of the standard of volume V_N

C_G = the gross activity in cpm of the sample of volume V_S and the detector volume

B = the background of the detector in cpm

Δt = counting time for the sample

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

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

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

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

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

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

where:

- N = total counts from sample (counts)
- Δt = counting time for sample (min)
- B = background rate of counter (cpm)
- 2.22 = dpm/pCi
- V = volume or weight of sample analyzed
- Y = chemical yield of the mount or sample counted
- DF = decay factor from the mid-collection date to the counting date
- E = efficiency of the counter for I-131, corrected for self absorption effects by the formula
- $E = E_s(\exp -0.0061M)/(\exp -0.0061M_s)$
- E_s = efficiency of the counter determined from an I-131 standard mount
- M_s = mass of PdI_2 on the standard mount, mg
- M = mass of PdI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

A 1.0 liter Marinelli beaker is filled with a representative aliquot of the sample. The sample is then counted for at least 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Dried Solids Other Than Soils and Sediments

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

Fish

As much as possible (up to the total sample) of the edible portion of the sample is loaded into a tared Marinelli and weighed. The sample is then counted for at least 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Soils and Sediments

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

Charcoal Cartridges (Air Iodine)

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

Air Particulate

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

A mini-computer software program defines peaks by certain changes in the slope of the spectrum. The program also compares the energy of each peak with a library of peaks for isotope identification and then performs the radioactivity calculation using the appropriate fractional gamma ray abundance, half life, detector efficiency, and net counts in the peak region. The calculation of results, two sigma error and the lower limit of detection (LLD) in pCi/volume or pCi/mass:

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

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

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

where:

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

ENVIRONMENTAL DOSIMETRY

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

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

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

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

where D_1 = the net mR of area 1 of the TLD, and similarly for D_2, D_3, and D_4

$D_1 = I_1 \, K/R_1 - A$

I_1 = the instrument reading of the field dose in area 1

K = the known exposure by the Cs-137 source

R_1 = the instrument reading due to the Cs-137 dose on area 1

A = average dose in mR, calculated in similar manner as above, of the transit control TLDs

ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

WATER

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a 5 to 7 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet 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 trichloracetic acid (TCA) is added to produce a curd. The curd is separated by filtration and is discarded. An oxalate precipitation is performed on the filtrate and the precipitate is ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as $SrNO_3$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for 7 to 10 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet 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 a 10 gram aliquot is taken. Stable strontium carrier is added and the sample is leached in nitric acid. The mixture is filtered and the liquid portion is reduced in volume by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for 7 to 10 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

where:

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

Organic Solids

A 200g wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in nitric acid. The sample is filtered and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitatd as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet 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 $Sr(NO_3)_2$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, is dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with 80 mg/cm^2 aluminum absorber for level beta counting.

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

$$\text{RESULT Sr-89} = (N/\Delta t - B_C - B_A)/(2.22\ V\ Y_S\ DF_{SR\text{-}89}\ E_{SR\text{-}89})$$

$$\text{TWO SIGMA ERROR Sr-89} = 2((N/\Delta t + B_C + B_A)/\Delta t)^{1/2}/(2.22\ V\ Y_S\ DF_{SR\text{-}89}\ E_{SR\text{-}89})$$

$$\text{LLD Sr-89} = 4.66((B_C + B_A)/\Delta t)^{1/2}/(2.22\ V\ Y_S\ DF_{SR\text{-}89}\ E_{SR\text{-}89})$$

$$\text{RESULT Sr-90} = (N/\Delta t - B)/(2.22\ V\ Y_1\ Y_2\ DF\ IF\ E)$$

$$\text{TWO SIGMA ERROR Sr-90} = 2((N/\Delta t + B)/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ DF\ E\ IF))$$

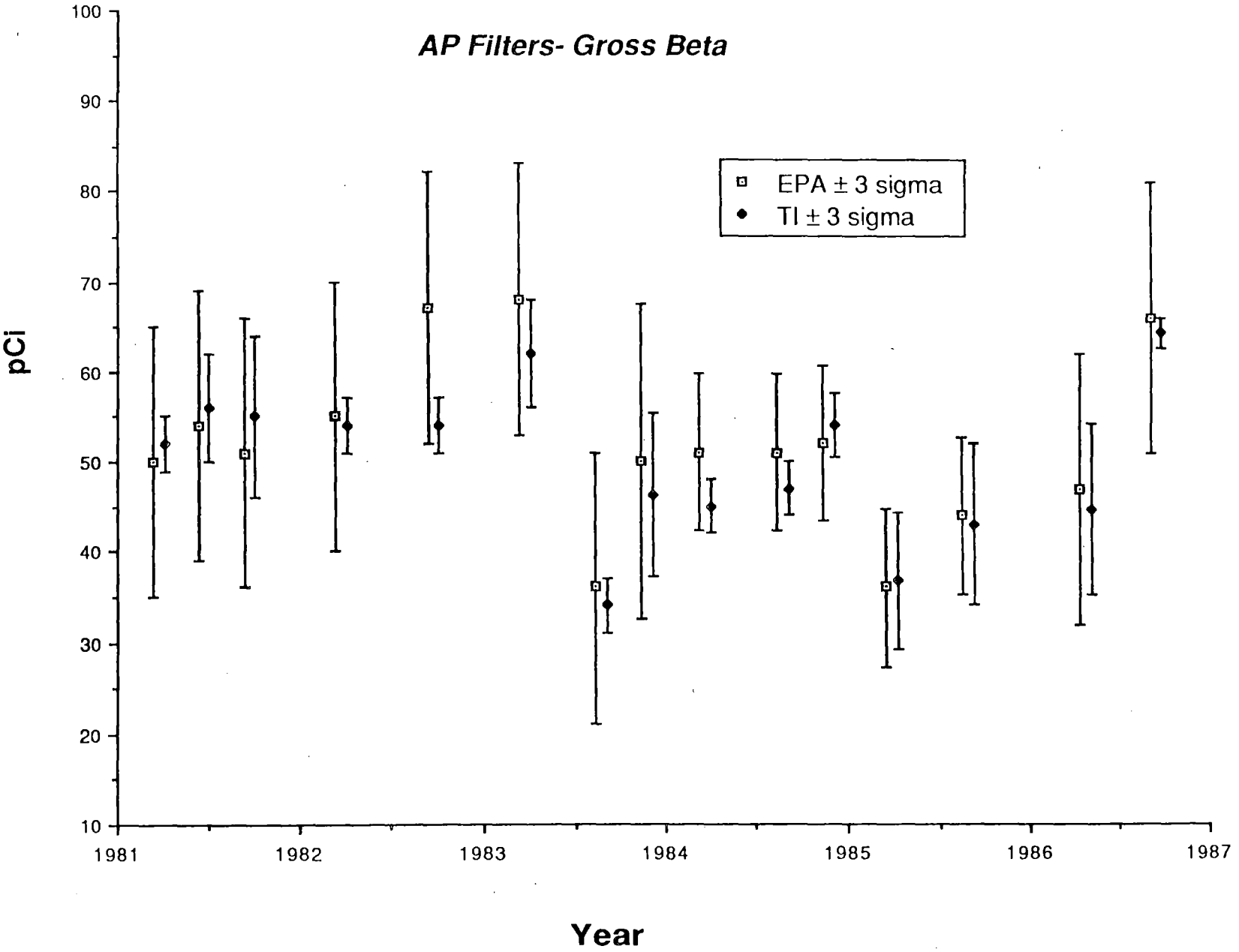
$$\text{LLD Sr-90} = 4.66(B/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ IF\ DF\ E)$$

VIII. EPA INTERLABORATORY COMPARISON PROGRAM

VIII. EPA INTERLABORATORY COMPARISON PROGRAM

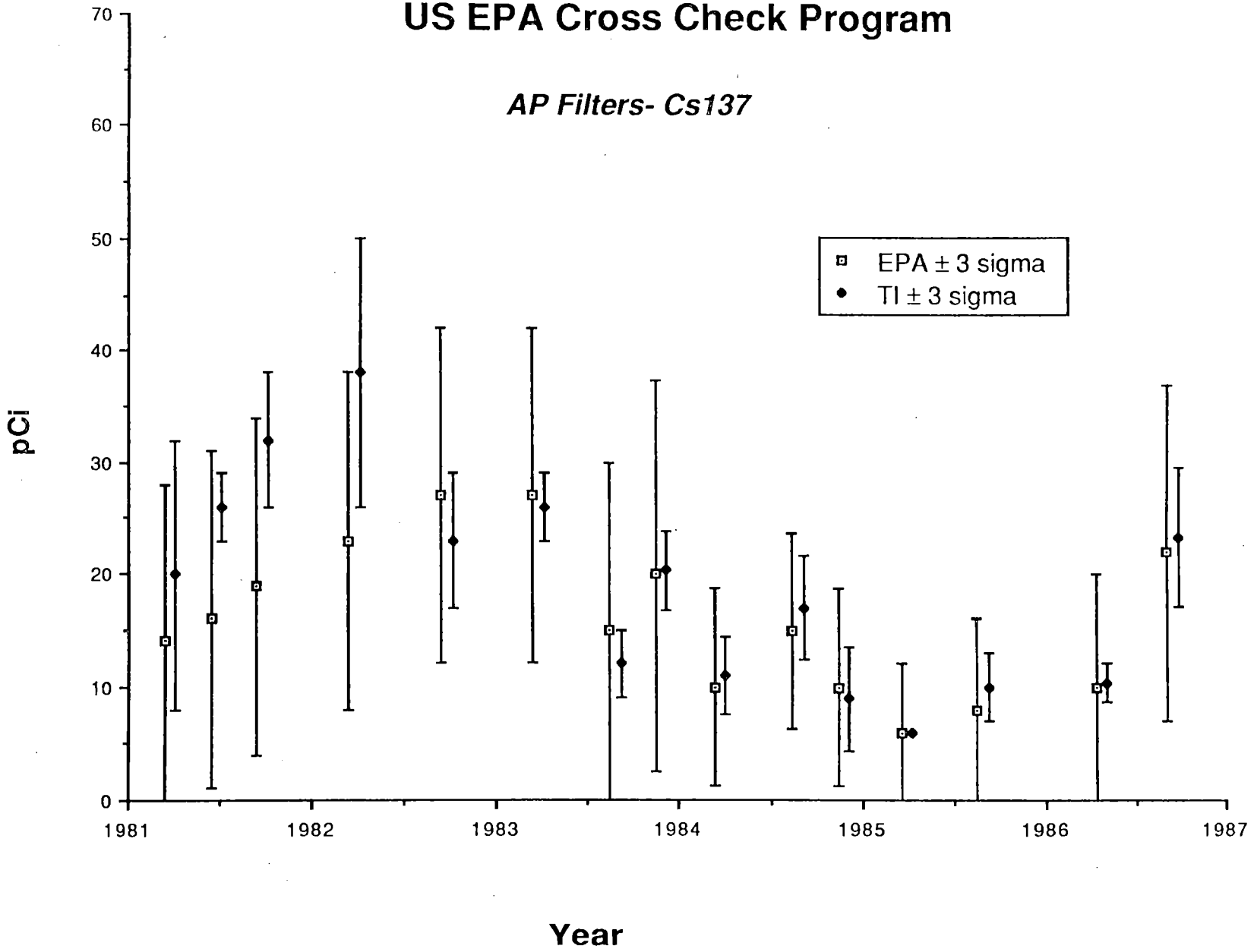
Teledyne Isotopes participates in the US EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1986 data summary tables are presented for isotopes in the various sample media applicable to the Surry Power Stations Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases.

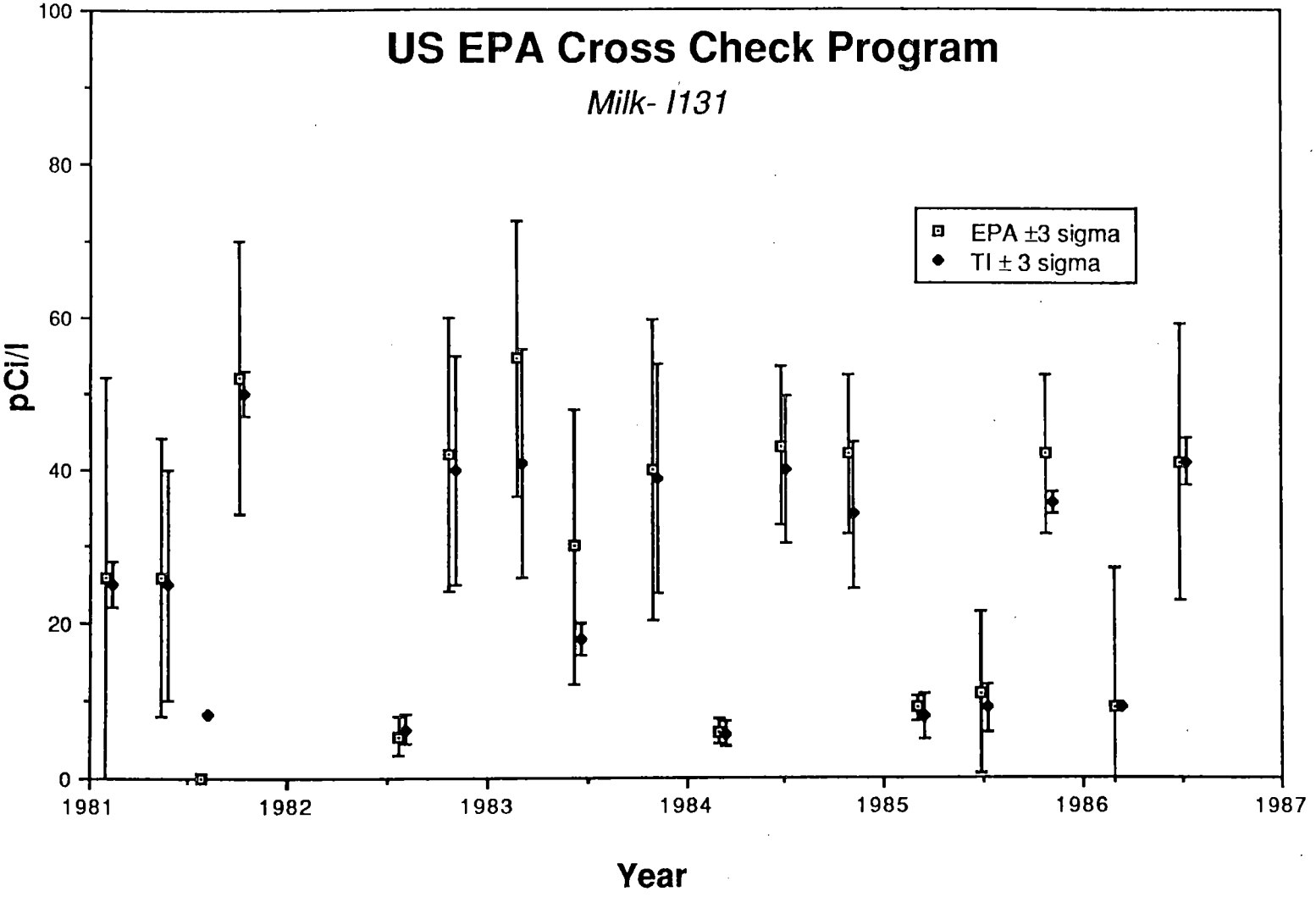
US EPA Cross Check Program

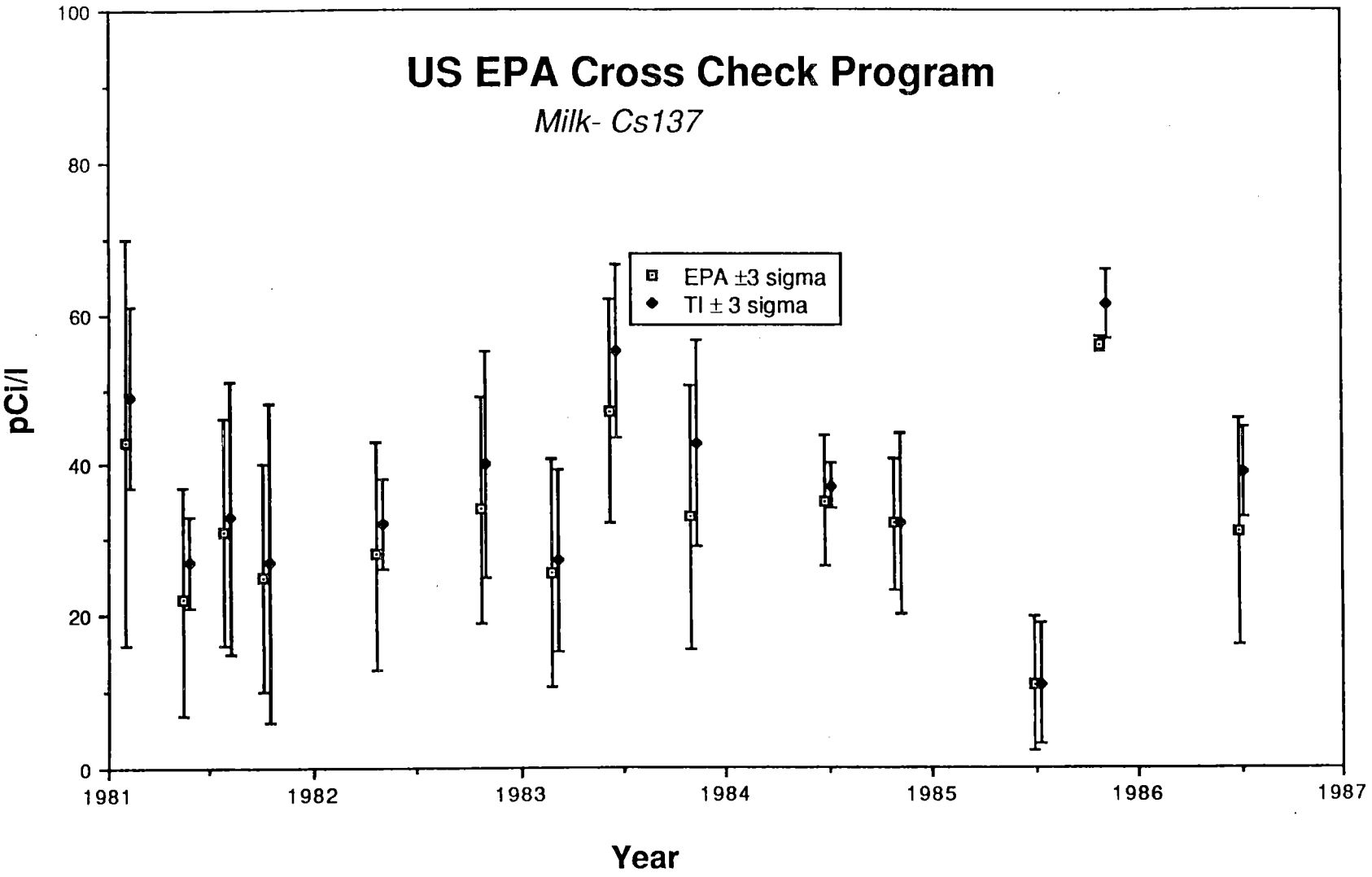


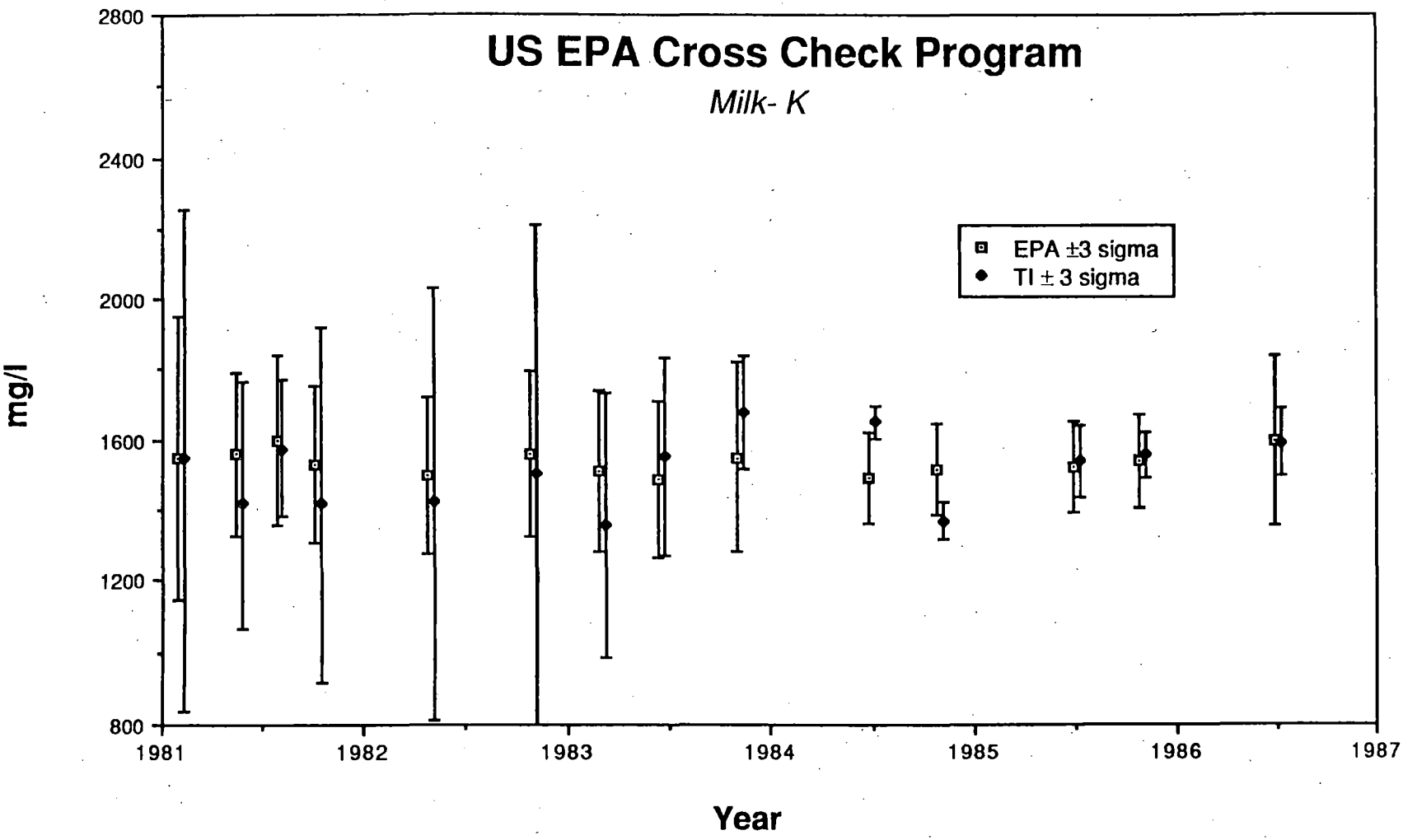
US EPA Cross Check Program

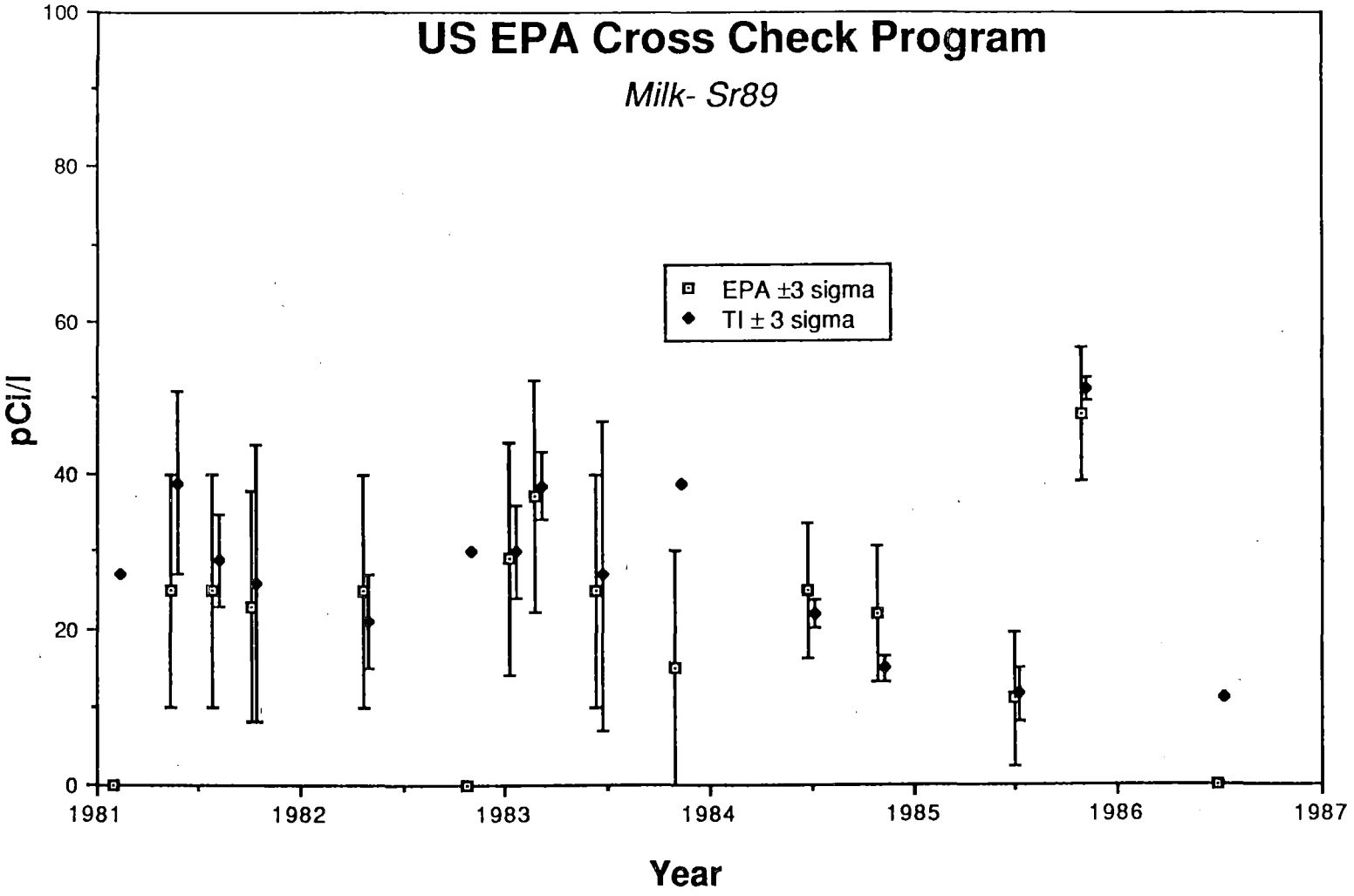
AP Filters- Cs137

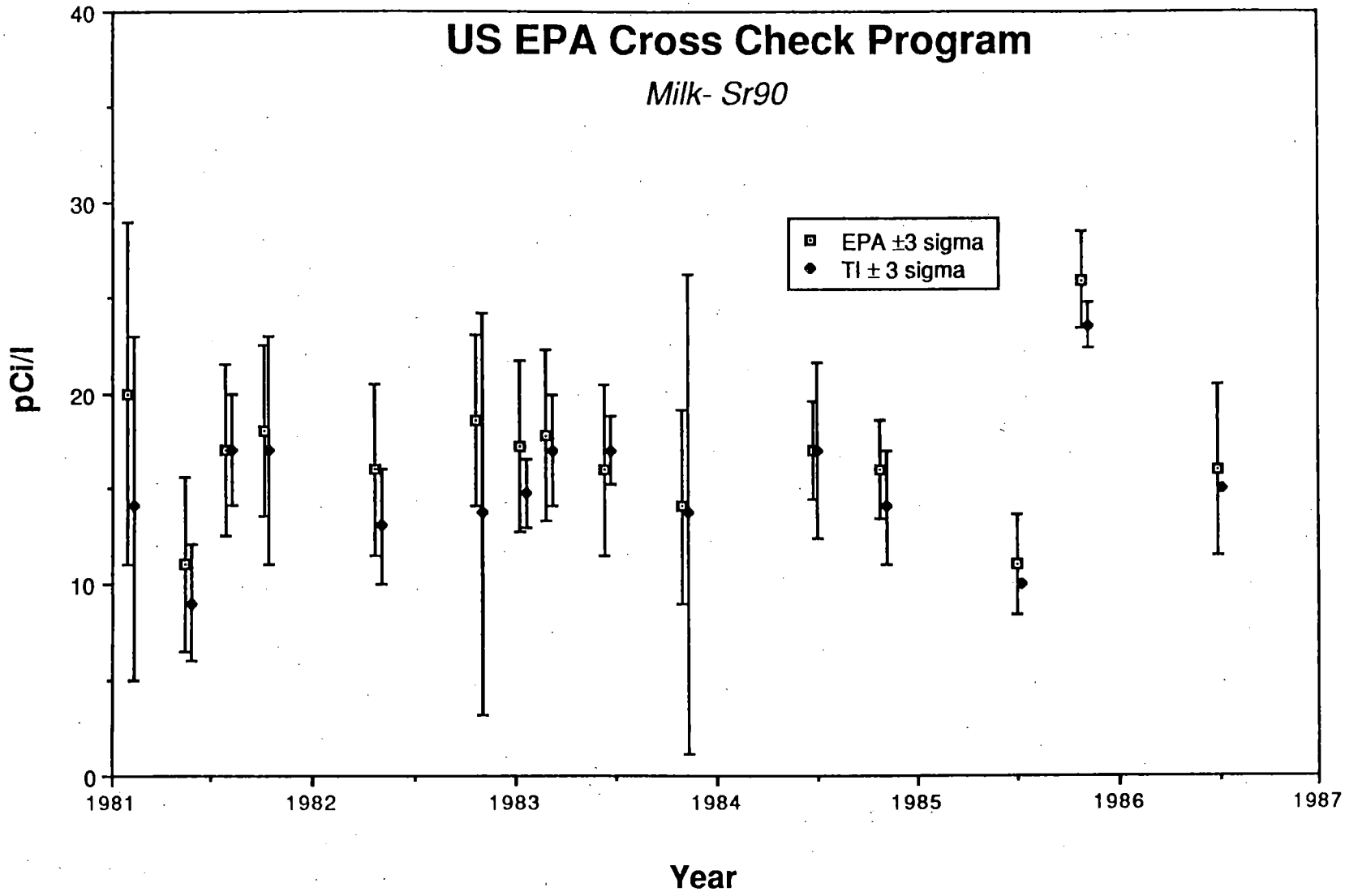


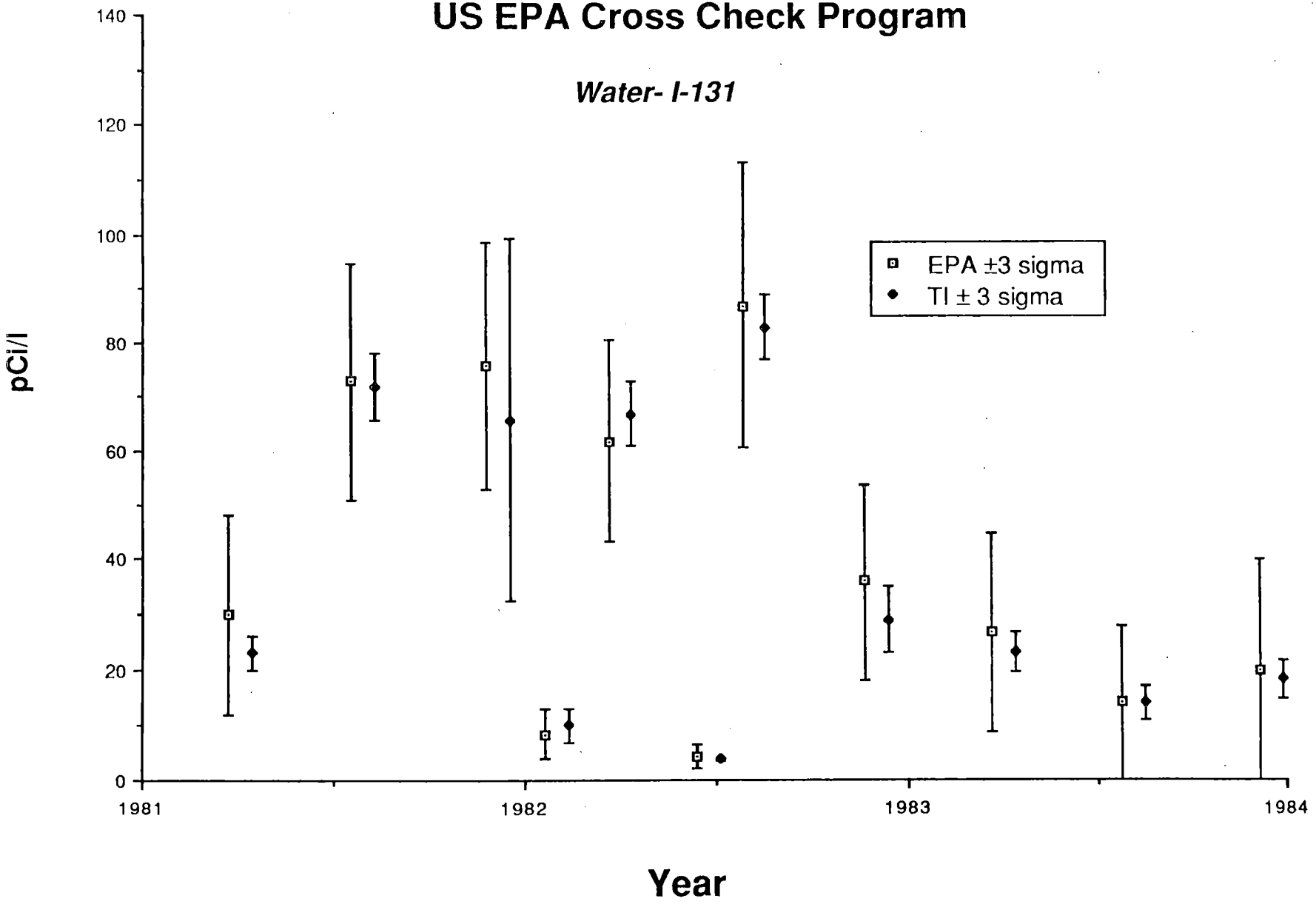

US EPA Cross Check Program
Milk- I131
EPA ±3 sigma
TI ± 3 sigma
pCi/l
100
80
60
40
20
0
1981
1982
1983
1984
1985
1986
1987
Year


US EPA Cross Check Program
Milk- Cs137
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
100
80
60
40
20
0
1981
1982
1983
1984
1985
1986
1987

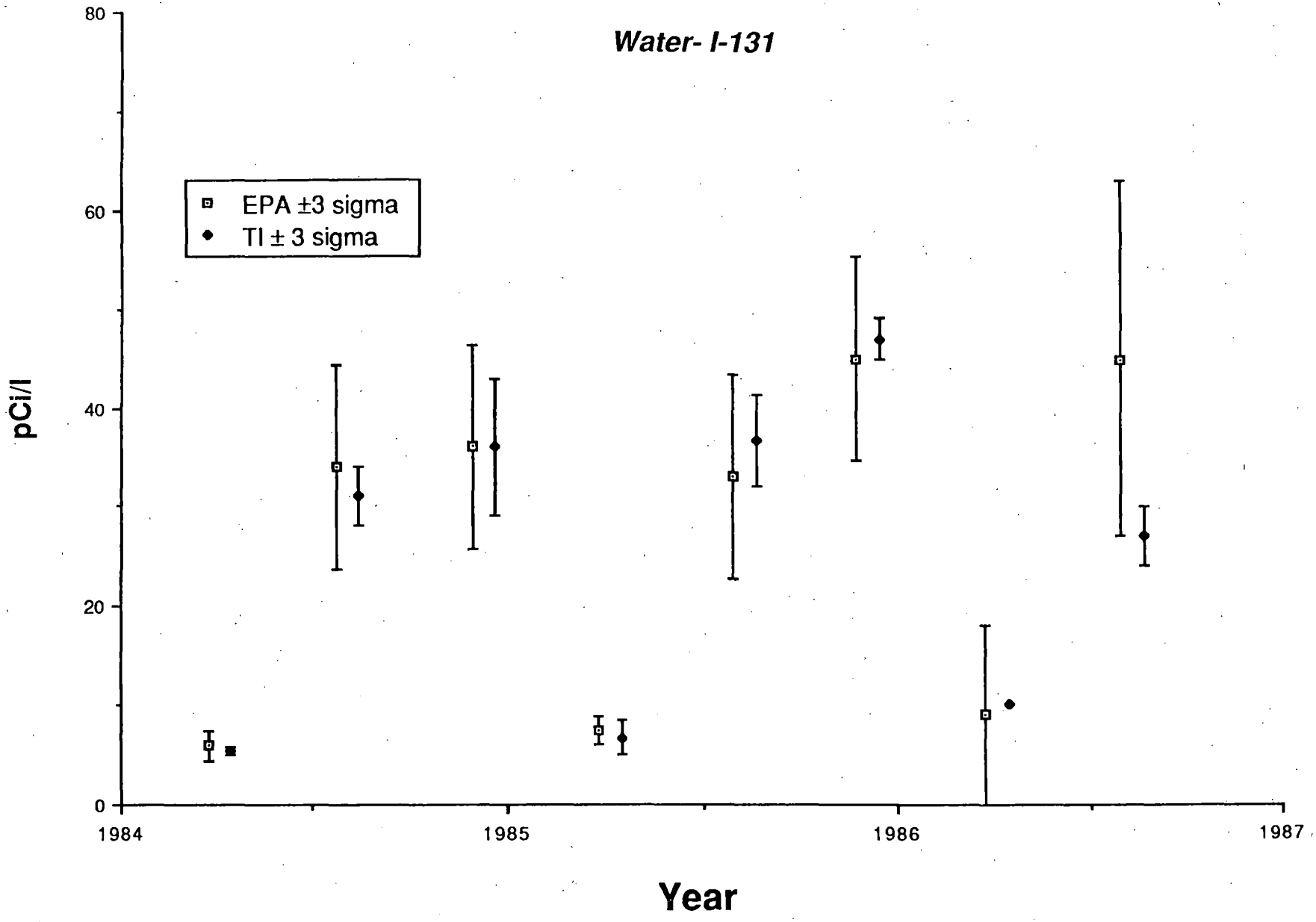

US EPA Cross Check Program
Milk- K
EPA ±3 sigma
TI ± 3 sigma
mg/l
2800
2400
2000
1600
1200
800
1981
1982
1983
1984
1985
1986
1987
Year

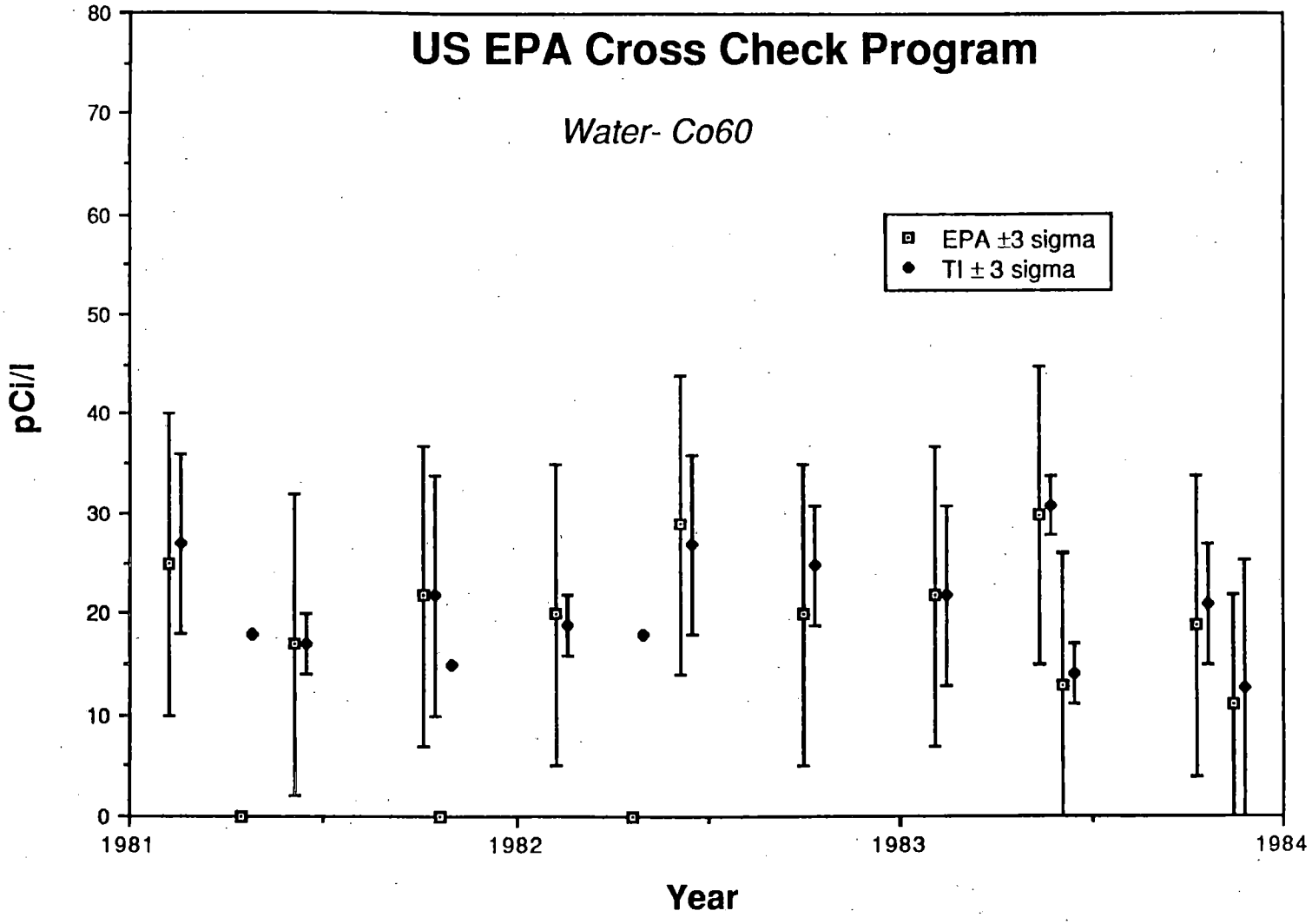

US EPA Cross Check Program
Milk- Sr89
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
100
80
60
40
20
0
1981
1982
1983
1984
1985
1986
1987

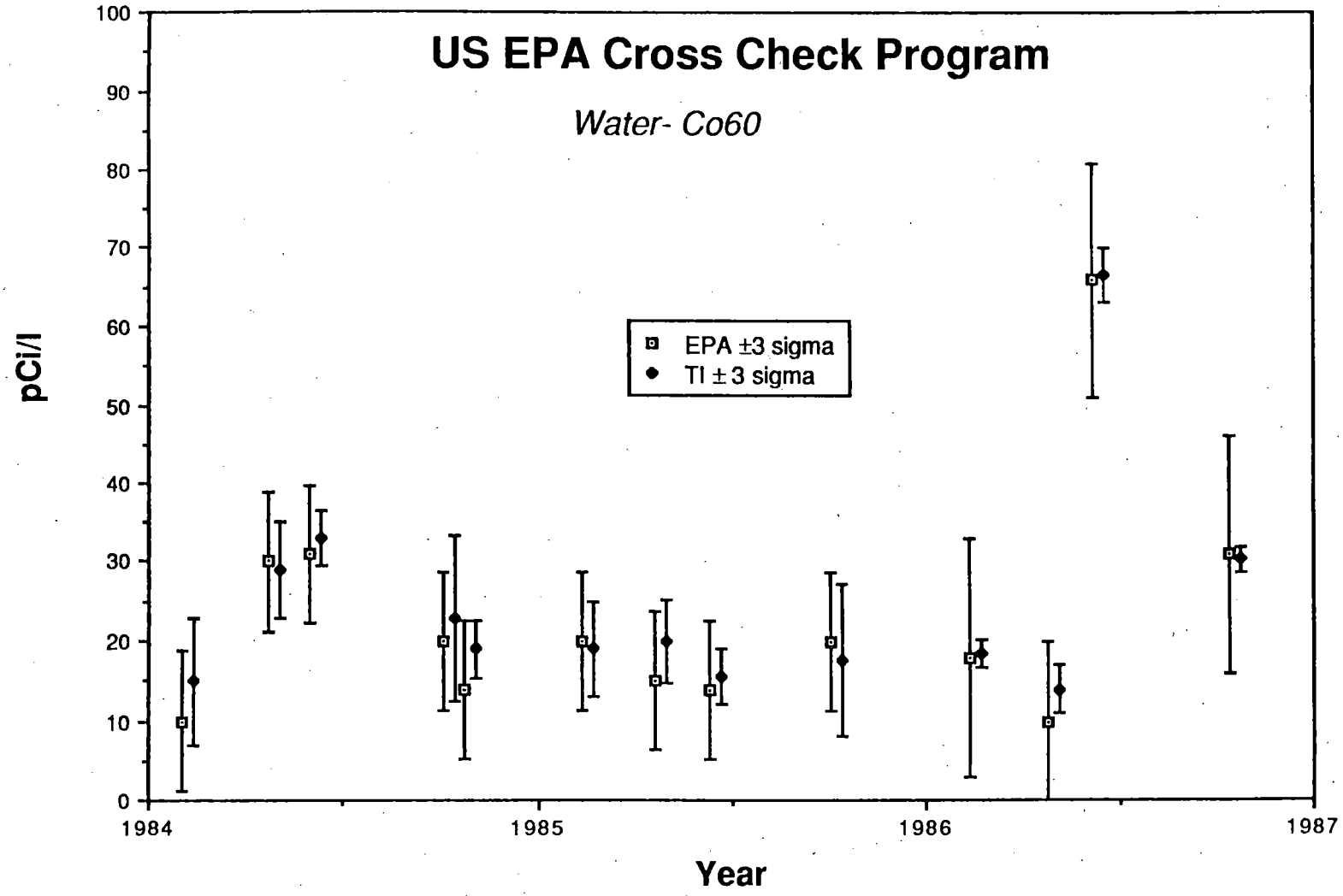

US EPA Cross Check Program
Milk- Sr90
EPA ±3 sigma
TI ± 3 sigma
pCi/l
40
30
20
10
0
1981
1982
1983
1984
1985
1986
1987
Year

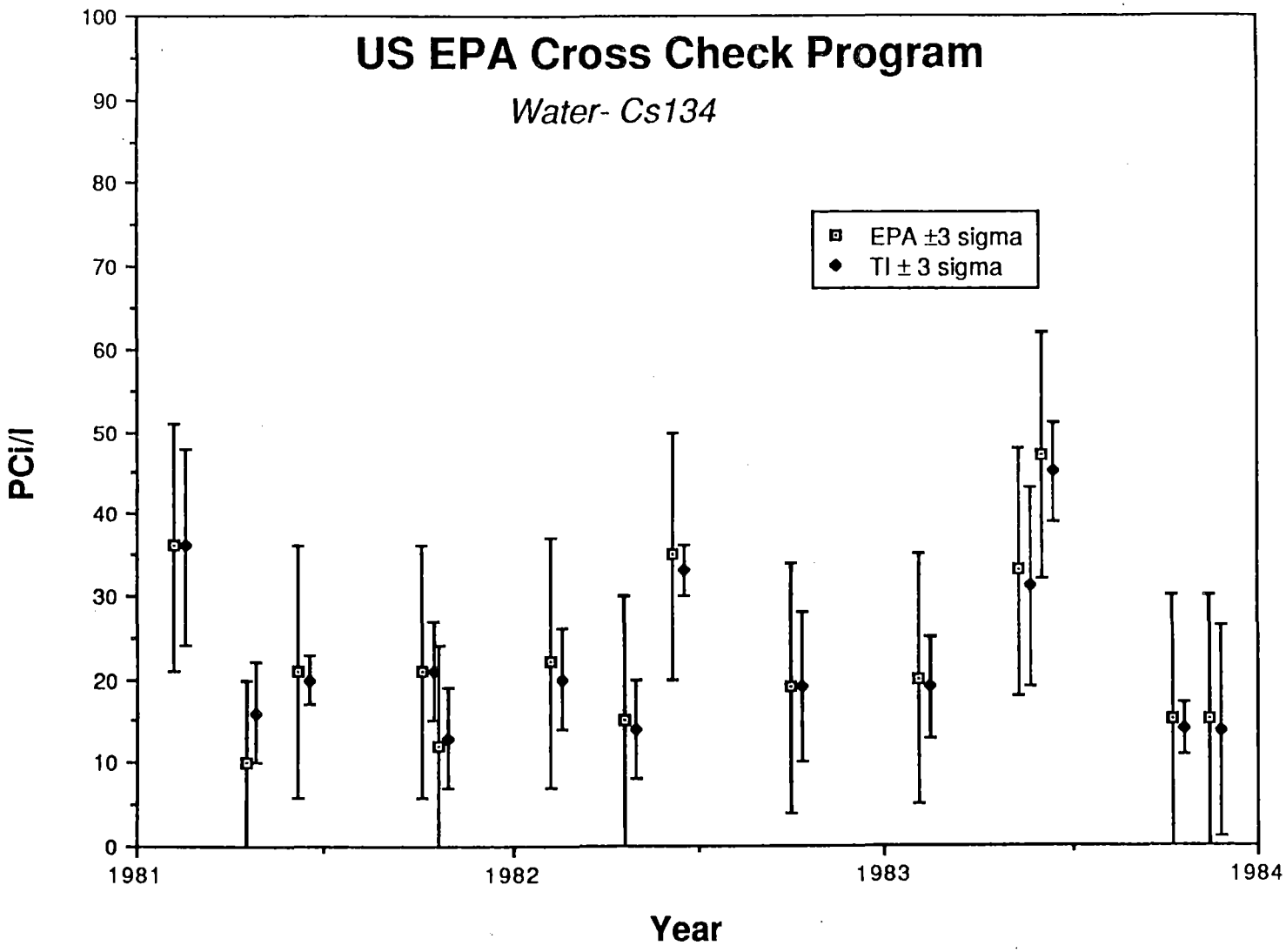

US EPA Cross Check Program
Water- I-131
pCi/l
140
120
100
80
60
40
20
0
1981
1982
1983
1984
Year
EPA ±3 sigma
TI ± 3 sigma

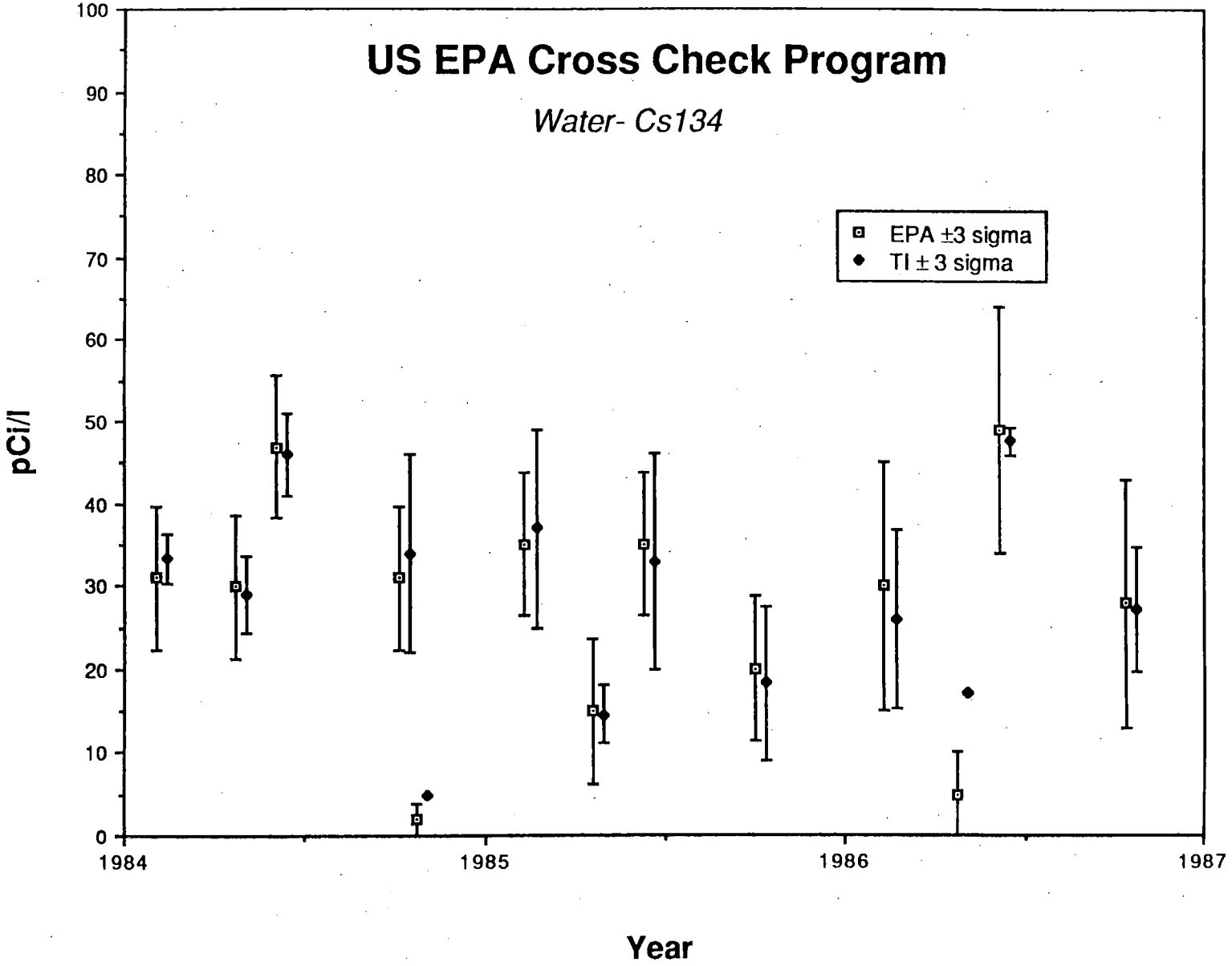
US EPA Cross Check Program

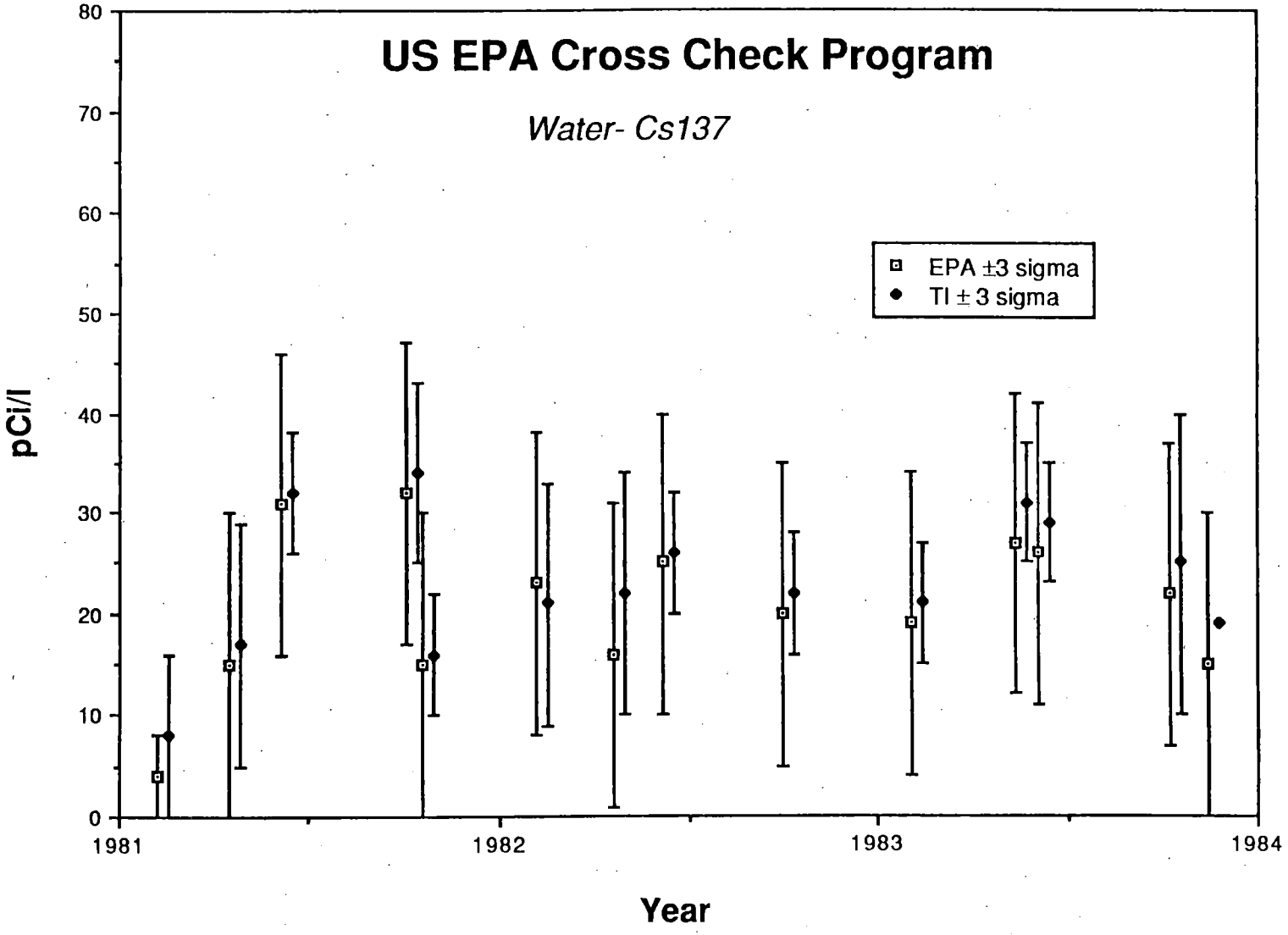


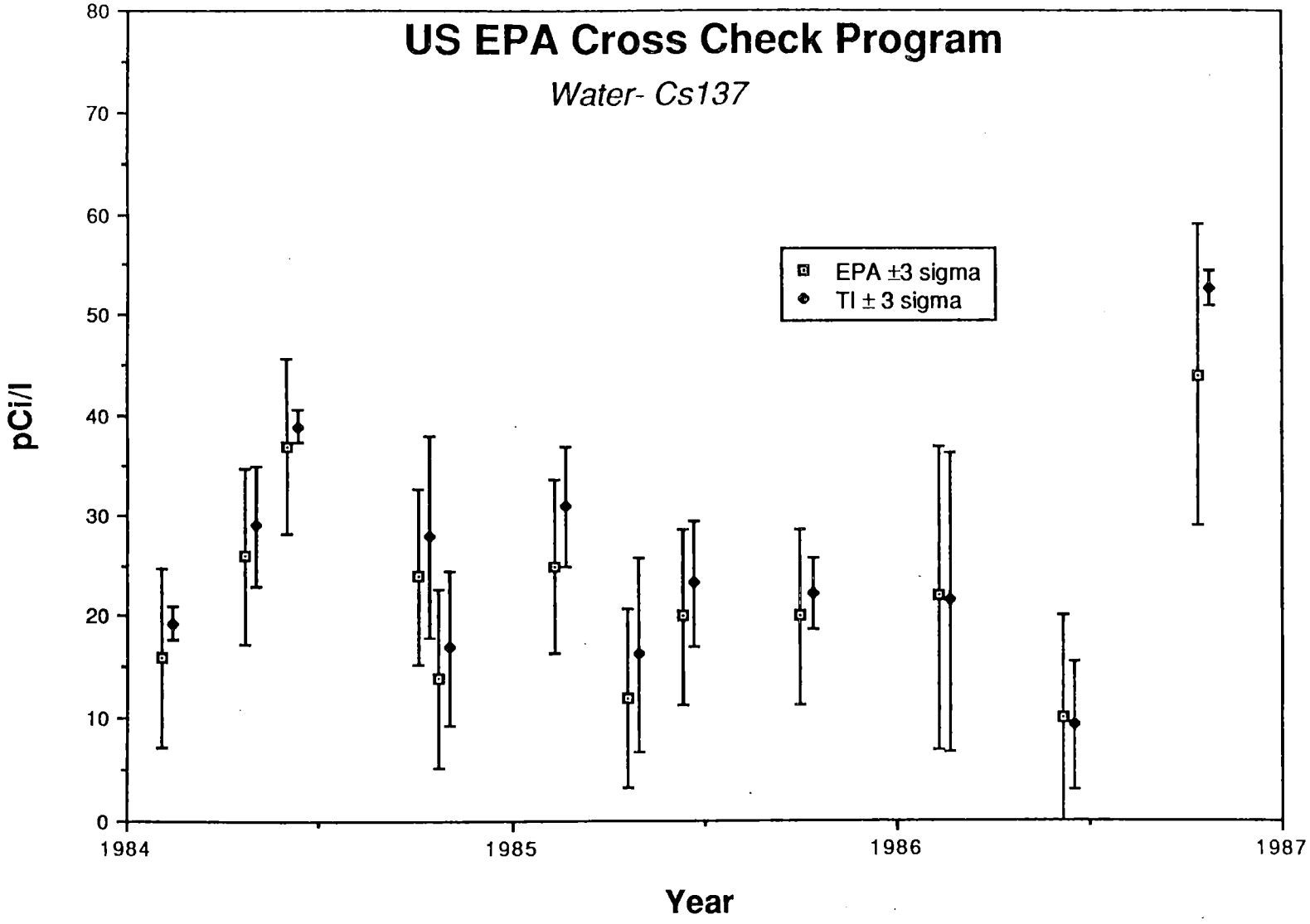

US EPA Cross Check Program
Water- Co60
EPA ±3 sigma
TI ± 3 sigma
pCi/l
80
70
60
50
40
30
20
10
0
1981
1982
1983
1984
Year

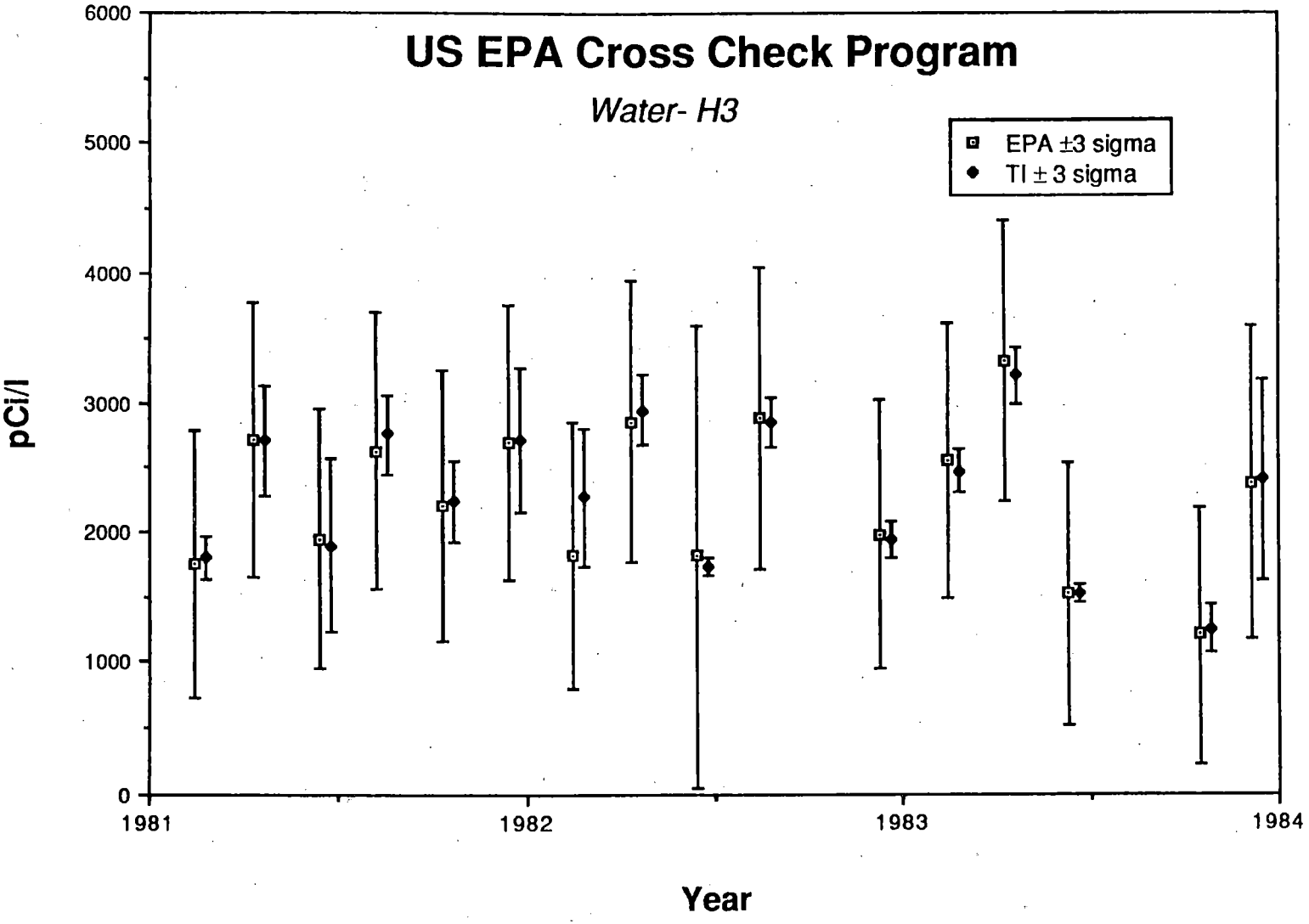

US EPA Cross Check Program
Water- Co60
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
100
90
80
70
60
50
40
30
20
10
0
1984
1985
1986
1987

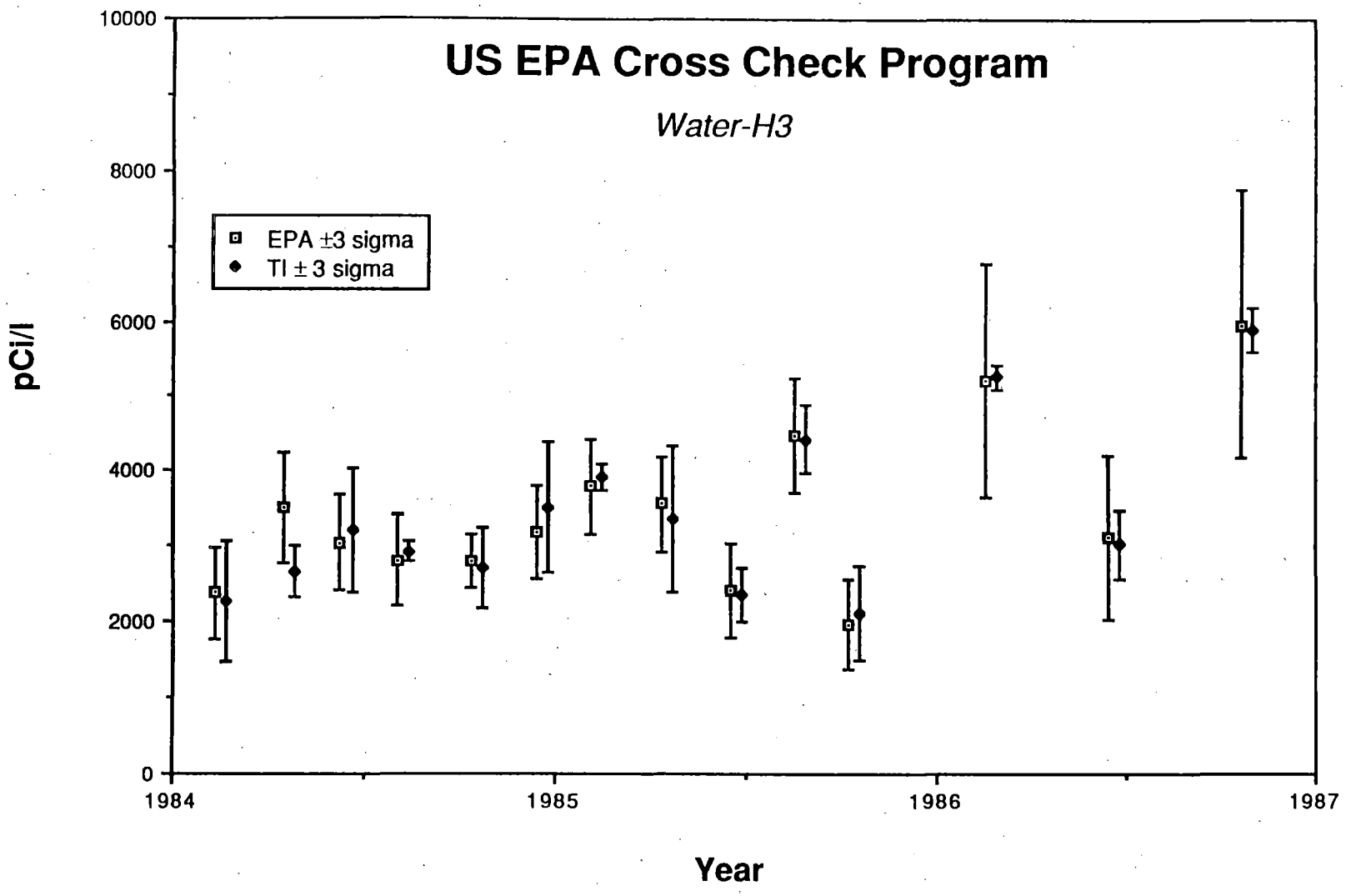

US EPA Cross Check Program
Water- Cs134
EPA ±3 sigma
TI ± 3 sigma
PCi/l
Year
100
90
80
70
60
50
40
30
20
10
0
1981
1982
1983
1984


US EPA Cross Check Program
Water- Cs134
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
100
90
80
70
60
50
40
30
20
10
0
1984
1985
1986
1987


US EPA Cross Check Program
Water- Cs137
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
0
10
20
30
40
50
60
70
80
1981
1982
1983
1984


US EPA Cross Check Program
Water- Cs137
EPA ±3 sigma
TI ± 3 sigma
pCi/l
Year
0
10
20
30
40
50
60
70
80
1984
1985
1986
1987


US EPA Cross Check Program
Water- H3
EPA ±3 sigma
TI ± 3 sigma
pCi/l
6000
5000
4000
3000
2000
1000
0
1981
1982
1983
1984
Year


US EPA Cross Check Program
Water-H3
EPA ±3 sigma
TI ± 3 sigma
pCi/l
10000
8000
6000
4000
2000
0
1984
1985
1986
1987
Year

TELEDYNE ISOTOPES

US EPA INTERLABORATORY COMPARISON PROGRAM 1986

VEPCO - SURRY

EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action
01/31/86	04/03/86	04/28/86	Food (c)	Sr-89	25.00 ± 5.00	23.66 ± 1.15	-0.46	
				Sr-90	10.00 ± 1.50	23.66 ± 1.52	15.78	*** (d)
				I-131	20.00 ± 6.00	18.00 ± 1.00	-0.58	
				Cs-137	15.00 ± 5.00	19.00 ± 1.00	1.38	
				K	950.00 ±143.00	959.00 ± 62.35	0.10	
02/07/86	03/21/86	04/21/86	Water	Cr-51	38.00 ± 5.00	L.T. 86.66	---	
				Co-60	18.00 ± 5.00	18.66 ± 0.58	0.23	
				Zn-65	40.00 ± 5.00	46.33 ± 5.77	2.19	** (e)
				Ru-106	0.00 ± 5.00	<40.00	---	
				Cs-134	30.00 ± 5.00	26.00 ± 3.60	-1.38	
				Cs-137	22.00 ± 5.00	21.66 ± 4.93	-0.11	
02/14/86	03/14/86	04/21/86	Water	H-3	5227.00 ±523.00	5266.67 ± 57.72	0.13	
02/28/86	04/03/86	05/30/86	Milk	I-131	9.00 ± 6.00	9.00 ± 0.00	0.00	
04/04/86	04/29/86	06/08/86	Water	I-131	9.00 ± 6.00	10.00 ± 0.00	0.29	
04/25/86	05/15/86	06/09/86	Air Filter	Gross Beta	47.00 ± 5.00	44.66 ± 3.21	-0.81	
				Sr-90	18.00 ± 1.50	15.66 ± 1.15	-2.69	** (f)
				Cs-137	10.00 ± 5.00	10.33 ± 0.58	0.11	
06/06/86	07/18/86	08/11/86	Water	Cr-51	0.00 ± 5.00	<92.7	---	
				Co-60	66.00 ± 5.00	66.67 ± 1.15	0.23	
				Zn-65	86.00 ± 5.00	87.67 ± 8.50	0.58	
				Ru-106	50.00 ± 5.00	<48.00	---	
				Cs-134	49.00 ± 5.00	47.66 ± 0.58	-0.46	
				Cs-137	10.00 ± 5.00	9.33 ± 2.08	-0.23	
06/13/86	07/09/86	07/28/86	Water	H-3	3125.00 ±360.00	3033.33 ±152.75	-0.44	
06/27/86	09/22/86	10/06/86	Milk	Sr-89	0.00 ± 5.00	<3.66	---	
				Sr-90	16.00 ± 1.50	15.00 ± 0.00	-1.15	
				I-131	41.00 ± 6.00	41.00 ± 1.00	0.00	
				Cs-137	31.00 ± 5.00	39.00 ± 1.73	2.77	** (g)
				K	1600.00 ±80.00	1593.33 ±32.14	-0.14	

US EPA INTERLABORATORY COMPARISON PROGRAM 1986

VEPCO - SURRY

EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action
07/25/86	10/01/86	12/01/86	Food (c)	Sr-89	30.00 ± 5.00	23.66 ± 1.15	-2.19	*** (h)
				Sr-90	19.00 ± 1.50	22.33 ± 1.52	3.85	*** (h)
				I-131	30.00 ± 6.00	25.66 ± 1.15	-1.25	
				Cs-137	20.00 ± 5.00	22.00 ± 4.58	0.69	
				K	1150.00 ± 58.00	1126.66 ± 57.74	-0.70	
08/08/86	08/29/86	10/17/86	Water	I-131	45.00 ± 6.00	27.00 ± 1.00	-5.20	*** (i)
09/12/86	10/27/86	12/12/86	Air Filter	Gross Beta	66.00 ± 5.00	64.33 ± 0.58	-0.58	
				Sr-90	22.00 ± 1.50	18.00 ± 1.00	-4.62	*** (j)
				Cs-137	22.00 ± 5.00	23.33 ± 2.08	0.46	
10/10/86	11/17/86	12/12/86	Water	Cr-51	59.00 ± 5.00	<113.0	---	
				Co-60	31.00 ± 5.00	30.33 ± 0.58	-0.23	
				Zn-65	85.00 ± 5.00	84.00 ± 5.29	-0.34	
				Ru-106	74.00 ± 5.00	<70.00	---	
				Cs-134	28.00 ± 5.00	27.33 ± 2.51	-0.23	
				Cs-137	44.00 ± 5.00	52.67 ± 0.58	3.00	*** (k)
10/17/86	11/14/86	12/12/86	Water	H-3	5973.00 ± 597.00	5900.00 ± 99.98	-0.21	

NOTES:

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

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

(c) Units for food analysis are pCi/kg.

(d) This sample is a synthetic food which may contain a substance which interferes with the strontium 89 and 90 analysis. Only 21 laboratories participated in the strontium analyses. Of the 21 who did participate 42.9% had results beyond the three sigma control limits.

(e) The three results reported were 43.0, 43.0, and 53.0. The one high result of 53.0 caused the average result to be above the 2 sigma limit. This sample was aliquoted last of the three samples and more of the spike may have settled in the bottom of the container.

US EPA INTERLABORATORY COMPARISON PROGRAM 1986

VEPCO - SURRY

EPA PREPARATION	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	** Warning *** Action

NOTES: (Cont.)

(f) These air filters are counted for gross alpha, beta and gamma before being analyzed for Sr-90. It was felt that some of the activity had been lost in handling. The air particulate filters will be handled more carefully in the future. This had not been a problem in previous analyses.

(g) The efficiency calibration for Cs-137 for the gamma spectrometer detectors was checked and no reason for the high result was evident. Previous analyses did not exceed the 2 sigma limits. If this situation recurs, a new efficiency for Cs-137 will be determined.

(h) For Sr-90 fourteen of the seventeen laboratories participating were beyond the ± sigma level. For Sr-89 thirteen of the fifteen laboratories had low results. It would appear that the sample is flawed in some way for this analysis.

(i) This analysis was performed by an inexperienced technician who has since received additional training and is performing satisfactorily. Previous I-131 analysis in water sample (4/29/86) indicated good agreement with EPA results.

(j) It is believed that too much $NaCO_3$ was used in the final precipitation of $SrCO_3$ resulting in a falsely high strontium-89 yield. Less $NaCO_3$ will be used in the future precipitation of $SrCO_3$.

(k) The data for the samples was examined and no obvious reason for the high result could be found. The Cs-137 calibration was checked and found to be in agreement with previous readings. Since this was not a trend in previous analyses for Cs-137 in Water (Test 418 -0.23; Test 406 -0.11) it was decided to follow the results to see if a trend developed.

IX. REFERENCES

IX. REFERENCES

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

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

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

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

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