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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261
LICENSE NO. DPR-23
1986 ANNUAL ENVIRONMENTAL MONITORING REPORT

Dear Sir:

Carolina Power and Light Company (CP&L) hereby submits twenty-three (23) copies of the 1986 Annual Environmental Monitoring Report as required by Technical Specification 6.9.1.d.7.

Please contact my staff if you need additional information.

Very truly yours,



R. E. Morgan
General Manager
H. B. Robinson S. E. Plant

AHS:ac

Enclosure

cc: J. N. Grace
H. E. P. Krug

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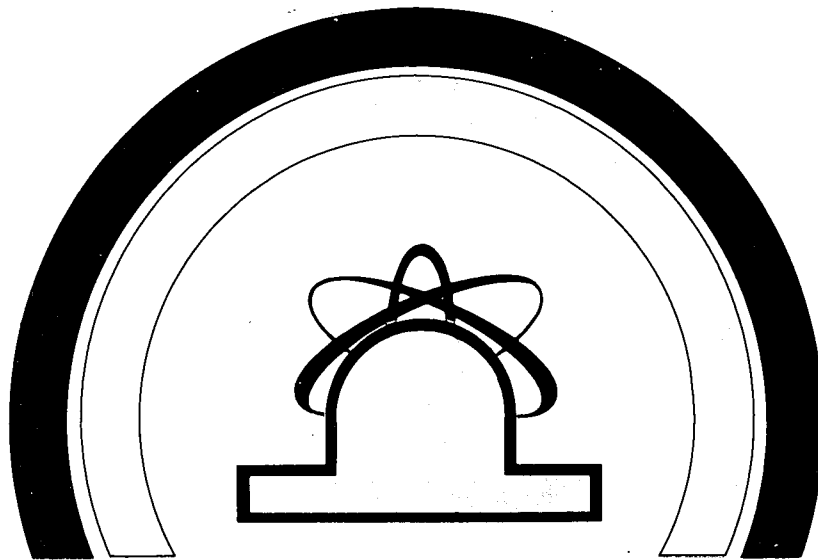
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Enclosure

cc: J. N. Grace
H. E. P. Krug

Environmental Surveillance Report

January 1, 1986 — December 31, 1986



**H.B. ROBINSON
STEAM ELECTRIC PLANT**
Unit No. 2
CAROLINA POWER & LIGHT COMPANY

Docket # *50-261*
Control # *8905060381*
Date *12/31/86* of Document
REGULATORY DOCKET FILE

Shearon Harris Energy & Environmental Center
Carolina Power & Light Company
New Hill, North Carolina

ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT

FOR

H.B. ROBINSON STEAM ELECTRIC PLANT

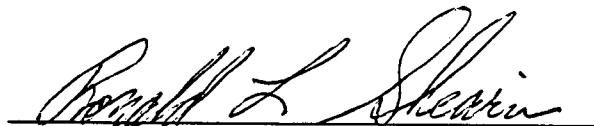
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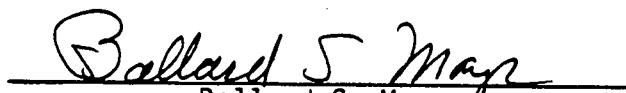
Don H. Edwards/Roger D. Pasteur
Senior Specialists - Environmental

Reviewed By:



Ronald L. Shearin
Project Specialist - Environmental

Approved By:



Ballard S. Mays
Principal Specialist - Environmental

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1.0 INTRODUCTION

The following report summarizes the radiological environmental data for the H.B. Robinson Steam Electric Plant during the calendar year 1986. The surveillance requirements for this report were performed by the requirements of the new Radiological Effluent Technical Specifications (RETS) which were implemented on January 1, 1985. This is the tenth year in which the program's sample analyses and data interpretations have been entirely performed by Carolina Power & Light Company.

1.1 Plant and Location

The H.B. Robinson Steam Electric Plant is located in northeastern South Carolina near Hartsville and approximately 25 miles northwest of Florence. This site includes a fossil-fueled plant, Unit 1, which was placed in service in 1960 and a pressurized water nuclear power reactor, Unit 2, which entered commercial operation on March 7, 1971. The Robinson Impoundment (hereafter referred to as Lake Robinson) on the plant site was created for Unit 1 and is also a cooling reservoir for Unit 2. Lake Robinson has an area of 2250 acres with plant intake at the south end adjacent to the dam. Following condenser use, the water is returned by a 4.2-mile canal to the north end of Lake Robinson near the mouth of Black Creek which flows into the lake from the north.

1.2 Radiological Impact Considerations

Potential population exposure due to plant operations is most significant in the liquid release fish-man pathway. Two additional pathways are also potentially important. They are the airborne radioiodine-pasture-milk pathway and the direct external radiation exposure to ground plumes of noble gases. Contact with Lake Robinson, including boating and immersion (swimming), constitutes an insignificant dose to man.

1.3 Environmental Monitoring Program

The required environmental sampling is defined by technical specifications. The program, as implemented by the plant, is described in the ODCM. The objectives of the program are to monitor the specific elements of exposure pathways. The sampling media and release pathways are listed below.

<u>Sampling Media</u>	<u>Release Pathway</u>
Glass Fiber Filter	Gaseous
Iodine Collection Cartridge	Gaseous
TLDs	Gaseous
Surface Water	Liquid
Groundwater	Liquid
Shoreline Sediment	Liquid
Milk	Gaseous
Fish	Liquid
Food Crops	Gaseous
Broadleaf Vegetation	Gaseous

SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7
AP	AIR PARTICULATE	1-7
SS	SHORELINE SEDIMENT	44
GW	GROUNDWATER	40 42 43
BL	BROADLEAF VEGETATION	50 51 52
SW	SURFACE WATER	40 41
TL	TLD	1-39
MK	MILK	53 54
FI	FISH	45 46 47
FC	FOOD PRODUCTS	49 54 58

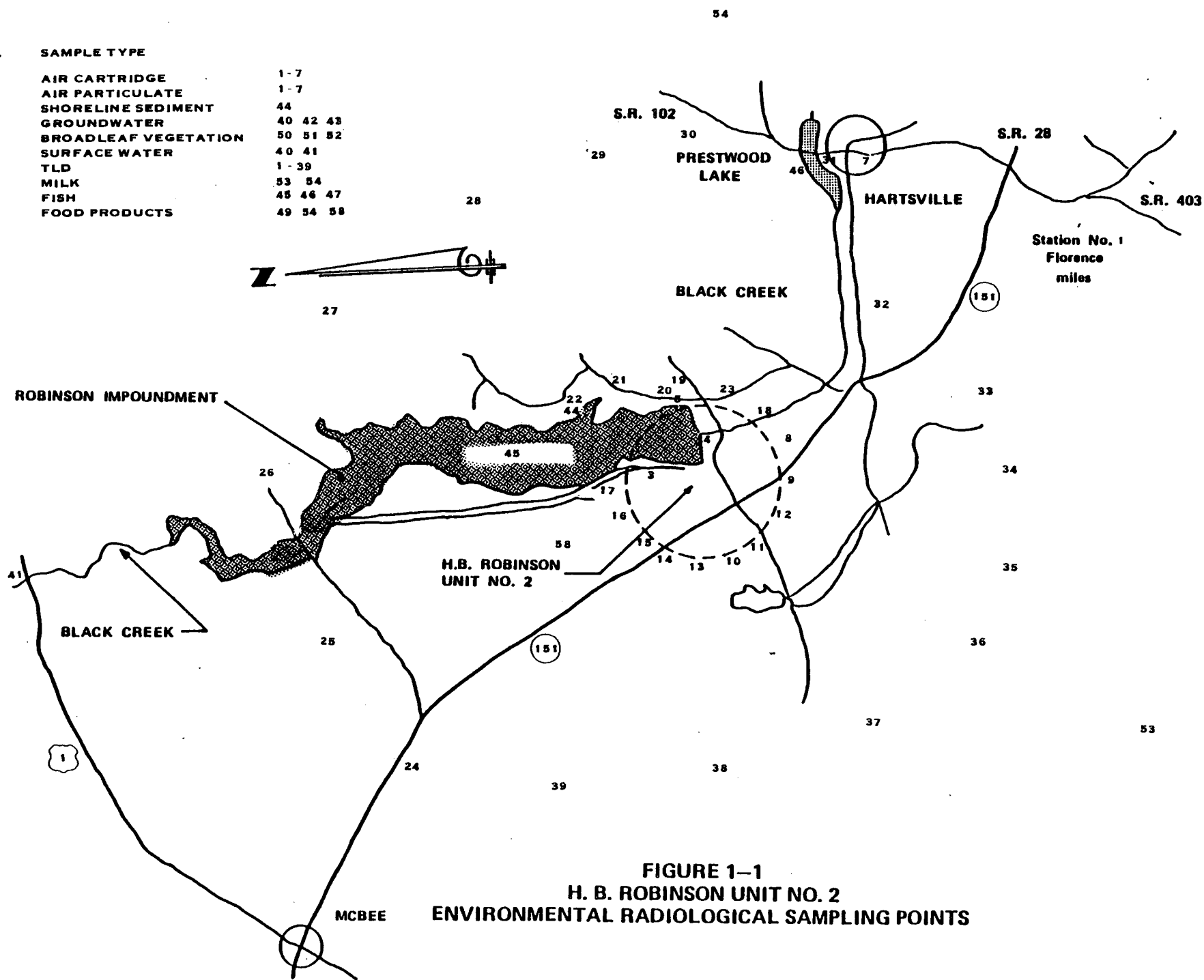


FIGURE 1-1
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS

1-3

47
49
52

SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7
AP	AIR PARTICULATE	1-7
SS	SHORELINE SEDIMENT	44
GW	GROUNDWATER	40 42 43
BL	BROADLEAF VEGETATION	50 51 52
SW	SURFACE WATER	40 41
TL	TLD	1 - 39
MK	MILK	53 54
FI	FISH	45 46 47
FC	FOOD PRODUCTS	48 54 58

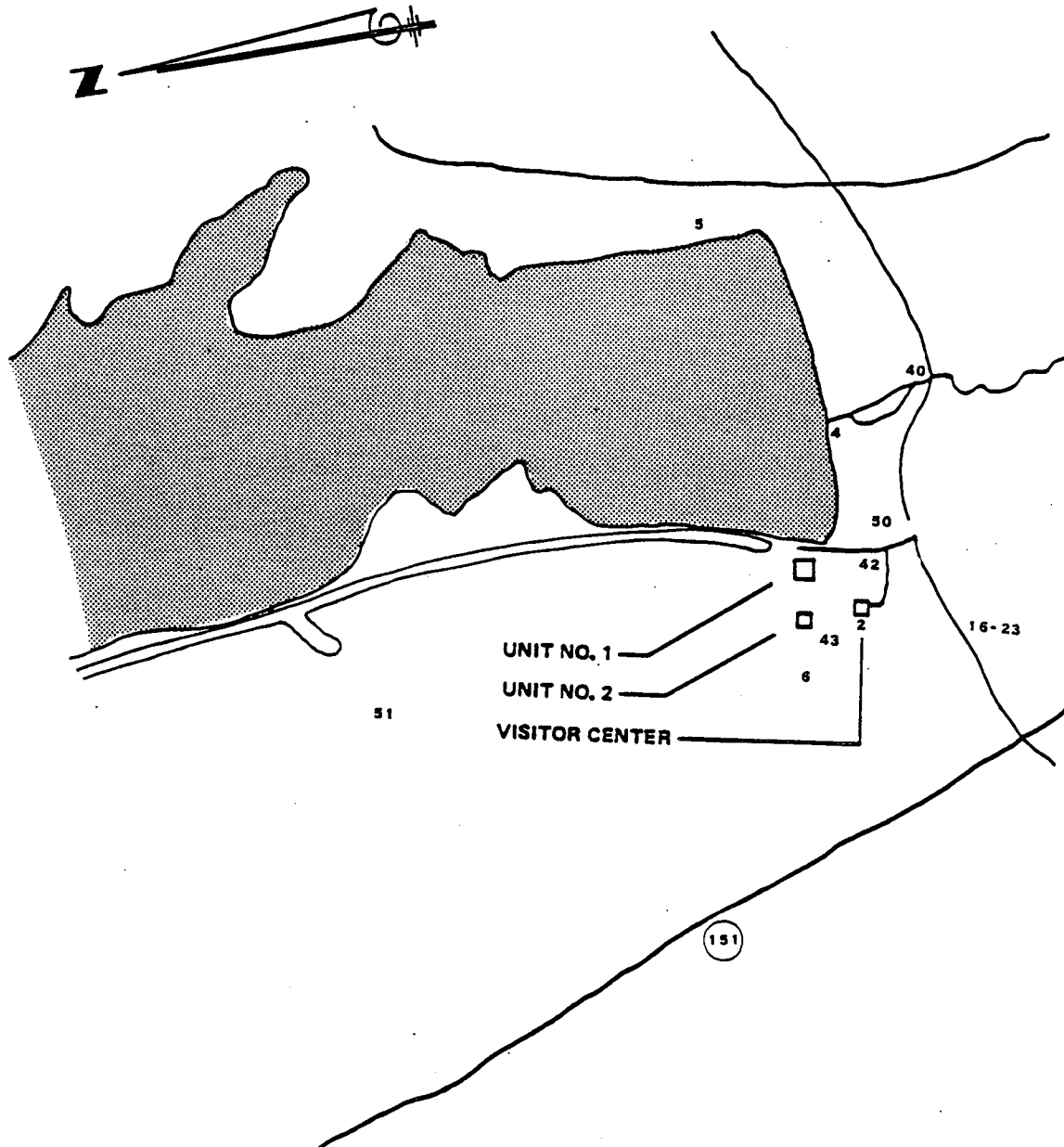


FIGURE 1-2
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS
ON SITE

TABLE 1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM
H.B. ROBINSON STEAM ELECTRIC PLANT

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Air Cartridge (AC)	1--26 miles ESE Florence--Control	Weekly	800 cu m	Iodine
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW End of Construction Road			
	7--6.3 miles ESE Hartsville			
Air Particulate (AP)	1--26 miles ESE Florence--Control	Weekly	800 cu m	Weekly--Gross Beta Quarterly--Composite- Gamma
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW End of Construction Road			
	7--6.3 miles ESE Hartsville			

TABLE 1-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
External Radiation Dose (TL)	1--26 miles ESE Florence--Control	Quarterly	Not Applicable	TLD Readout
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW End of Construction Road			
	7--6.3 miles ESE Hartsville			
	8--0.8 mile SSE Oak Tree Near Transmission Lines			
	9--1.0 mile S Second Pole From SC-151			
	10--1.0 mile WSW on Power Pole at Church of God			
	11--1.0 mile SW 4th Pole From Old Camden Road			
	12--1.2 miles SSW Tree at 2nd Intersection of Dirt Road			
	13--1.0 mile W Pine Tree on Corner Where Road Splits			
	14--0.9 mile WNW Power Pole at Pine Ridge Church			
	15--1.0 mile NW Pine Tree Adjacent to CP&L Ash Pond			
	16--1.0 mile NNW Darlington Co. IC Turbine Plant			
	17--1.1 miles N Pine Tree Beside Discharge Canal Road			
	18--0.7 mile SE Near Old Railroad Trestle at Black Creek			
	19--1.0 mile E Power Pole on Road 16-23			
	20--1.3 miles ENE Power Pole 47 on Road 16-39			
	21--1.4 miles NE Atkinson's Boat Landing			

TABLE 1-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
External Radiation Dose (TL) (cont.)	22--1.9 miles NNE Shady Rest Club on Light Pole	Quarterly	Not Applicable	TLD Readout
	23--1.2 miles ESE Power Pole 41E-5 on Road 16-39			
	24--5.0 miles NW 5th Pole from SR 151 on Road 13-711			
	25--4.6 miles NNW Fence Line off Road 13-346			
	26--5.0 miles N Power Pole 32J-6 on Road 13-346			
	27--5.0 miles NNE Road 13-763			
	28--4.8 miles NE Power Pole 30-4-A on Road 13-39			
	29--4.1 miles Transmission Pole Near Road 16-20			
	30--4.6 miles E Pole at Johnson's Fence and Awning Co.			
	31--4.6 miles ESE Pole 1122 on Lakeshore Drive			
	32--4.5 miles SE Transmission Tower at End of Kalber Drive			
	33--4.6 miles SSE Power Pole 25-4 on Road 16-493			
	34--4.6 miles S Transmission Pole Nearest Road 16-772			
	35--4.4 miles SSW Intersection of Roads 31-51 and 16-12			
	36--4.7 miles SW Pole on Dirt Road 3/4 mile From 16-85			
	37--5.0 miles WSW Transmission Tower Nearest Clay Road			
	38--4.9 miles W Pole Beside Union Church			
	39--5.0 miles WNW Pole in Middle of Field			

TABLE 1-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Surface Water (SW)	40--0.6 mile ESE Black Creek at Road 16-23 41--7.2 miles NNW Black Creek--Control	Monthly Composite	4 liters	Gamma Tritium
Groundwater (GW)	40--0.6 mile ESE Artesian Well 42--Unit 1 Deep Well 43--Unit 2 Deep Well	Monthly	4 liters	Gamma Tritium
Milk (MK)	53--9.0 miles SW Lyndale Farm--Control 54--10.1 miles E Auburndale Plantation*	Semimonthly when animals are on pasture; monthly at other times	8 liters	Iodine Gamma
Fish (FI)	45--Site Varies Within Lake Robinson 46--4.9 miles ESE Prestwood Lake 47--13.0 miles NNW Bee Lake or 12.5 miles NW May Lake--Control	Semiannually	500 grams	Flesh--Gamma
Shoreline Sediment (SS)	44--1.9 miles NNE Shady Rest Club	Semiannually	500 grams	Gamma

*Auburndale Plantation ceased dairy operations in May 1987.

TABLE 1-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Food Products (FC)	58--< 3 miles in Highest D/Q Sector 49--> 5 miles in Least D/Q Sector Control 54--10.1 miles E Auburndale Plantation	Annual at Harvest	500 grams	Gamma
Broadleaf Vegetation (BL)	50--0.25 mile SSE CP&L Property 51--0.25 mile NNE CP&L Property 52--10 miles W Bethune--Control	Monthly when Available	500 grams	Gamma--I-131

2.0 PROGRAM SUMMARY

The purpose of the Environmental Radiological Monitoring Program is to measure any accumulation of radioactivity in the environment, to determine whether this radioactivity is the result of the operation of the H.B. Robinson Plant, and to interpret the potential dose to off-site populations based on the cumulative measurement of radiation of plant origin.

The following locations were used as the control locations for the respective measurements and were intended to indicate conditions away from the H.B. Robinson Plant influence.

Florence
(Sample Location 1)

Thermoluminescent Dosimetry Area Monitors
Airborne Iodine and Particulate Samples

Black Creek Above Lake Robinson at US 1
(Sample Location 41)

Surface Water

Lake Bee or May Lake
(Sample Location 47)

Fish

Lyndale's Farm
(Sample Location 53)

Milk

10 miles W. Bethune
(Sample Location 52)

Broadleaf Vegetation

> 5 miles from plant with
lowest deposition rate (D/Q)
(Sample Location 49)

Food Crop

Table 2-1 summarizes the environmental monitoring data for the entire year of 1986.

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

H.B. Robinson Steam Electric Plant
Darlington County, South Carolina

Docket Numbers - 50-261
Calendar Year 1986

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Typical Lower Limit of Detection (LLD) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean		Control Location Mean Range (2)
				Name, Distance, and Direction	Mean Range (2)	
Air Cartridge (pCi/m ³)	I-131 362 ⁽³⁾	1.0E-2	1.03E-1 (26/310) 5.63E-3 - 2.09E-1	Lake Robinson Spillway 0.4 mile ESE	1.30E-1 (4/52) 1.47E-2 - 1.98E-1	1.05E-1 (4/52) 2.48E-2 - 1.72E-1
Air Particulate (pCi/m ³)	Gross Beta 362 ⁽³⁾	1.3E-3	3.07E-2 (310/310) 6.70E-3 - 2.30E-1	Information Center 0.2 mile S	3.26E-2 (52/52) 7.71E-3 - 2.30E-1	3.00E-2 (52/52) 7.34E-3 - 2.18E-1
	Gamma 28 Cs-134	1.0E-3	5.55E-3 (6/24) 4.91E-3 - 6.91E-3	Johnson's Landing 0.9 mile ENE	6.91E-3 (1/4) Single value	4.81E-3 (1/4) Single value
	Cs-137	1.0E-3	1.02E-2 (7/24) 4.53E-4 - 1.44E-2	Information Center 0.2 mile S	1.44E-2 (1/4) Single value	1.16E-2 (1/4) Single value
	Ru-103	1.0E-3	4.12E-03 (6/24) 3.26E-3 - 4.67E-3	Johnson's Landing 0.9 mile ENE	4.67E-3 (1/4) Single value	4.08E-3 (1/4) Single value
Broadleaf Vegetation (pCi/g) wet	Gamma 84 ⁽⁴⁾ Cs-134	1.4E-2	4.57E-2 (3/56) 4.18E-2 - 4.98E-2	CP&L Property 0.25 mile SSE	4.57E-2 (3/28) 4.18E-2 - 4.98E-2	4.77E-2 (1/28) Single value
	Cs-137	1.5E-2	1.87E-1 (44/56) 2.54E-2 - 9.03E-1	CP&L Property 0.25 mile SSE	2.04E-1 (22/28) 3.11E-2 - 5.74E-1	1.62E-1 (20/28) 1.04E-2 - 8.51E-1
	I-131	1.2E-2	2.77E-1 (11/56) 5.20E-2 - 6.33E-1	CP&L Property 0.25 mile SSE	2.88E-1 (6/28) 5.64E-2 - 6.10E-1	2.95E-1 (6/28) 2.95E-2 - 7.24E-1
	Ru-103	1.4E-2	3.37E-2 (8/56) 1.98E-2 - 7.19E-2	CP&L Property 0.25 mile SSE	3.52E-2 (6/28) 1.98E-2 - 7.19E-2	3.62E-2 (3/28) 2.53E-2 - 4.85E-2
Fish (pCi/g) wet Bottom Feeder	Gamma 9 Cs-134	1.7E-2	6.43E-2 (3/6) 4.98E-2 - 7.72E-2	Prestwood Lake 4.9 miles ESE	6.43E-2 (3/3) 4.98E-2 - 7.72E-2	All less than LLD
	Cs-137	1.8E-2	1.90E-1 (5/6) 9.16E-2 - 2.71E-1	Prestwood Lake 4.9 miles ESE	2.38E-1 (3/3) 1.83E-1 - 2.71E-1	2.30E-1 (3/3) 1.92E-1 - 3.00E-1
	K-40	5.0E-1	3.23E+0 (6/6) 2.04E+0 - 4.18E+0	Prestwood Lake 4.9 miles ESE	3.57E+0 (3/3) 2.89E+0 - 4.18E+0	3.51E+0 (3/3) 2.83E+0 - 4.10E+0

TABLE 2-1 (continued)

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

H.B. Robinson Steam Electric Plant.
Darlington County, South Carolina

Docket Numbers - 50-261
Calendar Year 1986

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Typical Lower Limit of Detection (LLD) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean		Control Location Mean Range (2)
				Name, Distance, and Direction	Mean Range (2)	
Fish (pCi/g) wet Free Swimmer	Gamma 9 Cs-134	1.7E-2	9.71E-2 (5/6) 5.79E-2 - 1.35E-1	Lake Robinson site varies	1.26E-1 (2/3) 1.17E-1 - 1.35E-1	All less than LLD
	Cs-137	1.8E-2	4.23E-1 (5/6) 3.20E-1 - 5.26E-1	Lake Robinson site varies	4.57E-1 (2/3) 4.05E-1 - 5.08E-1	4.65E-1 (3/3) 4.10E-1 - 5.61E-1
	K-40	5.0E-1	3.24E+0 (6/6) 2.85E+0 - 3.63E+0	Lake Robinson site varies	3.30E+0 (3/3) 2.85E+0 - 3.61E+0	4.16E+0 (3/3) 3.40E+0 - 5.23E+0
Food Products (pCi/g) wet	Gamma 3	N/A	All less than LLD	All less than LLD		All less than LLD
Groundwater (pCi/l)	Gamma 36	N/A	All less than LLD	All less than LLD		No control
	Tritium 36	1.2E+3	All less than LLD	All less than LLD		No control
Milk (pCi/l)	I-131 37 ⁽⁵⁾	3.0E-1	6.46E+0 (2/11) 9.20E-1 - 1.20E+1	Auburndale Planta- tion 10.1 miles E	6.46E+0 (2/11) 9.20E-1 - 1.20E+1	2.26E+0 (2/26) 2.23E+0 - 2.29E+0
	Gamma 37 Cs-137	4.7E+0	4.65E+0 (1/11) Single value	Auburndale Planta- tion 10.1 miles E	4.65E+0 (1/11) Single value	3.46E+0 (1/26) Single value
	I-131	4.0E+0	1.85E+1 (1/11) Single value	Auburndale Planta- tion 10.1 miles E	1.85E+1 (1/11) Single value	3.85E+0 (1/26) Single value
Shoreline Sediment (pCi/g) dry	Gamma 4 Cs-137	3.6E-2	1.25E-2 (1/4) Single value	Shady Rest Club 1.9 miles NNE	1.25E-2 (1/2) Single value	No control
Surface Water (pCi/l)	Gamma 36	N/A	All less than LLD	All less than LLD		All less than LLD
	Tritium 36	1.2E+3	2.14E+3 (14/24) 1.29E+3 - 3.31E+3	SC-23 at Black Creek 0.6 mile ESE	2.26E+3 (7/12) 1.29E+3 - 3.31E+3	All less than LLD
TLD (mrem/wk)	TLD 145 ⁽⁶⁾	1 mR	1.18E+0 (141/141) 6.00E-1 - 2.00E+0	Intersection of SR 13-51 and 16-12 4.4 miles SSW	1.82E+0 (4/4) 1.60E+0 - 2.00E+0	1.17E+0 (4/4) 1.00E+0 - 1.30E+0

FOOTNOTES:

1. The Lower Limit of Detection (LLD) is the smallest concentration of radioactive material in a sample that will yield a net count above system background which will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.
2. Mean and range are based on detectable measurements only. The fractions of detectable measurements at specific locations are indicated in parentheses.
3. Air particulate and charcoal cartridges are collected weekly for a possible total of 364 (7 locations x 52 weeks) samples. As shown in Table 2-1, 362 samples were collected. The two missing samples are discussed in Section 4.1.
4. Broadleaf vegetation samples are collected monthly when available from three locations for a possible total of 108 samples. The 24 missing samples are discussed in Section 4.2.
5. Milk samples are collected every two weeks from two commercial dairies. The Auburndale Plantation ceased dairy operations in June 1986. See Section 4.3.
6. TLDs are collected quarterly from 39 locations for a possible total of 156 analyses. The 11 missing TLDs are discussed in Section 4.4.

3.0 INTERPRETATIONS AND CONCLUSIONS

3.1 Air Sampling

Air samples from indicator locations during 1986 contained concentrations of radionuclides comparable to those detected from the control location. The measurable gross beta concentrations were observed in 310 of 310 samples, averaging $3.07\text{E-}2$ pCi/m^3 and $3.00\text{E-}2$ pCi/m^3 for the indicator and control locations, respectively. These are consistent with preoperational data obtained for the H.B. Robinson Plant and may be compared to the 1985 concentrations of $1.66\text{E-}2$ pCi/m^3 and $1.60\text{E-}2$ pCi/m^3 for the indicator and control locations, respectively.

The quarterly composite gamma analyses for air particulate samples for the first and fourth quarters revealed no man-made radionuclides. The second quarter composite contained cesium-134 (Cs-134), cesium-137 (Cs-137), and ruthenium-103 (Ru-103) in all air particulate samples including the control location. The concentrations are presented below:

Location	Cs-134	Cs-137	Ru-103
AP-2 0.2 mile S	5.53E-03	1.44E-02	4.31E-03
AP-3 0.7 mile N	5.00E-03	1.14E-02	4.67E-03
AP-4 0.4 mile ESE	5.29E-03	1.17E-02	3.98E-03
AP-5 0.9 mile ENE	6.91E-03	1.13E-02	4.67E-03
AP-6 0.3 mile SW	5.68E-03	1.13E-02	3.83E-03
AP-7 5.3 miles ESE	4.91E-03	1.10E-02	3.26E-03
Control* 26 miles ESE	4.81E-03	1.16E-02	4.08E-03

*Unaffected by plant operations

These activities are attributed to the fallout from the Chernobyl accident which occurred on April 26, 1986. The detection of nuclear debris was clearly documented by other facilities in the region, and the concentrations are similar to concentrations reported by other CP&L facilities including one in a preoperational stage. Figures 3-1 through 3-6 compare indicator and control location concentrations. The figures demonstrate that there were no significant deviations between indicator and control locations.

During the third quarter, Cs-137 was detected at Location 7, 5.3 miles ESE from the site, at a concentration of $4.53\text{E-}04$ pCi/m³. This concentration and the sporadic detection is consistent with ambient levels observed in recent years. Using a t-test at 95 percent confidence level, the indicator concentration is comparable to the control minimum detectable activity (MDA).

The concentrations of radionuclides in air from the Chernobyl accident are negligible compared to activities observed during 1977 when the People's Republic of China was conducting nuclear tests. The highest observed gross beta result from air particulate sampling during the second quarter of 1986 was 0.230 pCi/m³ as a result of the Chernobyl accident. The annual average gross beta activity during 1977 for all indicator locations was 0.254 pCi/m³. Figure 3-7 provides a comparison of the 1986 control location concentrations versus the 1977 control location concentration.

Determination of iodine-131 (I-131) in air charcoal was performed by gamma spectrometry. I-131 was not detected during the first, third, and fourth quarters of 1986. I-131 was detected during the second quarter for the collection dates of May 12, May 19, May 26, June 02, and June 09 in 26 of 30 indicator locations with an average concentration of $1.03\text{E-}01$ pCi/m³. I-131 was detected in 4 of 5 control location samples

during the same time period with an average concentration of $1.05E-01$ pCi/m³. Using a t-test at 95 percent confidence level, the I-131 concentrations at indicator and control stations appeared to be from similar distributions indicating no measurable effect from plant operations. The Chernobyl accident appears to be the primary causative agent.

The following table provides a summary of the estimated dose commitments to each age group during the six weeks following the Chernobyl accident for the thyroid of the maximum exposed individual.

	Dose to Thyroid (mrem/yr)			
	Infant	Child	Teen	Adult
I-131 (pCi/m ³)	0.103	0.103	0.103	0.103
Inhal. Dose Factor (mrem/pCi)	0.0106	0.00439	0.00183	0.001 49
Inhalation (m ³ /6 weeks)	162	427	923	923
Dose (mrem/yr)	0.18	0.19	0.17	0.14

3.2 Broadleaf Vegetation

Broadleaf vegetation sampling is accomplished by collecting media including oak, persimmon, magnolia, cherry, photinia, ligustrum, aspen, nandina, and sweetgum leaves. Samples were collected monthly when available from one control and two indicator locations. Broadleaf sampling is conducted since no milk animals are located within the area influenced by the plant, approximately 5 miles, and is used to simulate dose to the population via the milk pathway. Section 4.2 discusses missing samples.

Four isotopes of interest--Cs-134, Cs-137, I-131, and Ru-103-- were detected in the broadleaf vegetation samples. Following is the average concentration for each isotope for the indicator and control locations.

Isotope	Location	Average Concentration (pCi/g)
Cs-134	Indicator	0.046 (3 out of 56 samples)
	Control	0.048 (1 out of 28 samples)
Cs-137	Indicator	0.185 (45 out of 56 samples)
	Control	0.162 (20 out of 28 samples)
I-131	Indicator	0.293 (10 out of 56 samples)
	Control	0.295 (6 out of 28 samples)
Ru-103	Indicator	0.034 (8 out of 56 samples)
	Control	0.036 (3 out of 28 samples)

The data suggest that the control and indicator sample activities are similar. These activities are attributable to the Chernobyl accident and are not from plant operations. Cs-134, I-131, and Ru-103 were detected on the broadleaf samples only during May, June, and July following the Chernobyl accident.

3.3 Fish

Samples of free-swimming and bottom-feeding fish were collected from Lake Robinson, Prestwood Lake, and Bee Lake (control) during February, May, and November. Analyses of the samples for gamma-emitting radionuclides detected the presence of cesium-137 (Cs-137) activity with an average concentration of 0.307 pCi/g in 10 of 12 samples from the indicator locations in Lake Robinson and Prestwood Lake and 0.348 pCi/g in the control samples from Bee Lake. These concentrations suggest that any Cs-137 from the effluents of plant operations cannot be distinguished from that of debris of worldwide fallout.

Cesium-134 (Cs-134) was detected in 8 of 12 fish samples from Lake Robinson at an average concentration of 0.085 pCi/g. At

the control location, all six samples assayed as less than detectable activity with an average MDA of 0.029 pCi/g. The Cs-134 concentration in Lake Robinson fish is consistent with the plant's liquid effluent data. This activity could result in a dose commitment of 0.26 mrem to the liver or 0.22 mrem to the total body of a maximum exposed individual. Doses to an average adult due to this activity would be 0.09 mrem to the liver and 0.07 mrem to the total body. The adult is the critical receptor of all age groups. Table 3-1 provides a comparison of the calculated Cs-134 concentration in fish and the actual Cs-134 concentrations detected. The calculated concentrations are based on the quantity of Cs-134 released in 1986 and the flow rates of water from Lake Robinson.

3.4 Food Crops

Locally grown food products were sampled and analyzed for gamma-emitting radionuclides. The southeastern United States experienced a severe drought during 1986, resulting in very few gardens and reduced production. Only three samples were collected during the year. Tomatoes were collected from the two indicator locations, while peaches were collected from the control location. Only naturally occurring gamma-emitting radionuclides were detected in the samples.

3.5 Groundwater

Groundwater is sampled quarterly and analyzed for tritium and gamma-emitting radionuclides. The values from all three locations were less than the lower limit of detection.

3.6 Milk Samples

Milk samples were collected from the Auburndale Plantation (MK-54), 10.1 miles east, through May 1986. Dairy operations were closed after that date. Milk samples were collected from the control location, Lyndale Dairy (MK-53), 9.0 miles SW. Samples were analyzed for gamma-emitting radionuclides and iodine-131 (I-131). The I-131 activities were less than the

lower limit of detection for all milk samples except for the two samples collected in May from each dairy. The I-131 concentrations were 0.92 and 12.0 pCi/l from the Auburndale Plantation and 2.29 and 2.23 pCi/l from the Lyndale Dairy for May 12 and May 26, respectively. The increased concentrations are attributed to worldwide fallout from the accident at the Chernobyl facility.

To quantify the effect from Chernobyl, dose commitments from the I-131 in the milk pathway are calculated in the following table. The time period for each dose is two weeks, but the annual dose is also provided. Auburndale Plantation and Lyndale's Dairy are designated as MK-54 and MK-53, respectively. The variability between the two dairies is likely due to the variability in rainfall and the difference in feeding practices.

	Infant	Child	Teen	Adult
Consumption (liters/yr)	330	330	400	310
Ingestion dose factor (mrem/pCi)	1.39E-02	5.72E-03	2.39E-03	1.95E-03
Concentration I-131 (pCi/l)				
MK-54 May 12	0.92	0.92	0.92	0.92
MK-54 May 26	12.00	12.00	12.00	12.00
MK-53 May 12	2.29	2.29	2.29	2.29
MK-53 May 26	2.23	2.23	2.23	2.23
Dose (mrem/2 weeks*)				
MK-54 May 12	0.16	0.07	0.03	0.02
MK-54 May 26	2.12	0.87	0.44	0.28
MK-53 May 12	0.40	0.17	0.08	0.05
MK-53 May 26	0.39	0.16	0.08	0.05
*2 weeks is time between milk collections				
Dose (mrem)				
MK-54	2.28	0.94	0.48	0.30
MK-53	0.80	0.33	0.17	0.11
Average (mrem)	1.54	0.63	0.32	0.20

3.7 Shoreline Sediment

A shoreline sediment sample is required to be collected semi-annually from a downstream area with existing recreational value. This location is at the Shady Rest Club on Lake Robinson, 1.9 miles NNE. An additional shoreline sediment sample is collected from the northwest bank of the ash pond. Cs-137 was detected in one sample from the Shady Rest Club at a concentration of $1.25E-02$ pCi/gram. All other gamma-emitting radionuclides were less than the lower limit of detection (LLD). This activity would contribute an insignificant (less than 1 mrem/yr) dose to an exposed individual.

3.8 Surface Water

Surface water samples are analyzed monthly for gamma-emitting radionuclides and tritium. All gamma-emitting radionuclide activities were less than the lower limit of detection (< LLD). Tritium was detected in 14 of 24 indicator samples with an average concentration of $2.14E+3$ pCi/liter. The location with the highest concentration was at Secondary Road S-16-23 with an average concentration of $2.26E+3$ pCi/liter. This average concentration is consistent with concentrations detected in previous years, and the dose to an individual is insignificant. All control activities were less than the lower limit of detection.

3.9 Thermoluminescent Dosimetry (TLD) Area Monitors

The average dose rate of all indicator locations was 1.18 mrem/wk which is comparable to the control location average of 1.17 mrem/wk. The location with the highest reading was near the intersection of Secondary Roads S-31-51 and S-16-12, 4.4 miles SSW. This location had an average dose rate of 1.82 mrem/wk with a range of 1.6 to 2.0 mrem/wk. This location has a history of being approximately 65 percent higher than the

average of all indicator locations and is attributed to local geologic anomalies and is not related to plant operations.

To assess direct radiation from the Robinson Plant to members of the public, a one-sided t-test was performed. The TLDs are located in two concentric rings of which one is approximately a one-mile radius of the plant and the other is approximately a five-mile radius of the plant. The test was to determine if the average dose rate of the one-mile radius TLDs exceeded that of the five-mile radius TLDs. The results of the test showed statistically that the inner ring did not represent a higher dose than the outer ring. Therefore, no measurable effect from plant operations was detected.

3.10 Summary

The radiological environmental monitoring program was conducted in accordance with the technical specifications and procedures for the H.B. Robinson Steam Electric Plant.

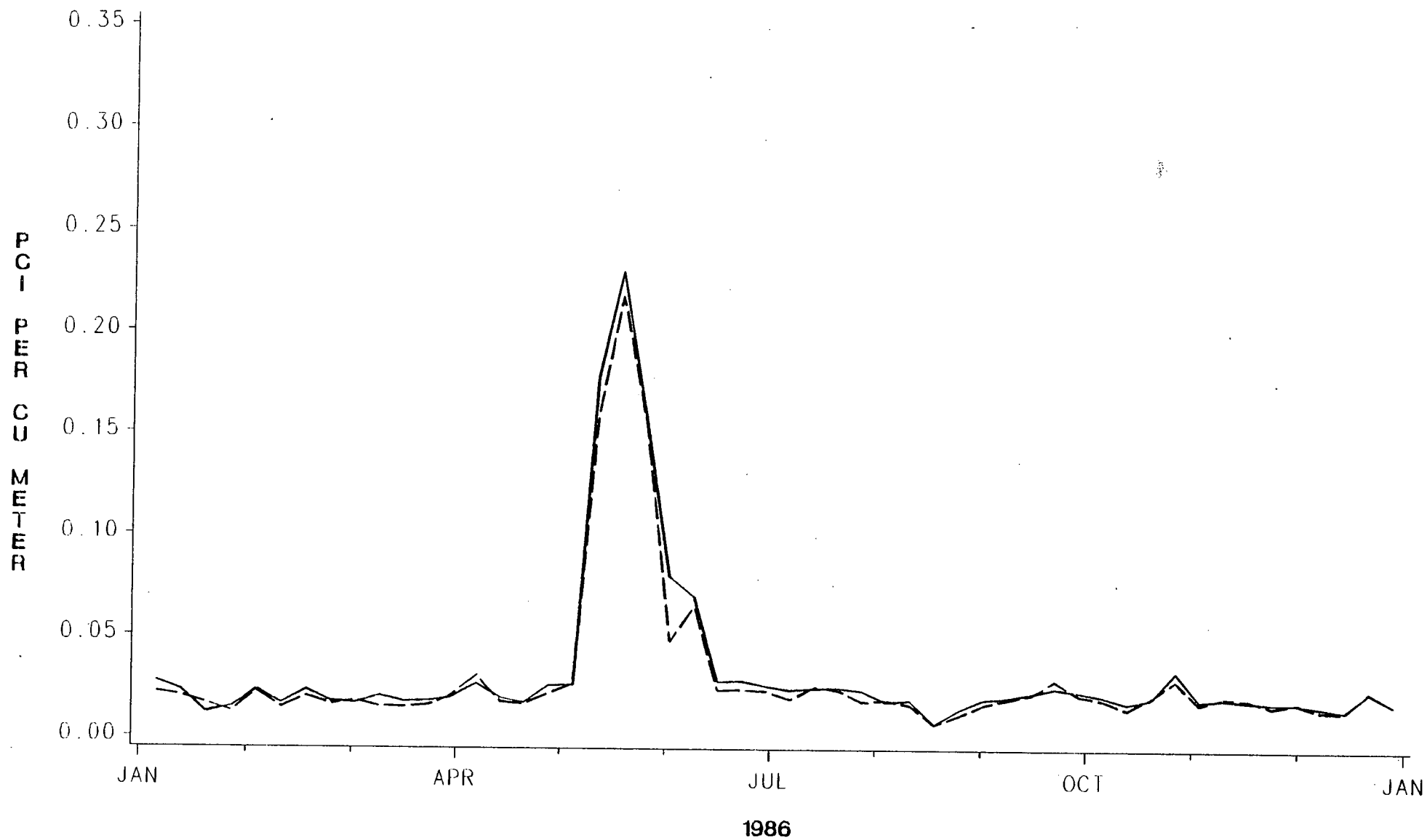
1. All detectable radioactivities have been within the guidance set forth in the technical specifications.
2. The environmental analyses performed during 1986 demonstrate that the H.B. Robinson Steam Electric Plant continues to operate in harmony with the environment and the general public.
3. Doses to the population from plant effluents were as follows:

PATHWAY	DOSE (mrem/yr)
Fish	0.26 max. adult (liver)
	0.22 max. adult (total body)
	0.09 avg. adult (liver)
	0.07 avg. adult (total body)

4. Doses to the public from the Chernobyl accident or from worldwide fallout were as follows:

PATHWAY	DOSE (mrem/yr)
Air sampling (I-131)	0.14 adult 0.17 teen 0.19 child 0.18 infant
Milk (I-131)	0.20 adult 0.32 teen 0.63 child 1.54 infant
Sediment	< .5

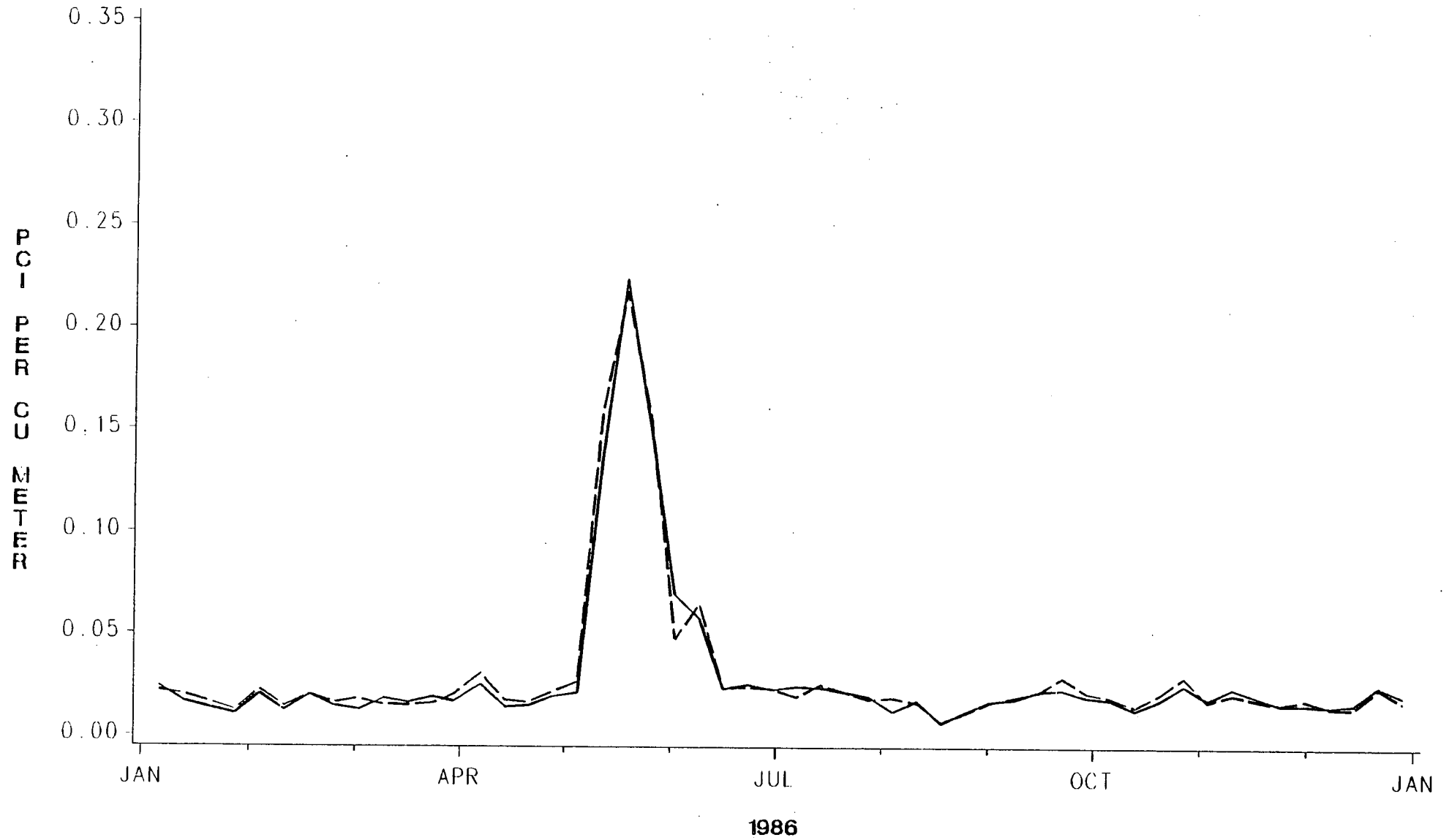
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0002



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

FIGURE 3-1

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0003



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0004

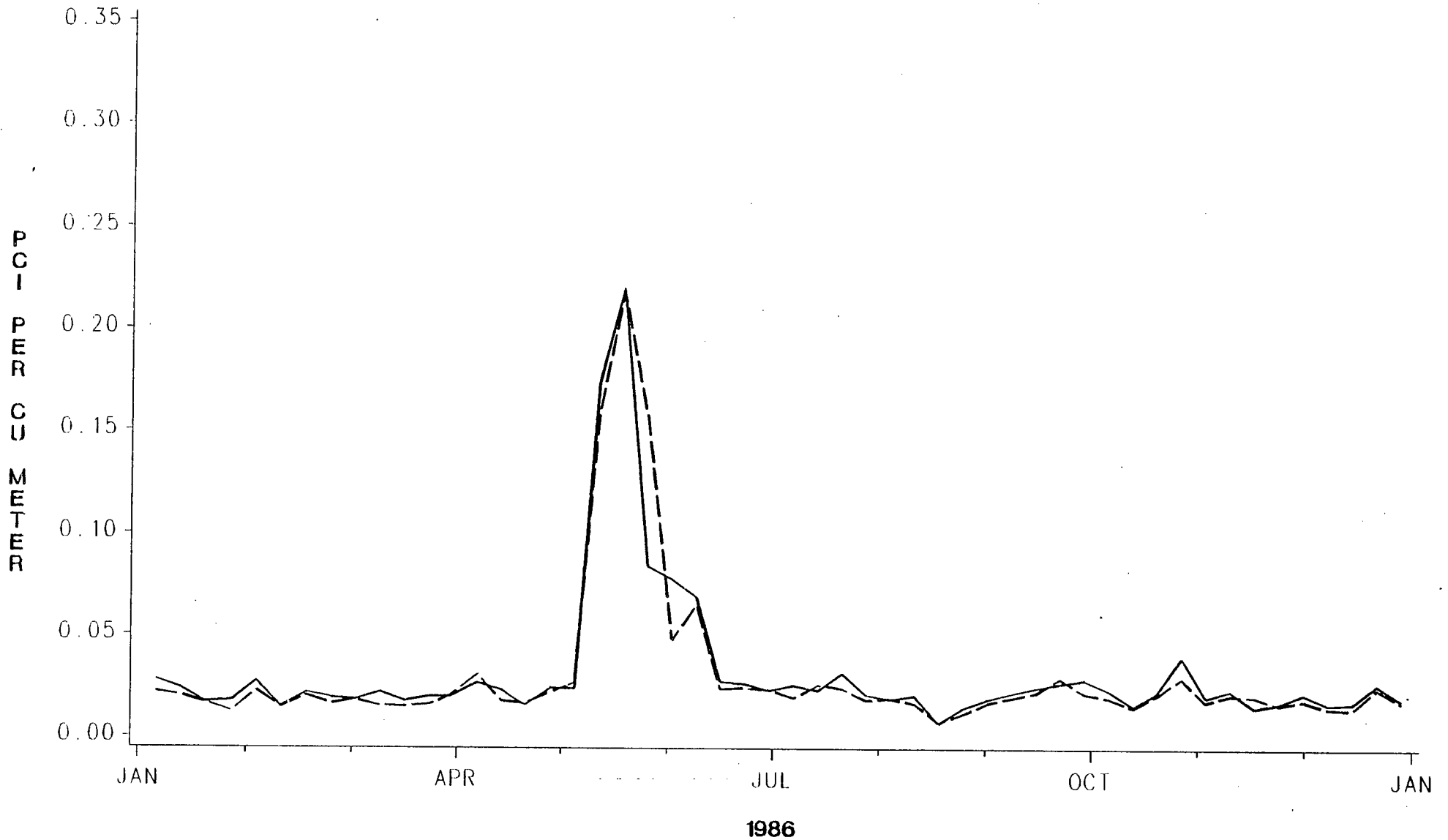
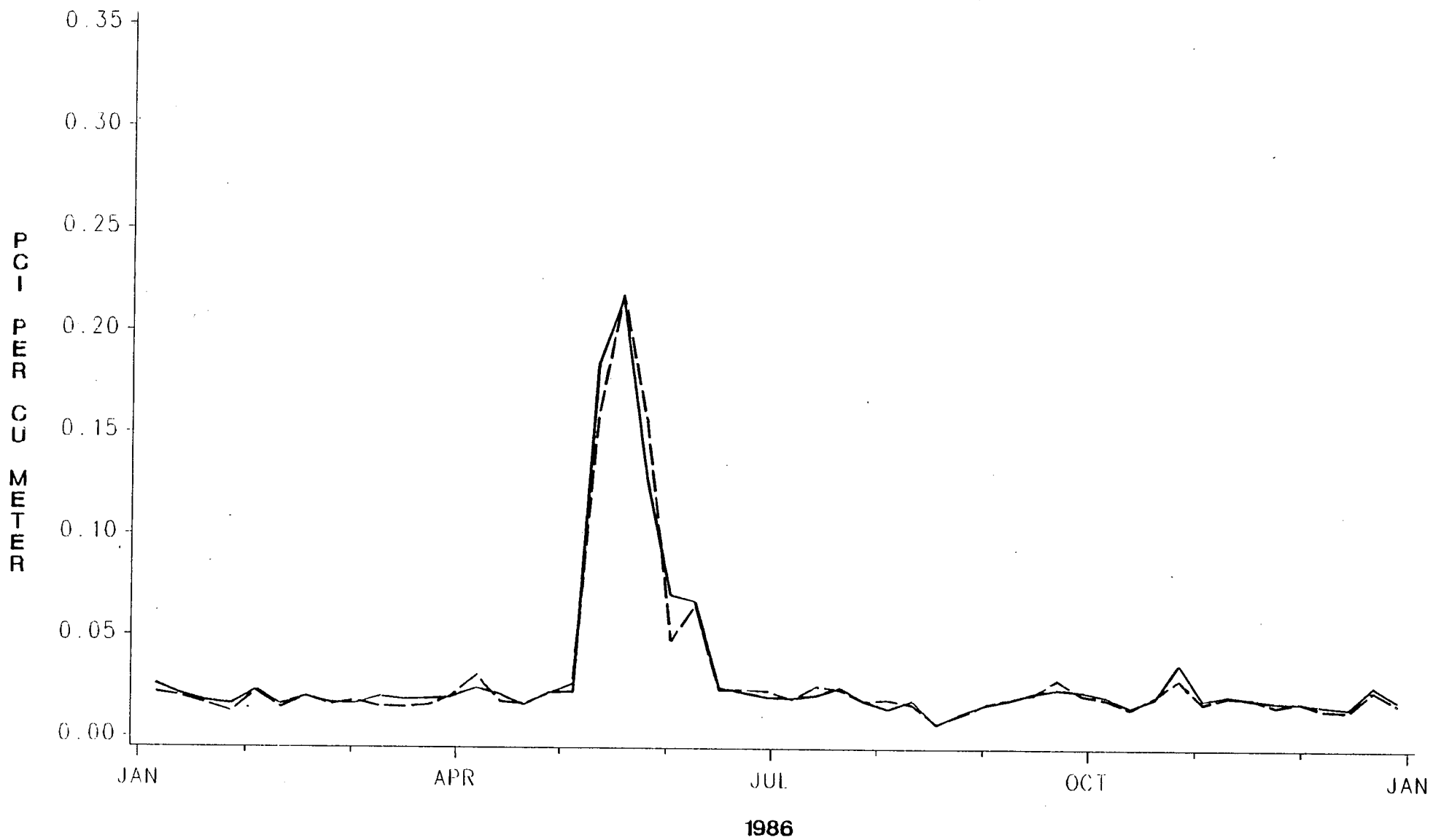


FIGURE 3-3

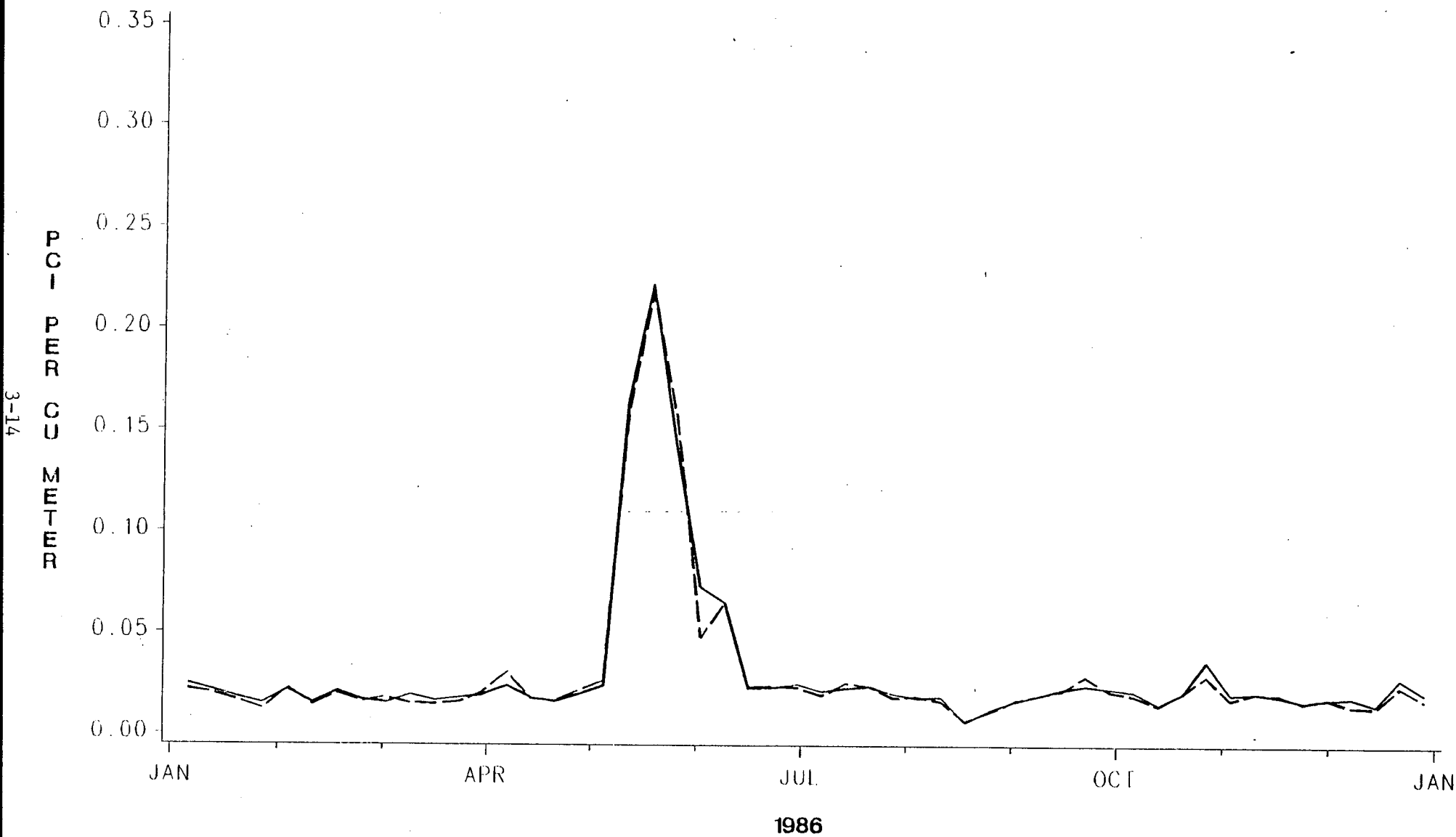
SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0005



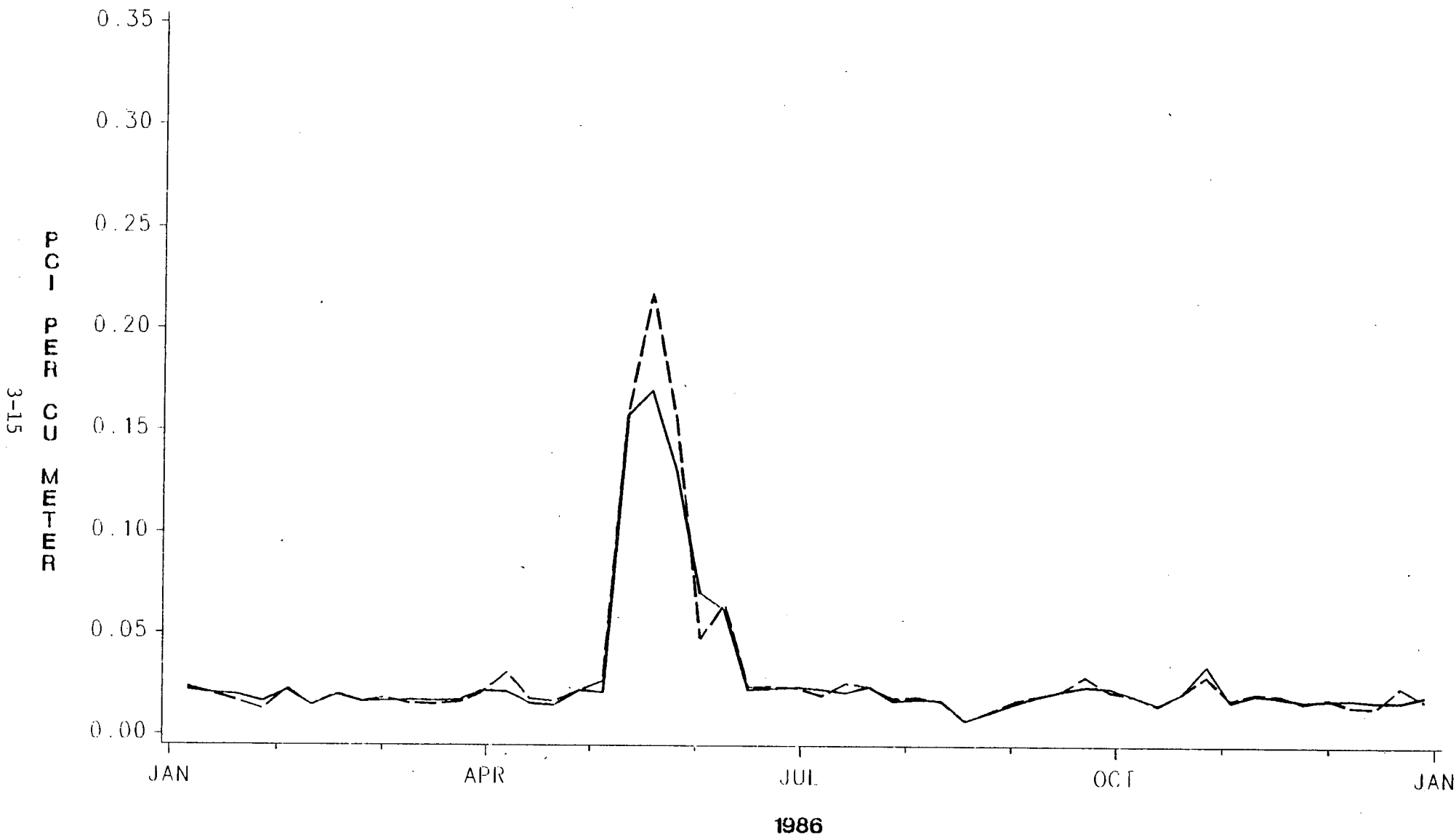
SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0006



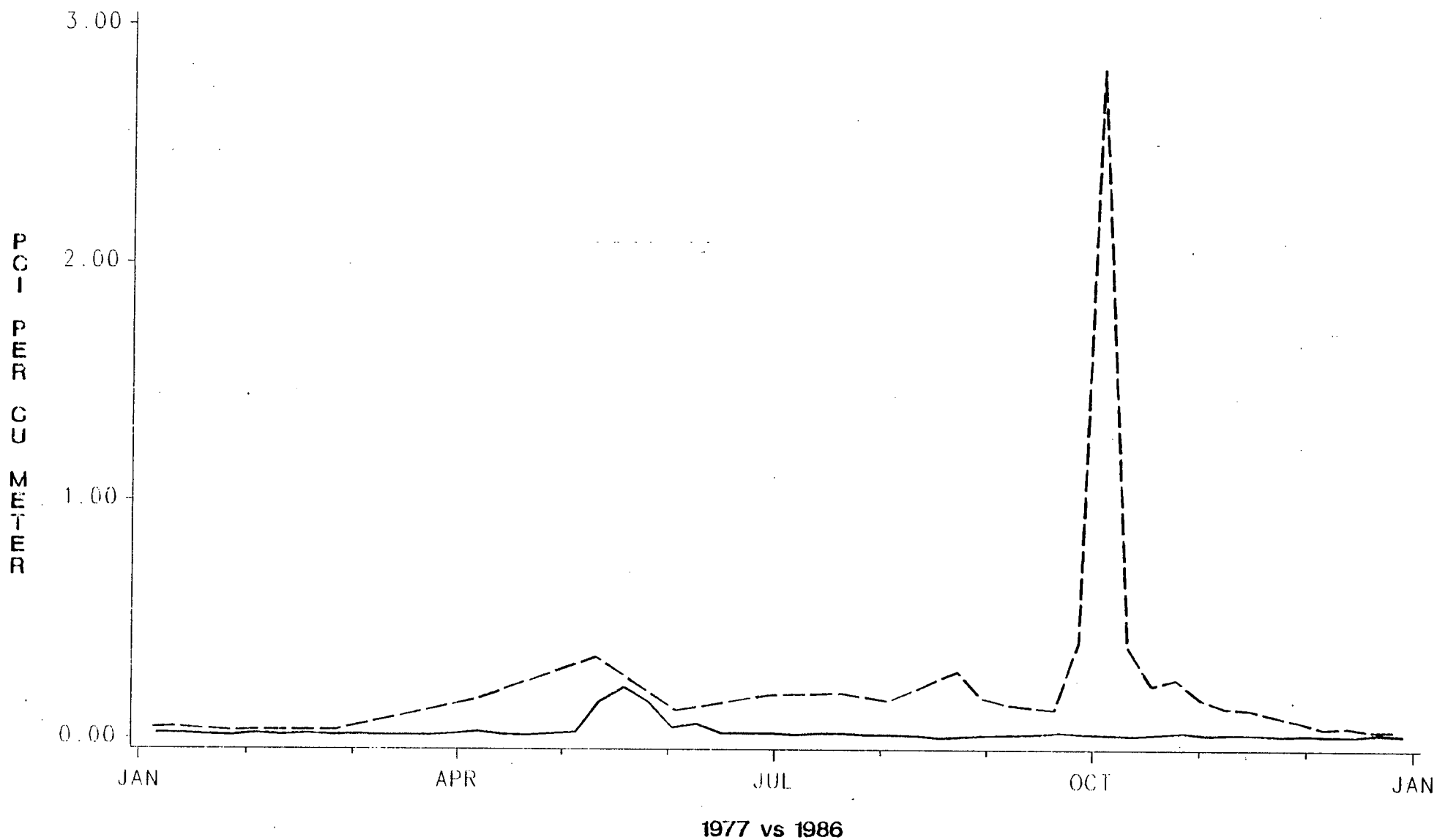
SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0007



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE CONTROLS
PLANT=HBR



SOLID LINE FOR 1986
BROKEN LINE FOR 1977

FIGURE 3-7

Table 3-1
Cs-134 Concentration in Fish
Actual vs Calculated (Reg. Guide 1.109)

Given: 6.289 E-3 Ci Cs-134 released in 1986

Given: 7.96 m³/sec Average flow from Lake Robinson
(2.27 to 13.65 m³/sec-range)

Given: Max concentration = $\frac{\text{release rate of nuclide}}{\text{flow rate of lake}}$

Given: Bioaccumulation factor for Cs-134 = 2000

Average concentration Cs-134

$$\frac{6.289 \text{ E-3 Ci}}{\text{yr}} \times \frac{\text{sec}}{7.96 \text{ m}^3} \times \frac{\text{yr}}{3.15\text{E}7 \text{ sec}} \times \frac{1\text{E}6 \text{ } \mu\text{Ci}}{\text{Ci}} \times \frac{\text{m}^3}{1\text{E}6 \text{ cc}} = \frac{2.50\text{E-}11 \text{ } \mu\text{Ci}}{\text{cc}}$$

Calculated Cs-134 in fish

$$\frac{2.50\text{E-}11 \text{ } \mu\text{Ci}}{\text{cc}} \times \frac{10^6 \text{ pCi}}{\mu\text{Ci}} \times \frac{1000 \text{ cc}}{1} \times \frac{2000 \text{ pCi/Kg}}{\text{pCi/l}} = \frac{50 \text{ pCi}}{\text{kg}} = \frac{5\text{E-}2 \text{ pCi}}{\text{g}}$$

Comparison of Cs-134 concentrations

Calculated = 5.0 E-2 pCi/g

Actual--Bottom-feeder (average) = 6.43E-2 pCi/g

Actual--Free-swimmer (average) = 9.71E-2 pCi/g

4.0 MISSED SAMPLES AND ANALYSES

4.1 Air Cartridge and Air Particulate (Weekly)

Air particulate and charcoal cartridges are collected weekly. There were 52 weeks in 1986 times 7 air-monitoring locations for a possible total of 364 samples. Listed below are the two samples that were not available for analysis:

<u>Location</u>	<u>Date</u>	<u>Reason</u>
Location 3	July 21, 1986	Low volume due to mechanical malfunction.
Location 3	November 17, 1986	Low volume due to faulty breaker.

4.2 Broadleaf Vegetation Samples (Monthly)

Broadleaf vegetation samples are collected monthly when available from three locations. Three different kinds of broadleaf vegetation should be collected from each location for a possible total of 108 samples. These samples were not collected due to seasonal availability.

January

BL-51	1 of 3 samples not available at this location.
BL-52 Ctrl	1 of 3 samples not available at this location.

February

BL-50	3 of 3 samples not available at this location.
BL-51	3 of 3 samples not available at this location.
BL-52 Ctrl	3 of 3 samples not available at this location.

March

BL-50 3 of 3 samples not available at this location.
BL-51 3 of 3 samples not available at this location.
BL-52 Ctrl 3 of 3 samples not available at this location.

November

BL-50 1 of 3 samples not available at this location.

December

BL-50 1 of 3 samples not available at this location.
BL-51 1 of 3 samples not available at this location.
BL-52 Ctrl 1 of 3 samples not available at this location.

4.3 Milk

Milk samples are typically collected every two weeks from two commercial dairies. The Auburndale Plantation ceased dairy operations after May 26, 1986. A total of 11 samples were collected from the Auburndale Plantation and 26 samples were collected from the Lyndale Farm (control) for a total of 37 milk samples.

4.4 Thermoluminescent Dosimeters (TLDs)

The following list identifies all TLDs from which results were not available.

<u>Location</u>	<u>Reason</u>	<u>Date</u>
Location 27	Missing in field at time of collection	First quarter
Location 2	Missing in field at time of collection	Second quarter

<u>Location</u>	<u>Reason</u>	<u>Date</u>
Location 3	Missing in field at time of collection	Second quarter
Location 13	Missing in field at time of collection	Second quarter
Location 2	Missing in field at time of collection	Third quarter
Location 4	Missing in field at time of collection	Third quarter
Location 10	Missing in field at time of collection	Third quarter
Location 15	Missing in field at time of collection	Third quarter
Location 10	Missing in field at time of collection	Fourth quarter
Location 13	Missing in field at time of collection	Fourth quarter
Location 18	Missing in field at time of collection	Fourth quarter

5.0 LAND-USE CENSUS

The 1986 land-use census was performed on May 6, 1986, in accordance with Technical Specification 3.17.2. The purpose of the survey was to identify the location of the nearest milk animal, the nearest resident, the nearest garden of greater than 500 square feet producing fresh, leafy vegetables in each of the 16 meteorological sectors within a distance of 5 miles.

Table 5-1 summarizes the locations of the nearest resident and garden within a five-mile radius of the site in each of the 16 meteorological sectors.

Table 5-1
Distances to Locations of Interest (miles)

Sector	Distance to Nearest Resident	Distance to Nearest Garden
N	2.9	3.35
NNE	1.3	1.25
NE	1.1	1.1
ENE	0.85	1.1
E	0.82	0.82
ESE	0.62	0.62
SE	0.3	1.9
SSE	0.30	0.25
S	0.3	0.3
SSW	0.30	0.30
SW	0.40	0.55
WSW	0.38	0.38
W	0.45	0.45
WNW	0.7	0.7
NW	1.2	1.2
NNW	2.9	2.9

No milk-producing animals are located within a five-mile radius of the plant.

6.0 ANALYTICAL PROCEDURES

6.1 Gross Beta

Gross beta radioactivity measurements are made utilizing a Tennelec Low-Background Alpha/Beta Counting System. The LLD for air particulates is approximately 0.0013 pCi/m³ for Robinson and Harris Nuclear Projects and 0.0038 for Brunswick Nuclear Project.

Air particulate samples are mounted in 2-inch stainless steel planchets and counted directly.

6.2 Tritium

Liquid samples requiring tritium analysis are first distilled. Five milliliters of the distillate are mixed with ten milliliters of liquid scintillation cocktail and counted on a liquid scintillation counter for 50 minutes. The LLD is approximately 1200 pCi/l.

6.3 Iodine-131

Iodine-131 airborne concentrations are quantified by the Ge(Li) gamma spectrometry systems. The cartridges are placed on the detector, and each charcoal cartridge is counted individually with an approximate LLD of 1E-2 to 3E-2 pCi/m³.

Iodine-131 in milk is analyzed by use of anion-exchange resin, sodium hypochlorite leach, and organic extraction. Iodine is precipitated as silver iodide, collected on a tared filter, dried, and counted on a beta-gamma coincidence system or by low-background beta counter. The LLD is approximately 0.3 pCi/liter.

6.4 Gamma Spectrometry Ge(Li)

Gamma spectrum analysis utilizes germanium or Ge(Li) detectors with thin aluminum windows housed in steel and lead shields. The analyzer systems are Nuclear Data 4420 and 6685. Table 6-1 summarizes LLD values derived from instrument sensitivity based upon a blank sample background.

Air particulate composites are placed in a Petri dish and analyzed directly.

Liquid samples, except milk, are boiled down to a small volume, transferred to a 250-ml polypropylene beaker with lid, and analyzed directly.

Shoreline sediments are dried, weighed, and then analyzed in a Marinelli beaker.

Food products and broadleaf vegetation samples are weighed wet and analyzed in a Marinelli beaker.

Fish samples are cleaned, dressed, and placed in a Marinelli beaker for analysis.

6.5 Thermoluminescent Dosimetry

Each area monitoring station includes a TLD packet, which is a polyethylene bag containing three calcium sulfate phosphors contained in a Panasonic UD-814 badge. The TLD is lighttight and the bag is weather-resistant.

Dosimeters are machine annealed before field placement. Following exposure in the field, each dosimeter is read utilizing a Panasonic TLD reader. This instrument integrates the light photons emitted from traps deexcited above 150°C. The lower-energy traps are automatically eliminated through a preheat cycle. Calibration is

checked regularly using dosimeters irradiated to known doses. Prior to the measurement of each dosimeter, the instrument is checked through use of an internal constant light source as a secondary standard. The minimum sensitivity of the dosimeters used is approximately 1 mR.

The exposure reported is corrected for exposure received in transit and during storage through the use of control dosimeters.

6.6 EPA Laboratory Intercomparison Program

The Radiological Environmental Laboratory at the Harris Energy & Environmental Center in New Hill, North Carolina, provides radioanalytical services for CP&L's nuclear plant environmental surveillance programs. The laboratory is a participant in the EPA cross-check program and uses its performance in this program as a major determinant of the accuracy and precision of its analytical results.

During 1986, 21 samples representing 3 major environmental media (water, milk, and air filters) and urine were analyzed. Data on the known activities and the 3 sigma control limits for 50 of the 52 required analyses have been received from the EPA. These 21 samples required triplicate determinations of the concentrations of radio-nuclides. A comparison of the average of our reported values with the EPA known activity and its standard deviation can be summarized as follows:

<u>Standard Deviation (sigma)</u> <u>From Known Activity</u>	<u>Percent of Analyses</u>
≤ 1 sigma	44
≤ 2 sigma	80
≤ 3 sigma	94

Of the 50 determinations, 3 (6 percent) fell outside the 3 sigma control limit.

In April and September of 1986, analyses of filters for gross beta activity were 20.6 percent and 23.7 percent higher than the known values, respectively. The CP&L values were calculated using an efficiency determined with a Cs-137 standard. The unknown contained Cs-137 and Sr-90. When the gross beta analysis was recalculated using an Sr-90 standard for the efficiency, the resultant analytical values were within an acceptable range of less than or equal to 2.0 (April) and 1.5 (September) normalized deviations of the true values.

Resolution of the problem was achieved by performing two new gross beta efficiency calibrations using Cs-137 and Sr-90. The Sr-90 generated efficiency will be used for determining gross beta for EPA comparison purposes.

In October an EPA water sample contained Ru-106. CP&L analysis based on a gamma assay was 18.5 percent lower than the known value. The values for the other five radionuclides were less than or equal to 2.5 times the normalized deviation from their respective known values. Ru-106 is determined using a low-abundance peak (9.8 percent) at 621.8 keV. An improved software version is being installed into the ND6685 system that can perform a more sensitive analysis thereby improving the analytical efficiency and reliability.

6.7 Lower Limits of Detection

All samples analyzed met the LLD required by Technical Specification 6.9.1.7 h and Table 4.12.1-1. Typical "a priori" LLD values for the samples analyzed are listed in Table 6-1.

Table 6-1

Typical Lower Limits of Detection (a priori LLD)
Ge(Li) Gamma Spectrometry

Surface Water Samples*
(Freshwater)

Isotope	(LLD)
Cr-51	28 pCi/l
Mn-54	6
Co-58	4
Co-60	7
Zn-65	11
Zr-Nb-95	5
I-131	4
Cs-134	5
Cs-137	5
Ba-La-140	7
Other Expected	2
Gamma Emitters	122

Surface Water Samples*
(Saline Water)

Isotope	(LLD)
Cr-51	25 pCi/l
Mn-54	3.7
Co-58	3.8
Co-60	6.4
I-131	4.0
Cs-134	4.7
Cs-137	4.1
Ba-La-40	5.9
Other Expected	1.9
Gamma Emitters	167

*The sample activities were decayed from the middle of the sampling period rather than from the end of the sampling period. This resulted in LLD values that appear higher than values calculated from the end of the period.

Air Particulates*
(Quarterly Composite)

Isotope	(LLD)
Cs-134	0.0068 pCi/cubic meter
Cs-137	0.0057
Ba-140	0.039
La-140	0.015
Other Expected	0.0035 to
Gamma Emitters	0.063

Groundwater Samples

Isotope	(LLD)
Cr-51	19 pCi/l
Mn-54	3.4
Co-58	3.0
Co-60	4.0
Cs-134	4.0
Cs-137	3.4
Ba-La-140	4.5
Other Expected	0.21 to
Gamma Emitters	116

*The sample activities were decayed from the middle of the sampling period rather than from the end of the sampling period. This resulted in LLD values that appear higher than values calculated from the end of the period.

Milk
(gamma scan)

Isotope	(LLD)
Cr-51	33 pCi/l
Mn-54	5
Co-58	3.8
Co-60	6.4
I-131	4.0
Cs-134	5.8
Cs-137	4.7
Ba-La-140	6.7
Other Expected Gamma Emitters	2.7 to 53

Sediments

Isotope	(LLD)
Cr-51	201 pCi/kg
Mn-54	33
Co-58	33
Co-60	55
Cs-134	50
Cs-137	31
Other Expected Gamma Emitters	19 to 721

Fish

Isotope	(LLD)
Cr-51	248 pCi/kg
Mn-54	46
Co-58	36
Co-60	20
Zn-65	83
I-131	24
Cs-134	54
Cs-137	41
Other Expected	18 to
Gamma Emitters	690

Food Products and Vegetation

Isotope	(LLD)
Cr-51	120 pCi/kg
Mn-54	18
Co-58	19
Co-60	19
I-131	14
Cs-134	19
Cs-137	16
Other Expected	9 to
Gamma Emitters	248