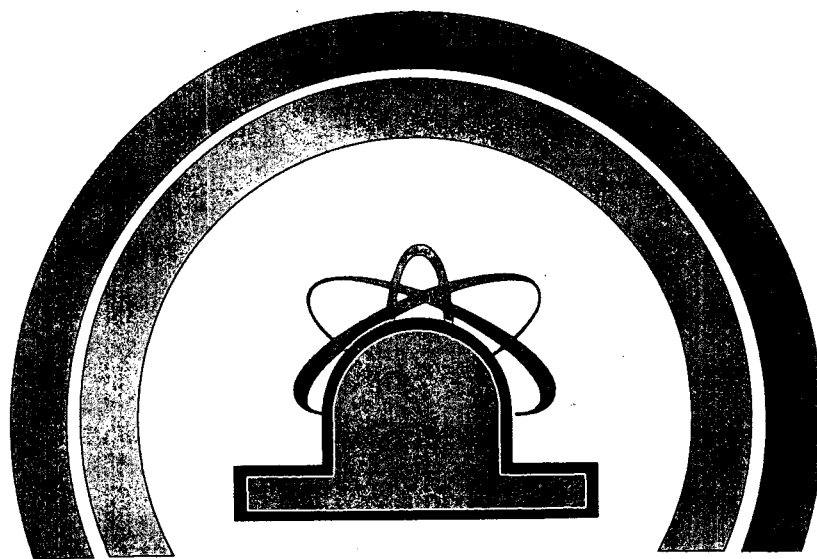


Radiological Environmental Operating Report

1989



ROBINSON NUCLEAR PROJECT

CAROLINA POWER & LIGHT COMPANY

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


RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

FOR

H.B. ROBINSON STEAM ELECTRIC PLANT


JANUARY 1, 1989, THROUGH DECEMBER 31, 1989

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1.0 SUMMARY

The Radiological Environmental Surveillance Program was conducted in accordance with the Robinson Technical Specification, Off-Site Dose Calculation Manual, and approved procedures.

The purpose of the Radiological Environmental Surveillance 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 assess the potential dose to off-site populations based on the cumulative measurement of radiation of plant origin. Of 1,300 sample analyses and measurements taken during the year, detectable radioactivity resulting from plant operations was found in 28 measurements.

1. Radioactivity in environmental samples which could be attributed to plant operations in 1989 is as follows:

<u>Sample Media</u>	<u>Radio-nuclide</u>	<u>Average Concentration and Occurrence Fraction</u>	<u>Maximum Individual Dose (mrem/yr)</u>
Fish	Cs-134	53 pCi/kg wet (1/8)	1.7E-1
Shoreline sediment (ash pond)	Co-60	45 pCi/kg dry (1/4)	1.3E-3
	Cs-137	34 pCi/kg dry (3/4)	2.4E-4
Surface water	H-3	1,760 pCi/l (9/22)	4E-3

2. All detectable radionuclides in the samples for 1989 were less than technical specifications' reportable levels.
3. Environmental analyses performed during 1989 demonstrate that the H.B. Robinson Steam Electric Plant continues to operate with minimum impact on the environment and little dose to the general public.

The following locations are used as control locations and are 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)

Cunningham Dairy*
(Sample Location 63)

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

A statistical summary of all the data gathered in 1989 has been compiled in Table 1-1.

*Lyndale Farm ceased dairy operations April 10, 1989. Control station was then changed to Cunningham Dairy.

TABLE 1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

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

Docket Numbers - 50-261
Calendar Year 1989

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)	1-131 404 (3)	1.0E-2	All less than LLD		All less than LLD	All less than LLD
Air Particulate (pCi/m ³)	Gross Beta 404 (3)	1.3E-3	1.60E-2 (352/352) 6.55E-3 - 3.36E-2	Johnson's Landing 0.9 mile ENE	1.70E-2 (51/51) 8.45E-3 - 3.28E-2	1.58E-2 (52/52) 7.20E-3 - 2.55E-2
	Gamma 32	N/A	All less than LLD		All less than LLD	All less than LLD
Broadleaf Vegetation (pCi/g) wet	Gamma 55 (4)	1.5E-2	1.56E-1 (32/36) 2.11E-2 - 6.58E-1	CP&L Property 0.25 mile SSE	2.27E-1 (15/18) 2.40E-2 - 6.58E-1	4.68E-1 (8/19) 2.59E-2 - 1.12E+0
	Cs-137					
Fish (pCi/g) wet Bottom-Feeder	Gamma 6	1.8E-2	1.17E-1 (4/4) 1.50E-2 - 2.49E-1	Lake Robinson site varies	1.70E-1 (2/2) 9.11E-2 - 2.49E-1	1.48E-1 (2/2) 1.19E-1 - 1.77E-1
	Cs-137					
	K-40	5.0E-1	3.42E+0 (4/4) 2.89E+0 - 4.42E+0	Prestwood Lake 4.9 miles ESE	3.65E+0 (2/2) 2.89E+0 - 4.42E+0	3.07E+0 (2/2) 2.73E+0 - 3.42E+0
Fish (pCi/g) wet Free-Swimmer	Gamma 6	1.7E-2	5.29E-2 Single value	Prestwood Lake 4.9 miles ESE	5.29E-1 (1/2) Single value	All less than LLD
	Cs-134					
	Cs-137	1.8E-2	2.13E-1 (4/4) 1.46E-1 - 3.02E-1	Prestwood Lake 4.9 miles ESE	2.56E-1 (2/2) 2.10E-1 - 3.02E-1	2.80E-1 (2/2) 2.12E-1 - 3.48E-1
	K-40	5.0E-1	3.67E+0 (4/4) 2.94E+0 - 4.39 E+0	Prestwood Lake 4.9 miles ESE	4.19E+0 (2/2) 3.99E+0 - 4.39E+0	3.50E+0 (2/2) 2.13E+0 - 4.87E+0
Food Products (pCi/g) wet	Gamma 3 (5)	N/A	All less than LLD		All less than LLD	All less than LLD
Groundwater (pCi/l)	Gamma 34 (6)	N/A	All less than LLD		All less than LLD	No control
	Tritium 34 (6)	1.2E+3	All less than LLD		All less than LLD	No control

TABLE 1-1 (continued)

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

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

Docket Numbers - 50-261
Calendar Year 1989

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)	
Milk (pCi/l)	1-131 (7)					
	52	3.0E-1	All less than LLD		All less than LLD	All less than LLD
	Gamma (7)	5.0E-1	4.12E+0	Auburndale	4.12E+0	
	52		Single value	Plantation	Single value	All less than LLD
	Cs-137			10.1 miles E		
Shoreline Sediment (pCi/g) dry	Gamma	3.6E-2	4.54E-2	Ash Pond	4.54E-2	No control
	4		Single value	0.9 mile NNW	Single value	
	Co-60					
	Cs-137	3.9E-2	3.38E-2 (3/4)	Ash Pond	4.53 E-2 (2/2)	No control
			1.07E-2 - 6.74E-2	0.9 mile NNW	2.32E-2 - 6.74E-2	
Bottom Sediment (pCi/g) dry	Gamma		4.83E-2 (2/3)	Lake Robinson	7.61E-2	All less than LLD
	4 (8)	5.0E-2	2.05E-2 - 7.61E-2	site varies	Single value	
	Mn-54					
	Co-60	3.6E-2	1.16E+0 (3/3)	Lake Robinson	2.20E+0	All less than LLD
			6.15E-2 - 2.20E+0	site varies	Single value	
	Cs-137	3.9E-2	9.38E-1 (3/3)	Prestwood Lake	2.26E+0	2.70E-1 (1/1)
			6.64E-2 - 2.26E+0	4.9 miles ESE	Single value	Single value
Aquatic vegetation (pCi/g) wet	Gamma		9.28E-2 (3/3)	Prestwood Lake	4.78E-2	Less than LLD
	Mn-54		1.98E-2 - 4.78E-2	4.9 miles ESE	Single value	
	Co-58		9.26E-2 (2/3)	Prestwood Lake	1.21E-1	Less than LLD
			6.41E-2 - 1.21E-1	4.9 miles ESE	Single value	
	Co-60		1.92E-1 (3/3)	Lake Robinson	3.50E-1	Less than LLD
			1.28E-2 - 3.50E-1	site varies	Single value	
	Sb-125		1.05E-1 (2/3)	Lake Robinson	1.32E-1	Less than LLD
			7.69E-2 - 1.32E-1	site varies	Single value	
Surface Water (pCi/l)	Gamma					
	34	N/A	All less than LLD		All less than LLD	All less than LLD
	Tritium	1.2E+3	1.76E+3 (9/22)	SC-23 at Black	1.86E+3 (4/12)	1.32E+3
	34		1.27E+3 - 2.65E+3	Creek 0.6 mile ESE	1.27E+3 - 2.65E+3	Single value
TLD (mrem/wk)	TLD		1.09E+0 (157/157)	Intersection of	1.72E+00 (4/4)	1.12E+0 (4/4)
	161 (8)	1 mR	7.00E-1 - 1.80E+0	SR 31-51 and 16-12	1.70E+0 - 1.80E+0	9.00E-1 - 1.30E+0
					4.4 miles SSW	

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. (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. Food products are normally sampled at locations where plant effluents are used to irrigate food crops. The farm previously sampled has ceased its irrigation operations. Food products were also sampled for split sampling with the state of South Carolina.
6. Groundwater samples are collected monthly from three locations for a possible total of 36 samples. The missing samples are discussed in Section 4.4.
7. Although control milk Station 53 ceased operations after April 10, 1989, Station 63 was immediately installed as a substitute and no sampling periods were omitted. See Section 4.3 for more information.
8. TLDs are collected quarterly from 41 locations for a possible total of 164 analyses. The three missing TLD are discussed in Section 4.5.

2.0 GENERAL INFORMATION

The following report summarizes the radiological environmental data for the H.B. Robinson Steam Electric Plant during the calendar year 1989. The surveillance requirements for this report were performed by the requirements of the Radiological Effluent Technical Specifications (RETS) which were implemented on January 1, 1985.

2.1 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.

2.2 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. These are the airborne radioiodine-pasture-milk pathway and the direct external radiation exposure to individuals on the ground from plumes of noble gases. Contact with Lake Robinson, including boating and immersion (swimming), constitutes an insignificant dose to man.

2.3 Environmental Monitoring Program

The required environmental sampling is defined by technical specifications. The program, as implemented by the plant, is described in the Off-Site Dose Calculation Manual. The program objective is to monitor specific elements of exposure pathways. The sampling media and release pathways are listed below.

Sampling Media

Release Pathway

Glass Fiber Filter
Iodine Collection Cartridge
TLDs Gaseous
Surface Water
Groundwater
Shoreline Sediment
Milk

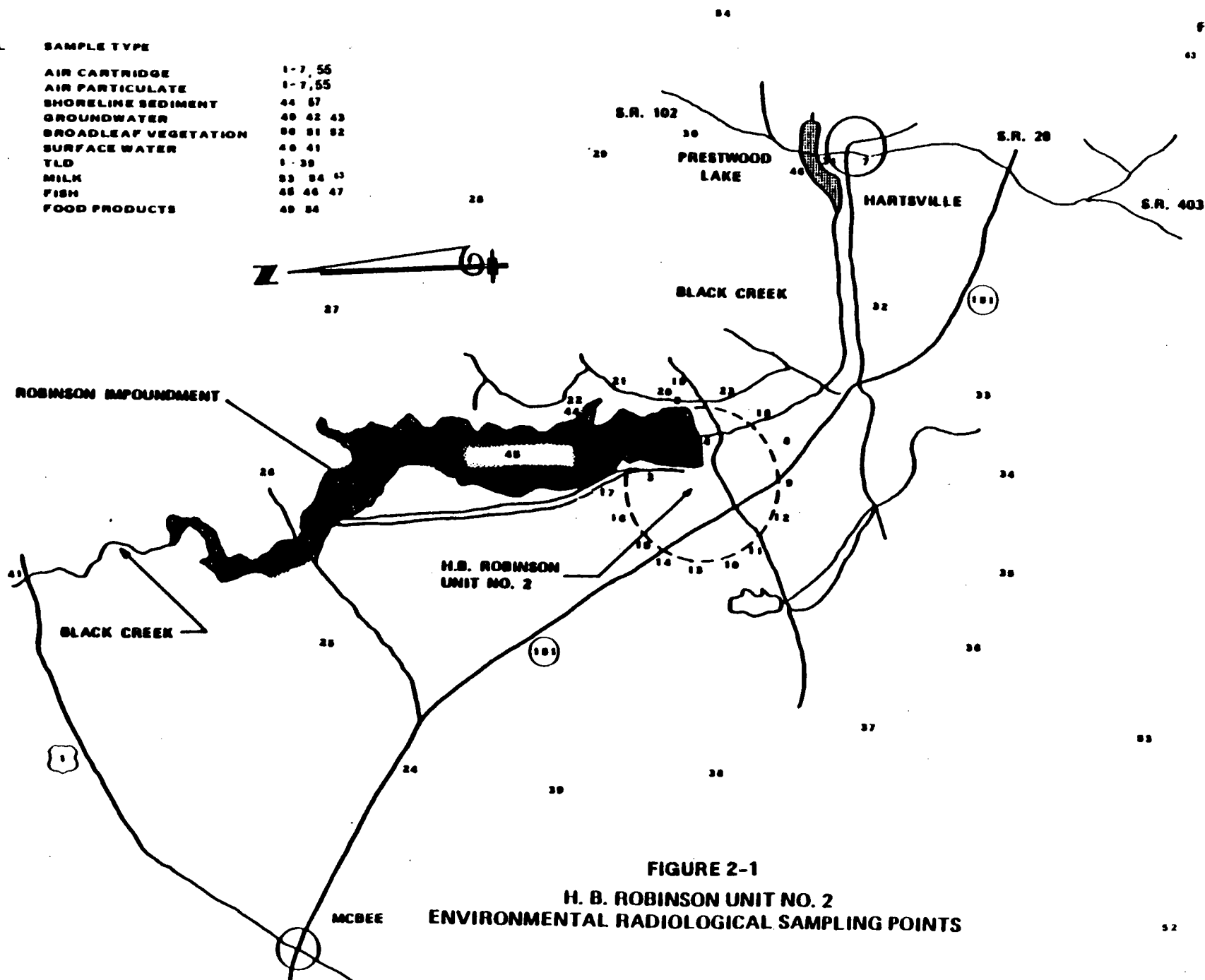
Fish
Food Crops

Broadleaf Vegetation
(when there is no milk locations
within 5 miles of plant site)

Gaseous
Gaseous

Liquid
Liquid
Liquid
Gaseous and liquid
(when irrigating)
Liquid
Liquid
(when irrigating)
Gaseous

SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7, 55
AP	AIR PARTICULATE	1-7, 55
SS	SHORELINE SEDIMENT	44 57
GW	GROUNDWATER	40 42 43
BL	BROADLEAF VEGETATION	50 51 52
SW	SURFACE WATER	40 41
TL	TLD	1-30
MK	MILK	53 54 55
FI	FISH	45 46 47
FC	FOOD PRODUCTS	40 54



SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7, 55
AP	AIR PARTICULATE	1-7, 55
SS	SHORELINE SEDIMENT	44, 57
GW	GROUNDWATER	40, 42, 43
BL	BROADLEAF VEGETATION	30, 31, 32
SW	SURFACE WATER	40, 41
TL	TLD	1-39
MK	MILK	53, 54
FI	FISH	45, 46, 47
PC	FOOD PRODUCTS	48, 54, 58

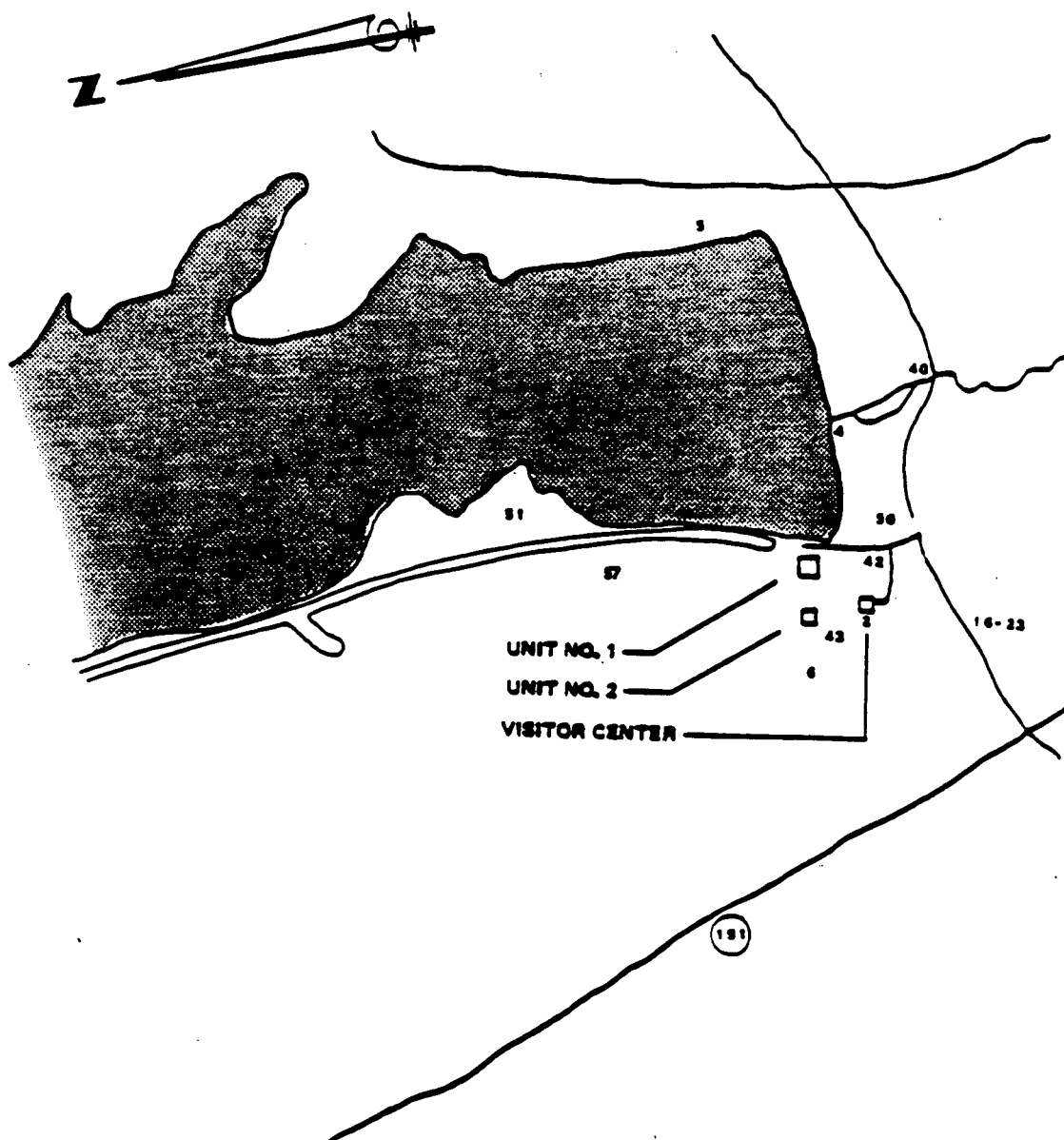


FIGURE 2-2
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS
ON SITE

TABLE 2-1

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 Information Center			
	7--6.3 miles ESE Hartsville			
	55--0.3 mile SSE Site Boundary*			
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 Information Center			
	7--6.3 miles ESE Hartsville			
	55--0.3 mile Site Boundary*			

*This location was added November 1988.

TABLE 2-1 (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 Information Center			
	7--6.3 miles ESE Hartsville			
	8--0.8 mile SSE Oak Tree Near Trans- mission Lines			
	9--1.0 mile S Second Pole From SC-151			
	10--1.0 mile WSW on Power Pole at Church of God Cemetery			
	11--1.0 mile SW 4th Pole From Old Camden Road			
	12--1.2 miles SSW Tree at 2nd Inter- section 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 Dis- charge 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 Near Atkinson's Boat Landing Sign			

TABLE 2-1 (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 Lake-shore 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 2-1 (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 57-- Ash Pond	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 (to 4/10/89) 54--10.1 miles E Auburndale Plantation 63--18 miles ESE Cunningham Dairy--Control (after 4/10/89)	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	(Edible Portion) Gamma

TABLE 2-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Shoreline Sediment (SS)	44--1.9 miles NNE Shady Rest Club 57--Ash Pond*	Semiannually	500 grams	Gamma
Food Products (FC)	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

*This location was added in 1981.

3.0 INTERPRETATIONS AND CONCLUSIONS

3.1 Air Sampling

Air samples collected during 1989 have measurable gross beta activity in 404 of 404 samples at an average concentration of $1.60\text{E}-2$ pCi/m³ and $1.58\text{E}-2$ pCi/m³ for the indicator and control locations, respectively. These are consistent with preoperational data obtained for the H.B. Robinson Plant and are typical of naturally occurring radionuclides. Figures 3-1 through 3-7 compare indicator and control location to preoperational gross beta activity. The average preoperational gross beta activity of 0.14 pCi/m³ is from the Preoperational Environmental Monitoring Report (January 1, 1970, through September 30, 1970) prepared by Eberline Instrument Corporation. The figures demonstrate that there were no significant deviations between indicator and control locations and that these stations' gross beta concentrations are less than concentrations measured during preoperational monitoring.

The quarterly composite gamma analyses for air particulate samples for all quarters revealed no radionuclides typical of plant effluents.

All 404 air cartridge samples from indicator and control locations had iodine-131 (I-131) activities which were less than the LLD.

3.2 Broadleaf Vegetation

Broadleaf vegetation sampling is accomplished by collecting oak, wild cherry, pin oak, willow oak, and sassafras leaves. Three species of samples, when available, are collected monthly at three locations (one control and two locations at site boundary using site historical meteorology with the highest calculated annual average ground level deposition). Broadleaf sampling is conducted since no milk animals are located within a radius of approximately five miles from the plant and is used to simulate dose to an individual via the milk pathway.

Cesium-137 was the only radionuclide detected during 1989 at an average concentration of $4.68\text{E-}1$ pCi/g (8 of 19 analyses) for the control location and $1.56\text{E-}1$ pCi/g (32 of 36 analyses) for the indicator locations.

Table 3.1 demonstrates the variability of the broadleaf data. The presence of measurable concentrations of cesium-137 in the control samples verifies that cesium from world-wide fallout is present in the biosphere and is likely the major contributor to the activities measured in the indicator stations as well as control stations. The resulting effect is that any contribution of cesium-137 from plant effluents to the cesium content of the broadleaf vegetation is not discernible in this year's data.

Table 3-1

**Cesium-137 in Broadleaf Vegetation
(pCi/g Wet Weight \pm 2 Sigma Error)**

Wild Cherry

<u>DATE</u>	<u>0.25 mi. SSE (BL-50)</u>	<u>0.25 mi. NNE (BL-51)</u>	<u>Control (BL-52)</u>
4/27	$6.4E-2 + 1.0$	$4.7E-2 + 1.2$	$< 9.0E-3$
5/18	$< 1.9E-2$	$< 1.4E-2$	$< 2.2E-2$
5/16	$< 2.0E-2$	$< 2.3E-2 + 0.5$	$< 1.8E-2$
7/13	$6.6E-2 + 0.9$	$2.2E-2 + 0.8$	$< 2.2E-2$
9/15	$7.5E-2 + 0.8$	$3.6E-2 + 0.8$	$2.6E-2 + 0.7$

Willow Oak, Pin Oak

4/27	$2.26E-1 + 0.15$	$4.1E-2 + 1.1$	$4.76E-1 + 0.19$
5/18	$< 3.4E-2$	$1.87E-2 + 0.19$	$< 2.0E-2$
6/15	$2.4E-2 + 0.11$	$1.97E-1 + 0.17$	$5.37E-1 + 0.15$
7/13	$4.50E-1 + 0.16$	$1.01E-1 + 0.17$	$1.12E-0 + 0.03$
8/17	$6.58E-1 + 0.19$	$1.24E-1 + 0.18$	$3.28E-1 + 0.13$
9/15	$4.45E-1 + 0.21$	$3.92E-1 + 0.22$	$5.65E-1 + 0.29$

Sassafras

4/27	$3.59E-1 + 0.11$	--	$4.32E-1 + 0.19$
5/18	$1.45E-1 + 0.11$	$3.4E-2 + 1.0$	$1.13E-1 + 0.14$
6/16	$1.31E-1 + 0.13$	$4.8E-2 + 1.0$	$< 1.7E-2$
7/13	$1.43E-1 + 0.09$	$5.6E-2 + 1.0$	$< 1.9E-2$
8/17	$2.08E-1 + 0.14$	$4.2E-2 + 1.1$	$< 2.4 E-2$
9/15	$1.47E-1 + 0.12$	$7.3E-2 + 0.9$	$< 2.6E-2$

Blackjack Oak

4/27	--	$1.39E-1 + 0.10$	$6.11E-1 + 0.17$
------	----	------------------	------------------

3.3 Fish

Samples of free-swimming and bottom-feeding fish were collected from Lake Robinson, Prestwood Lake, and Bee Lake or May Lake (control) during May and November. Gamma isotopic analyses were performed on the edible portions revealing cesium-137 (Cs-137) and cesium-134 (Cs-134) activity. Using a T-test at 99.5 percent confidence level for comparing the Cs-137 concentrations in Robinson Lake and Prestwood Lake (indicator locations) to Bee Lake (control location) reveals no discernible increase in Cs-137 from plant operations is indicated (see Table 3.2).

Table 3-2

Cesium-137 Concentrations in Fish Samples
(pCi/g wet weight \pm 2 Sigma Error)

Free Swimmers

	<u>Bee Lake (Control)</u>	<u>Robinson Lake</u>	<u>Prestwood Lake</u>
May	$2.12\text{E-}1 \pm .25$	$1.94\text{E-}1 \pm .17$	$3.02\text{E-}1 \pm .23$
November	$3.48\text{E-}1 \pm .30$	$1.46\text{E-}1 \pm .15$	$2.10\text{E-}1 \pm .25$

Bottom Feeders

May	$1.19\text{E-}1 \pm .20$	$9.1\text{E-}2 \pm .16$	$1.14\text{E-}1 \pm .16$
November	$1.77\text{E-}1 \pm .29$	$2.49\text{E-}1 \pm .14$	$1.5\text{E-}2 \pm .2$

Cesium-134 activity was detected in one of four fish samples from Prestwood Lake but in none of the four fish samples from Lake Robinson. The single concentration of Cs-134 in fish from Prestwood Lake was $5.3\text{E-}2$ pCi/g (wet). Using 21 kg/yr consumption rate for an adult, dose conversion factor of $1.48\text{E-}4$ mrem/pCi, the methodology in Regulatory Guide 1.109, and a cesium-134 activity at a concentration of $5.3\text{E-}2$ pCi/g (wet) from Prestwood Lake could yield a dose to the liver (most critical organ) of 0.165 mrem/yr.

A similar dose calculation using the cesium-137 average concentration in "free-swimmers" in all indicator sites (Lake Robinson and Prestwood Lake) of $2.13\text{E-}1$ pCi/g yields .49 mrem/yr to the liver of an adult. This value best estimates the dose via the fish pathway for the RNP environs.

3.4 Groundwater

Groundwater is sampled monthly and analyzed for tritium and gamma-emitting radionuclides at three locations. All analyses were less than the lower limit of detection.

3.5 Milk Samples

Milk samples from the Auburndale Plantation (10.1 miles east) are collected and analyzed to evaluate the potential dose via a grass-cow-milk-man pathway. One of twenty-six samples from this source revealed one sample with detectable Cs-137 at 4.12 ± 1.51 pCi/liter. Consumption of milk with this concentration of Cs-137 for one year by an infant would deliver 0.83 mrem to an infant's liver. Since this data occurred in only 1 of 26 samples, the maximum dose is likely less than .008 mrem.

3.6 Food Crop Samples

During 1989 rainfall increased and farming practices changed at the Auburndale Plantation such that irrigation from Black Creek, the receptor of RNP liquid effluents, was terminated thereby removing the only irrigation-food-man pathway known to exist. Food crops of collards, peaches, and corn were sampled once each to provide sample materials for comparative analyses with the state of South Carolina. No plant effluents were detected in these samples.

3.7 Shoreline Sediment

Shoreline sediment samples are collected semiannually from the nearest downstream area with existing recreational value. This location is at the Shady Rest Club on Lake Robinson 1.9 miles NNE. One of two samples from

this location contained $1.02\text{E-}2$ pCi/g of cesium-137. Shoreline sediments are collected from $.5\text{ ft}^2$ area thus translating this activity to 334 pCi/m^2 . Using the methodology in Regulatory Guide 1.109, this would provide an annual dose of less than $1\text{E-}4$ mrem to a teenager, assumed maximum exposed individual with 67 hours/yr exposure.

A second location sampled is an ash pond on CP&L property (0.9 mile NNW) with limited accessibility by the public. This ash pond does not receive normal radioactive effluents from the plant but has in the past received slightly contaminated soils under approval by NRC (10CFR20.302) and by the state of South Carolina. Shoreline sediment sampling indicated the presence of small concentrations of Co-60 ($4.54\text{E-}2$ pCi/g) and of Cs-137 ($4.53\text{E-}2$ pCi/g). Using the methodology of Regulatory Guide 1.109, this indicates an annual dose of $< .002$ mrem/yr.

3.8 Surface Water

Surface water composite samples are analyzed monthly for gamma-emitting radionuclides and tritium. All gamma-emitting radionuclide activities were less than the lower limit of detection ($< \text{LLD}$). There are two sample indicator locations for Robinson. One is for evaluating routine releases and the other for trending long-term impact from disposal of slightly contaminated fly ash/soil in the ash ponds (see Figure 3-11). Tritium was detected in 5 of 10 ash pond supernate samples with an average concentration of $1.68\text{E+}3$ pCi/liter. Tritium was detected at the other indicator location (Secondary Road S-16-23) in 4 of 12 samples with an average concentration of $1.86\text{E+}3$ pCi/liter. This location is used for evaluating routine releases (see Figure 3-12). The only significant dose from tritium in the liquid pathway would be from eating fish. Using the methodology in Regulatory Guide 1.109, an adult consumption rate of 21 kg/yr, bioaccumulation factor of 0.90 pCi/kg of fish/pCi/liter of water, and the ingestion dose factor for the adult total body of $1.05\text{E-}7$ mrem/pCi ingested would yield a dose of $3.69\text{E-}3$ mrem/yr for the maximum individual.

3.9 Thermoluminescent Dosimetry (TLD) Area Monitors

The average dose rate of all indicator locations was 1.09 mrem/wk which is comparable to the control location average of 1.12 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 1.72 mrem/wk with a range of 1.70 to 1.80 mrem/wk. This location has a history of being approximately 60 percent higher than the average of all indicator locations and its value is attributed to local geologic anomalies and not to plant operations.

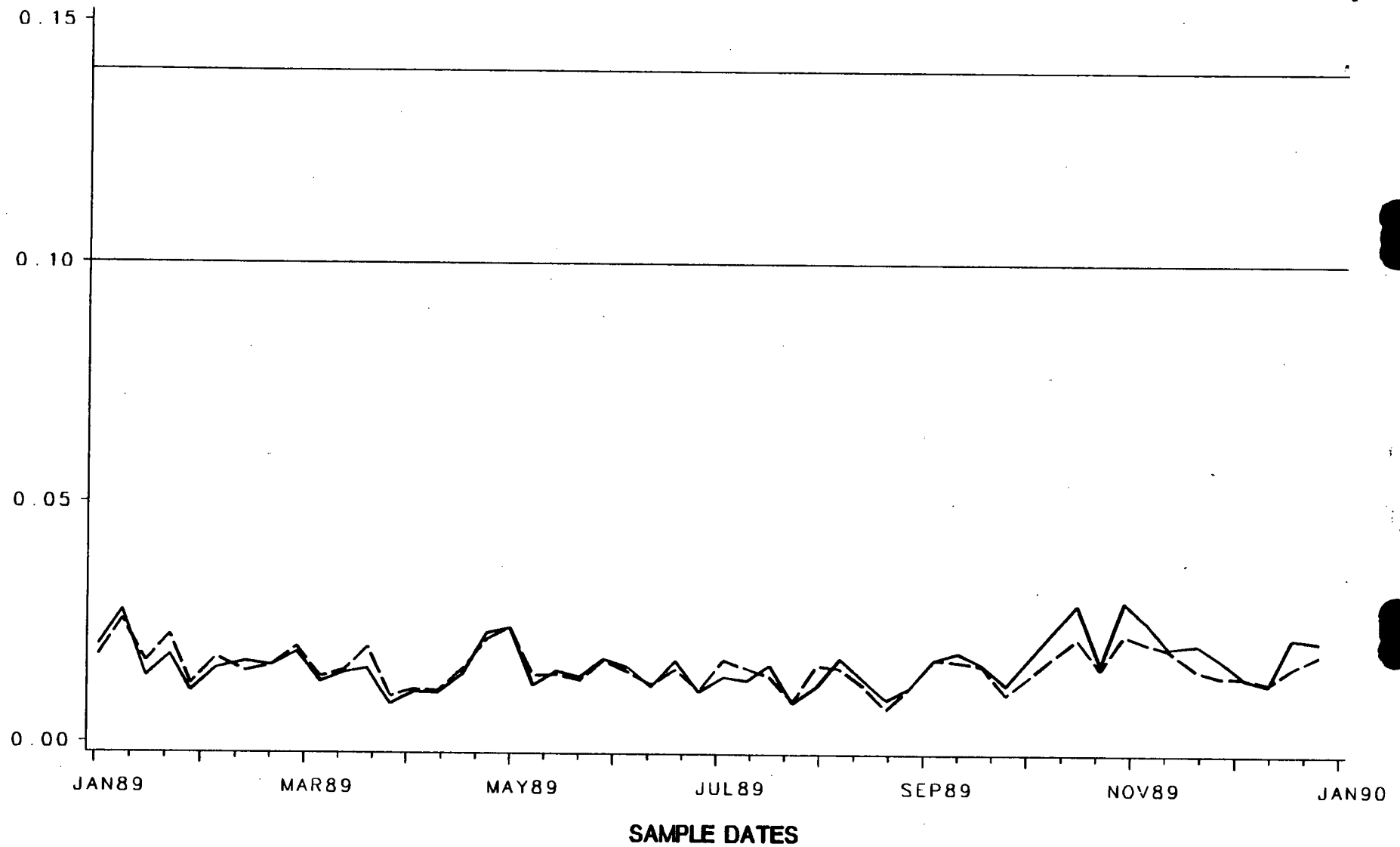
The TLDs are generally located in two concentric rings. The first ring consists of TLDs within 3 miles of the plant (approximate average is 1.0 mile) and the second ring consists of those TLDs greater than 3 miles (approximate average is 5 miles). To assess direct radiation from the Robinson Plant to members of the public, a one-sided t-test was performed. The test was to determine if the average dose rate of the TLD inner ring exceeded that of outer ring. The results of the test showed statistically that the inner ring did not receive a higher dose than the outer ring. Therefore, no measurable effect from plant operations was detected (see Figure 3-13).

CP&L ENVIRONMENTAL SURVEILLANCE

GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES

PLANT=HBR SAMPLE POINT=0002

3-8
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C
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P
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C
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M
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L
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SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

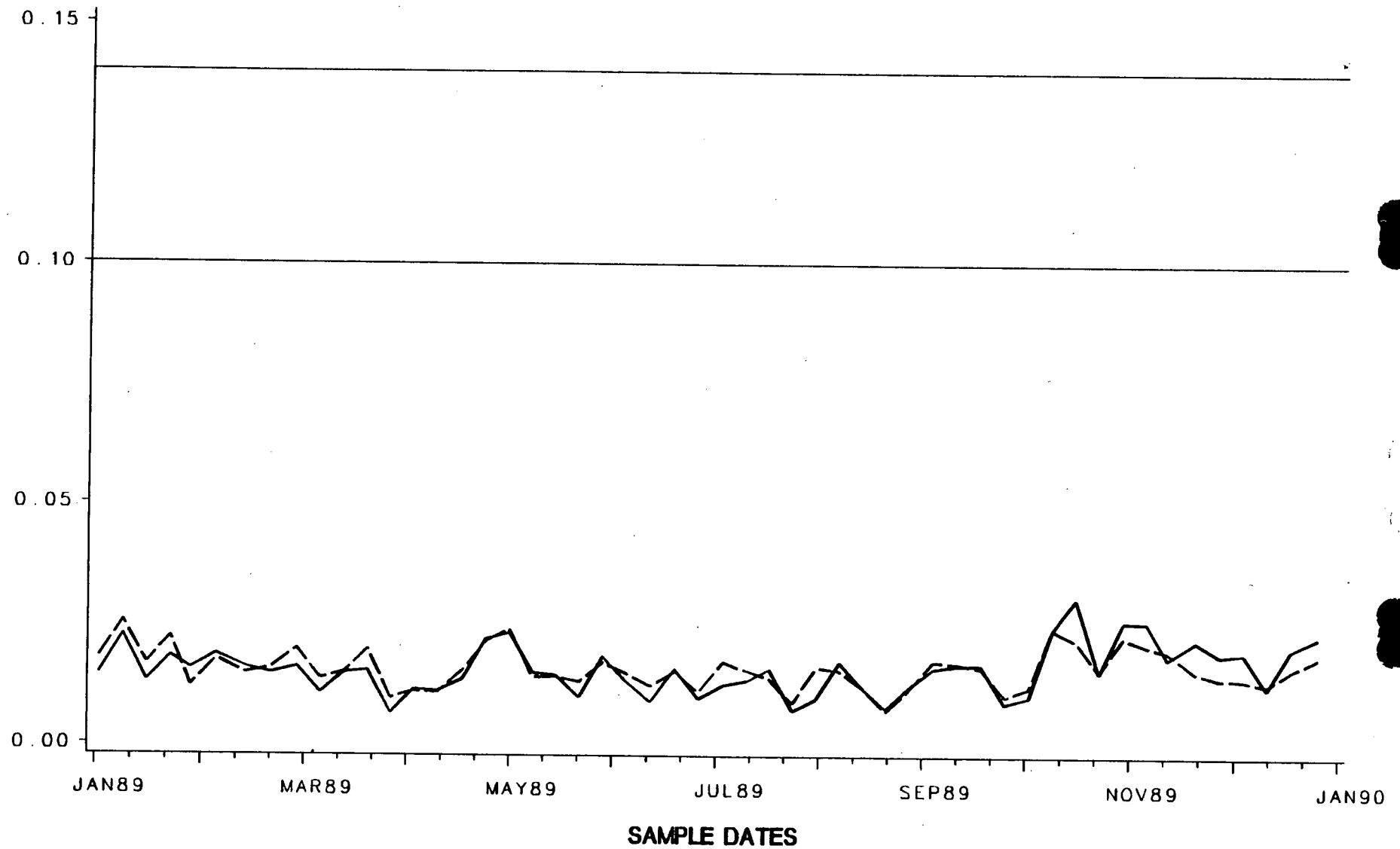
PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

CP&L ENVIRONMENTAL SURVEILLANCE

GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES

PLANT=HBR SAMPLE POINT=0003

PC
I
P
R
C
U
M
M
E
R
3-9



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

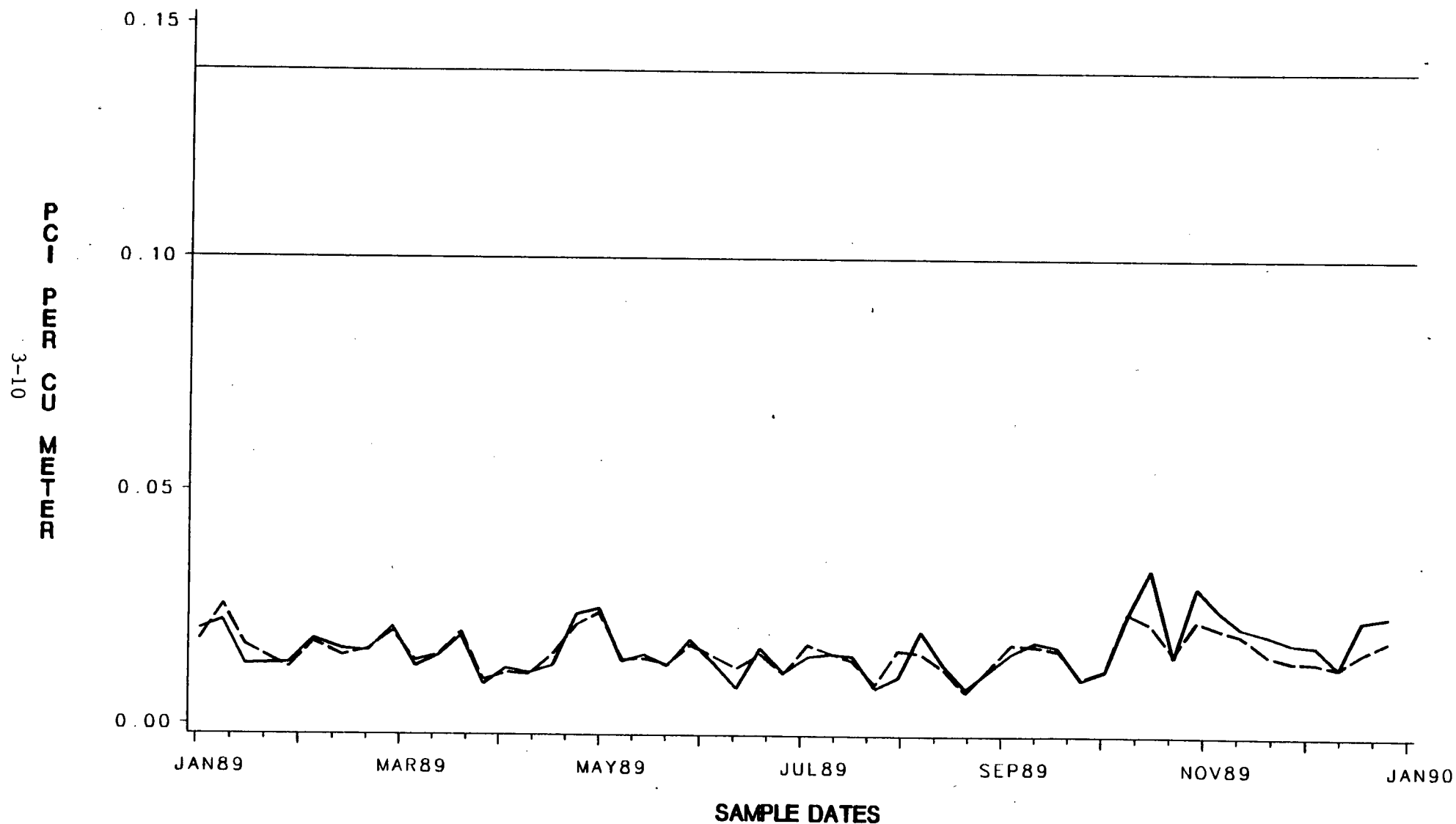
PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

CP&L ENVIRONMENTAL SURVEILLANCE

GROSS BETA ACTIVITY FOR

AIR PARTICULATE SAMPLES

PLANT=HBR SAMPLE POINT=0004



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

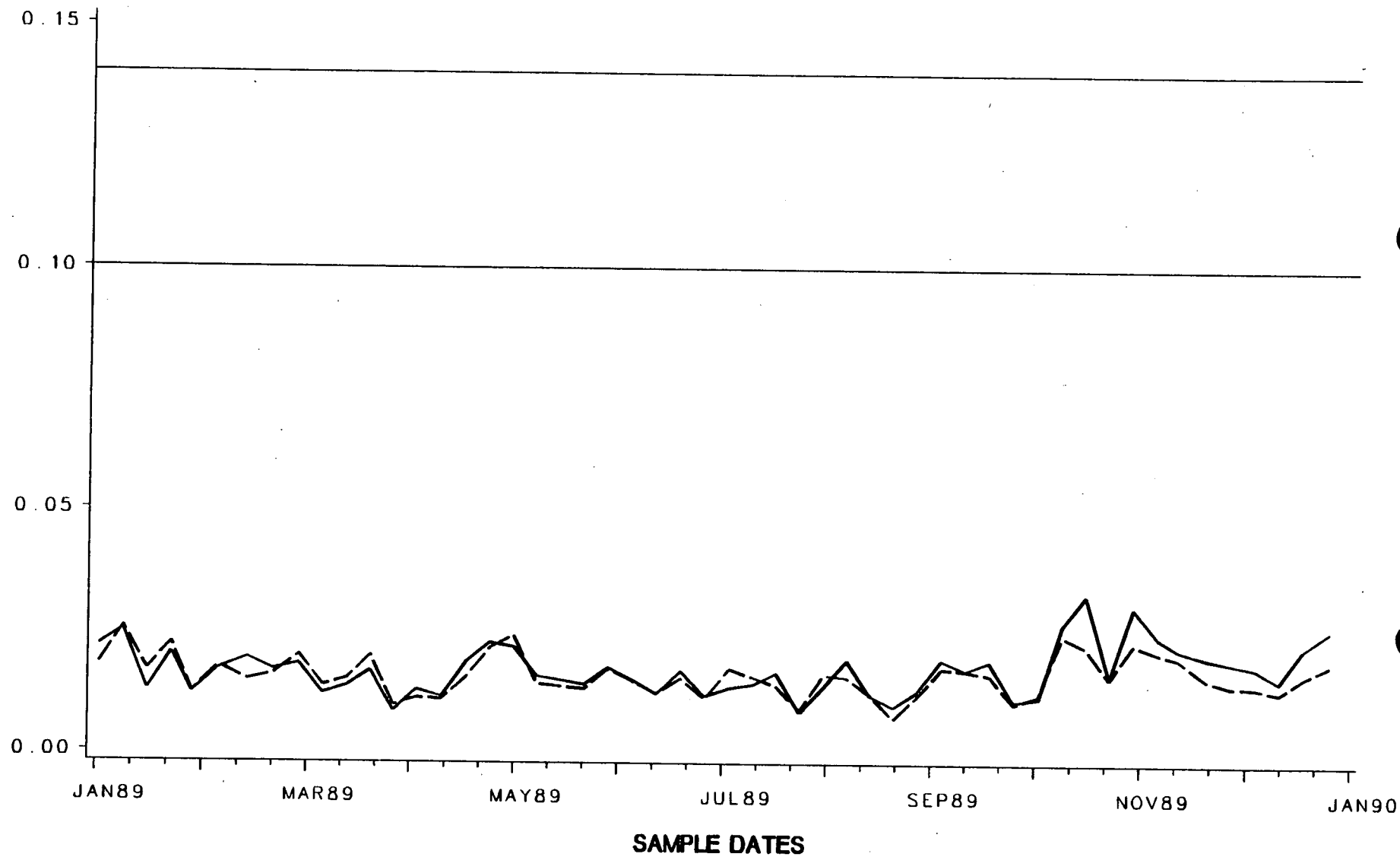
CP&L ENVIRONMENTAL SURVEILLANCE

GROSS BETA ACTIVITY FOR

AIR PARTICULATE SAMPLES

PLANT=HBR SAMPLE POINT=0005

PC-1
PLANT CODE
3-11



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-4

CP&L ENVIRONMENTAL SURVEILLANCE

GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES

PLANT=HBR SAMPLE POINT=0006

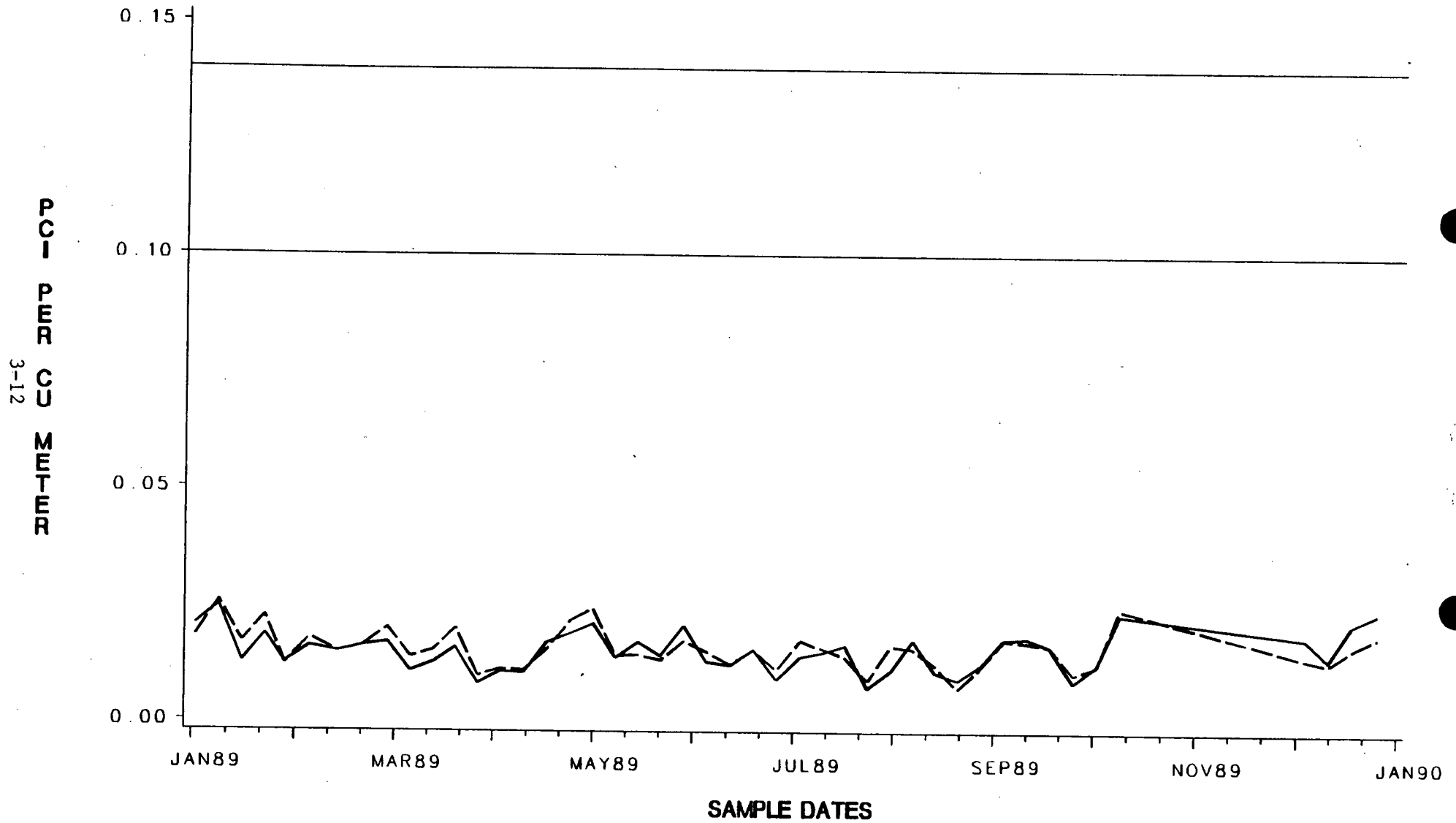


Figure 3-5

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

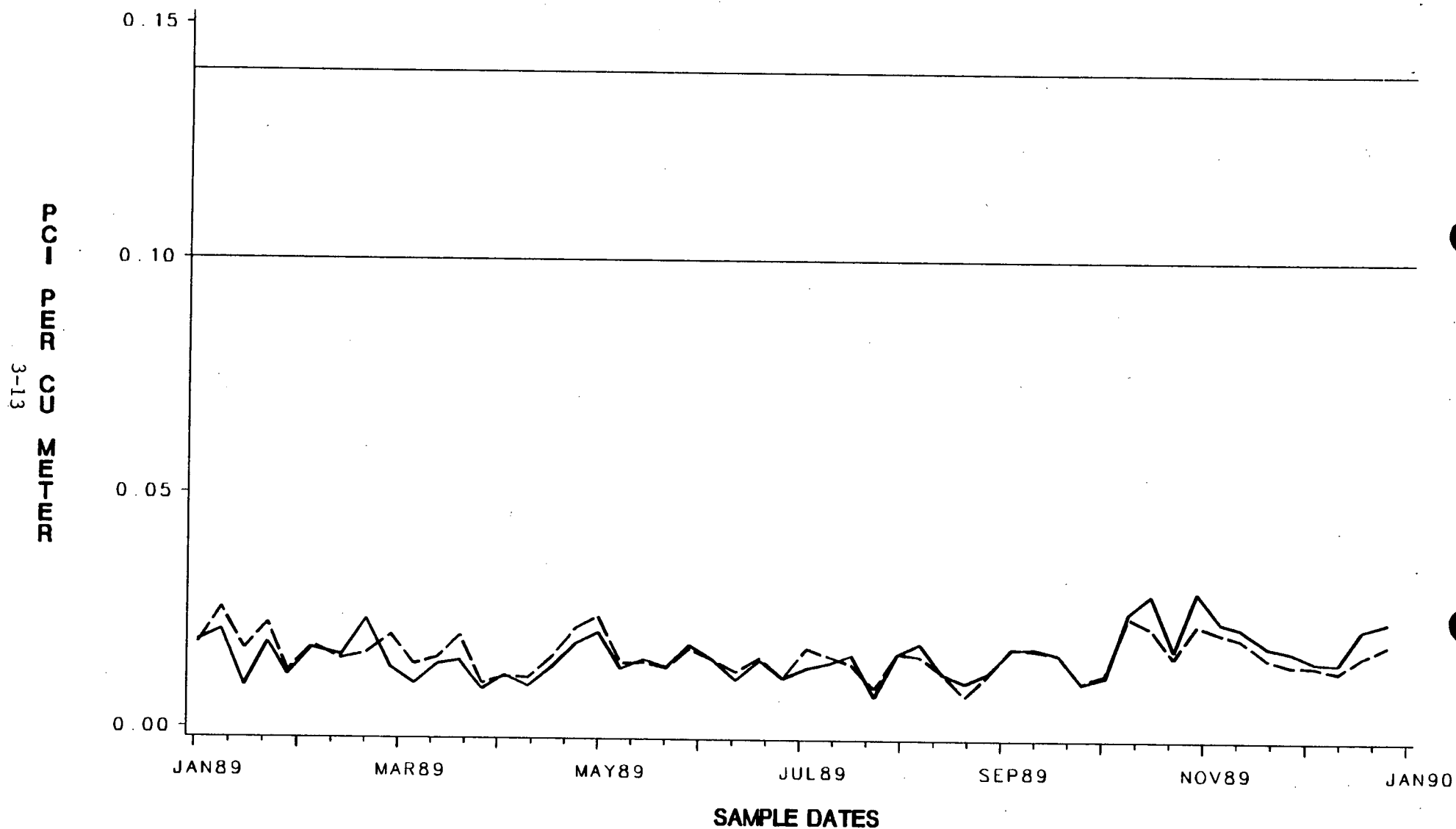
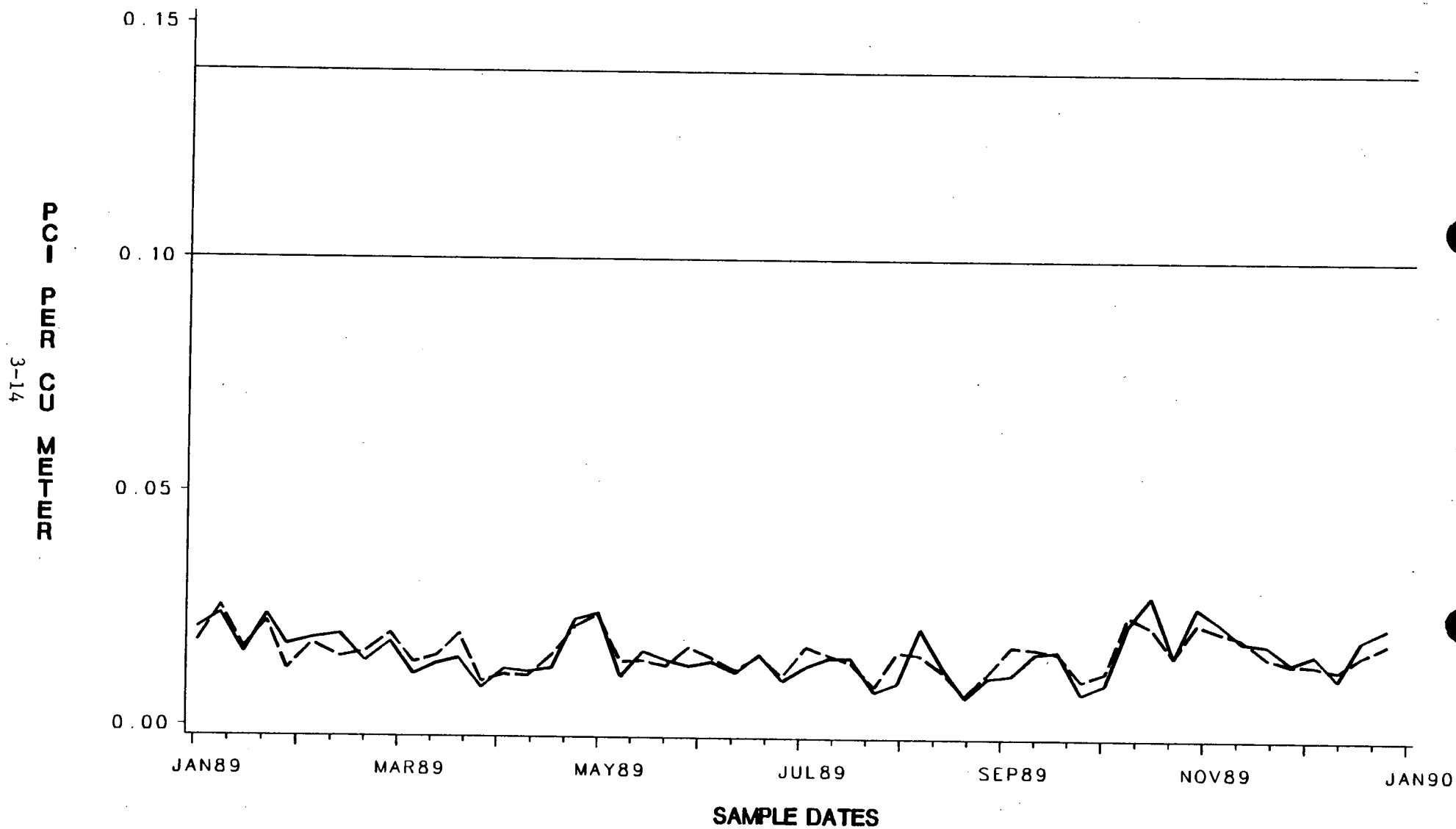


Figure 3-6

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0055



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

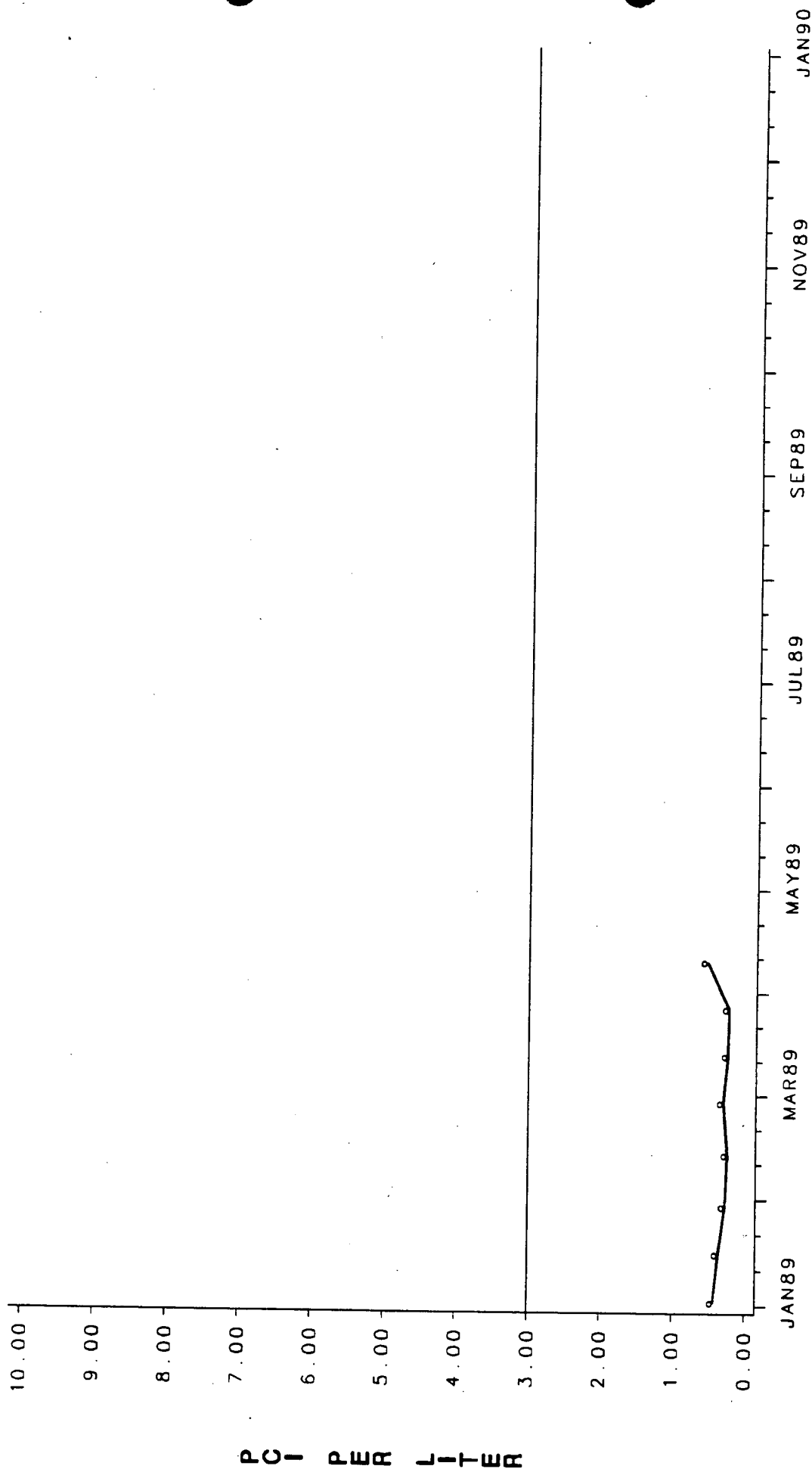
PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

CP&L ENVIRONMENTAL SURVEILLANCE

IODINE-131 ACTIVITY FOR

MILK SAMPLES

PLANT=HBR POINT=0053



SYMBOL < LLD

STATION '0053' IS THE CONTROL POINT

REPORTING LEVEL IS 3.0

Figure 3-8

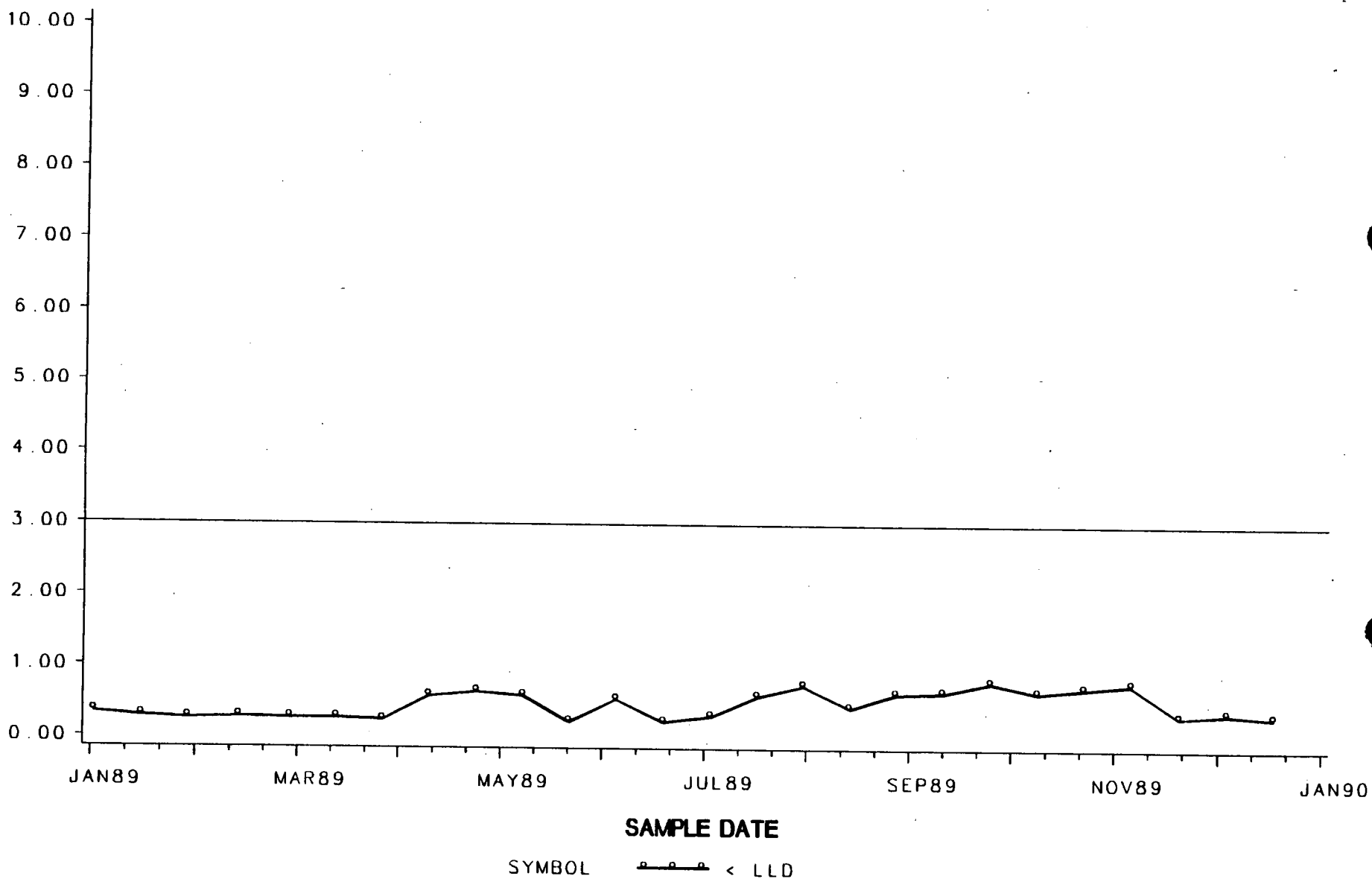
CP&L ENVIRONMENTAL SURVEILLANCE

IODINE-131 ACTIVITY FOR

MILK SAMPLES

PLANT=HBR POINT=0054

3-16
PC-1
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M
J
J
M
M



STATION '0053' IS THE CONTROL POINT

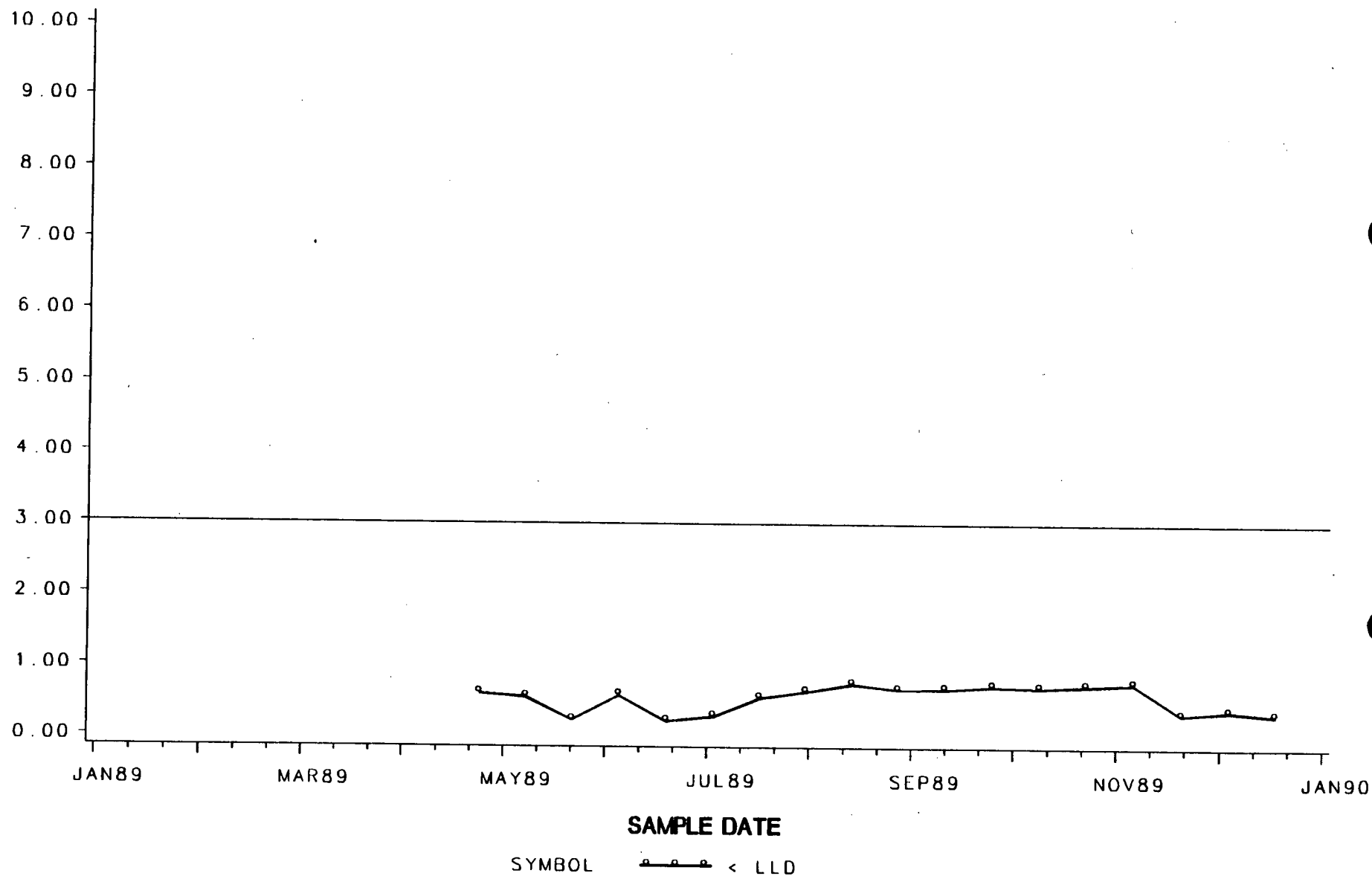
CP&L ENVIRONMENTAL SURVEILLANCE

IODINE-131 ACTIVITY FOR

MILK SAMPLES

PLANT=HBR POINT=0063

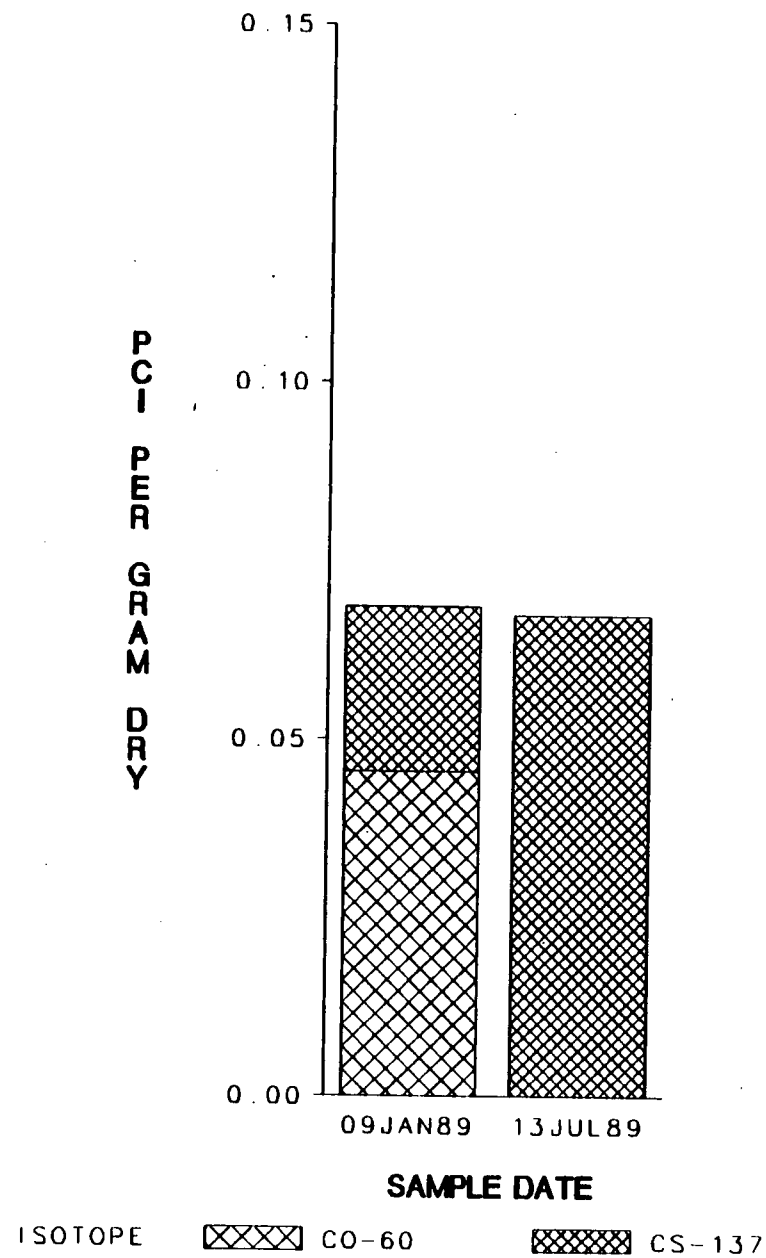
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PC-3
PC-4
PC-5
PC-6
PC-7
PC-8
PC-9
PC-10
PC-11
PC-12
PC-13
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PC-96
PC-97
PC-98
PC-99
PC-100



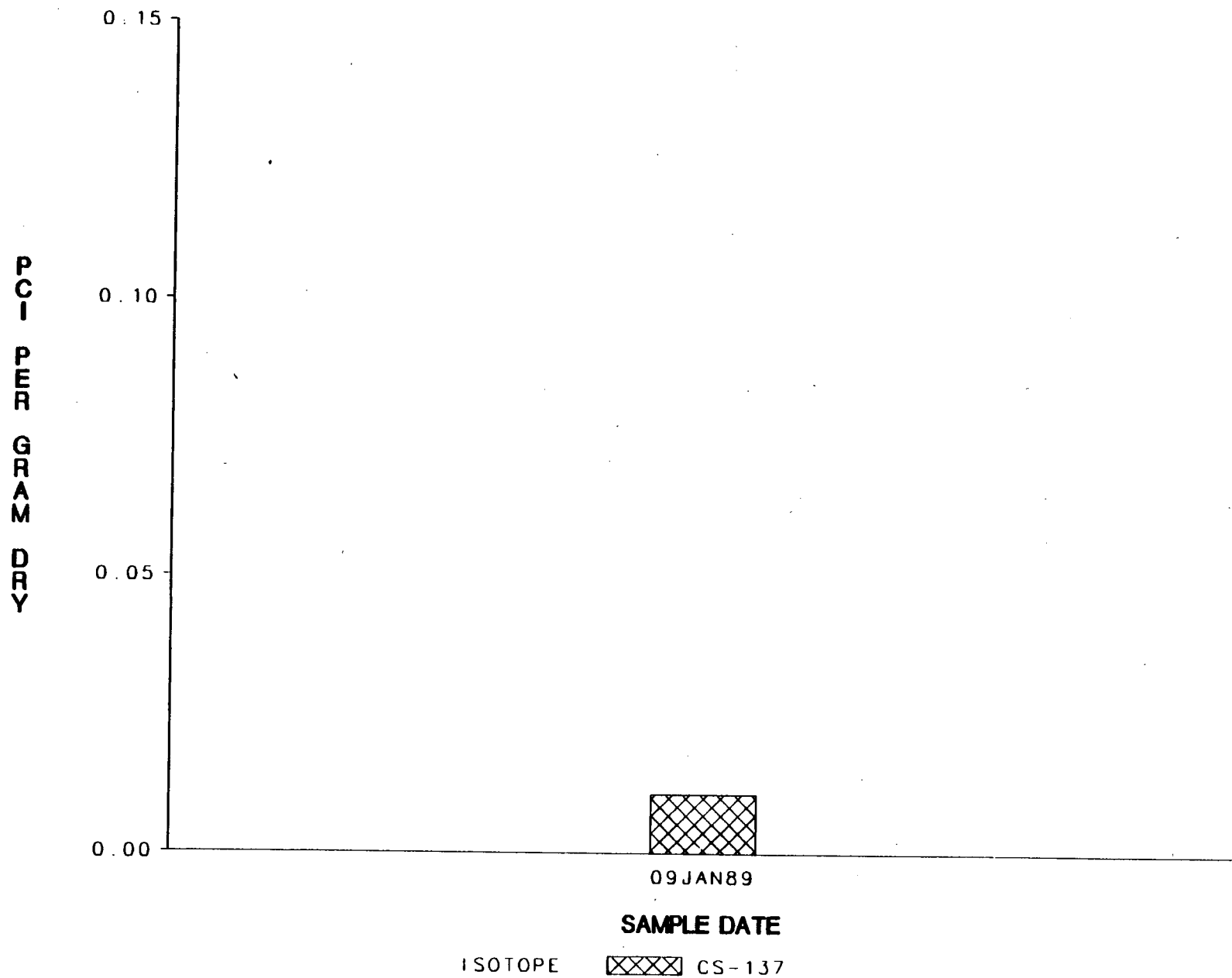
STATION '0053' IS THE CONTROL POINT

REPORTING LEVEL IS 3.0

CP&L ENVIRONMENTAL SURVEILLANCE
GAMMA ACTIVITY FOR
SHORELINE SEDIMENT SAMPLES
PLANT=HBR SAMPLE POINT=0057



CP&L ENVIRONMENTAL SURVEILLANCE
GAMMA ACTIVITY FOR
SHORELINE SEDIMENT SAMPLES
PLANT=HBR SAMPLE POINT=0044



CP&L ENVIRONMENTAL SURVEILLANCE
YEARLY GAMMA ACTIVITY FOR
SHORELINE SEDIMENT SAMPLES
PLANT=HBR SAMPLE POINT=0010

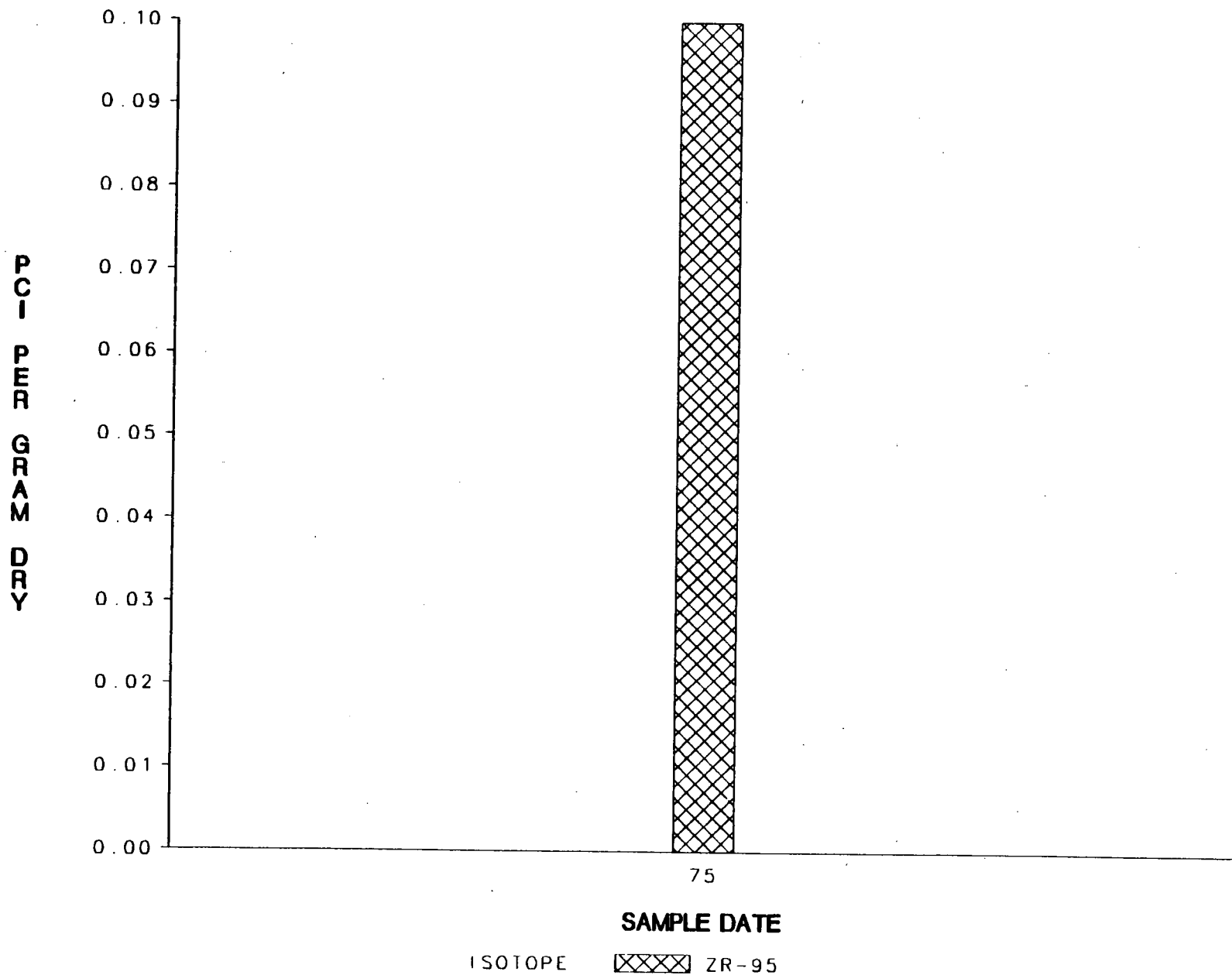
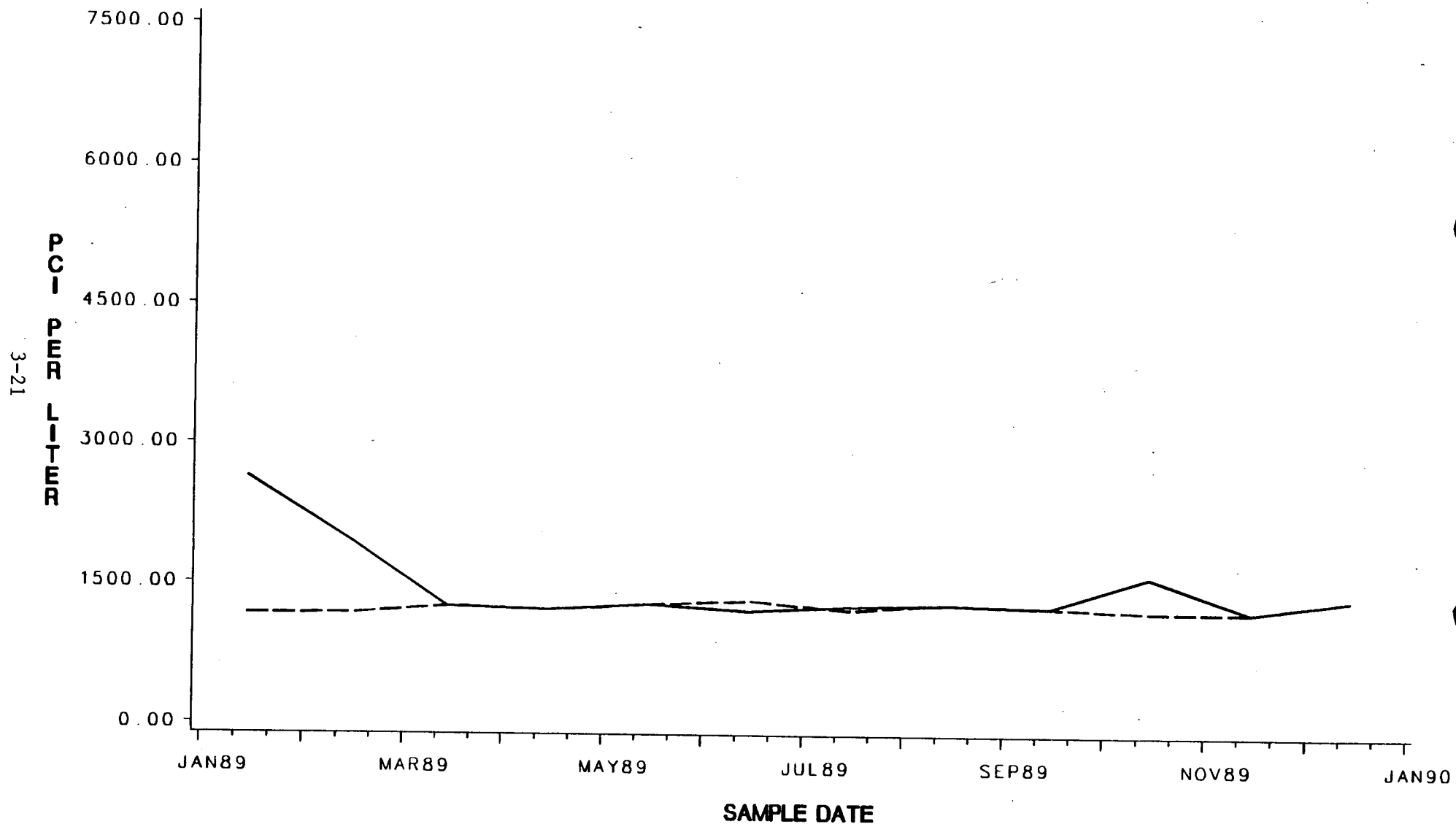


Figure 3-13

CP&L ENVIRONMENTAL SURVEILLANCE

TRITIUM ACTIVITY FOR
SURFACE WATER SAMPLES

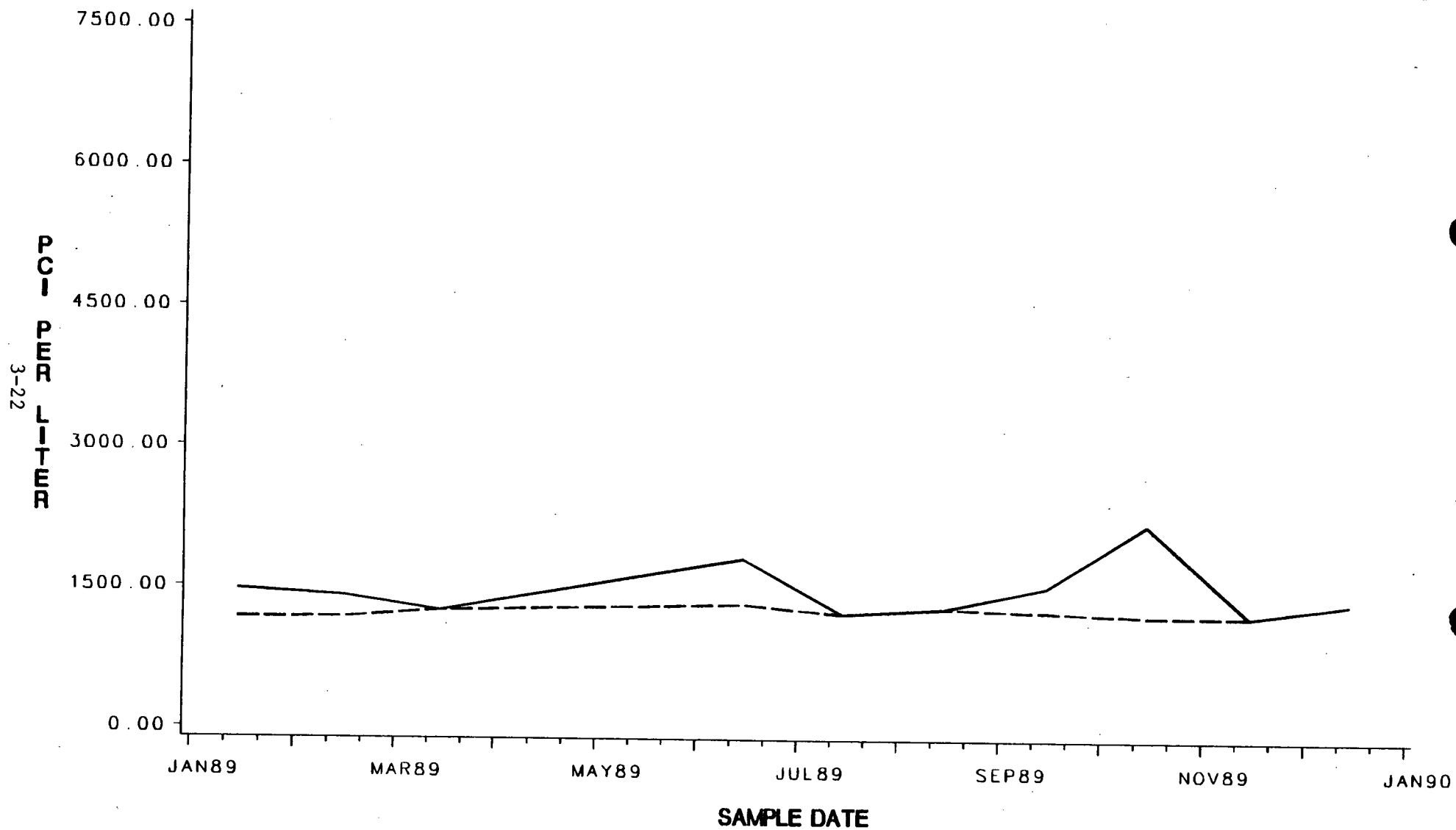
PLANT=HBR SAMPLE POINT=0040



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

SAMPLE DATA MAY OVERLAY CONTROL DATA

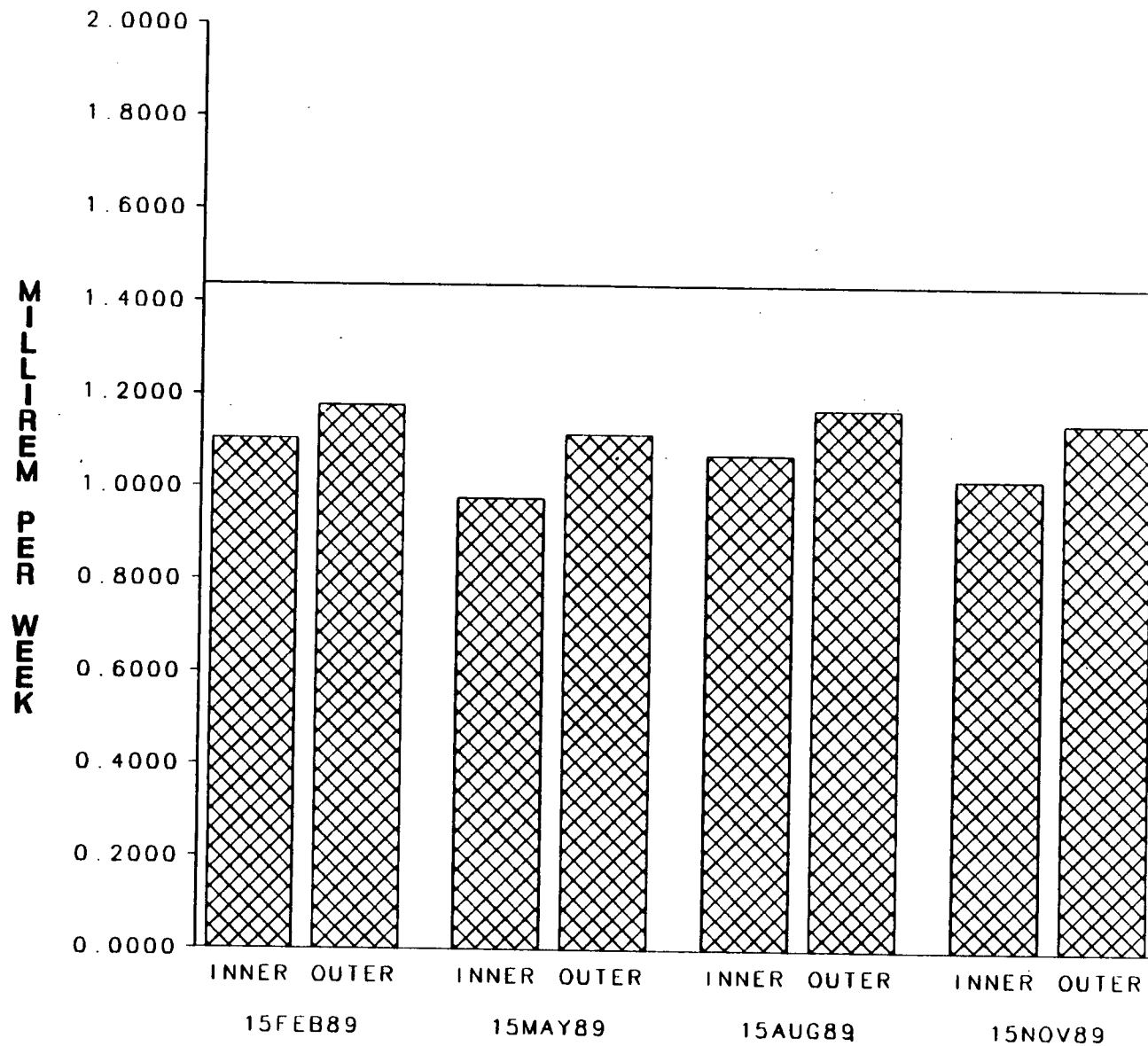
CP&L ENVIRONMENTAL SURVEILLANCE
TRITIUM ACTIVITY FOR
SURFACE WATER SAMPLES
PLANT=HBR SAMPLE POINT=0057



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

SAMPLE DATA MAY OVERLAY CONTROL DATA

CP&L ENVIRONMENTAL SURVEILLANCE
 TLD AVERAGES FOR
 INNER AND OUTER RING LOCATIONS
 PLANT=HBR



AVERAGE(1983-1987)=1.4358

4.0 MISSED SAMPLES AND ANALYSES

4.1 Air Cartridge and Air Particulate

Air filters and charcoal cartridges are collected weekly. In 1989 there were 52 weeks for each of 8 air monitoring locations for a possible total of 416 samples of each type. Twelve samples of each type were lost as detailed below.

<u>Location</u>	<u>Date(s)</u>	<u>Reason</u>
AC/AP-4	1/23	Tripped power breaker
AC/AP-5	5/15	Sampler malfunction
AC/AP-4	8/28	Pump and motor failure
AC/AP-2	10/2, 10/9	Power outage with Hurricane Hugo
AC/AP-6	10/16, 10/30, 11/6, 11/12 11/20, 11/27	Motor failure; replacement delayed

4.2 Broadleaf Vegetation

Broadleaf vegetation samples are collected monthly from three locations when available. Three different kinds of broadleaf vegetation should be collected from each location. Sampling at the control station is conducted to match each vegetation type from the indicator stations. Broadleaf vegetation was not available for the months of January, February, March, October, November, and December. During April "sassafras" was not available at BL 51, and "Black Jack Oak" was the third species. This entailed a fourth sample of "Black Jack Oak" at BL 52, the control station for comparison to the BL 51 sample. This provided 55 samples of a possible 108 samples.

4.3 Groundwater

Three deep wells are sampled monthly for a possible 36 samples. Groundwater site (GW 42) was not sampled during the months of January and February due to a pump failure.

4.4 Milk

During the month of April 1989, the milk production at the control station, Lyndale Farm Dairy (MK 53), ceased when the dairy went out of business. This station was replaced by Cunningham Dairy (MK 63) without a loss of a sample period.

4.5 Surface Water

SW 57 is an ash pond used by Unit 1. The pond was allowed to dry up during the months of April and May. No sample was available for those two sample periods.

4.6 Thermoluminescent Dosimeters (TLDs)

Forty TLD sites are maintained including one identified as an indicator station for the Robinson Impoundment Spent-Fuel Storage Installation (ISFSI). Excluded from the data set is one on-site station also maintained for the ISFSI. This would generate a maximum of 160 TLDs per year. The following TLDs were missing at the time of field collection for this indicated quarter:

Station	Location	Quarter
22	Shady Rest (1.9 miles NNE)	1
22	Shady Rest (1.9 miles NNE)	2
8	Power Poles (0.8 mile SSE)	3

5.0 LAND-USE CENSUS

The 1989 land-use census was performed on May 24-25, 1989, 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, and 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 with a 5-mile radius of the site in each of the 16 meteorological sectors. Changes in the land-use census from the previous year did not yield a potential higher dose to the maximum exposed individual from plant effluents sufficient to require changes in the environmental program.

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

Sector	Distance to Nearest Resident	Distance to Nearest Garden
N	2.90	2.90
NNE	1.30	1.80
NE	1.10	1.30
ENE	0.85	1.10
E	0.90	1.30
ESE	0.60	0.60
SE	0.30	1.60
SSE	0.30	2.00
S	0.30	0.30
SSW	0.25	0.25
SW	0.40	0.60
WSW	0.40	0.40
W	0.55	0.55
WNW	0.60	1.00
NW	1.35	1.35
NNW	2.80	2.80

No milk-producing animals are located within a 5-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 0.002 pCi/m^3 .

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 $1\text{E}-2 \text{ pCi/m}^3$.

Iodine-131 in milk is determined either by radiochemical or instrumental methods. Analysis involves use of anion-exchange resin and either direct gamma analysis of the resin with a sodium iodide (NaI) well-detector or sodium hypochlorite elution of the resin and organic extraction of the iodine, followed by precipitation as silver iodide. The precipitate is collected on a tared filter, dried, and counted on a low-background beta counter. The LLD using the NaI detector is approximately 0.5 pCi/l for milk. The LLD using the radiochemical separation and beta counting is approximately 0.4 pCi/l .

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 system is the Nuclear Data 6685. Table 6-1 summarizes LLD values derived from instrument sensitivity based upon a blank sample background.

Air particulate filter quarterly 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. One-liter samples of milk are analyzed in a Marinelli beaker.

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

Food products and broadleaf and aquatic 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 (TLD)

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 Radiochemistry 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 1989, 55 analyses were completed on 21 samples representing 3 major environmental media (water, milk, and air filters). Data on the known activities and the normalized standard deviations for these 55 analyses have been received from the EPA. 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) From Known Activity</u>	<u>Percent of Analyses</u>
≤ 1 standard deviation	67
≤ 2 standard deviation	85
≤ 3 standard deviation	98

A gross alpha analysis of a water sample received in November 1989 fell outside the 3σ limit. Preliminary examination of the problem suggests that the counter alpha efficiency at low self-absorption weights may be incorrect. New self-absorption curve will be prepared.

6.7 Lower Limits of Detection (LLD)

All samples analyzed met the LLD required by Technical Specification 6.9.1.7 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/Groundwater Samples
(Freshwater)

Isotope	(LLD)
Cr-51	19 pCi/l
Mn-54	3
Co-58	3
Co-60	3
Zn-65	4
Nb-95	5
Zr-95	3
I-131	7
Cs-134	3
Cs-137	3
Ba-140	20
La-140	7
Other Expected Gamma Emitters	1-79

Air Particulates
(Quarterly Composite)

Isotope	(LLD)
Cs-134	0.001 pCi/cubic meter
Cs-137	0.001
Ba-140	0.017
La-140	0.006
Other Expected Gamma Emitters	0.001-.014

Table 6-1 (continued)

Milk
(gamma scan)

Isotope	(LLD)
Cr-51	27 pCi/l
Mn-54	4
Co-58	4
Co-60	6
I-131	4
Cs-134	5
Cs-137	5
Ba-140	16
La-140	5
Other Expected Gamma Emitters	1-95

Sediments
(Shoreline or Bottom)

Isotope	(LLD)
Cr-51	263 pCi/kg (dry weight)
Mn-54	50
Co-58	36
Co-60	36
Cs-134	61
Cs-137	39
Other Expected Gamma Emitters	28-618

Table 6-1 (continued)

Fish

Isotope	(LLD)
Cr-51	174 pCi/kg (wet weight)
Mn-54	13
Co-58	32
Co-60	38
Zn-65	62
I-131	28
Cs-134	33
Cs-137	29
Other Expected Gamma Emitters	13-668

Food Products and Vegetation

Isotope	(LLD)
Cr-51	105 pCi/kg (wet weight)
Mn-54	15
Co-58	17
Co-60	18
I-131	12
Cs-134	16
Cs-137	13
Other Expected Gamma Emitters	11-310