APPENDIX 5

ANNUAL REPORT: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1989

DONALD C. COOK NUCLEAR PLANT

UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1989 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1989

Prepared by

INDIANA MICHIGAN POWER COMPANY
and
TELEDYNE ISOTOPES

April 15, 1990

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

APPENDECIES

TABLE OF CONTENTS (Cont)

LIST OF FIGURES

LIST OF TABLES

SUMMARY

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK POWER NUCLEAR PLANT

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY

This report summarizes the collection and analysis of various environmental sample media in 1989 for the Radiological Environmental Monitoring Program for the Donald C. Cook Nuclear Plant.

The various analyses of most sample media suggest that there was no discernable impact of the nuclear plant on the environment. The analysis of air particulate filters, charcoal cartridges, direct radiation by thermoluminescent dosimeters, fish, water, and sediments from Lake Michigan, drinking water, and food products, either did not detect any radioactivity or measured only naturally occurring radionuclides at normal background levels. Of the 174 milk samples analyzed for iodine-131, three samples had measurable activity, but very low concentrations. The highest iodine-131 concentration was only two times the required measurement sensitivity. Since no iodine-131 was detected in any charcoal cartridge, which monitors the potential airborne pathway to the farms, it seems unlikely that the measured iodine-131 is a result of plant operations.

Tritium, measured at low levels in on-site wells, appears to be the only radionuclide attributable to the plant operations. However, the associated groundwater does not provide a direct dose pathway to man.

I. INTRODUCTION

I. INTRODUCTION

The Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program (REMP) is conducted in compliance with NRC Regulatory Guides 1.21 and 4.1, licensing commitments, and Technical Specifications. The REMP was developed in accordance with the NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, November 1979. A synopsis of the sampling program and maps can be found in Section II, Sampling and Analysis Program. This report represents the Annual Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1, 1989 through December 31, 1989.

A. The Donald C. Cook Nuclear Plant of Indiana Michigan Power Company is located on the southeastern shore of Lake Michigan approximately one mile northwest of Bridgman, Michigan. The plant consists of two pressurized water reactors, Unit 1, 1133 MWE and Unit 2, 1152 MWE. Unit 1 achieved initial criticality on January 18, 1975 and Unit 2 achieved initial criticality on March 10, 1978.

B. Objectives

The objectives of the operational radiological environmental monitoring program are:

1. Identify and measure radiation and radioactivity in the plant environs for the calculation of potential dose to the population.

2. Verify the effectiveness of in-plant measures used for controlling the release of radioactive materials.

3. Provide reasonable assurance that the predicted doses, based on effluent data, have not been substantially underestimated and are consistent with applicable standards.

4. Comply with regulatory requirements and Station Technical Specifications and provide records to document compliance.

II. SAMPLING AND ANALYSIS PROGRAM

II. SAMPLING AND ANALYSIS PROGRAM

Table I summarizes the sampling and analysis program for the Donald C. Cook Nuclear Plant for 1989. For each sample medium, the table lists the sample locations, including distance and direction from the center of the two units, and the station identification. The station identifications for many of the sampling locations are shown on the maps, Figures 1, 2, and 3. Also for each sample medium the sample collection frequency, type of analysis, and frequency of analysis are listed.

TABLE 1

DONALD C. COOK NUCLEAR PLANT- 1989

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance		Direction	Degrees	Collection Frequency	Analysis/Frequency
Environmental (TLD's)							
ONS-1	(A-1)	0.4	mi	NNE	18°	Quarterly	Direct Radiation/Quarterly
ONS-2	(A-2)	0.4	mi	NE	48°		
ONS-3	(A-3)	0.5	mi	E	90°		
ONS-4	(A-4)	0.4	mi	ESE	118°		
ONS-5	(A-5)	0.4	mi	S	189°		
ONS-6	(A-6)	0.4	mi	SSW	210°		
ONS-7	(A-7)	0.4	mi	NE	36°		
ONS-8	(A-8)	0.4	mi	ENE	80°		
ONS-9	(A-9)	0.3	mi	SSE	149°		
ONS-10	(A-10)	0.3	mi	SE	127°		
ONS-11	(A-11)	0.4	mi	NNE	11°		
ONS-12	(A-12)	0.4	mi	ENE	63°		
New Buffalo	(NBF)	16.0	mi	SSW			
South Bend	(SBN)	24.0	mi	SE			
Dowagiac	(DOW)	26.0	mi	ENE			
Coloma	(COL)	20.0	mi	NNE			
Intersection of Red Arrow Hwy. & Marquette Woods Rd, Pole #B294-44	(OFS-1)	4.5	mi	NNE			
Stevensville Substation	(OFS-2)	3.0	mi	NNE			
Pole #B296-13	(OFS-3)	5.0	mi	NE			
Pole #B350-72	(OFS-4)	4.2	mi	ENE			
Intersection of Shawnee & Cleveland, Pole #B387-32	(OFS-5)	4.0	mi	ESE			
Intersection of Snow Rd. & Holden, Pole #B426-70	(OFS-6)	4.5	mi	SE			
Bridgman Substation	(OFS-7)	2.5	mi	S			
California Rd., Pole #B424-20	(OFS-8)	4.0	mi	SSE			
Ruggles Rd., Pole B369-214	(OFS-9)	4.5	mi	E			
Intersection of Red Arrow Hwy., & Hildebrant Rd.,Pole #B422-152	(OFS-10)	3.8	mi	SSW			
Intersection of Snow Rd. & Baldwin Rd., Pole #B423-12	(OFS-11)	3.8	mi	S			

TABLE 1 (Cont.)
DONALD C. COOK NUCLEAR PLANT- 1989
RADIOLOGICAL SAMPLING STATIONS
DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Air Charcoal/Particulates						
ONS-1	(A-1)	0.4 mi	NNE	18°	Weekly	Gross Beta/Weekly
ONS-2	(A-2)	0.4 mi	NE	48°		I-131/Weekly
ONS-3	(A-3)	0.5 mi	E	90°		Gamma Isotopic/
ONS-4	(A-4)	0.4 mi	ESE	118°		Quarterly Composite
ONS-5	(A-5)	0.4 mi	S	189°		
ONS-6	(A-6)	0.4 mi	SSW	210°		
New Buffalo	(NBF)	16.0 mi	SSW			
South Bend	(SBN)	24.0 mi	SE			
Dowagiac	(DOW)	26.0 mi	ENE			
Coloma	(COL)	20.0 mi	NNE			
Ground/Well Water						
Onsite	(W-1)	0.4 mi	NNE	11°	Quarterly	Gamma Isotopic/Quarterly
Onsite	(W-2)	0.4 mi	ENE	63°		Tritium/Quarterly
Onsite	(W-3)	0.6 mi	ESE	107°		I-131/Quarterly
Onsite	(W-4)	0.1 mi	WNW	301°		
Onsite	(W-5)	0.1 mi	WNW	290°		
Onsite	(W-6)	0.1 mi	W	273°		
Onsite	(W-7)	0.4 mi	S	189°		
Non Technical Specification Wells						
Steam Generator Storage Facility	(SGRP-1)	0.8 mi	ESE	96°	Quarterly	Gross Beta/Quarterly Gross Alpha/Quarterly
Steam Generator Storage Facility	(SGRP-2)	0.7 mi	ESE	93°		Gamma Isotopic/Quarterly I-131/Quarterly
Steam Generator Storage Facility	(SGRP-4)	0.7 mi	ESE	96°		
Steam Generator Storage Facility	(SGRP-5)	0.7 mi	ESE	94°		

TABLE 1 (Cont.)
DONALD C. COOK NUCLEAR PLANT- 1989
RADIOLOGICAL SAMPLING STATIONS
DISTANCE AND DIRECTION FROM PLANT AXIS

Location		Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Drinking Water							
St. Joseph Public Intake		(STJ)	9.0 mi	NE		Daily	Gross Beta/14 Day Composite Gamma Isotopic/14 Day Composite I-131/14 Day Composite
Lake Township Public Intake Station		(LTW)	0.40 mi	S			Tritium/Quarterly Composite
Surface Water							
Condenser Circulating Water Intake		L1					
Lake Michigan Shoreline		L-2	0.24 mi	S		Daily	Gamma Isotopic/Monthly
Lake Michigan Shoreline		L-3	0.44 mi	N			Composite
Lake Michigan Shoreline		L-4	0.33 mi	SSW			Tritium/Quarterly Composite
Lake Michigan Shoreline		L-5	0.35 mi	NNE			I-131/Monthly Composite
Sediment							
Lake Michigan Shoreline		L-2	0.24 mi	S			
Lake Michigan Shoreline		L-3	0.44 mi	N		Semi-annually	Gamma Isotopic/Semi-
Lake Michigan Shoreline		L-4	0.33 mi	SSW			Annually
Lake Michigan Shoreline		L-5	0.35 mi	NNE			
Milk							
Totzke Farm	Baroda	Totzke	4.5 mi	ENE			
Wyant Farm	Dowagaic	Wyant	18.0 mi	E			
Schuler Farm	Baroda	Schuler	4.25 mi	SE			
Livinghouse Farm	La Porte	Livinghouse	20.0 mi	S		Once per every	Gamma Isotopic/per Sample
Warmbien Farm	Three Oaks	Warmbien	7.8 mi	S		14 Days	I-131 per Sample
Zelmer Farm	Bridgman	Zelmer	4.75 mi	SSE			
Lomzack Farm	Gallen	Lozmack	9.0 mi	SSE			

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1989

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

Location		Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Fish							
Lake Michigan		ONS-N	0.5 mi maximum	N		Semi-annually	Gamma Isotopic/
Lake Michigan		ONS-S	0.5 mi maximum	S			Semi-annually
Lake Michigan		OFS-N	0.5 mi minimum	N			
Lake Michigan		OFS-S	0.5 mi minimum	S			
Food							
Grapes,Grape Leaves,	Offsite	Indicator	Variable	Determined from offsite			
Grapes,Grape Leaves,	Offsite	Control	20 miles	Dose Calculation manual		At time of harvest	Gamma Isotopic/
Broadleaf Vegetation	Onsite		Variable				At time of harvest

- Composite samples of Drinking and Surface water shall be collected at intervals not to exceed 24 hours.

- Particulate sample filters should be analyzed for gross beta activity 24 or more hours following filter removal. This will allow for radon and thoron daughter decay. If gross beta activity in air or water is greater than 10 times the yearly mean of control samples for any medium, gamma isotopic analysis should be performed on the individual samples.

Please note the following defenitions:

Weekly - at least once per every seven (7) days

Quarterly - at least once per every ninety-two (92) days

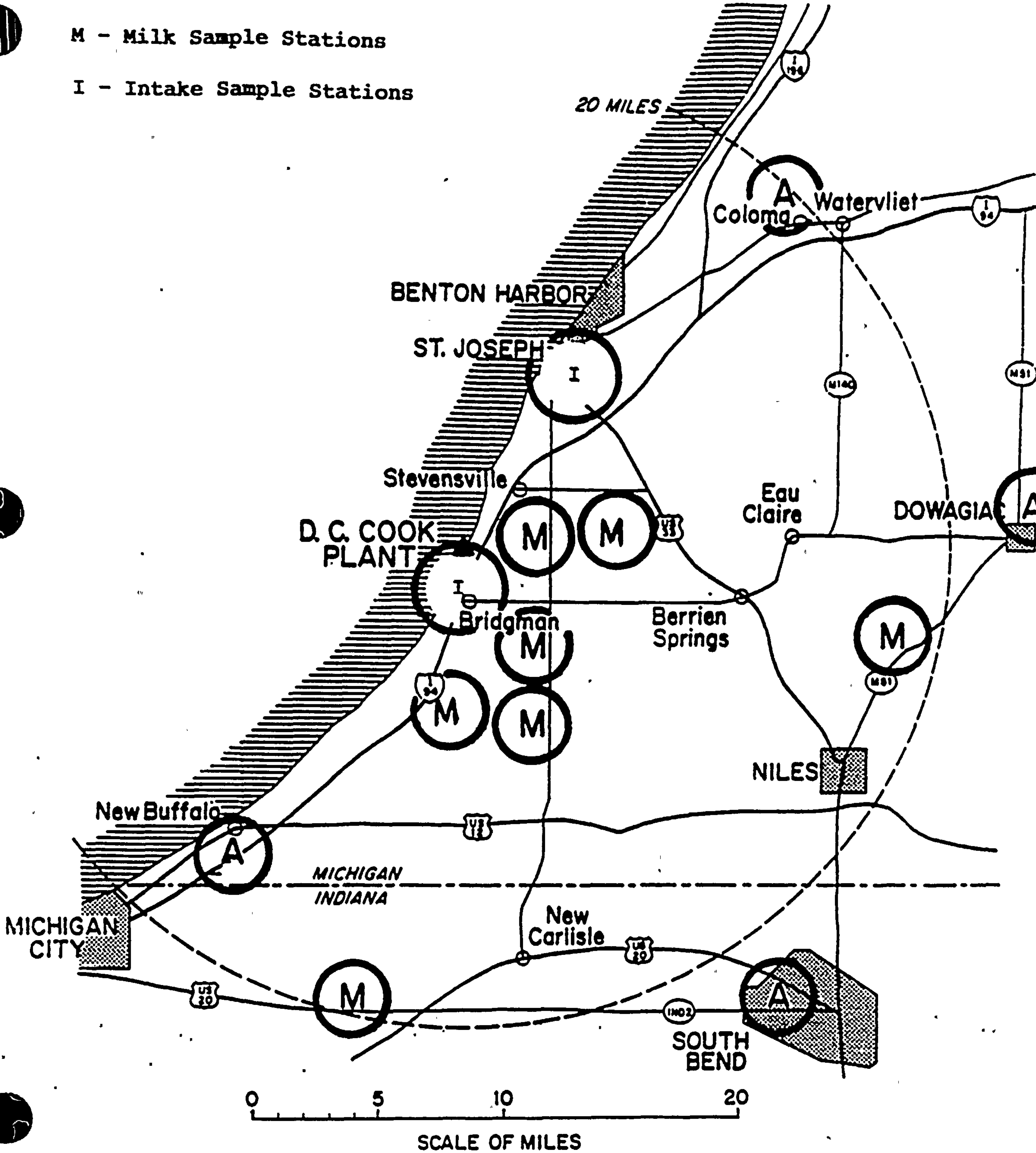
Semi-annually - at least once every one hundred eighty-four (184) days

Figure 1

A - Control Air and TLD Stations

M - Milk Sample Stations

I - Intake Sample Stations



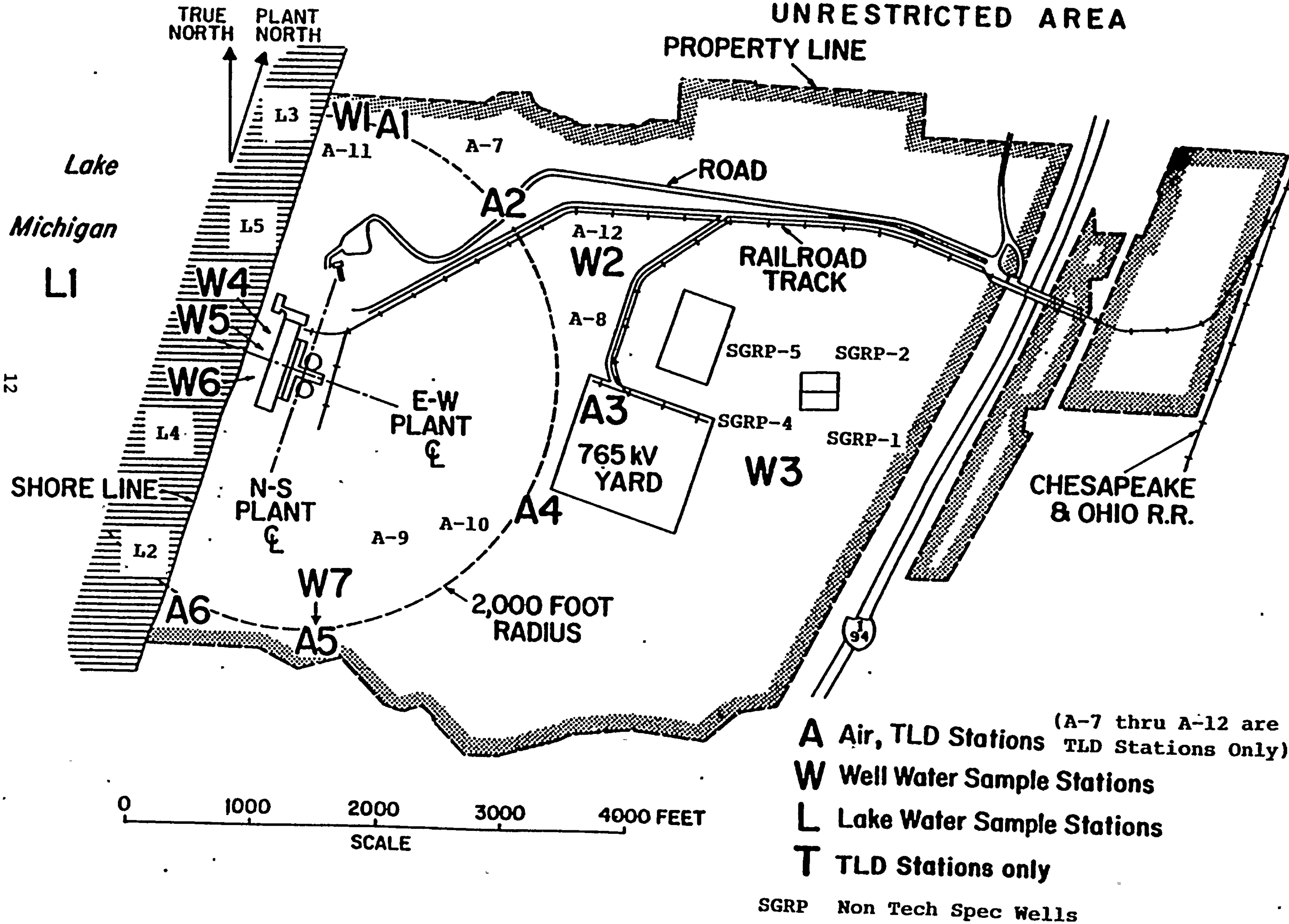
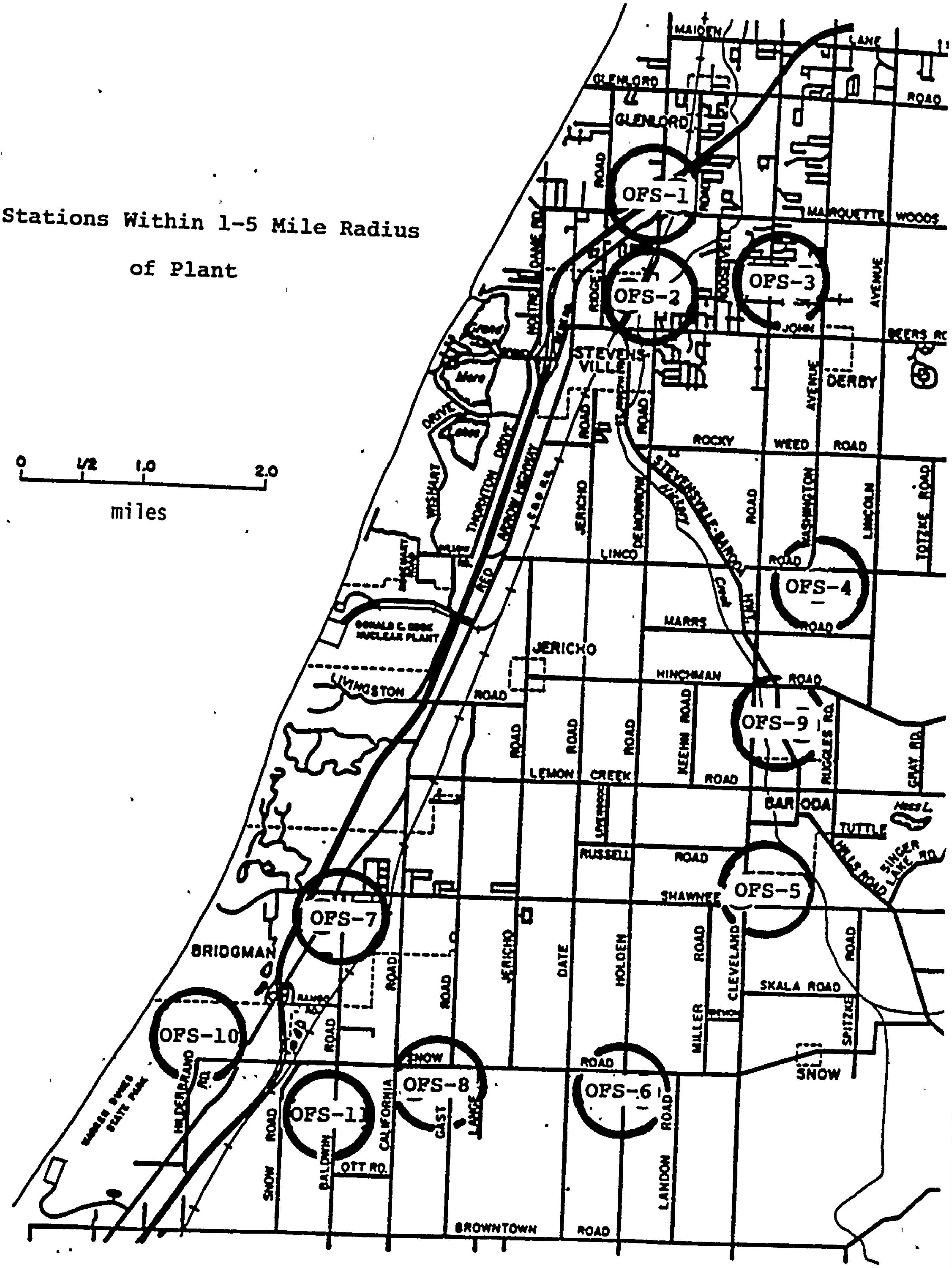

UNRESTRICTED AREA
PROPERTY LINE
TRUE NORTH
PLANT NORTH
Lake Michigan
L1
L2
L3
L4
L5
W1
A1
A-7
A-11
A2
ROAD
A-12
W2
RAILROAD TRACK
W4
W5
W6
A-8
SGRP-5
SGRP-2
SGRP-4
SGRP-1
E-W PLANT ℄
A3
765 kV YARD
W3
CHESAPEAKE & OHIO R.R.
SHORE LINE
N-S PLANT ℄
A-9
A-10
A4
W7
A6
A5
2,000 FOOT RADIUS
I 94
0
1000
2000
3000
4000 FEET
SCALE
A Air, TLD Stations (A-7 thru A-12 are TLD Stations Only)
W Well Water Sample Stations
L Lake Water Sample Stations
T TLD Stations only
SGRP Non Tech Spec Wells

Figure 2

Figure 3

TLD Stations Within 1-5 Mile Radius

of Plant



III. SUMMARY AND DISCUSSION OF 1989 ANALYTICAL RESULTS

III. SUMMARY AND DISCUSSION OF 1989 ANALYTICAL RESULTS

A discussion of the data from the radiological analyses of environmental media collected during the report period is provided in this section. Analyses of samples collected in the first ten months of 1989 were performed by Controls for Environmental Pollution, Inc. (CEP) in Santa Fe, New Mexico. Analyses of samples collected in November and December of 1989 were analyzed by Teledyne Isotopes, Inc. (TI) in Westwood, New Jersey. The procedures and specifications followed at Teledyne Isotopes 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 are proved in Appendix C. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Appendix D.

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 performed during the reporting period. Comparison is made where possible with radioactivity concentrations measured in the preoperational period of August 1971 to the initial criticality of Unit 1 on January 12, 1975. A brief summary of the preoperational program is found in Appendix G.

A. <u>Airborne Particulates</u>

Results of gross beta activities are presented in Table B-1. The measurement of the gross beta activity on the weekly air particulate filters is a good indication of the levels of natural and or manmade radioactivity in the environment. The average gross beta concentration of the six indicator locations was 0.021 pCi/m^3 with a range of individual values between 0.004 and 0.049 pCi/m^3. The average gross beta concentration of the four control locations was 0.022 pCi/m^3 with a range between 0.011 and 0.057 pCi/m^3. In Figure 4 the monthly average gross beta concentrations for the indicator locations and for the control locations are plotted. The gross beta concentrations in air particulate filters in 1989 were lower than at the end of the preoperational period when the effects of the recent atmospheric nuclear tests were being detected.

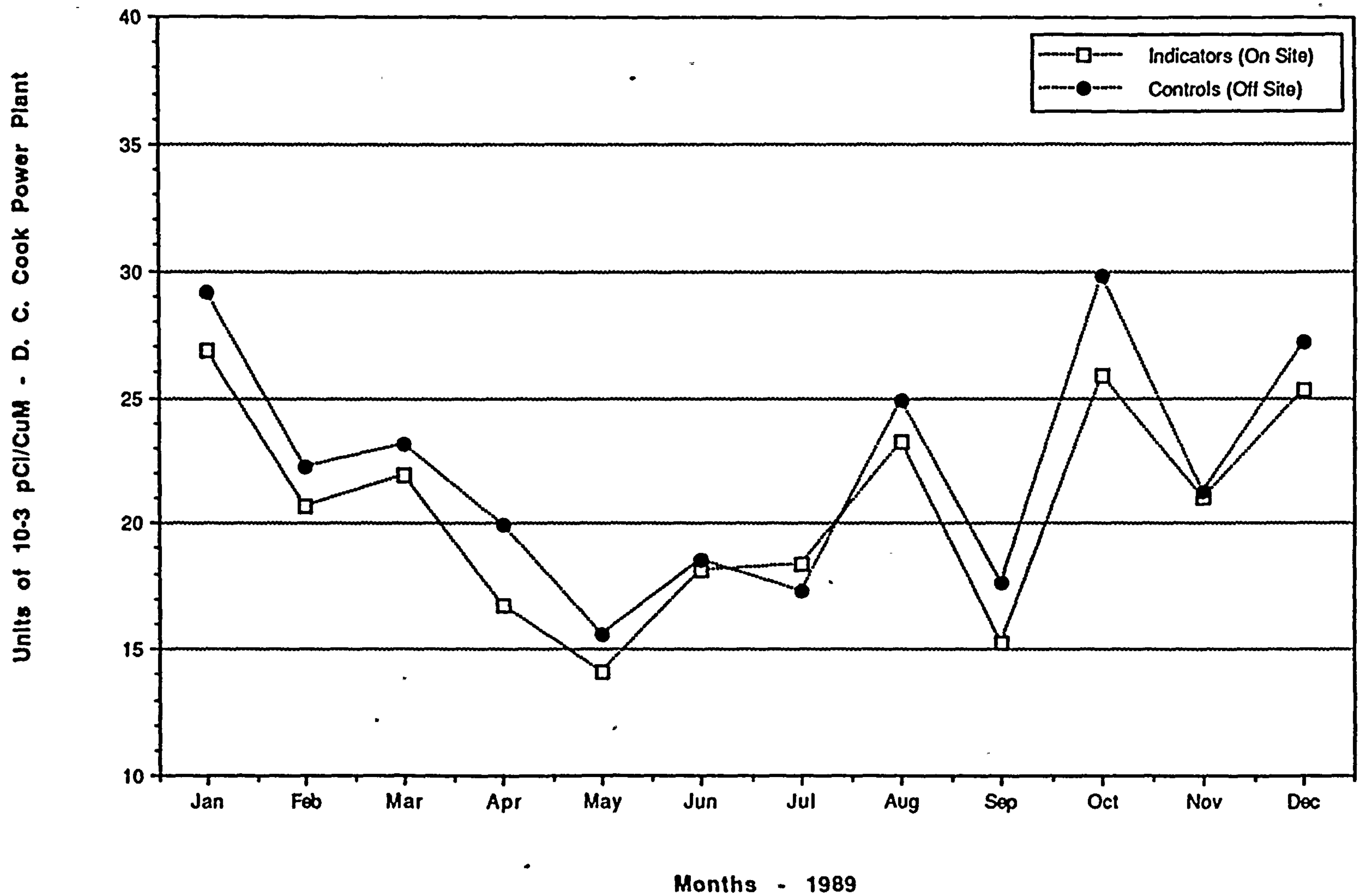
Air particulate filters were composited by location on a quarterly basis and were analyzed by gamma ray spectroscopy. Cosmogenically produced beryllium-7 was measured in the fourth quarter composites by Teledyne Isotopes. The average concentration was 0.083 pCi/m^3 and the values ranged from 0.074 to 0.103 pCi/m^3. These values are typical of beryllium-7 measured at various locations throughout the United States. CEP did not report beryllium-7 results in the first three quarters of the year but undoubtedly beryllium-7 was measured. Naturally occurring potassium-40, probably from dust, was measured in one of the fourth quarter composites with a concentration of 0.005 pCi/m^3. No other gamma emitting radioactivity was detected.

B. <u>Airborne Iodine</u>

Charcoal cartridges are installed downstream of the particulate filters and are used to collect airborne radioiodine. The results of the weekly analysis of the charcoal cartridges are presented in Table B-3. All results were below the lower level of detection with no positive activity detected.

Figure 4

AVERAGE MONTHLY GROSS BETA IN AIR PARTICULATES



C. Direct Radiation - Thermoluminescent Dosimeters

Thermoluminescent dosimeters (TLDs) measure external radiation exposure from several sources including naturally occurring radionuclides in the air and soil, radiation from cosmic origin, fallout from atomic weapons testing, potential radioactive airborne releases from the power plant and direct radiation from the power plant. The TLDs record the exposure from all of these potential sources and then are processed on a quarterly basis. The average value of the readings of the four areas of each dosimeter (calibrated individually after each field exposure period for response to a known exposure and for intransit exposure) are presented in Table B-4.

Teledyne Isotopes was the subcontractor to CEP for the environmental TLD service for this program in 1989. As a result the TLDs were subjected to a circuitous transit route from New Jersey to New Mexico to Michigan for the initial trip and the reverse for the return trip. An added complication was the use of site controls at all three locations. The results of the first and fourth quarters had average exposures of 0.91 and 1.1 mR/week, respectively. Those exposure rates are quite typical of observed rates at many other locations in the country. The second and third quarters had average exposures that appear to be low (0.55 mR/week) by a factor of two and high (2.1 mR/week) by a factor of two, respectively. Perhaps fortuitously then, the annual average of 1.2 mR/week for all locations of dosimeters for this program in 1989 is approximately a typical exposure rate. The 1989 annual average in the environs of the Donald C. Cook Nuclear Plant is at the low range of the exposure rates (1.0 to 2.0 mR/week) measured during the preoperational period.

D. Surface Water

Lake Michigan surface water samples from the condenser circulating water intake and from four shoreline locations, all within 0.5 mile of the two reactors were collected daily and composited monthly for iodine-131 analysis and analyzed by gamma ray

spectroscopy and composited quarterly for tritium analysis. The results of analyses are shown in Table B-5. No iodine-131 nor gamma emitting isotopes were detected. During the first nine months of 1989 tritium was analyzed monthly (more frequently than required). All tritium measurements for the year were at normal background levels or below the lower limit of detection. The fourth quarter composite tritium concentrations were between 160 and 280 pCi/liter. Tritium was measured in preoperational surface water samples at concentrations of approximately 400 pCi/liter. Naturally occurring gamma emitting isotopes were detected by gamma ray spectroscopy.

E. Groundwater

Water samples are collected quarterly from seven wells, all within 1000 meters of the reactors. The samples are analyzed for gamma emitters and for tritium. The results are presented in Table B-6. No gamma emitting isotopes were detected. The on-site wells 4, 5, and 6 had measurable tritium activity throughout 1989 with average concentrations of 2300, 1930, and 1560 pCi/liter. The well at Livingston Beach had measurable tritium in the first half of 1989 with an average concentration of 1000 pCi/liter. The fourth quarter tritium measurements were performed with a tritium detection capability within the program requirements but not with the higher sensitivity capability method used in the first three quarters. As a result the fourth quarter tritium measurements in the wells at Rosemary Beach and Scrapyard are not considered as reliable as in previous quarters. The measured concentration of 2400 pCi/liter at each location is marginally above the detection limit. Tritium measurements in 1990 will be performed with a detection limit of 300 pCi/liter. At that time it will be possible to determine more precisely whether tritium is above background levels at those two locations. The annual concentrations of tritium in the seven wells are plotted from 1979 through 1989 in Figure 5.

Figure 5 pg. 1

TRITIUM IN GROUND/WELL WATER

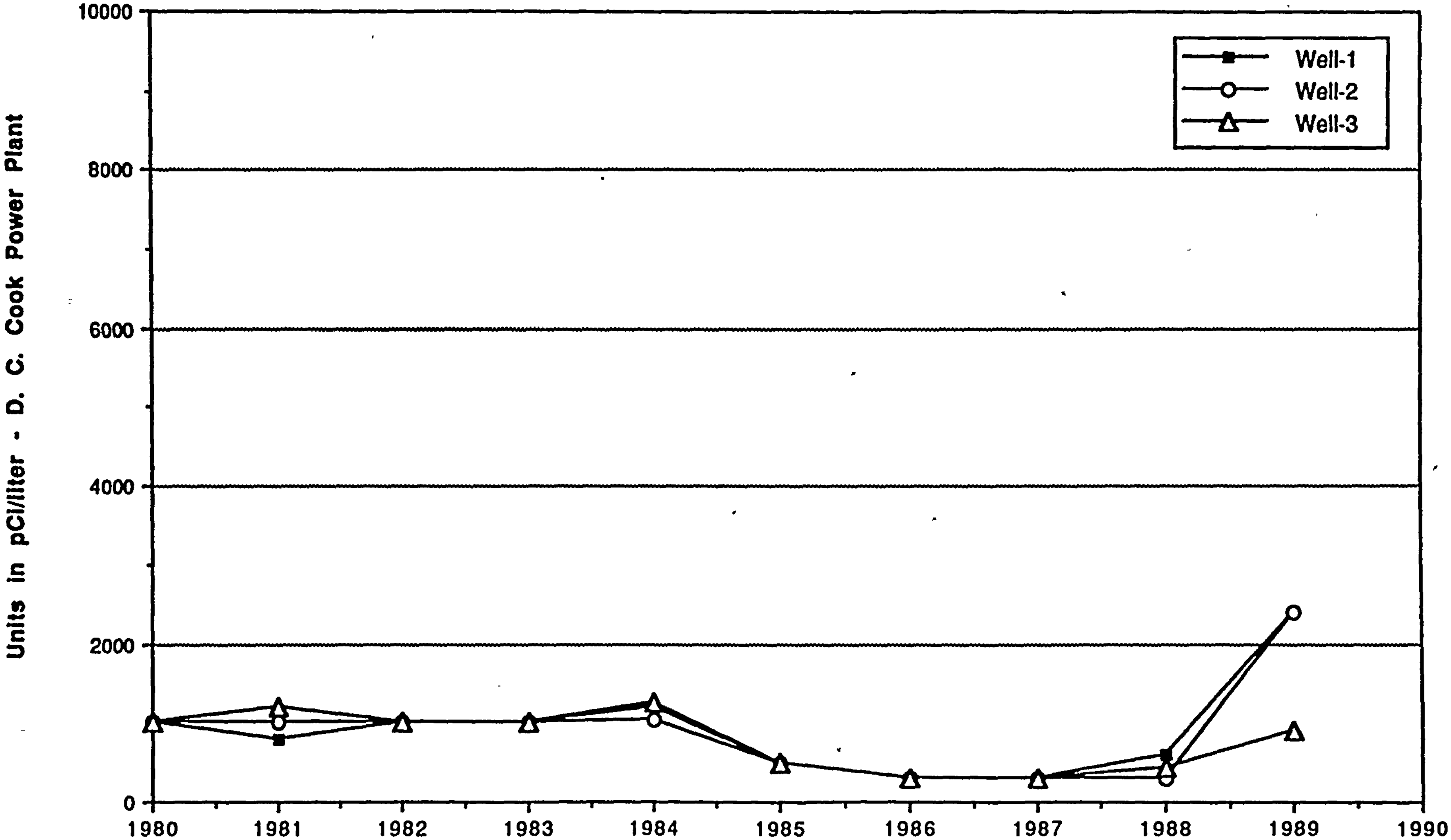
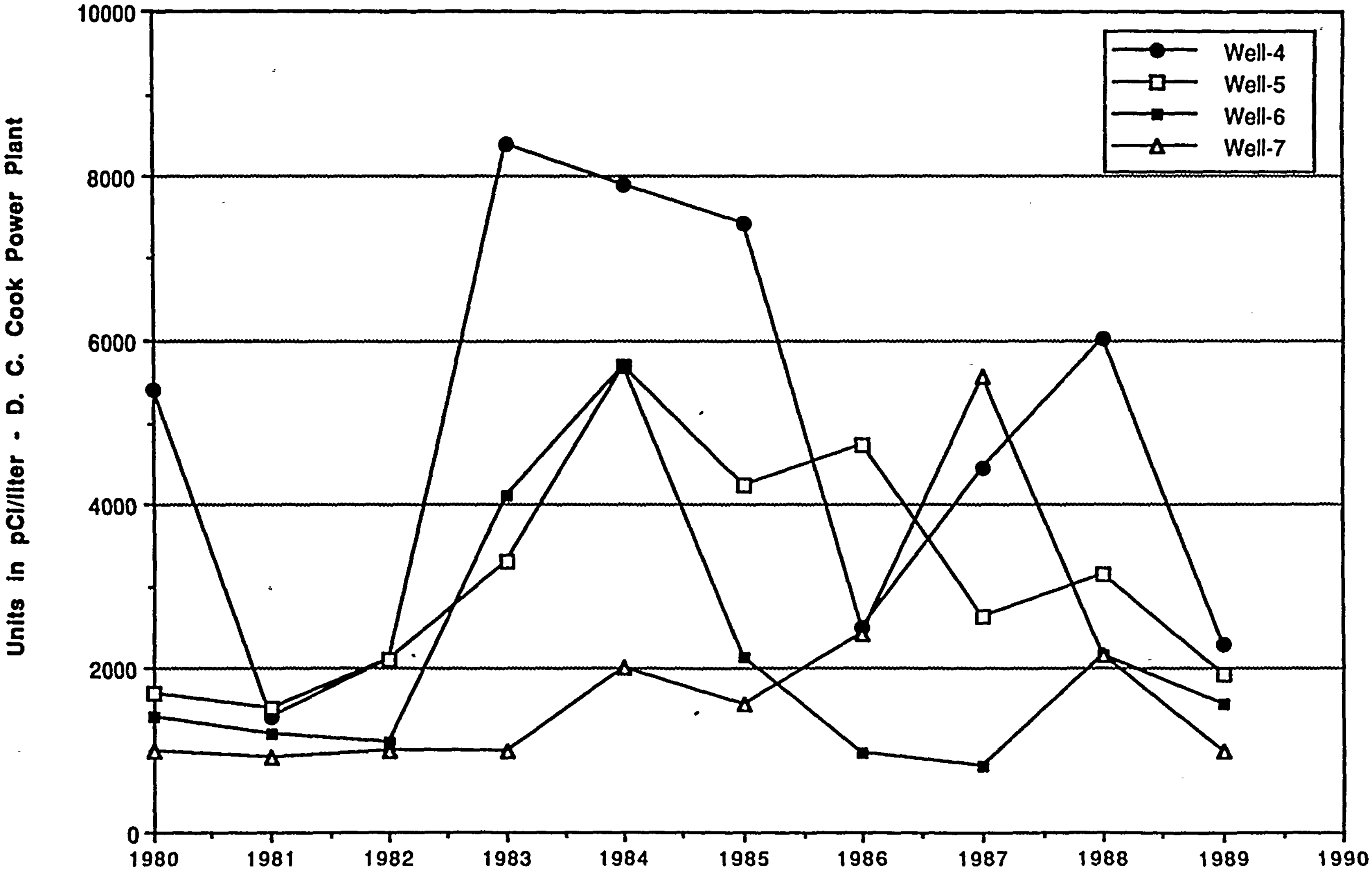


Figure 5 pg. 2

TRITIUM IN GROUND/WELL WATER



F. Drinking Water

Daily samples are collected at the intake of the the purification plants for St. Joseph and Lake Township. The samples at each location are composited biweekly and analyzed for gross beta, iodine-131 to a sensitivity of 1 pCi/liter, and for gamma emitters. On a quarterly basis the samples are composited and analyzed for tritium. The results of analyses of drinking water samples are shown in Table B-7. The collection date is the end date of each biweekly composite. In the first nine months tritium was analyzed more frequently than required.

Gross beta activity was measured in five samples from the Lake Township intake with an average concentration of 4.8 pCi/liter and a range from 3.4 to 6.2 pCi/liter. Gross beta activity was measured in six samples from the St. Joseph intake with an average concentration of 3.9 pCi/liter and a range from 2.7 to 5.8 pCi/liter. No gamma emitting isotopes or iodine-131 were detected. Tritium was measured in two samples (1035 and 190 pCi/liter) from the Lake Township intake and in one sample (170 pCi/liter) from the St. Joseph intake.

There were no drinking water analyzes performed in the preoperational program.

G. Sediment

Sediment samples are collected semiannually along the shoreline of Lake Michigan at the same four locations as the surface water samples. The sediment samples are analyzed by gamma ray spectroscopy, the results of which are shown in Table B-8. In November two samples were collected at locations L2 and L3 and one sample at L4 and L5. Gamma ray spectroscopy detected naturally occurring potassium-40 and thorium-228 in all the samples. The average potassium-40 concentration was 4920 pCi/kg with a range from 3250 to 6130 pCi/kg. The average thorium-228 concentration

was 183 pCi/kg with a range from 129 to 314 pCi/kg. Radium-226, also naturally occurring, was measured in one sample from L3 at a concentration of 602 pCi/kg. All the measured activities of the naturally occurring isotopes were at background levels. Cesium-137, attributed to fallout from previous atmospheric nuclear tests, was detected at L5 at a concentration of 33 pCi/kg. That activity level is often observed in soils and sediments.

H. Milk

Milk samples are collected every fourteen days from seven farms located between 4.25 miles and 20 miles from the site. The samples are analyzed for iodine-131 and for gamma emitters. The results are shown in Table B-9. Iodine-131 was measured in two samples collected at the Zelmer farm (4.75 miles SSE of the site) at concentrations of 1.3 and 2.1 pCi/liter. Iodine-131 was measured in one sample at the Livinghouse Farm (20 miles S of the site) at a concentration of 1.3 pCi/liter. These measurements of iodine-131 may not be related to the nuclear plant since the pathway for iodine-131 to reach pasture grass on the associated farms would have been airborne and no iodine-131 was detected in any charcoal cartridge during the year. The charcoal cartridges are a continuous collection system.

During the preoperational period potassium-40 was measured in all samples with a range from 520 to 2310 pCi/liter, a range comparable to that in 1989. Iodine-131 was measured in four samples collected soon after an atmospheric nuclear test with concentrations between 0.2 and 0.9 pCi/liter. Cesium-137 was measured in numerous samples after the nuclear test with concentrations between 7 and 64 pCi/liter.

Naturally occurring potassium-40 was measured in all of the November and December milk samples (and undoubtedly in all samples in the remainder of the year, but were not reported) by gamma ray spectroscopy. The average potassium-40 concentration in

November and December was 1375 pCi/liter and the concentrations ranged between 1080 and 1760 pCi/liter.

I. Fish

Fish are collected semiannually, when available, from four locations in Lake Michigan in the vicinity of the site and analyzed by gamma ray spectroscopy. Cesium-137, attributed to previous atmospheric nuclear tests was measured in two fish samples in May at concentrations of 39 and 72 pCi/kg.

J. Food Products

Grapes, grape leaves, and broadleaf vegetation are collected annually at harvest time at one on-site location and one off-site location. The samples are analyzed by gamma ray spectroscopy. Naturally occurring beryllium-7, potassium-40, and cesium-137, attributed to previous atmospheric nuclear tests, were measured at normal background levels. The average concentration for November samples were 1920, 2930 and 28.6 pCi/kg, respectively, for grape leaves and 170 and 4720 pCi/kg for beryllium-7 and potassium-40 in grapes. No cesium-137 was measured in grapes.

IV. CONCLUSIONS

IV. CONCLUSIONS

The results of the 1989 Radiological Environmental Monitoring Program for the Donald C. Cook Nuclear Plant have been presented. The results were as expected for normal environmental samples. Naturally occurring radioactivity was observed in sample media in the expected activity ranges.

Occasional samples of a few 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. Specific examples of sample media with positive analysis results are discussed below.

Air particulate gross beta concentrations of all the indicator locations for 1989 appears to follow the gross beta concentrations at the control locations. The concentration levels are actually lower than during the preoperational period when the influence of atmospheric nuclear tests was being detected. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). No man-made activity was found in the particulate media during 1989. No iodine-131 was detected in charcoal filters in 1989.

Thermoluminescent dosimeters (TLD) measure external gamma radiation from naturally occurring radionuclides in the air and soil, radiation from cosmic origin and fallout from atmospheric nuclear weapons testing, and potential radioactive airborne releases and direct radiation from the power station. The average annual TLD result was a normal background exposure level although one quarterly average was low by a factor of two and another quarterly average was high by a factor of two. There variations are attributed to incorrect transit control background corrections due to the circuitous transit route between the nuclear plant and two vendors and the various handling techniques of site TLD controls at three locations. Recent changes in the TLD

program should rectify these problems in 1990. Control TLD's are being used to monitor each leg of TLD shipments for intransit exposures. In addition, the TLD's are currently being shipped directly to the analytical laboratory.

Surface water samples collected monthly from five locations in Lake Michigan were analyzed for iodine, tritium, and gamma emitting isotopes. Only tritium was measured and the concentrations were at normal background levels.

Groundwater samples were collected quarterly at seven wells, all within 1000 meters of the reactors. The three wells within 130 meters had measurable tritium which could be attributed to the operation of the plant. The tritium levels are rather low (the highest concentration was 3600 pCi/liter) and in fact are lower than in some previous years of the past decade as can be seen in an accompanying figure. No gamma emitting isotopes were detected.

Samples are collected daily at the intakes of the drinking purification plants for St. Joseph and Lake Township. Samples composited biweekly are analyzed for iodine-131, gross beta, and for gamma emitting isotopes and analyzed quarterly for tritium. No iodine-131 or gamma emitting isotopes were detected. In a few cases gross beta activity and tritium were measured at normal background concentrations.

Sediment samples can be a sensitive indicator of discharges from nuclear power stations. Sediment samples are collected semiannually along the shoreline of Lake Michigan at four locations in close proximity of the reactors. The samples were analyzed by gamma ray spectroscopy. In 1989 only naturally occurring radionuclides were measured. There is no evidence of station discharges affecting Lake Michigan, either in the sediments or in the water, as previously discussed.

Milk samples were collected every fourteen days from seven farms up to a distance of 20 miles from the site. The samples were

measured for iodine-131 and for gamma emitting isotopes. Iodine-131 was detected in three samples with the highest concentration being only a factor of two above the required measurement sensitivity. For reasons described in the Summary, the presence of iodine-131 is not believed to be attributable to plant operation. Potassium-40 was measured in the milk samples at normal background levels.

Fish samples collected in Lake Michigan in the vicinity of the nuclear plant were analyzed by gamma ray spectroscopy. The only gamma emitting isotope measured was cesium-137 which was in very low concentrations, typical of those found in other parts of the country and which are attributed to previous atmospheric nuclear tests.

Food products, consisting of grapes, grape leaves, and broadleaf vegetation were collected and analyzed by gamma ray spectroscopy. The only gamma emitting isotope measured was cesium-137, again attributed to previous atmospheric nuclear tests.

Based upon the evidence of the radiological environmental monitoring program the Donald C. Cook Nuclear Plant continues to operate within regulatory limits. Tritium in five on-site wells appears to be the only radionuclide which can be directly correlated with the plant and the associated ground water does not provide a direct dose pathway to man.

V. REFERENCES

V. REFERENCES

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

2. Indiana Michigan Power Company, D. C. Cook Technical Specifications, Units 1 and 2.

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

4. Eberline Instrument Company. Indiana Michigan Power Company, "D. C. Cook Nuclear Plant Radiological Environmental Monitoring Program - 1974 Annual Report", May 1975.

5. Data Tables from 1985-1988 CEP-AEPSC Annual Radiological Environmental Monitoring Program Reports.

6. United States Nuclear Regulatory Commission, Regulatory Guide 4.1 "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants", April 1975.

7. United States Nuclear Regulatory Commission, Regulatory Guide 1.21 "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, April 1974.

APPENDIX A
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT DOCKET NO. 50-315/50-316

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1989

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENT
Air Iodine (pCi/m^3)	I-131	529	LLD	N/A	N/A	LLD	0
Airborne Particulates ($1E\text{-}03\ pCi/m^3$)	Gross Beta (Weekly)	529	20.8(317/317) (4-59)	NBF 16.0 mi SSW	23.0(53/53) (11-57)	22.4(212/212) (11-57)	0
	Gamma	40	LLD	N/A	N/A	LLD	0
Direct Radiation (mR/Week)	Gamma Dose Quarterly	105	1.15(89/89) (0.40-3.35)	NBF 16.0 mi SSW	1.59(4/4) (0.56-3.55)	1.37(16/16) (0.42-3.55)	0

(a/b) Ratio of samples with detectable activity to total number of samples analyzed.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT · DOCKET NO. 50-315/50-316

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1989

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENT
Surface Water (pCi/liter)	Gamma	55	LLD	N/A	N/A	-(0/0) -	0
	H-3	55	261(7/55) (160-447)	L-3 0.44 mi N	319(2/10) (190-447)	-(0/0) -	0
Ground Water (pCi/liter)	Gamma	28	LLD	N/A	N/A	-(0/0) -	0
	H-3	28	1891(14/28) (854-3600)	Wells 4/5/6 Onsite	1968(10/12) (926-3600)	-(0/0) -	0
Drinking Water (pCi/liter)	Gross Beta	50	4.3(11/50) (2.7-6.2)	Lake Township	4.8(5/25) (3.4-6.2)	-(0/0)	0
	I-131	50	LLD	N/A	N/A	-(0/0) -	0
	Gamma	50	LLD	N/A	N/A	-(0/0) -	0
	H-3	42	46.5(3/42) (170-1035)	Lake Township	613(2/21) (190-1035)	-(0/0) -	0

(a/b) Ratio of samples with detectable activity to total number of samples analyzed.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT DOCKET NO. 50-315/50-316

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1989

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENT
Sediment (pCi/kg wet)	Gamma	8	LLD	N/A	N/A	No Control	0
Milk (pCi/liter)	Gamma	174	LLD	N/A	N/A	LLD	0
	I-131	174	1.9(2/124) (1.3-2.1)	Zelmer 4.75 mi SSE	1.9(2/25) (1.3-2.1)	1.3(1/50)	0
Fish (pCi/kg wet)	Gamma	4	LLD	N/A	N/A	No Control	0
Food/Vegetation (pCi/kg wet)	Gamma	5	LLD	N/A	N/A	No Control	0

(a/b) Ratio of samples with detectable activity to total number of samples analyzed.

APPENDIX B
DATA TABLES

TABLE B-1

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
JANUARY 89											
01/02/89	32 ± 2	31 ± 2	37 ± 2	34 ± 2	34 ± 2	35 ± 2	37 ± 2	35 ± 2	38 ± 2	37 ± 2	35 ± 5
01/09/89	36 ± 2	35 ± 2	40 ± 2	36 ± 2	35 ± 2	38 ± 2	45 ± 2	40 ± 2	41 ± 2	39 ± 2	39 ± 6
01/16/89	22 ± 1	21 ± 1	23 ± 1	22 ± 1	24 ± 1	21 ± 1	26 ± 1	24 ± 1	24 ± 1	24 ± 1	23 ± 3
01/23/89	19 ± 1	17 ± 1	19 ± 1	16 ± 1	17 ± 1	18 ± 1	20 ± 1	18 ± 1	19 ± 1	19 ± 1	18 ± 2
01/30/89	24 ± 1	21 ± 1	26 ± 1	25 ± 1	23 ± 1	24 ± 1	25 ± 1	24 ± 1	25 ± 1	23 ± 1	24 ± 3
FEBRUARY											
02/06/89	22 ± 1	22 ± 1	22 ± 1	20 ± 1	21 ± 1	21 ± 1	22 ± 1	22 ± 1	23 ± 1	24 ± 1	22 ± 2
02/13/89	19 ± 1	8 ± 1(a)	27 ± 2	5 ± 1(a)	22 ± 1	23 ± 1	24 ± 1	23 ± 1	19 ± 1	21 ± 1	19 ±14
02/20/89	19 ± 1	20 ± 1	20 ± 1	23 ± 1	19 ± 1	22 ± 1	22 ± 1	21 ± 1	21 ± 1	18 ± 1	21 ± 3
02/27/89	25 ± 2	24 ± 1	23 ± 1	23 ± 1	22 ± 1	25 ± 2	27 ± 2	24 ± 1	26 ± 2	19 ± 1	24 ± 5
MARCH											
03/06/89	21 ± 1	20 ± 1	18 ± 1	19 ± 1	19 ± 1	21 ± 1	22 ± 1	21 ± 1	22 ± 2	19 ± 1	20 ± 3
03/13/89	12 ± 1	21 ± 1	19 ± 1	19 ± 1	21 ± 1	22 ± 1	24 ± 1	22 ± 1	21 ± 1	23 ± 1	20 ± 7
03/20/89	16 ± 1	19 ± 1	18 ± 1	18 ± 1	18 ± 1	18 ± 1	22 ± 1	16 ± 1	21 ± 1	16 ± 1	18 ± 4
03/27/89	30 ± 2	32 ± 2	30 ± 2	31 ± 2	31 ± 2	33 ± 2	31 ± 2	28 ± 2	33 ± 2	29 ± 2	31 ± 3
Quarter Average ± 2 Sigma	**23 ±13**	**22 ±14**	**25 ±14**	**22 ±16**	**24 ±12**	**25 ±13**	**27 ±14**	**24±13**	**26 ±14**	**24 ±14**	**24 ± 13**

(a) Results confirmed by a recount.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
APRIL											
04/03/89	12 ± 1	11 ± 1	12 ± 1	11 ± 1	11 ± 1	11 ± 1	13 ± 1	13 ± 1	12 ± 1	12 ± 1	12 ± 2
04/10/89	12 ± 1	13 ± 1	13 ± 1	12 ± 1	14 ± 1	14 ± 1	15 ± 1	12 ± 1	14 ± 1	13 ± 1	13 ± 2
04/17/89	23 ± 1	24 ± 1	20 ± 1	17 ± 1	22 ± 1	22 ± 1	26 ± 1	22 ± 2	26 ± 1	24 ± 2	23 ± 5
04/24/89	23 ± 1	5 ± 1(a)	26 ± 2	28 ± 2	17 ± 1	28 ± 2	29 ± 2	26 ± 2	32 ± 2	30 ± 2	24 ±16
MAY											
05/01/89	14 ± 1	15 ± 1	14 ± 1	11 ± 1	14 ± 1	14 ± 1	14 ± 1	14 ± 1	17 ± 1	17 ± 1	14 ± 3
05/08/89	12 ± 1	15 ± 1	14 ± 1	15 ± 1	14 ± 1	14 ± 1	17 ± 1	12 ± 1	14 ± 1	15 ± 1	14 ± 3
05/15/89	17 ± 1	14 ± 1	13 ± 1	14 ± 1	12 ± 1	13 ± 1	15 ± 1	15 ± 1	15 ± 1	14 ± 1	14 ± 3
05/22/89	12 ± 1	13 ± 1	14 ± 1	13 ± 1	13 ± 1	14 ± 1	14 ± 1	15 ± 1	16 ± 1	16 ± 1	14 ± 3
05/29/89	16 ± 1	17 ± 1	15 ± 1	15 ± 1	16 ± 1	16 ± 1	18 ± 1	17 ± 1	18 ± 1	19 ± 1	17 ± 3
JUNE											
06/05/89	19 ± 1	19 ± 1	18 ± 1	19 ± 1	17 ± 1	19 ± 1	19 ± 1	19 ± 1	21 ± 1	21 ± 1	19 ± 2
06/12/89	16 ± 1	15 ± 1	15 ± 1	15 ± 1	15 ± 1	15 ± 1	17 ± 1	15 ± 1	17 ± 1	17 ± 1	16 ± 2
06/19/89	17 ± 1	17 ± 1	17 ± 1	17 ± 1	16 ± 1	18 ± 1	17 ± 1	17 ± 1	16 ± 1	19 ± 1	17 ± 2
06/26/89	22 ± 1	22 ± 1	24 ± 1	22 ± 1	20 ± 1	21 ± 1	21 ± 1	19 ± 1	20 ± 1	22 ± 1	21 ± 3
Quarter Average ± 2 Sigma	**17 ± 8**	**15 ±10**	**17 ± 9**	**16 ±10**	**15 ± 6**	**17 ± 9**	**18 ±10**	**17 ± 8**	**18 ±11**	**18 ±10**	**17 ± 8**

(a) Results confirmed by a recount.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
JULY											
07/03/89	13 ± 1	12 ± 1	12 ± 1	14 ± 1	14 ± 1	18 ± 1	11 ± 1	11 ± 1	14 ± 1	15 ± 1	13 ± 4
07/10/89	24 ± 2	19 ± 1	19 ± 1	24 ± 1	22 ± 1	23 ± 1	23 ± 1	21 ± 1	21 ± 1	23 ± 1	22 ± 4
07/17/89	(a)	59 ± 5	5 ± 1	15 ± 1	12 ± 1	15 ± 1	13 ± 1	13 ± 1	17 ± 1	15 ± 1	18 ±31
07/24/89	16 ± 1	17 ± 1	17 ± 1	17 ± 1	17 ± 1	19 ± 1	17 ± 1	17 ± 1	21 ± 1	20 ± 1	18 ± 3
07/31/89	20 ± 1	18 ± 1	17 ± 1	17 ± 1	17 ± 1	18 ± 1	20 ± 1	17 ± 1	20 ± 1	18 ± 1	18 ± 3
AUGUST											
08/07/89	13 ± 1	14 ± 1	12 ± 1	14 ± 1	13 ± 1	16 ± 2	14 ± 1	13 ± 1	17 ± 1	16 ± 1	14 ± 3
08/14/89	29 ± 1	31 ± 1	31 ± 1	33 ± 2	31 ± 1	43 ± 2	35 ± 2	33 ± 1	40 ± 2	32 ± 1	34 ± 9
08/21/89	17 ± 1	17 ± 1	14 ± 1	17 ± 1	18 ± 1	17 ± 1	17 ± 1	16 ± 1	14 ± 1	19 ± 1	17 ± 3
08/28/89	27 ± 1	28 ± 1	29 ± 1	36 ± 1	26 ± 1	31 ± 1	37 ± 2	37 ± 2	27 ± 1	31 ± 1	31 ± 9
SEPTEMBER											
09/04/89	17 ± 1	16 ± 1	4 ± 1	15 ± 1	16 ± 1	15 ± 1	16 ± 1	17 ± 1	16 ± 1	18 ± 1	15 ± 8
09/11/89	17 ± 1	16 ± 1	15 ± 1	18 ± 1	17 ± 1	17 ± 1	19 ± 1	19 ± 1	20 ± 1	18 ± 1	18 ± 3
09/18/89	16 ± 1	15 ± 1	15 ± 1	20 ± 1	15 ± 1	15 ± 1	21 ± 1	18 ± 1	18 ± 1	17 ± 1	17 ± 4
09/25/89	16 ± 1	15 ± 1	14 ± 1	15 ± 1	14 ± 1	15 ± 1	17 ± 1	15 ± 1	17 ± 1	16 ± 1	15 ± 2
Average ± 2 Sigma	**19 ±10**	**21 ±25**	**16 ±15**	**20 ± 14**	**18 ±11**	**20 ±16**	**20 ±16**	**19 ±15**	**20 ±14**	**20 ±11**	**19 ± 13**

(a) No sample available.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
OCTOBER											
10/02/89	16 ± 1	15 ± 1	15 ± 1	17 ± 1	15 ± 1	16 ± 1	18 ± 1	16 ± 1	22 ± 1	18 ± 1	17 ± 4
10/09/89	22 ± 1	23 ± 1	23 ± 1	26 ± 1	21 ± 1	24 ± 1	29 ± 1	37 ± 2	26 ± 1	39 ± 2	27 ±13
10/16/89	27 ± 2	29 ± 2	24 ± 1	29 ± 2	28 ± 1	25 ± 1	28 ± 1	25 ± 1	31 ± 2	27 ± 1	27 ± 4
10/23/89	16 ± 1	15 ± 1	15 ± 1	19 ± 1	16 ± 1	18 ± 1	17 ± 1	16 ± 1	19 ± 1	22 ± 1	17 ± 4
10/30/89	44 ± 2	49 ± 2	48 ± 2	50 ± 2	47 ± 2	43 ± 2	50 ± 2	46 ± 2	57 ± 2	52 ± 2	49 ± 8
NOVEMBER											
11/06/89	25 ± 2	23 ± 2	25 ± 2	27 ± 2	24 ± 2	23 ± 2	25 ± 2	24 ± 2	26 ± 2	26 ± 2	25 ± 3
11/13/89	17 ± 2	11 ± 2	13 ± 2	15 ± 2	11 ± 2	15 ± 2	13 ± 2	14 ± 2	11 ± 2	13 ± 2	13 ± 4
11/20/89	23 ± 2	25 ± 2	21 ± 2	23 ± 2	23 ± 2	23 ± 2	22 ± 2	22 ± 2	26 ± 2	24 ± 2	23 ± 3
11/27/89	23 ± 2	23 ± 2	21 ± 2	23 ± 2	22 ± 2	25 ± 2	23 ± 2	21 ± 2	25 ± 2	25 ± 2	23 ± 3
DECEMBER											
12/04/89	22 ± 2	22 ± 2	19 ± 2	23 ± 2	19 ± 2	19 ± 2	22 ± 2	19 ± 2	26 ± 2	24 ± 2	22 ± 5
12/11/89	23 ± 2	24 ± 2	23 ± 2	24 ± 2	25 ± 2	25 ± 2	23 ± 2	23 ± 2	25 ± 2	22 ± 2	24 ± 2
12/18/89	28 ± 2	29 ± 2	27 ± 2	29 ± 2	30 ± 2	30 ± 2	28 ± 2	29 ± 2	32 ± 3	34 ± 3	30 ± 4
12/24/89	30 ± 3	28 ± 3	26 ± 2	28 ± 3	27 ± 3	30 ± 3	27 ± 3	30 ± 3	33 ± 3	40 ± 3	30 ± 8
01/01/89	25 ± 2	23 ± 2	23 ± 2	26 ± 2	26 ± 2	26 ± 2	25 ± 2	23 ± 2	29 ± 2	29 ± 2	26 ± 4
Quarter Average ± 2 s.d.	**24 ±14**	**24 ±18**	**23 ±17**	**26 ±16**	**24 ±17**	**24 ±14**	**25 ±17**	**25 ±17**	**28 ±20**	**28 ±20**	**25 ±17**
Annual Average ± 2 s.d.	**21 ±13**	**21 ±18**	**20 ±16**	**21 ±16**	**20 ±14**	**22 ±15**	**22 ±16**	**21 ±15**	**23 ±17**	**23 ±16**	**21 ± 8**

TABLE B-2

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIRBORNE PARTICULATES

Results in Units of pCi/m^3 ± 2 sigma

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend
First Quarter - 01/02/89-03/27/89										
Gamma Analysis	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
Second Quarter - 04/03/89-06/26/89										
Gamma Analysis	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
Third Quarter - 07/03/89-09/25/89										
Gamma Analysis	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
Fourth Quarter - 10/02/89-01/02/90										
Gamma Analysis	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD

- Typical LLDs are found in table B-12.
- Cosmogenically produced Be-7 was measured at normal concentrations in the fourth quarter composites by TI. Since CEP did not report Be-7 values for the first three quarters, a "LLD" has been entered for fourth quarter results for consistency.

TABLE B-3

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

	STATION CODES									
COLLECTION DATES	**A-1**	**A-2**	**A-3**	**A-4**	**A-5**	**A-6**	**Coloma**	**Dowagiac**	**New Buffalo**	**South Bend**
JANUARY 89										
01/02/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
01/09/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
01/16/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
01/23/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
01/30/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
FEBRUARY										
02/06/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
02/13/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
02/20/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
02/27/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
MARCH										
03/06/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
03/13/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
03/20/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
03/27/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

	STATION CODES									
COLLECTION DATES	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
APRIL										
04/03/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
04/10/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
04/17/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
04/24/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
MAY										
05/01/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
05/08/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
05/15/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
05/22/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
05/29/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
JUNE										
06/05/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
06/12/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
06/19/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
06/26/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} $pCi/m^3 \pm 2$ sigma

	STATION CODES									
COLLECTION DATES	**A-1**	**A-2**	**A-3**	**A-4**	**A-5**	**A-6**	**Coloma**	**Dowagiac**	**New Buffalo**	**South Bend**
JULY										
07/03/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
07/10/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
07/17/89	(a)	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
07/24/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
07/31/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
AUGUST										
08/07/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
08/14/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
08/21/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
08/28/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
SEPTEMBER										
09/04/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
09/11/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
09/18/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
09/25/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

(a) No sample available.

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
					STATION CODES					
OCTOBER										
10/02/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
10/09/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
10/16/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
10/23/89	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
10/30/89	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
NOVEMBER										
11/06/89	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 9	< 20
11/13/89	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 10	< 20
11/20/89	< 10	< 10	< 10	< 10	< 9	< 9	< 9	< 9	< 8	< 9
11/27/89	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 9	< 10
DECEMBER										
12/04/89	< 10	< 20	< 20	< 10	< 10	< 20	< 20	< 20	< 10	< 20
12/11/89	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 10	< 10
12/18/89	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 10	< 20
12/24/89	< 20	< 20	< 20	< 20	< 10	< 20	< 30	< 30	< 10	< 30
01/02/90	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

TABLE B-4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

DIRECT MEASUREMENTS - QUARTERLY TLD RESULTS

Results in Units of mR/week

STATION CODES	FIRST QUARTER 01/21/89-04/19/89	SECOND QUARTER 04/19/89-07/20/89	THIRD QUARTER 04/19/89-10/21/89	FOURTH QUARTER 10/21/89-01/20/90	AVERAGE ± 2 s.d.
A-1	0.90 ± 0.15	0.53 ± 0.02	0.95 ± 0.14	1.02 ± 0.08	0.85 ± 0.44
A-2	0.92 ± 0.17	0.40 ± 0.02	1.58 ± 0.20	1.00 ± 0.06	0.98 ± 0.97
A-3	0.96 ± 0.17	0.50 ± 0.02	2.05 ± 0.19	1.14 ± 0.11	1.16 ± 1.30
A-4	0.97 ± 0.17	0.50 ± 0.02	1.79 ± 0.08	0.99 ± 0.05	1.06 ± 1.07
A-5	0.95 ± 0.17	0.48 ± 0.01	1.37 ± 0.08	1.04 ± 0.07	0.96 ± 0.73
A-6	0.90 ± 0.18	0.50 ± 0.02	1.45 ± 0.08	0.97 ± 0.05	0.96 ± 0.78
A-7	0.95 ± 0.05	0.57 ± 0.02	0.83 ± 0.04	1.25 ± 0.07	0.90 ± 0.56
A-8	0.96 ± 0.18	0.49 ± 0.02	0.97 ± 0.07	1.05 ± 0.15	0.87 ± 0.51
A-9	1.04 ± 0.13	0.63 ± 0.02	1.13 ± 0.08	1.11 ± 0.08	0.98 ± 0.47
A-10	0.95 ± 0.07	0.41 ± 0.01	1.53 ± 0.11	0.98 ± 0.08	0.97 ± 0.91
A-11	(b)	(a)	1.23 ± 0.15	1.08 ± 0.10	1.16 ± 0.21
A-12	(b)	0.79 ± 0.02	0.82 ± 0.04	1.08 ± 0.05	0.90 ± 0.32
OFS-1	1.15 ± 0.07	0.53 ± 0.02	1.38 ± 0.08	1.12 ± 0.19	1.05 ± 0.72
OFS-2	0.73 ± 0.06	0.50 ± 0.02	1.47 ± 0.06	1.06 ± 0.08	0.94 ± 0.84
OFS-3	0.75 ± 0.09	0.53 ± 0.02	2.17 ± 0.13	1.09 ± 0.08	1.14 ± 1.45
OFS-4	0.88 ± 0.10	0.65 ± 0.01	2.59 ± 0.20	1.29 ± 0.12	1.35 ± 1.73
OFS-5	0.95 ± 0.10	0.56 ± 0.02	2.87 ± 0.20	1.13 ± 0.11	1.38 ± 2.05
OFS-6	0.83 ± 0.08	0.56 ± 0.02	3.35 ± 0.24	1.12 ± 0.09	1.47 ± 2.55
OFS-7	0.80 ± 0.06	0.50 ± 0.02	3.12 ± 0.20	1.03 ± 0.08	1.36 ± 2.38
OFS-8	1.00 ± 0.08	0.68 ± 0.02	3.24 ± 0.19	1.25 ± 0.15	1.54 ± 2.31
OFS-9	1.03 ± 0.11	0.64 ± 0.02	3.17 ± 0.20	1.19 ± 0.15	1.51 ± 2.26
OFS-10	0.94 ± 0.10	0.55 ± 0.02	3.02 ± 0.18	1.03 ± 0.07	1.39 ± 2.22
OFS-11	0.95 ± 0.07	0.76 ± 0.03	3.23 ± 0.13	1.20 ± 0.12	1.54 ± 2.29
NBF	1.10 ± 0.10	0.56 ± 0.02	3.55 ± 0.21	1.16 ± 0.12	1.59 ± 2.67
SBN	0.85 ± 0.06	0.67 ± 0.04	3.29 ± 0.26	1.22 ± 0.10	1.51 ± 2.42
DOW	0.71 ± 0.04	0.47 ± 0.01	3.07 ± 0.16	0.97 ± 0.06	1.31 ± 2.39
COL	0.66 ± 0.06	0.42 ± 0.01	2.20 ± 0.23	1.04 ± 0.12	1.08 ± 1.58
Average ± 2 s.d.	**0.91 ± 0.24**	**0.55 ± 0.20**	**2.13 ± 1.86**	**1.10 ± 0.18**	**1.17 ± 1.36**

(a) TLD Missing
(b) New station initiated at start of second quarter.

TABLE B-5

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE, TRITIUM AND GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	Gamma Spec	Tritium
L-1 (Condenser Circ.)	01/12/89	(a)	< LLD	< 330
	02/09/89		< LLD	< 330
	03/09/89		< LLD	< 300
	04/06/89		< LLD	< 330
	05/04/89	< 2.0	< LLD	< 330
	06/01/89	< 2.0	< LLD	< 330
	07/27/89		< LLD	< 330
	08/24/89 (b)			
	09/21/89		< LLD	< 330
	10/19/89		< LLD	< 330
	11/16/89	< 3	< LLD	(c)
	12/14/89	< 0.5	< LLD	280 ± 120
L-2 (South Comp)	01/12/89	(a)	< LLD	< 330
	02/09/89		< LLD	< 330
	03/09/89 (d)			
	04/06/89		< LLD	< 330
	05/04/89	< 2.0	< LLD	< 330
	06/01/89	< 2.0	< LLD	< 330
	07/27/89		< LLD	< 330
	08/24/89		< LLD	< 330
	09/21/89		< LLD	< 330
	10/19/89		< LLD	< 330
	11/16/89	< 3	< LLD	(c)
	12/14/89	< 0.5	< LLD	160 ± 70

See footnotes at end of table.

TABLE B-5 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE, TRITIUM AND GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	Gamma Spec	Tritium
L-3	01/12/89	(a)	< LLD	< 330
(North Comp)	02/09/89		< LLD	< 330
	03/09/89 (d)			
	04/06/89		< LLD	447 ± 316
	05/04/89	< 2.0	< LLD	< 330
	06/01/89	< 2.0	< LLD	< 330
	07/27/89		< LLD	< 330
	08/24/89		< LLD	< 330
	09/21/89		< LLD	< 330
	10/19/89		< LLD	< 330
	11/16/89	< 3	< LLD	(c)
	12/14/89	< 0.5	< LLD	190 ± 90
L-4	01/12/89	(a)	< LLD	< 330
(South 500)	02/09/89		< LLD	< 330
	03/09/89 (d)			
	04/06/89		< LLD	< 330
	05/04/89	< 2.0	< LLD	< 330
	06/01/89	< 2.0	< LLD	< 330
	07/27/89		< LLD	< 330
	08/24/89		< LLD	< 330
	09/21/89		< LLD	< 330
	10/19/89		< LLD	< 330
	11/16/89	< 3	< LLD	(c)
	12/14/89	< 1	< LLD	180 ± 70

See footnotes at end of table.

TABLE B-5 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE, TRITIUM AND GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	Gamma Spec	Tritium
L-5	01/12/89	(a)	< LLD	< 330
(North 500)	02/09/89		< LLD	< 330
	03/09/89 (d)			
	04/06/89		< LLD	< 330
	05/04/89	< 2.0	< LLD	< 330
	06/01/89	< 2.0	< LLD	350 ± 329
	07/27/89		< LLD	< 330
	08/24/89		< LLD	< 330
	09/21/89		< LLD	< 330
	10/19/89		< LLD	< 330
	11/16/89	< 2	< LLD	(c)
	12/14/89	< 0.5	< LLD	220 ± 80

* Typical LLDs are found in Table B-12.
(a) Analysis not required.
(b) Sample not collected.
(c) Tritium analysis now done on quarterly basis.
(d) Sample not available due to ice on the shoreline.

TABLE B-6

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN QUARTERLY GROUND WATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	Gamma Spec	Tritium
Well - 1	02/02/89	< LLD	< 330
Rosemary Beach	05/03/89	< LLD	< 330
	08/03/89	< LLD	< 330
	11/01/89	< LLD	2400 ± 1200
Well - 2	02/02/89	< LLD	< 330
Scrapyard	05/03/89	< LLD	< 330
	08/03/89	< LLD	< 330
	11/01/89	< LLD	2400 ± 1200
Well - 3	02/23/89	< LLD	< 330
University of Michigan	05/03/89	< LLD	< 330
Trailer	08/03/89	< LLD	< 330
	11/01/89	< LLD	< 2000
Well - 4	02/02/89	< LLD	1247 ± 347
Onsite	05/03/89	< LLD	2725 ± 377
	08/03/89	< LLD	1615 ± 300
	11/01/89	< LLD	3600 ± 1300
Well - 5	02/02/89	< LLD	1200 ± 348
Onsite	05/03/89	< LLD	1596 ± 344
	08/03/89	< LLD	< 330
	11/01/89	< LLD	3000 ± 1200
Well - 6	02/02/89	< LLD	926 ± 339
Onsite	05/03/89	< LLD	1766 ± 347
	08/03/89	< LLD	< 330
	11/01/89	< LLD	2000 ± 1200
Well - 7	02/02/89	< LLD	854 ± 346
Livingston Beach	05/03/89	< LLD	1145 ± 356
	08/03/89	< LLD	< 330
	11/01/89	< LLD	< 2000
Average ± 2 s.d.			**1891 ± 1665**

* Typical LLDs are found in Table B-12.

TABLE B-7

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA, IODINE, TRITIUM AND GAMMA EMITTERS* IN DRINKING WATER

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATE	Gross Beta	Gamma Spec	Iodine-131	Tritium
Lake Township				
01/12/89	< 3.0	< LLD	< 2.0	< 330
01/26/89	< 3.0	< LLD	< 2.0	1035 ± 336
02/09/89	< 3.0	< LLD	< 2.0	< 330
02/23/89	< 3.0	< LLD	< 2.0	< 330
03/09/89	< 3.0	< LLD	< 2.0	< 330
03/23/89	< 3.0	< LLD	< 2.0	< 330
04/06/89	< 3.0	< LLD	< 2.0	< 330
04/20/89	< 3.0	< LLD	< 2.0	< 330
05/04/89	< 3.0	< LLD	< 2.0	< 330
05/18/89	< 3.0	< LLD	< 2.0	< 330
06/01/89	< 3.0	< LLD	< 2.0	< 330
06/15/89	< 3.0	< LLD	< 2.0	< 330
06/29/89	< 3.0	< LLD	< 1.0	< 330
07/13/89	< 3.0	< LLD	< 1.0	< 330
07/27/89	< 3.0	< LLD	< 1.0	< 330
08/10/89	< 3.0	< LLD	< 1.0	< 250
08/24/89	< 3.0	< LLD	< 1.0	< 330
09/07/89	< 3.0	< LLD	< 1.0	< 330
09/21/89	< 3.0	< LLD	< 1.0	< 330
10/05/89	< 3.0	< LLD	< 1.0	< 330
11/02/89	4.6 ± 1.1	< LLD	< 0.4	190 ± 100
11/16/89	4.5 ± 1.1	< LLD	< 0.4	(a)
11/30/89	5.1 ± 1.3	< LLD	< 0.4	
12/14/89	6.2 ± 1.2	< LLD	< 0.2	
12/28/89	3.4 ± 1.0	< LLD	< 0.3	
Average ± 2 Sigma	**4.8 ± 2.0**			**613 ± 1195**

* Typical LLDs are found in table B-12.

(a) Tritium to be analyzed on a quarterly basis.

TABLE B-7 (Cont.)
INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT
CONCENTRATIONS OF GROSS BETA, IODINE, TRITIUM AND GAMMA EMITTERS* IN DRINKING WATER
Results in Units of pCi/liter ± 2 sigma

COLLECTION DATE	Gross Beta	Gamma Spec	Iodine-131	Tritium
St. Joseph				
01/12/89	< 3.0	< LLD	< 2.0	< 330
01/26/89	< 3.0	< LLD	< 2.0	< 330
02/09/89	< 3.0	< LLD	< 2.0	< 330
02/20/89	< 3.0	< LLD	< 2.0	< 330
03/09/89	< 3.0	< LLD	< 2.0	< 330
03/23/89	< 3.0	< LLD	< 2.0	< 330
04/06/89	< 3.0	< LLD	< 2.0	< 330
04/20/89	< 3.0	< LLD	< 2.0	< 330
05/04/89	< 3.0	< LLD	< 2.0	< 330
05/18/89	< 3.0	< LLD	< 2.0	< 330
06/01/89	3.1 ± 0.4	< LLD	< 2.0	< 330
06/15/89	< 3.0	< LLD	< 2.0	< 330
06/29/89	< 3.0	< LLD	< 1.0	< 330
07/13/89	< 3.0	< LLD	< 1.0	< 330
07/27/89	< 3.0	< LLD	< 1.0	< 330
08/10/89	< 3.0	< LLD	< 1.0	< 250
08/24/89	< 3.0	< LLD	< 1.0	< 330
09/07/89	< 3.0	< LLD	< 1.0	< 330
09/21/89	< 3.0	< LLD	< 1.0	< 330
10/05/89	< 3.0	< LLD	< 1.0	< 330
11/02/89	2.7 ± 0.9	< LLD	< 0.4	170 ± 90
11/16/89	3.8 ± 1.0	< LLD	< 0.7	(a)
11/30/89	4.2 ± 1.2	< LLD	< 0.4	
12/14/89	5.8 ± 1.2	< LLD	< 0.3	
12/28/89	3.5 ± 1.0	< LLD	< 0.3	
Average ± 2 Sigma	**3.9 ± 2.2**			**170 ± 90**

* Typical LLDs are found in table B-12.
(a) Tritium to be analyzed on a quarterly basis.

TABLE B-8

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN SEDIMENT

Results in Units of pCi/kg (wet) ± 2 sigma

Collection Date	Station	Analysis	pCi/kg
05/10/89	L-2	Gamma Spectralanalysis	< LLD
05/10/89	L-3	Gamma Spectralanalysis	< LLD
05/10/89	L-4	Gamma Spectralanalysis	< LLD
05/10/89	L-5	Gamma Spectralanalysis	< LLD
11/10/89	L-2	Gamma Spectralanalysis	< LLD
11/10/89	L-3	Gamma Spectralanalysis	< LLD
11/10/89	L-4	Gamma Spectralanalysis	< LLD
11/10/89	L-5	Gamma Spectralanalysis	< LLD

* Typical LLDs are found in table B-12.
* Naturally occurring radionuclides and cesium-137, attributed to previous atmospheric nuclear tests, were measured in sediment samples but are not listed because they were at normal background levels.

TABLE B-9

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES SHULER	TOTZKE	LOZMACK	WARMBIEN	ZELMER	LIVING HS	WYANT
01/13/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
01/27/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
02/10/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
02/24/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
03/10/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	1.3 ± 1.0 (a)	1.3 ± 0.6 (a)	< 0.4
03/24/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4

* Typical LLDs are found in table B-12.
(a) Verified by second analysis.

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

		STATION CODES						
COLLECTION DATES	ANALYSIS	SHULER	TOTZKE	LOZMACK	WARMBIEN	ZELMER	LIVING HS	WYANT
04/07/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4
04/21/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4
05/05/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4
05/19/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4
06/02/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5
06/16/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5
06/30/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5

* Typical LLDs are found in table B-12.

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES SHULER	TOTZKE	LOZMACK	WARMBIEN	ZELMER	LIVING HS	WYANT
07/14/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4
07/28/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5
08/11/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD 2.1 ± 1.3 (a)	< LLD < 0.4	< LLD < 0.4
08/26/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5
09/08/89	Gamma Iodine	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5	< LLD < 0.5
09/22/89	Gamma Iodine	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4	< LLD < 0.4

* Typical LLDs are found in table B-12.
(a) Verified by second analysis.

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	SHULER	TOTZKE	STATION CODES LOZMACK	WARMBIEN	ZELMER	LIVING HS	WYANT
10/06/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
10/20/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
11/03/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.5	< 0.2	< 0.3	< 0.5	< 0.3	< 0.2	< 0.3
11/17/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.2	< 0.3	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
12/01/89	Gamma	< LLD	< LLD	(a)	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.3	< 0.3		< 0.3	< 0.2	< 0.3	< 0.3
12/15/89	Gamma	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD
	Iodine	< 0.2	< 0.3	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2

- Typical LLDs are found in table B-12.
- Naturally occurring K-40 was measured at normal concentrations in November and December samples by TI. Since CEP did not report K-40 values in the first 10 months, a "LLD" has been entered for November and December result for consistency.

(a) Sample unavailable.

TABLE B-10

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN FISH

Results in Units of pCi/kg (wet) ± 2 sigma

Collection Date	Station	Description	Analysis	pCi/kg
05/17/89	ONS-South		Gamma Spectralanalysis	< LLD
05/17/89	OFS-South		Gamma Spectralanalysis	< LLD
05/17/89	ONS-North	(a)		
05/17/89	OFS-North	(a)		
10/11/89	ONS-North	Suckers	Gamma Spectralanalysis	< LLD
10/11/89	ONS-South	Salmon	Gamma Spectralanalysis	< LLD
10/11/89	OFS-North	(a)		
10/11/89	OFS-South	(a)		

* Typical LLDs are found in table B-12.
* Cesium-137, attributed to previous atmospheric nuclear tests was measured in two samples but is not listed because the concentrations were at normal background levels.

(a) Attempts to catch fish using gill nets were unsuccessful.

TABLE B-11

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN FOOD/VEGETATION

Results in Units of pCi/kg (wet) ± 2 sigma

COLLECTION DATE	Station	Description	Analysis	pCi/kg
08/13/89	SECTOR-D	Broad Leaves	Gamma Spectralanalysis	< LLD
08/18/89	SECTOR-D	Grapes	Gamma Spectralanalysis	< LLD
08/18/89	SECTOR-D	Leaves	Gamma Spectralanalysis	< LLD
08/18/89	SECTOR-K	Grapes	Gamma Spectralanalysis	< LLD
08/18/89	SECTOR-K	Leaves	Gamma Spectralanalysis	< LLD

- Typical LLDs are found in table B-12.
- Naturally occurring radionuclides and cesium-137, attributed to previous atmospheric nuclear tests, were measured in vegetation samples but are not listed because they were at normal background levels.

TABLE B-12

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GAMMA SPECTROMETRY LOWER LIMITS OF DETECTION AND REPORTING LEVELS

Isotope	CEP LLD	TI LLD	Tech Spec LLD	Rept Level	CEP LLD	TI LLD	Tech Spec LLD	Rept Level
	Vegetation - pCi/Kg-wet				**Water - pCi/liter**			
Cerium-144	121	60	N/A	N/A	17	30	N/A	N/A
Barium/La-140	75	10	N/A	N/A	4	50/10	60/15	200
Cesium-134	29	10	60	1000	7	7	15	30
Ru,Rh-106	143	80	N/A	N/A	2	50	N/A	N/A
Cesium-137	40	10	60	2000	2	6	18	50
Zr,Nb-95	66	10	N/A	N/A	6	10/15	30/15	400
Manganese-54	21	10	N/A	N/A	2	5	15	1000
Iron-59	21	15	N/A	N/A	3	15	30	400
Zinc-65	60	20	N/A	N/A	15	10	30	300
Cobalt-60	60	10	N/A	N/A	5	5	30	300
Cobalt-58	20	10	N/A	N/A	5	5	15	1000
Iodine-131	30	20	60	100	1	10	1	2
	Milk - pCi/liter				**Air Filter - pCi/m^3**			
Cerium-144	10	30	N/A	N/A	0.005	0.007	N/A	N/A
Barium/La-140	4	50/10	60/15	300	0.030	0.005	N/A	N/A
Cesium-134	5	7	15	60	0.023	0.002	0.06	10
Ru,Rh-106	2	50	N/A	N/A	0.001	0.010	N/A	N/A
Cesium-137	4	6	18	70	0.001	0.002	0.06	20
Zr,Nb-95	8	20	N/A	N/A	0.026	0.002	N/A	N/A
Manganese-54	2	5	N/A	N/A	0.001	0.002	N/A	N/A
Iron-59	3	15	N/A	N/A	0.006	0.002	N/A	N/A
Zinc-65	16	10	N/A	N/A	0.045	0.002	N/A	N/A
Cobalt-60	5	5	N/A	N/A	0.019	0.002	N/A	N/A
Cobalt-58	3	5	N/A	N/A	0.001	0.002	N/A	N/A
Iodine-131	1	10	1	3	0.02*	0.040	0.07	0.9

* Charcoal Trap

TABLE B-12 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GAMMA SPECTROMETRY LOWER LIMITS OF DETECTION AND REPORTING LEVELS

Isotope	CEP LLD	TI LLD	Tech Spec LLD	Rept Level	CEP LLD	TI LLD	Tech Spec LLD	Rept Level
	Fish - pCi/Kg-wet				Sediment/Soil - pCi/Kg-dry			
Cerium-144	30	40	N/A	N/A	80	150	N/A	N/A
Barium/La-140	40	60	N/A	N/A	40	5	N/A	N/A
Cesium-134	40	6	130	1000	70	30	150	N/A
Ru,Rh-106	40	50	N/A	N/A	40	200	N/A	N/A
Cesium-137	40	6	150	2000	40	30	180	N/A
Zr,Nb-95	30	30	N/A	N/A	40	40	N/A	N/A
Manganese-54	60	5	130	30000	80	9	N/A	N/A
Iron-59	100	15	260	10000	30	50	N/A	N/A
Zinc-65	100	10	260	20000	100	60	N/A	N/A
Cobalt-60	30	5	130	10000	80	20	N/A	N/A
Cobalt-58	60	5	130	30000	20	20	N/A	N/A
Iodine-131	30	10	N/A	N/A	30	30	N/A	N/A

Gross Beta/Tritium LLDs and Reporting Levels

Gross Beta

Air Particulates	0.004	0.01	0.01 pCi/m^3	N/A
Surface Water	4	4	4.0 pCi/l	N/A
Ground Water	4	4	4.0 pCi/l	N/A
Drinking Water	3	4	4.0 pCi/l	N/A

Tritium

Surface Water	330	2000	2000	20,000
Groundwater	330	2000	2000	20,000
Drinking Water	330	2000	2000	20,000

APPENDIX C
ANALYTICAL PROCEDURES SYNOPSIS

SYNOPSIS OF ANALYTICAL PROCEDURES

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

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

1.0 INTRODUCTION

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

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

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

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

2.0 DETECTION CAPABILITY

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

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

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

GROSS BETA ANALYSIS OF SAMPLES

Air Particulates

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

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

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

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

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

where:

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

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:

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
	CG	=	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 STRONTIUM-89 AND -90

Water

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a minimum of 5 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon 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 the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved and precipitated as $SrNO_3$ 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 a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon 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 an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrachloric acid. The mixture is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(NO_3)_2$ 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 a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon 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/cm2 aluminum absorber for low level beta counting.

Organic Solids

A wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in hydrochloric acid. The sample is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(NO_3)$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a minimu of 5 days period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon 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. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylong 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 nylong 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:

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

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

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, is reduced with hydroxylamine hydrochloride and is extracted into carbon tetrachloride as free iodine. It is then back-extracted as iodide into sodium bisulfite solution and is precipitated as palladium iodide. The sodium bisulfite solution and is precipitated as palladium iodide. The precipitate is weighed for chemical yield and is mounted on a nylon 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 = $(N/\Delta t\text{-}B)/(2.22\ E\ V\ Y\ DF)$

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

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

where:

N	=	total counts from sample (counts)
Δt	=	counting time for sample (min)
B	=	background rate of counter (cpm)
2.22	=	dpm/pCi
V	=	volume or weight of sample analyzed
Y	=	chemical yield of the mount or sample counted
DF	=	decay factor from the collection to the counting date
E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
E	=	$E_s(\exp\text{-}0.0061M)/(\exp\text{-}0.0061M_s)$
E_s	=	efficiency of the counter determined from an I-131 standard mount
Ms	=	mass of PdI_2 on the standard mount, mg
M	=	mass of PDI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

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

Dried Solids Other Than Soils and Sediments

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

Fish

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

Soils and Sediments

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

Charcoal Cartridges (Air Iodine)

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

Air Particulate

The thirteen airborne particulate filters for a quarterly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

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

RESUT = (S-B)/2.22 t E V F DF)

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

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

where:

S = Area, in counts, of sample peak and background (region of spectrum of interest)

B = Background area, in counts, under sample peak, determined by a linear interpolation of the representative backgrounds on either side of the peak

t = length of time in minutes the sample was counted

2.22 = dpm/pCi

E = detector efficiency for energy of interest and geometry of sample

V = sample aliquot size (liters, cubic meters, kilograms, or grams)

F = fractional gamma abundance (specific for each emitted gamma)

DF = decay factor from the mid-collection date to the counting date

ENVIRONMENTAL DOSIMETRY

Teledyne 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 milliRoentgen (mR):

RESULT		=	$D = (D_1+D_2+D_3+D_4)/4$
TWO SIGMA ERROR		=	$2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$
WHERE:	D_1	=	the net mR of area 1 of the TLD, and similarly for D_2, D_3, and D_4
	D1	=	I_1 K/R_1 - A
	I_1	=	the instrument reading of the field dose in area 1
	K	=	the known exposure by the Cs-137 source
	R_1	=	the instrument reading due to the Cs-137 dose on area 1
	A	=	average dose in mR, calculated in similar manner as above, of the transit control TLDs
	D	=	the average net mR of all 4 areas of the TLD.

APPENDIX D
SUMMARY OF EPA INTERLABORATORY COMPARISONS

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 1989 data summary tables are presented for isotopes in the various sample media applicable to the Donald C. Cook Power Stations Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases.

US EPA INTERLABORATOTRY COMPARISON PROGRAM 1989
Donald C. Cook Nuclear Plant

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Isotopes Result(b)	
01/06/89	Water	Sr-89	40.00 ± 5.00	37.00 ± 2.65	
		Sr-90	25.00 ± 1.50	26.00 ± 2.00	
01/20/89	Water	Gr-Alpha	8.00 ± 5.00	8.00 ± 1.00	
		Gr-Beta	4.00 ± 5.00	6.00 ± 0.00	
02/10/89	Water	Cr-51	235.00 ± 24.00	245.67 ± 11.72	
		Co-60	10.00 ± 5.00	12.67 ± 1.53	
		Zn-65	159.00 ± 16.00	181.33 ± 5.51	(c)
		Ru-106	178.00 ± 18.00	191.00 ± 9.85	
		Cs-134	10.00 ± 5.00	10.33 ± 0.58	
		Cs-137	10.00 ± 5.00	13.67 ± 0.58	
02/17/89	Water	I-131	106.00 ± 11.00	98.67 ± 0.58	
02/24/89	Water	H-3	2754.00 ± 356.00	2866.67 ± 251.66	
03/10/89	Water	Ra-226	4.90 ± 0.70	5.07 ± 0.29	
		Ra-228	1.70 ± 0.30	1.47 ± 0.29	
03/31/89	Air Filter	Gr-Alpha	21.00 ± 5.00	28.67 ± 1.15	(d)
		Gr-Beta	62.00 ± 5.00	65.67 ± 1.53	
		Sr-90	20.00 ± 1.50	19.67 ± 2.08	
		Cs-137	20.00 ± 5.00	18.00 ± 1.00	
04/18/89	Lab Perf.	Gr-Alpha	29.00 ± 7.00	21.33 ± 2.31	
	Water	Ra-226	3.50 ± 0.50	3.47 ± 0.23	
	Sample A	Ra-228	3.60 ± 0.50	3.60 ± 0.10	
	Sample B	Gr-Beta	57.00 ± 5.00	53.00 ± 3.61	
		Sr-89	8.00 ± 5.00	8.00 ± 0.00	
		Sr-90	8.00 ± 1.50	7.67 ± 0.58	
		Cs-134	20.00 ± 5.00	19.67 ± 1.53	
		Cs-137	20.00 ± 5.00	20.00 ± 2.65	
04/28/89	Milk	Sr-89	39.00 ± 5.00	36.67 ± 1.15	
		Sr-90	55.00 ± 3.00	56.33 ± 1.53	
		Cs-137	50.00 ± 5.00	53.33 ± 2.31	
		K	1600.00 ± 80.00	1760.00 ± 113.58	(e)
05/05/89	Water	Sr-89	6.00 ± 5.00	6.33 ± 0.58	
		Sr-90	6.00 ± 1.50	6.33 ± 0.58	

Footnotes at end of table.

US EPA INTERLABORATORY COMPARISON PROGRAM 1989 (Cont.

Donald C. Cook Nuclear Plant

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Isotopes Result(b)	
06/09/89	Water	Ba-133	49.00 ± 5.00	33.00 ± 3.61	(f)
		Co-60	31.00 ± 5.00	30.00 ± 2.65	
		Zn-65	165.00 ± 17.00	165.33 ± 0.58	
		Ru-106	128.00 ± 13.00	113.67 ± 17.50	
		Cs-134	39.00 ± 5.00	34.00 ± 2.65	
		Cs-137	20.00 ± 5.00	22.00 ± 3.61	
06/23/89	Water	H-3	4503.00 ± 450.00	4466.67 ± 152.75	
08/25/89	Air Filter	Gr-Alpha	6.00 ± 5.00	8.33 ± 0.98	
		Cs-137	10.00 ± 5.00	12.00 ± 1.00	
09/22/89	Water	Gr-Alpha	4.00 ± 5.00	5.00 ± 5.00	
		Gr-Beta	6.00 ± 5.00	8.00 ± 0.00	
10/06/89	Water	Ba-133	59.00 ± 6.00	51.00 ± 4.36	(g)
		Co-60	30.00 ± 5.00	30.67 ± 2.08	
		Zn-65	129.00 ± 13.00	128.33 ± 2.89	
		Ru-106	161.00 ± 16.00	139.00 ± 15.72	(g)
		Cs-134	29.00 ± 5.00	23.67 ± 1.15	
		Cs-137	59.00 ± 5.00	61.67 ± 1.53	
10/20/89	Water	H-3	3496.00 ± 364.00	3433.33 ± 57.74	
10/31/89	Lab Perf.	Gr-Alpha	49.00 ± 12.00	42.33 ± 5.77	
	Water	Ra-226	8.40 ± 1.30	9.20 ± 0.46	
	Sample A	Ra-228	4.10 ± 0.60	4.00 ± 0.50	
	Sample B	Gr-Beta	32.00 ± 5.00	30.33 ± 0.58	
		Sr-89	15.00 ± 5.00	15.00 ± 3.46	
		Sr-90	7.00 ± 1.50	7.00 ± 0.00	
		Cs-134	5.00 ± 5.00	5.33 ± 1.15	
		Cs-137	5.00 ± 5.00	7.00 ± 0.00	
11/10/89	Water	Ra-226	8.70 ± 1.30	8.47 ± 0.49	
		Ra-228	8.57 ± 1.40	8.57 ± 1.46	

Footnotes at end of table.

US EPA INTERLABORATORY COMPARISON PROGRAM 1989 (Cont.)
Donald C. Cook Nuclear Plant.

Footnotes:

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

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

(c) The three Zn-65 measurements were 184, 175 and 185 pCi/liter. These were measured on three detectors using the same aliquot. The other reported results (Cr-51, Co-60, Ru-106, Cs-134, Cs-137) were all within two standard deviations of the EPA results. This would indicate that the dilution made was correct (except that possibly the Zn-65 was not well mixed). Other parameters were investigated. The branching intensity, decay factor, and detection efficiencies were checked. Since one of the Co-60 gamma ray energies is only 60 KeV from Zn-65, the detector efficiencies must be correct. There is no obvious reason for the deviation. Another aliquot will be prepared from the original solution and will be counted.

(d) The EPA deposits activity on the filter over a small diameter (nearly a point source) whereas our calibration is based on a deposit nearly 2 inches in diameter. In order to correct to point source geometry our practice has been to divide our results by 1.2. We neglected to do it on this test.

(e) There is no apparent reason why the potassium was high. Three separate detectors were used and the K-40 value for each was correctly divided by 0.86 to convert to potassium in mG/liter.

(f) There is no apparent reason why Ba-133 was low by 5.54 standard deviation while the other isotopes were within ± 2 standard deviations. The detector efficiencies and Ba-133 branching intensities were checked and found to be correct. On 10/31/89, 300 ml of the original, irradiated sample was counted giving 43.9 ± 5.8 pCi/liter Ba-133.

(g) This EPA sample was counted in two geometries; one in diluted stage, the other undiluted. There was no significant difference. Comparing detector efficiencies between two annual sets did not reveal any significant difference. Thus there is no apparent reason why our results differed as much as they did.

APPENDIX E
REMP SAMPLING AND ANALYTICAL EXCEPTIONS

PROGRAM EXCEPTIONS

REMP deviations for 1989 are listed at the end of this appendix. Where possible, the causes of the deviations have been corrected to prevent recurrence.

The surface water analysis results for the samples collected on 11/16/89 contained LLD values for iodine-131 and lanthanum-140 which exceeded the Technical Specification LLD requirements. All of the affected samples contained no detectable activity for these isotopes. The cause for the unacceptably high LLD values was the exceptionally long time period (40 days) between sample collection and shipment. Precautions have been taken to ensure that future samples will be received by the analytical laboratory within 5 days, as requested by the laboratory.

The 08/24/89 surface water sample for station L-1 was inadvertently disposed of prior to shipment. Steps have been taken to ensure that future samples are turned over to the Environmental Section in a timely manner following collection. It is anticipated that this will significantly reduce the likelihood of a recurrence.

The second quarter TLD sample for station A11 was not in its holder when collection was attempted on 07/20/89. A lock has been installed on the TLD holder to prevent a recurrence.

REMP EXCEPTIONS FOR SCHEDULED SAMPLING AND ANALYSIS DURING 1989

Station	Description	Date of Sampling	Reason(s) for Loss/ Exception
A1	Air Particulate/ Air Iodine	07/17/89	Sampler malfunction; sample unavailable.
A-11	TLD	2nd Qtr	TLD Missing
L-1	Surface Water	08/24/89	Sample inadvertently disposed of prior to shipment.
L-2, L-3 L-4, L-5	Surface Water	03/09/89	Sample unavailable due to ice on shoreline.
Lozmack	Milk	12/01/89	Sample unavailable. Milk wholesaler collected all milk prior to sampling.
OFS-N ONS-N OFS-N OFS-S	Fish	05/12/89 05/12/89 10/11/89 10/11/89	Attempts to collect fish using gill nets were unsuccessful.
L-1, L-2 L-3, L-4, L-5	Surface Water	11/16/89,	LLD levels for La-140 and I-131 were above Tech Spec requirements due to excessive time period between sample collection and shipment.

APPENDIX F
1989 LAND USE CENSUS

APPENDIX F
SUMMARY OF THE 1989 LAND USE CENSUS

The 1989 Milk Farm Survey identified two minor changes from the 1988 survey. One milk farm changed ownership and an established farm added a dairy operation. These changes did not affect the milk sample collection program or the calculation of off-site doses through the milk pathway.

The milk animal previously identified as closest to the plant center line axis remains the closest milk animal. The closest milk animals for each sector are identified in the Milk Survey Table at the end of the appendix.

The 1988 Land Use Survey identified the need to verify the distance to the nearest residences in each of the land sectors. A review of drawings, photographs, and other documentation was performed by the AEP Civil Engineering laboratory to establish the new distances using available data. The results from this review were included in the 1988 Annual Environmental Operating Report.

A surveying firm was subsequently contracted to remap the Cook Plant area and establish residence distances using updated technology. The new distances are reflected in the 1989 Annual Environmental Operating Report and have been incorporated into the Cook Plant Offsite dose assessment program. In accordance with T/S 3.12.2, broadleaf vegetation sampling is performed in lieu of a garden census. The broadleaf samples are obtained in an onsite location where it is estimated that the maximum concentration of plant related radionuclides would occur. The broadleaf gamma isotopic analysis results were all <LLD.

Figure 6

DONALD C. COOK NUCLEAR PLANT

RESIDENTIAL LAND USE SURVEY TABLE

SECTOR	SURVEY YEAR	HOUSE#[1]	DISTANCE IN FEET	LOT#	STREET ADDRESS
A	a	1	2161	6-4.1	Rt #1, Rosemary Rd.
	b	1	2162	6-4.1	Rt #1, Rosemary Rd.
B	a	2	2165	6-4.9	Rt #1, Rosemary Rd.
	b	2	2178	6-4.9	Rt #1, Rosemary Rd.
C	a	3	3093	6-28	Rt #1, Rosemary Rd.
	b	3	3117	6-28	Rt #1, Rosemary Rd.
D	a	4	5733	5-36	7500 Thorton Drive
	b	4	5971	5-36	7500 Thorton Drive
E	a	5	5631	5-25.5	7927 Red Arrow Hwy.
	b	5	5646	5-25.5	7927 Red Arrow Hwy.
F	a	6	5392	8-10.3	3900 Livingston Rd.
	b	6	5426	8-10.3	3900 Livingston Rd.
G	a	7	3728	7-4	4212 Livingston Rd.
	b	7	3753	7-4	4212 Livingston Rd.
H	a	8	4944	7-7+8	8700 Red Arrow Hwy.(Wildwood Subdivision
	b	8	4957	7-7+8	8700 Red Arrow Hwy.(Wildwood Subdivision
J	a	9	3366	7-10.3	4600 W. Livingston Rd.(Livingston Hills
	b	9	3442	7-10.3	4600 W. Livingston Rd. " Subd
K	a	10	3090	7-10.3	4600 W. Livingston Rd.(Livingston Hills
	b	10	3110	7-10.3	4600 W. Livingston Rd. " Subd

All other sectors are over water.

[1]House# indicated is the reference number used on map when obtaining the raw field data.

[a]Reporting Year

[b]Year Prior to Reporting Year

Figure 7

DONALD C. COOK NUCLEAR PLANT

MILK ANIMAL SURVEY TABLE

SECTOR	SURVEY YEAR	DISTANCE (MILES)	NAME	ADDRESS
B	a	N/A	No milk animals	N/A
	b	N/A	No milk animals	N/A
C	a	N/A	No milk animals	N/A
	b	N/A	No milk animals	N/A
D	a	4.75	Gerald Totzke	6744 Totzke Rd.,Baroda, MI.
	b	4.75	Gerald Totzke	6744 Totzke Rd.,Baroda, MI.
E	a	10.5	Andrews University	Berrien Springs, MI.
	b	10.5	Andrews University	Berrien Springs, MI.
F	a	6.8	Lee Nelson	RFD 1, Box 390A Snow Rd.,Baroda, MI
	b	6.8	Lee Nelson	RFD 1, Box 390A Snow Rd.,Baroda, MI
G	a	4.25	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda, MI.
	b	4.25	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda, MI.
H	a	5.2	Norman Zelmer	11701 S. Gast Rd., Bridgman, MI.
	b	5.2	Norman Zelmer	11701 S. Gast Rd., Bridgman, MI.
J	a	7.8	Jerry Warmbein	Box 184, Avery Rd.,Three Oaks, MI
	b	7.8	Jerry Warmbein	Box 184, Avery Rd.,Three Oaks, MI
K	a	12	Kenneth Tappan	Rt 2, Kruger Rd.,Three Oaks, MI.
	b	12	Kenneth Tappan	Rt 2, Kruger Rd.,Three Oaks, MI.

All other sectors are over water.

[a] Reporting Year

[b] Year Prior to Reporting Year

A	a	N/A	No milk animals	N/A
	b	N/A	No milk animals	N/A

APPENDIX G
SUMMARY OF THE PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

SUMMARY OF THE PREOPERATIONAL RADIOLOGICAL MONITORING PROGRAM

A preoperational radiological environmental monitoring program was performed for the Donald C. Cook Nuclear Plant from August 1971 until the initial criticality of Unit 1 on January 18, 1975. The analyses of samples collected in the vicinity of the nuclear power plant were performed by Eberline Instrument Corporation. The summary of the preoperational program presented in this appendix is based on the seven semi-annual reports covering the period. The purpose of this summary is to provide a comparison of the radioactivity measured in the environs of the plant during the pre-start up of Unit 1 and the radioactivity measured in 1989.

As stated in the report for the period of July 1 to December 31, 1971, the purposes of a preoperational radiological monitoring program include:

(a) "To yield average values of radiation levels and concentrations of radioactive material in various media of the environment.

(b) To identify sample locations and/or types of samples that deviate from the averages.

(c) To document seasonal variations that could be erroneously interpreted when the power station is operating.

(d) To indicate the range of values that should be considered "background" for various types of samples.

(e) To "proof test" the environmental monitoring equipment and procedures prior to operation of the nuclear power station.

(h) To provide baseline information that will yield estimates of the dose to man, if any, which will result from plant operation."

The discussion that follows is for the various sample media collected and analyzed in both the preoperational period and in 1989. Analyses, such as strontium-89 and strontium-90 in milk and air

particulates performed during the preoperational but not required in 1989, are not discussed.

The gross beta activity in air particulate filters ranged from 0.01 to 0.17 pCi/m^3 from the middle of 1971 to the middle of 1973. In June of 1973 and in June of 1974 the People's Republic of China detonated atmospheric nuclear tests. As a result there were periods during which the gross beta results were elevated to as high as 0.45 pCi/m^3 with no statistically significant differences between indicator and background stations. By the end of the preoperational period the values were approximately 0.06 pCi/m^3.

The gamma ray analyses of composited air particulate filters showed "trace amounts" of fission products, Ce-144, Ru-106, Ru-103, Zr-95, and Nb-95, the results of fallout from previous atmospheric nuclear tests. Cosmogenically produced beryllium-7 was also detected.

The direct radiation background as measured by thermoluminescent dosimeters (TLD) ranged between 1.0 and 2.0 mRem/week during the three and one-half years period.

Milk samples during the preoperational period were analyzed for iodine-131 and by gamma ray spectroscopy (and for strontium-89 and strontium-90). All samples had naturally occurring potassium-40 with values ranging between 520 and 2310 pCi/liter. Cesium-137 was measured in many samples after the two atmospheric nuclear tests mentioned above. The cesium-137 activity ranged from 8 to 33 pCi/liter. Iodine-131 was measured in four milk samples collected July 9, 1974. The values ranged between 0.2 and 0.9 pCi/liter.

Lake water samples were collected and analyzed for tritium and by gamma ray spectroscopy. Tritium activities were below 1000 pCi/liter and typically averaged about 400 pCi/liter. No radionuclides were detected by gamma ray spectroscopy.

Gamma ray spectroscopy analyses of lake sediment detected natural abundances of potassium-40, uranium and thorium daughters, and traces of cesium-137 below 0.1 pCi/g which is attributed to fallout.

Gamma spectroscopy analyses of fish detected natural abundances of potassium-140 and traces of cesium-137, the latter attributed to fallout.

Drinking water analysis was not part of the preoperational program.

APPENDIX H
OPERATIONAL REMP DATA

OPERATIONAL REMP DATA

The mean and range values of the analytical results for the previous three years of the radiological environmental monitoring program are listed in this appendix. A ratio of the number of samples with detectable activity and the number of samples analyzed, (a/b), has been provided for selected analyses.

Only the results from indicator sample stations were used when determining mean and range values for the milk, airborne, and TLD (onsite) media. Groundwater results were determined using the data from the three wells located in the Plant's protected area (wells #4, #5, #6). all other results were determined using data from all the sample stations contained within each sampling program.

As noted in the table, some 1986 samples reflect increased mean and range values attributable to the Chernobyl accident.

OPERATIONAL REMP DATA

Media/Analysis	1988 Mean - Range	1987 Mean - Range	1986[C] Mean Range
Air/Gross Beta	.022(.005-.043)	.022(.01-.045)	.028(.004-.142)
Air/Iodine (a/b)	.005(.005-.013) (2/311)	.005(.005-.016) (5/312)	.01(.005-.122)
Air/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	Cs-137 .009(.001-.013)
TLD/Direct Radiation mRem/week	.86(.36-1.51)	.65(.33-1.00)	1.0(.59-2.07)
Milk/Iodine (a/b)	.4(.4-.7) (1/135)	.42(.4-3) (2/130)	.54(.4-5.7)
Milk/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	Cs-137 .4(.4-11.3)
Groundwater/Tritium	2524(891-6033)	1729(300-4444)	1528(300-4734)
Groundwater/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	LLD for T/S Isotopes
Vegetation/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	LLD for T/S Isotopes
Fish/Gamma Isotopic	Cs-137 103(24-210)	Cs-137 86(40-153)	Cs-137 85(40-291)
Sediment/Gamma Isotopic	Cs-137 40.4(40-43)	LLD for T/S Isotopes	Cs-137 40.8(40-43) Mn-54 25(20-40)
Drinking Water/Gross Beta	2.1(2-3)	2.4(2-12.8)	2.4(2-6.4)
Drinking Water/Tritium (a/b)	302(300-411) (1/52)	< 300	308(300-520) (2/46)
Drinking Water/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	Co-60 7.4(5-144)
Surface Water/Tritium	335(300-731)	388(300-2504)	317(300-650)
Surface Water/Gamma Isotopic	LLD for T/S Isotopes	LLD for T/S Isotopes	LLD for T/S Isotopes

OPERATIONAL REMP DATA (Cont.)

C Increased mean and range values in 1986 are attributable to the Chernobyl accident.

(a/b) Ratio of samples with detectable activity to number of samples analyzed.

Units:	Air Parameters	=	pCi/m^3
	Milk Parameters	=	pCi/l
	Water Parameters	=	pCi/l
	Vegetation Parameters	=	pCi/kg, wet
	Fish Parameters	=	pCi/kg, wet
	Sediment Parameters	=	pCi/kg, dry
	TLD Parameters	=	mRem/week

APPENDIX I
SUMMARY OF THE BLIND DUPLICATE SAMPLE PROGRAM

SUMMARY OF THE BLIND DUPLICATE SAMPLE PROGRAM

Six blind duplicate samples were submitted to the analytical laboratories as a means of monitoring for consistency of analyses. The duplicate samples were collected in parallel with the routine samples. The results are contained in a table located at the end of this appendix. The counting errors associated with each sample were used when comparing duplicate samples and routine samples.

When an acceptable range of ± 1 standard deviation of the routine sample is used as per the plants procedure, the TLD, air (gross beta only), and grape/grape leaves duplicate samples were not within the acceptable range. However, when a more universally accepted range of ± 2 standard deviations is used, all duplicate samples with the exception of the grape/grape leaves samples fall within the acceptable range.

It is believed that the lack of homogeneity of the grape/grape leaves samples was a direct cause for the discrepancy with the routine samples. Alternate processing methods for improving homogeneity are being evaluated.

It also should be noted that many of the sample activities used in the blind duplicate sample program were below the detection levels of analysis, making the value of comparison somewhat limited. However, with the exception previously noted, the duplicate sample results were in close agreement with the routine sample results.

BLIND DUPLICATE SAMPLE PROGRAM
COMPARISON TABLE

(TI) - Teledyne Isotopes
(C) - CEP

Collection Date	Sample/ Location	Parameters/ Units	Routine Sample	Duplicate Sample	± 1 S.D.	± 2 S.D.
(C) 04/19/89	TLD/OFS-9	Direct Radiation/mRem	13.0 ± 1.4	11.1 ± 1.0	12.3-13.7	11.6-14.4
(C) 05/03/89	Groundwater/Well #3	Gamma Spec/pCi/liter	< LLD	< LLD	< LLD	< LLD
		Tritium/pCi/liter	< 330	< 330	< 330	< 330
(C) 09/25/89	Air/ONS-3	Gross Beta/pCi/m^3	.014 ± .001	.012 ±.001	.0135 ±.0145	.013-.015
		I-131/pCi/m^3	< .005	< .005	< .005	< .005
(C) 10/20/89	Milk/Zelmer	Gamma Spec/pCi/liter	< LLD	< LLD	< LLD	< LLD
		I-131/pCi/liter	< .4	< .4	< .4	< .4
(T) 11/18/89	Sediment/L2	Gamma Spec (K-40) pCi/kg Dry	5060 ± 510	5500 ± 550	4805-5315	4550-5570
		Gamma Spec (Th-228) pCi/Kg Dry	164 ± 22	152 ± 21	153-175	142-186
(T) 11/08/89	Grapes/Ruggles Rd.	Gamma Spec (Be-7) (pCi/Kg Wet)	< 100	170 ± 66	< 100	< 100
		Gamma Spec (K-40) (pCi/Kg Wet)	5690 ± 570	3750 ± 370	5405-5975	5120-6260
	Grape Leaves/ Ruggles Rd.	Gamma Spec (Be-7) (pCi/Kg Wet)	2410 ± 240	1430 ± 140	2290-2530	2170-2650
		Gamma Spec (K-40) (pCi/Kg Wet)	4390 ± 440	1460 ± 150	4170-4610	3950-4830
		Gamma Spec (Cs-137) (pCi/Kg Wet)	43.3 ± 9.4	13.9 ± 5.7	38.6-48.0	33.9-52.7

APPENDIX J

TLD QUALITY CONTROL PROGRAM

TLD QUALITY CONTROL PROGRAM

Teledyne Isotopes performs an in-house quality assurance testing program for the environmental TLD laboratory. On a quarterly basis the QA manager exposes groups of TLDs to three different doses using a known cesium-137 exposure rate. Typical exposures are between 12 and 57 mR. The TLDs are readout on each of the three Model 8300 Readers in the environmental TLD laboratory and the calculated results are reported to the QA manager. The QA manager evaluates the results and writes a report discussing the performance of the labs. For 1989 all results were within the requirements of Regulatory Guide 4.13, Section C. The standard deviations were less than 7.5% and the variations from the known were less than 30%. The accompanying graphs show the percent normalized deviations of the measured doses to the exposure does for each of the three readers.

FIGURE 8

QUALITY CONTROL TEST ENVIRONMENTAL TLDs - 1989

TLD READER 205

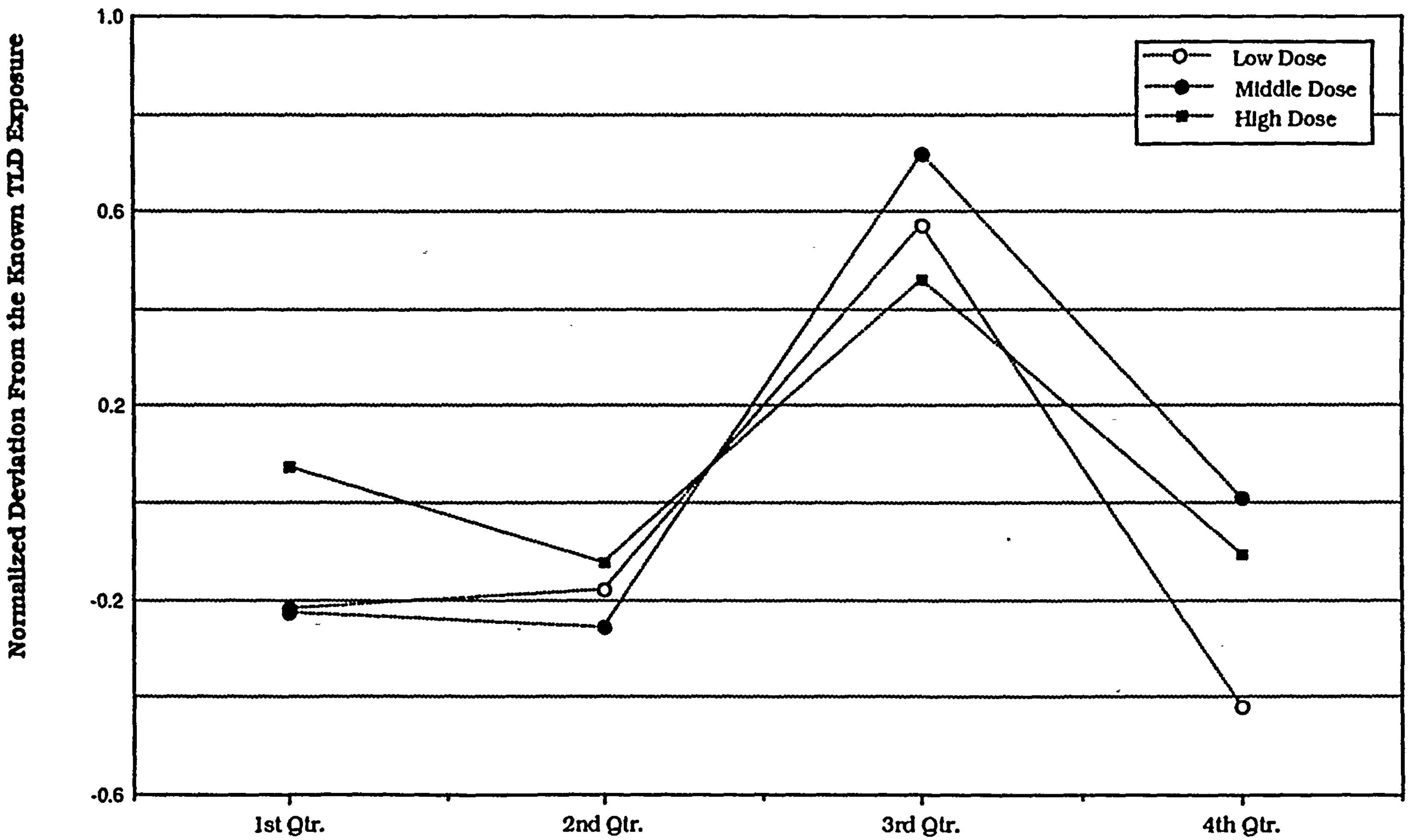


FIGURE 8 (Cont.)

QUALITY CONTROL TEST ENVIRONMENTAL TLDs - 1989

TLD READER 211

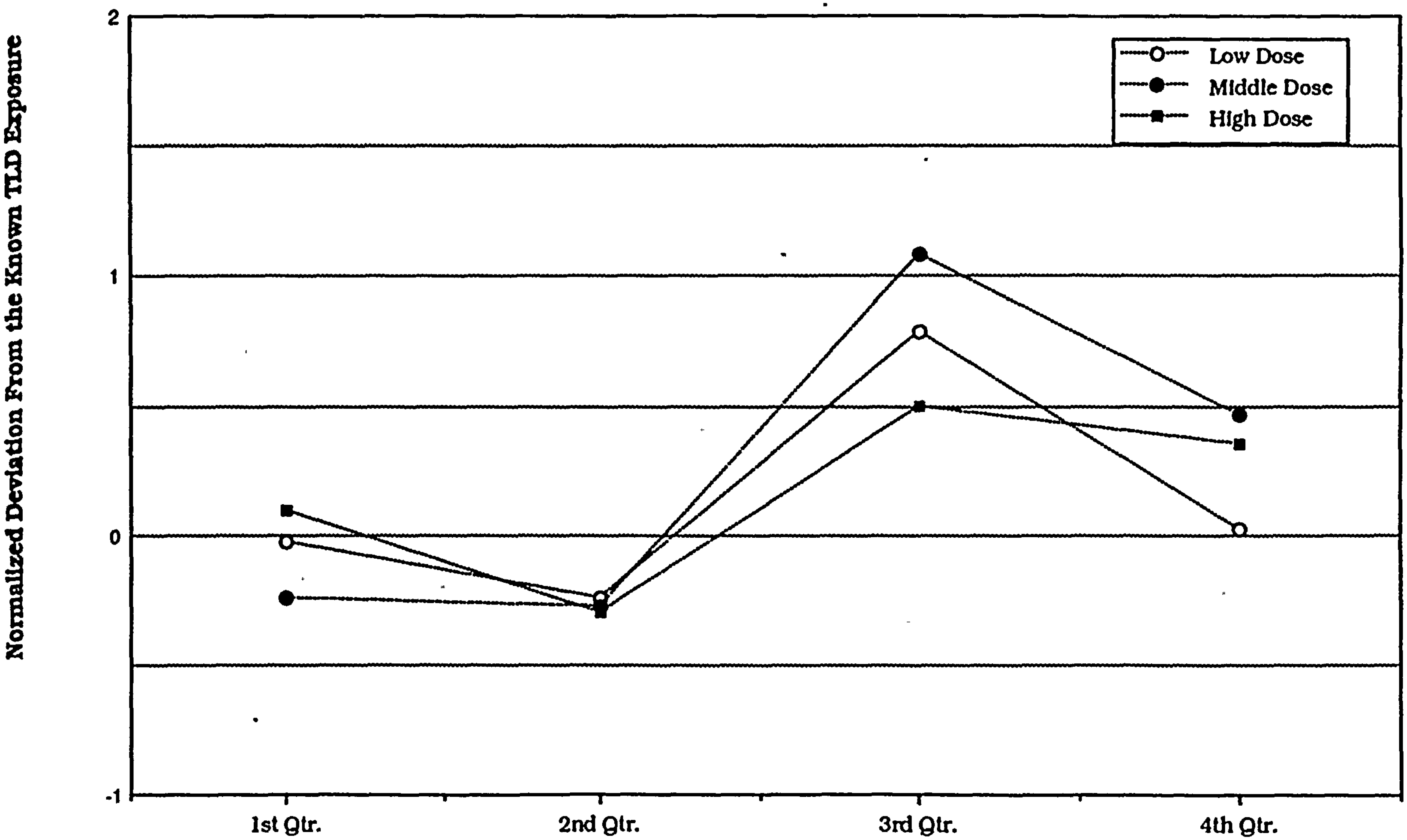
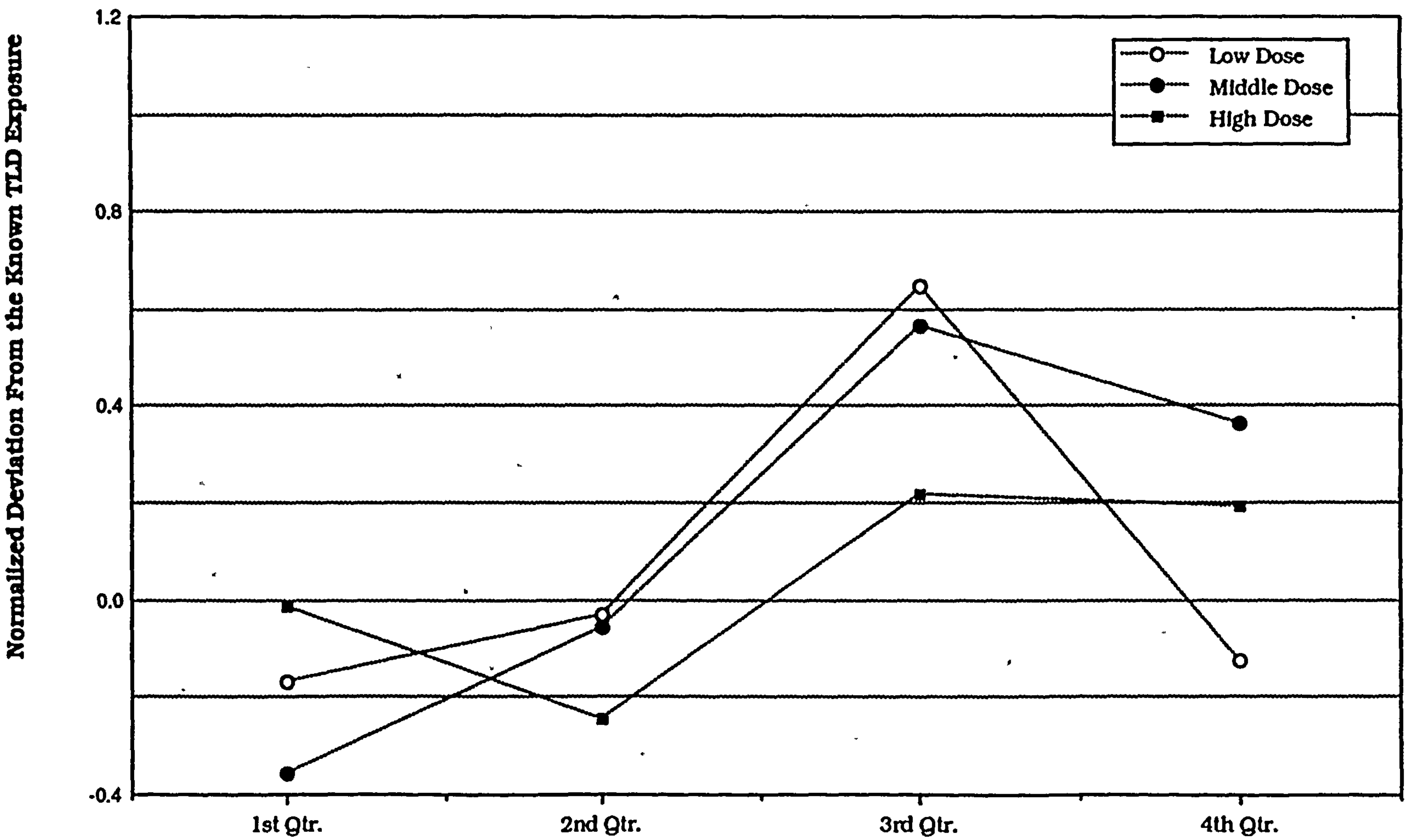


FIGURE 8 (Cont.)

QUALITY CONTROL TEST ENVIRONMENTAL TLDs - 1989

TLD READER 242



APPENDIX 6

TRITIUM CONCENTRATION COMPARISON CHART

1976 - 1989

TRITIUM CONCENTRATION COMPARSION CHART
All Units: pCi/l

Highest Concentration	W-1	W-2	W-3	W-4	W-5	W-6	W-7
Pre-Operational	800	800	800	800	760	700	1000
Operational							
* 1989	2400	2400	<2000	3600	3000	2000	1145
1988	602	<300	435	6033	3141	2165	2155
1987	<300	<300	<300	4444	2631	816	5563
1986	<300	<300	<300	2500	4734	965	2412
1985	<500	<500	<500	7440	4240	2120	1570
1984	1190	1030	1260	7890	5700	5690	2000
1983	<1000	<1000	<1000	8400	3300	4100	<1000
1982	<1000	<1000	<1000	2100	2100	1100	<1000
1981	800	<1000	1200	1400	1500	1200	900
1980	<1000	<1000	<1000	5400	1700	1400	<1000
1979	700	850	<1000	21000A 9200B	1400000A 300000A 4400B	2300	2500
1978	<1000	<1000	<1000	7800	2900	3900	<1000
1977	<1000	<1000	<1000	640	680	9000	<1000
1976	<1000	<1000	530	700	<1000	<1000	480

A) Data may not be quantitative due to interference from hydrocarbons. Oil in the wells.

B) Highest value after analysis techniquess corrected for hydrocarbon interferences.

*) The values for Wells 1 through 6 were obtained from fourth quarter data. The LLD value used for the fourth quarter was 2000 pCi/l as opposed to the 330 pCi/l LLD used for the first three quarters. Therefore the reliability of these values is affected. Tritium LLD values of 330 pCi/l will be used for 1990 samples.