CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9704240079 DOC.DATE: 96/12/31 NOTARIZED: NO DOCKET #
FACIL:50-315 Donald C. Cook Nuclear Power Plant, Unit 1, Indiana M 05000315
50-316 Donald C. Cook Nuclear Power Plant, Unit 2, Indiana M 05000316
AUTH.NAME AUTHOR AFFILIATION
FITZPATRICK,E. Indiana Michigan Power Co.
RECIP.NAME RECIPIENT AFFILIATION

See Environmental Reports

SUBJECT: "Annual Environ Operating Rept for 960101-961231." W/970418 ltr.

DISTRIBUTION CODE: C001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 180
TITLE: Licensing Submittal: Environmental Rept Amdt & Related Correspondence

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	HICKMAN,J	1	1			
INTERNAL:	FILE CENTER 01	1	1	NUDOCS-ABSTRACT	1	1
	OGC/HDS2	1	0	RGN3 DRS/RSB	1	1
EXTERNAL:	NOAC	1	1	NRC PDR	1	1

C A T E G O R Y 1 D O C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE. TO HAVE YOUR NAME OR ORGANIZATION REMOVED FROM DISTRIBUTION LISTS OR REDUCE THE NUMBER OF COPIES RECEIVED BY YOU OR YOUR ORGANIZATION, CONTACT THE DOCUMENT CONTROL DESK (DCD) ON EXTENSION 415-2083

TOTAL NUMBER OF COPIES REQUIRED: LTTR 7 ENCL 6

Indiana Michigan
Power Company
500 Circle Drive
Buchanan, MI 49107 1395

INDIANA
MICHIGAN
POWER

April 18, 1997

AEP:NRC:0806Q

Docket Nos.: 50-315
50-316

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

Gentlemen:

Donald C. Cook Nuclear Plant Units 1 and 2
ANNUAL ENVIRONMENTAL OPERATING REPORT
JANUARY 1, 1996 TO DECEMBER 31, 1996

Attached is the Donald C. Cook Nuclear Plant Annual Environmental Operating Report for the year 1996. This report was prepared in accordance with procedure 12 PMP 6010 OSD.001, "Offsite Dose Calculation Manual," section 4.8.1, and Technical Specification, Appendix B, Part 2, section 5.4.1.

Sincerely,

E. E. Fitzpatrick
Vice President

vlb

Attachment

cc: A. A. Blind
A. B. Beach
MDEQ - DW & RPD
NRC Resident Inspector
J. R. Padgett

C001

230115
9704240079 961231
PDR ADOCK 05000315
R PDR

ATTACHMENT TO AEP:NRC:0806Q

ANNUAL ENVIRONMENTAL OPERATING REPORT
JANUARY 1, 1996 TO DECEMBER 31, 1996

9704240079

TABLE OF CONTENTS

Page

I. Introduction 1

II. Changes to the Environmental Technical Specifications 1

III. Non-Radiological Environmental Operating Report 1

A. Plant Design and Operation 1
B. Non-Routine Reports 1
C. Environmental Protection Plan 1
D. Potentially Significant Unreviewed Environmental Issue 1
E. Environmental Monitoring-Herbicide Applications 2
F. Mollusc Biofouling Monitoring 2
G. Special Reports 2

IV. Radiological Environmental Operating Report 2

A. Changes to the REMP 2
B. Radiological Impact of Donald C. Cook Nuclear Plant Operations ... 3
C. Land Use Census 3
D. Solid, Liquid, and Gaseous Radioactive Waste Treatment Systems ... 3

V. Conclusion 3

LIST OF APPENDICES

Appendix	Title
I.	Non-Routine Reports - 1996
II.	Environmental Screening Reports - 1996
III.	Herbicide Application Report - 1996
IV.	Mollusc Biofouling Monitoring - 1996
V.	Special Reports
VI.	Annual Report: Radiological Environmental Monitoring Program - 1996
A.	Radiological Environmental Monitoring Program Summary - 1996
B.	Data Tables
C.	Analytical Procedures Synopsis
D.	Summary of EPA Interlaboratory Comparisons
E.	REMP Sampling and Analytical Exceptions
F.	Land Use Census
G.	Summary of the Preoperational Radiological Monitoring Program
H.	Summary of the Spike and Blank Sample Program
I.	TLD Quality Control Program

I. INTRODUCTION

Procedure 12 PMP 6010 OSD.001, "Offsite Dose Calculation Manual," Section 4.8.1 and Technical Specification, Appendix B, Part 2, Section 5.4.1 require that an annual report, which details the results and findings of ongoing environmental radiological and non-radiological surveillance programs, be submitted to the Nuclear Regulatory Commission. This report services to fulfill these requirements and 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 through December 31, 1996.

During 1996, based on the monthly operating reports for Unit 1 and Unit 2, the annual gross electrical generation, average unit service factors, and capacity factors were:

Parameter	Unit 1	Unit 2
Gross Electrical Generation (MWH)	8,687,540	8,298,030
Unit Service Factor (%)	97.6	87.0
Unit Capacity Factor - MDC* Net (%)	95.3	86.2

* Maximum Dependable Capacity

II. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

There were no environmental Technical Specification changes in 1996.

III. NON-RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

A. Plant Design and Operation

During 1996, no instances of noncompliance with the Environmental Protection Plan occurred, nor were there any changes in station design, operations, tests, or experiments which involved a potentially significant unreviewed environmental issue.

There was one environmental screening during the reporting period. A copy of this screening is located in Appendix II of this report. It was concluded that no environmental evaluations were required and that no unreviewed environmental questions existed.

B. Non-Routine Reports

A summary of the 1996 non-routine events is located in Appendix I of this report. No long-term, adverse environmental effects were noted.

C. Environmental Protection Plan

There were no instances of Environmental Protection Plan noncompliance in 1996.

D. Potentially Significant Unreviewed Environmental Issues

There were no changes in station design, operations, tests or experiments which involved a potentially significant unreviewed environmental issue.

There was one environmental screening during the reporting period. A copy of this screening is located in Appendix II of this report. The screening determined that there were no unreviewed environmental

questions.

E. Environmental Monitoring - Herbicide Application

Technical Specifications Appendix B, Part 2, section 5.4.1, states that the Annual Environmental Operating Report shall include: summaries and analyses of the results of the environmental protection activities required by section 4.2 of this Environmental Protection Plan for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous non-radiological environmental monitoring reports, and an assessment of the observed impacts of the plant operation on the environment.

Herbicide applications are the activities monitored in accordance with section 4.2. There were no preoperational herbicide studies to which comparisons could be made. Herbicide applications are managed by plant procedure 12 THP 2160 HER.001.

A summary of the 1996 herbicide applications is contained in Appendix III of this report. Based on observations, there were no negative impacts or evidence of trends toward irreversible change to the environment as a result of the herbicide applications. Based on our review of application records and field observations, the applications conformed with EPA and State requirements for the approved use of herbicides.

F. Mollusc Biofouling Monitoring Program

Macrofouler monitoring and control activities during 1996 are discussed in Appendix IV of this report. Whole water sampling studies showed no adverse environmental impact.

G. Special Reports

There were no special reports identified during 1996.

IV. RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

The Radiological Environmental Monitoring Program annual report is located in Appendix VI of this report.

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 material.

3. Provide reasonable assurance that the predicted doses, based on radiological 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.

A. Changes to the REMP

There were no identified changes to the REMP during 1996.

There were no identified changes to the REMP during 1996.

B. Radiological Impact of Donald C. Cook Nuclear Plant Operations

This report summarizes the collection and analysis of various environmental sample media in 1996 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, mild 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.

The only radionuclide which appears attributable to the Donald C. Cook Nuclear Plant operation is tritium, which was measured at low levels in onsite wells. However, the associated groundwater does not provide a direct dose pathway to man.

C. Land Use Census

The Land Use Census is performed to ensure that significant changes in the immediate vicinity of the Donald C. Cook Nuclear Plant are identified. Any identified changes are evaluated to determine whether a modification must be made to the REMP or other related programs. Two deletions of milk farms were identified during the 1996 Land Use Census. A further discussion of the Land Use Census can be found in Appendix VI of this report.

D. Solid, Liquid, and Gaseous Radioactive Waste Treatment Systems

There were no changes in the solid, liquid, or gaseous radioactive waste treatment systems during 1996.

V. CONCLUSION

Based upon the results of the radiological environmental monitoring program and the radioactive effluent release reports for the 1996 reporting year, it can be concluded that there were no adverse affects to the environment or to the general public due to the operation of the Donald C. Cook Nuclear Plant.

APPENDIX I

NON-ROUTINE REPORTS

1996

1996 Non-Routine Events

February 26, 1996 - Outfall 00D Continuous pH monitoring was interrupted. The interruption was caused by fouling problems associated with the glass pH electrode.

March 10, 1996 - Outfall 00D continuous pH monitoring was interrupted. The interruption was caused by an electronic failure of pH monitoring instrumentation.

May 10, 1996 - An estimated 1 gallon of oil was washed down the roof drains to the storm water system as a result of oil vapor accumulating on the roof from the Unit 2 hydrogen seal oil vapor extractors (an estimated 5 gallon accumulation).

August 19, 1996 - Approximately 2 gallons of lube oil leaked from a damaged oil reservoir for a traveling water screen to the Unit 1 forebay.

APPENDIX II

ENVIRONMENTAL SCREENING REPORTS

1996

AMERICAN ELECTRIC POWER

Date June 4, 1996

Subject Donald C. Cook Nuclear Plant
Environmental Evaluation Unit 2 Uprate Per AEP: NRC: 1223

From J. P. Carlson / G. P. Arent / S. L. Colvis

To AEP: NRC: 1223
Donald C. Cook Nuclear Plant

Introduction

This environmental screening is written in support of the application for amendment of the Donald C. Cook Nuclear Plant, Unit Number 2 Facility Operating License; for amendment of the Donald C. Cook Nuclear Plant, Unit 2 Technical Specifications; and for related changes to the Unit 1 Technical Specifications proposed primarily to support operation of Cook Nuclear Plant Unit 2 at an increased core Rated Thermal Power of 3588 MWt.

In anticipation of the proposed Unit 2 uprate, the March 1994 renewal submittal for the National Pollution Discharge Elimination Systems (NPDES) Permit included a request for increasing the thermal effluent discharge limit. The following excerpt provides the scope of the change and the justification.

> "The current thermal effluent limit for the circulating water system discharging to Lake Michigan is 15.5 x 10^9 BTU/hr. This is calculated from measurements taken at Outfalls 001 and 002 for Units 1 and 2, respectively. At this limit, the units are operating with calculated maximum temperature differentials of 22.3 and 18.3 degrees F for Units 1 and 2, respectively. The units have been required to reduce load from 100% during the hottest summer months to maintain the thermal discharge within limits. In order to maintain 100% load throughout the entire year, including the hot summer months, we propose increasing the thermal discharge limit to 16.25 x 10^9 BTU/hr.
>
> At the proposed thermal discharge, the temperature differentials are calculated to be approximately 1 degree F greater, or 23.4 and 19.3 degrees F for Units 1 and 2 respectively, using the same conditions as in the above calculations. The increase in heat load and discharge temperature to Lake Michigan are minimal and are not expected to result in adverse environmental harm in and around the plant discharges."

The 16.25 x 10^9 BTU/hr was increased to 16.8 x 10^9 BTU/hr in a later proposal to the MDNR, as described in the demonstration of the acceptability of the proposed increase in heat discharge of Rule 98 Michigan Water Quality Standards (Attachment C).

On June 28, 1995, the Cook Nuclear Plant received a new NPDES Permit which included permission to increase Heat Addition Discharge Limitation to 16.8 x 10^9 BTU/hr with the following Special Condition 9 to perform a Thermal Plume Study:

> "As a condition of this permit, the permittee shall conduct a thermal plume study for outfalls 001 and 002. The study shall be conducted seasonally, during spring, summer and fall. Each seasonal study shall include a determination of the current velocity and volume which serves to dilute the discharge in Lake Michigan, a determination of the stratification of the effluent, if any in Lake Michigan, predominant wind direction and velocity at the time of the study, and detailed mapping of the plume for each study.
>
> Within three (3) months of the effective date of this permit, a plan for conducting the study shall be submitted to the Plainwell District Supervisor of the Surface Water Quality Division for approval. The study shall be implemented in accordance with the approved plan, which will include information regarding initiation of the study. If the permittee desires to make any substantial changes in the approved plan, such proposed changes shall be submitted to and be approved by the Plainwell District Supervisor prior to implementation. The result of this study shall be submitted to the Plainwell District Supervisor within four (4) months of the completion of the study."
>
> A plan for conducting the study was submitted on September 25, 1995 to the Michigan Department of Natural Resources (MDNR) (now known as the Michigan Department of Environmental Quality or MDEQ) District Supervisor of the Surface Water Quality Division (SWQD) (Attachment A). Approval from the MDEQ SWQD was received on November 6, 1995 (Attachment B).

Schedules have been established to meet the other items of Special Condition 9.

It should also be noted that Special Condition 10 - Temperature Modification exists as follows in the current NPDES Permit:

> "The Michigan Department of Natural Resources is considering the necessity of incorporating temperature limitations in this permit to assure that the requirements of Rule 82 (1) of the Michigan Water Quality Standards are met. Therefore, when consideration of this issue has been completed, the Department may modify this permit in accordance with Part II.B.4 to add appropriate temperature limitations or requirements."

Review Action Taken

The Final Environmental Statement (FES), National Pollution Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential environmental impact associated with this proposed uprate.

In accordance with 661000-LTG-2200-1, Revision 0 "Preparation and Distribution of Environmental Evaluations," an Environmental Check Sheet was completed. The conclusions of this check sheet follow.

1. Will the proposed activity result in a significant increase in any adverse environmental impact previously evaluated in the Final Environmental Statement (FES)?

   No The proposed uprate will result in an increase in temperature of the cooling water that will enter Lake Michigan as found in the summary of environmental impact and adverse effects in the FES. The area of the thermal plume is also expected to increase from 593 to 700 acres, an increase of about 18%. We believe that the impact of this change will have a negligible effect on the environment and does not represent a significant increase in any adverse impact discussed in the FES. On the basis of the statement 7, in the summary and conclusions portion of the FES, all requirements set forth in the FES called forth by the National Environmental Policy Act (NEPA) such as License Conditions has been met and reviewed and approved by the Michigan Department Natural Resources and the United States Environmental Protection Agency. A thermal plume study as required per NPDES permit is scheduled once the uprate has occurred.

   Technical Specifications associated with the uprate will be included in AEP: NRC: 1223.

2. Is the proposed activity a matter not previously evaluated in the Final Environmental Statement?

   No The FES discusses thermal effluent discharge and the Unit 2 uprate represents a change to the NPDES effluent limits as discussed in question 3 and 4. The proposed activity was not evaluated at the heat discharge levels that were evaluated in the original FES. However, the FES did evaluate thermal effluent discharge. Current modeling studies indicated that the calculated mixing zone will expand, yet this is not expected to be a significant deviation from the original study and does not indicate an adverse environmental impact previously evaluated in the FES. This activity and associated effect have been previously evaluated in the FES and are all potential adverse effects were addressed via the NPDES Permit approval process.

   David J. Jude from the Center for Great Lakes and Aquatic Sciences for the University of Michigan, was contracted to perform an investigation of changes that might occur due to the heat increase and how these changes might impact the current Lake Michigan fauna in the vicinity of the plant (Attachment D). The review determined that the requested heat input and increased thermal plume size will have a negligible impact on the integrity of the Lake Michigan ecosystem in this area of the lake. In addition, this report and underlying studies show the size and increased temperatures expected within the plume will have no discernible adverse environmental impact on the wide array of fishes, zooplankton, and benthic organisms that are common, rare, endangered, or uncommon in the vicinity of the Cook Plant.

   The environmental impacts and adverse effects contained in the FES were reviewed and all appropriate measures required under the National Environmental Policy Act and Appendix D to 10 CFR Part 50 were addressed via the NPDES Permit approval process described and attached throughout this document.

3. Will the proposed activity result in a significant change in constituent or quantity of effluent?

   No There is no significant change in constituent of effluent. The quantity of the effluent will only change in the amount of heat being discharged. This change is from 15.5×10^9 BTU/hr to 16.8×10^9 BTU/hr. Heat is different from chemical pollutants in that it will not interfere with the designated uses in the receiving stream, nor will it impact the public health or environment. The additional heat to be rejected to Lake Michigan is not expected to result in a significant change in the quality of effluent and has been reviewed and approved and permitted by the MDNR.

4. Will the proposed activity result in a significant change in authorized power level?

   Yes The change to Rated Thermal Power from 3411 to 3588 by definition reflects a change in authorized Power level. Impacts resulting from this change are discussed in the response to question 3 and will be addressed in AEP:NRC:1223 Technical Specification amendment proposal to the USNRC.

5. Will a previously <u>undisturbed</u> area be impacted by this activity?

   No The thermal plume size is expected to increase, although this increase is not expected to impact previously undisturbed areas in Lake Michigan. The thermal plume study that will be performed as required in the NPDES permit will document whether there will be a significant environmental effect as a result of the uprate.

6. Will initiation or implementation of the proposed activity require modification to existing permits?

   No In accordance with the NPDES Permit No. MI0005827 for the Donald C. Cook Nuclear Plant PART II A.2. Change of Conditions, a new application was submitted to the Chief of the Permit Section of the Surface Water Quality Division to increase the heat rejected to Lake Michigan from 15.5×10^9 BTU/hr to 16.8×10^9 BTU/hr. Also submitted to the Michigan Department of Natural Resources per Part 4 of the general rules of the Michigan Water Resource Commission (Water Quality Standards) was a Demonstration of Acceptability of Increase Heat Addition proposed in accordance to Rule 98 (Attachment C).

<u>Conclusion</u>

Based on this review of the proposed uprate of Cook Nuclear Plant Unit 2 from 3411 MWt to 3588 MWt, it is concluded that an unreviewed environmental question does exist. As such, information concerning the change will be submitted to the Nuclear Regulatory Commission in accordance with procedure 661-LTG-2200-01 "Preparation and Distribution of Environmental Evaluations."

It should be noted that the determination that an unreviewed environmental question existed was an expected result of this evaluation. The purpose of this evaluation was to support the proposed Technical Specification Amendment submittal package. From a strictly environmental perspective, the proposed uprate is not considered to have a significant adverse impact on the environment as discussed in the FES. Finally, the Michigan Department of Natural Resources has approved the proposed increase in the thermal effluent limit.

Based on a review of the FES, Appendix B Technical Specifications, the current NPDES Permit for the Cook Nuclear Plant, and 10 CFR 51 requirements no environmental assessment (EA) or environmental impact statement (EIS) is required. EAs or EISs are not required for any action included in the list of "categorical exclusions" set forth in 10 CFR 51.22(c). Specifically, 10 CFR 51.22(c)(a), provides that an EA is not required for the issuance of an amendment provided that:

(i) the amendment involves no significant hazards consideration,
(ii) there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and
(iii) there is no significant increase in individual or cumulative occupational radiation exposure.

Plant radiation protection features are designed to limit the radiation exposure to plant personnel and the general public to 10 CFR 20 limits under normal conditions. While certain isotopes are present in greater concentration in the fuel gap due to the uprated power level, the actual increases in occupational dose are expected to be minimal. The fuel has been designed to operate at the higher power level without any damage, which would negate any increases in radioactivity trapped within an intact fuel rod. Also, our technical specifications limit the concentration of radioactivity within the reactor coolant system (see Technical Specification 3.4.8).

Nevertheless, accident offsite doses have been recalculated based on the uprated source term and other analysis assumptions used in the Uprating Program. In some cases, the resulting thyroid offsite dose consequence's increase slightly above the values presently in the UFSAR. The new calculated whole body doses either remain the same as the UFSAR values or decrease. For both types of calculations, the changes in the offsite radiation dose for each accident are not significant and are within the acceptance criteria as defined in 10 CFR 100.

Since systems and procedures controlling normal radioactive releases are based on limiting plant effluents to a small fraction of regulatory limits, the proposed uprating of Unit 2 will not exceed 10 CFR 20 or 10 CFR 100 limits. Based on this information, there will be no significant increase in the types or amounts of effluents that may be released offsite and no significant increase in individual or cumulative occupational radiation exposure.

AEPNO believes that the provisions of 10 CFR 51.22(c)(a) are applicable to this power increase. For reasons described in the submittal, AEPNO believes the three criteria of 10 CFR 51.22(c)(9) are satisfied. Therefore, this Technical Specification amendment should be considered under the "categorical exclusions" provision of 10 CFR 51.22(c)(9).

The environmental impacts at the higher power level are bounded by the impacts assumed in the existing FES and controlled by the Michigan Department of Environmental Quality through the NPDES Permit program, and Rule 98 of the Michigan Quality Standards. A copy of the Demonstration of Acceptability of Increased Heat Addition, which was submitted as part of the compliance requirements by the MDNR and EPA, is also included with this package for review at Attachment C. This submittal should assist the NRC in making a "finding of no significant impact" in accordance with 10 CFR 51.32.

References

1. Unit 1 and 2 Technical Specifications, Appendix B.
2. NPDES Permit No. MI0005827, June 28, 1995
3. Final Environmental Statement, August 1973
4. 10 CFR 51.22.(c), 10 CFR 51.32

Approved by: S J Brewer for

D. H. Malin, Section Manager
Nuclear Licensing and Fuels

Attachments

c: S.J. Brewer
D.M. Fitzgerald
M.A. Ackerman

APPENDIX III

HERBICIDE APPLICATION REPORT

1996

AMERICAN ELECTRIC POWER

Date March 26, 1997

Subject 1996 Herbicide Spray Report - Cook Nuclear Plant

From E. C. Mallen

To J. P. Carlson

The following herbicides were applied on Cook Nuclear Plant property during 1996.

. Round-up Pro .Preen
. Oust .Weed-B-Gon

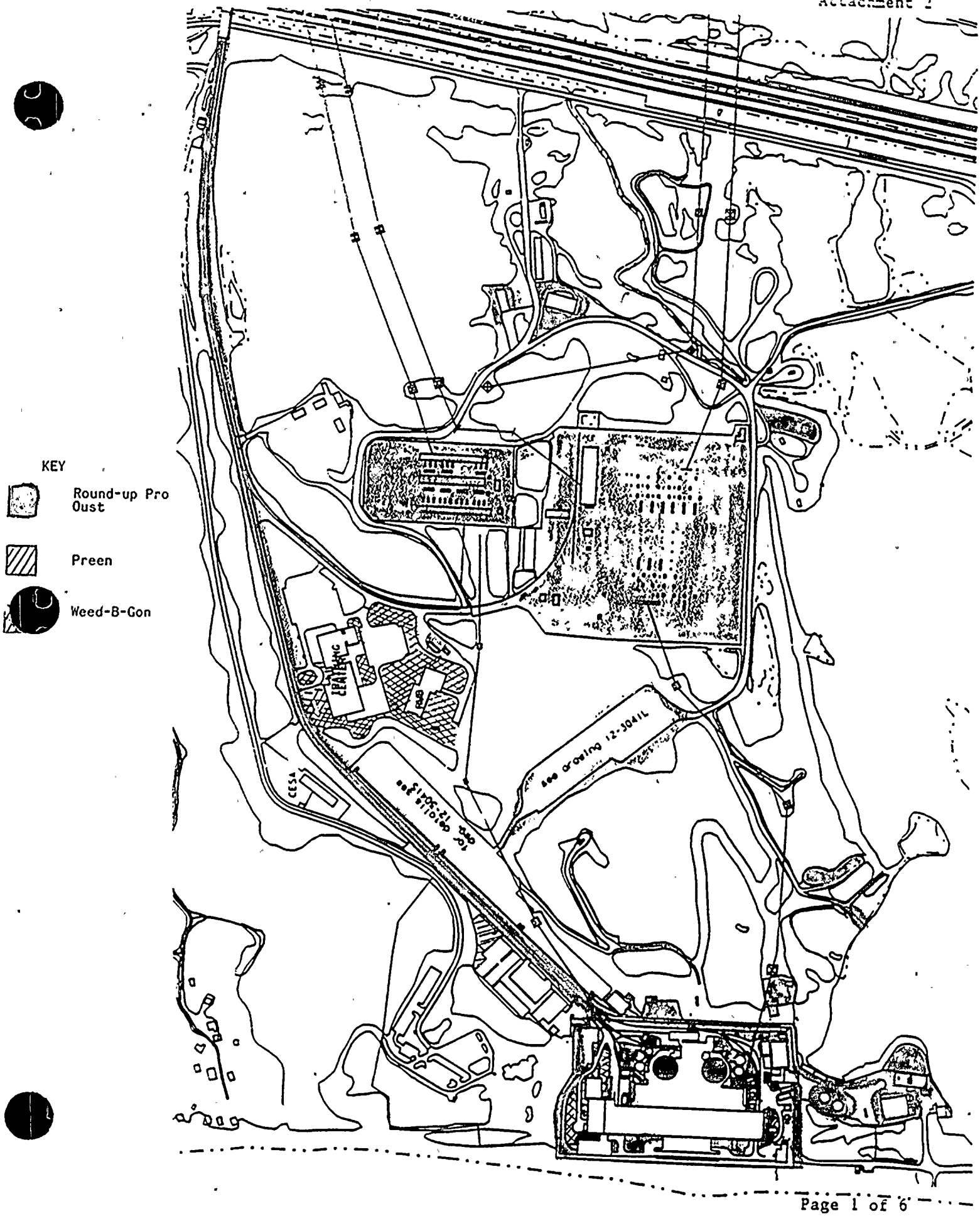
From July 24-29, 1996, a mixture of Round-up Pro and Oust was used for total plant control in the switch yards, railroad right-of-way, around buildings, parking lots, the sewage and absorption ponds, and within the plant's protected area. The application was performed by DeAngelo Brothers, a licensed herbicide applicator on contract to the AEP Western Division.

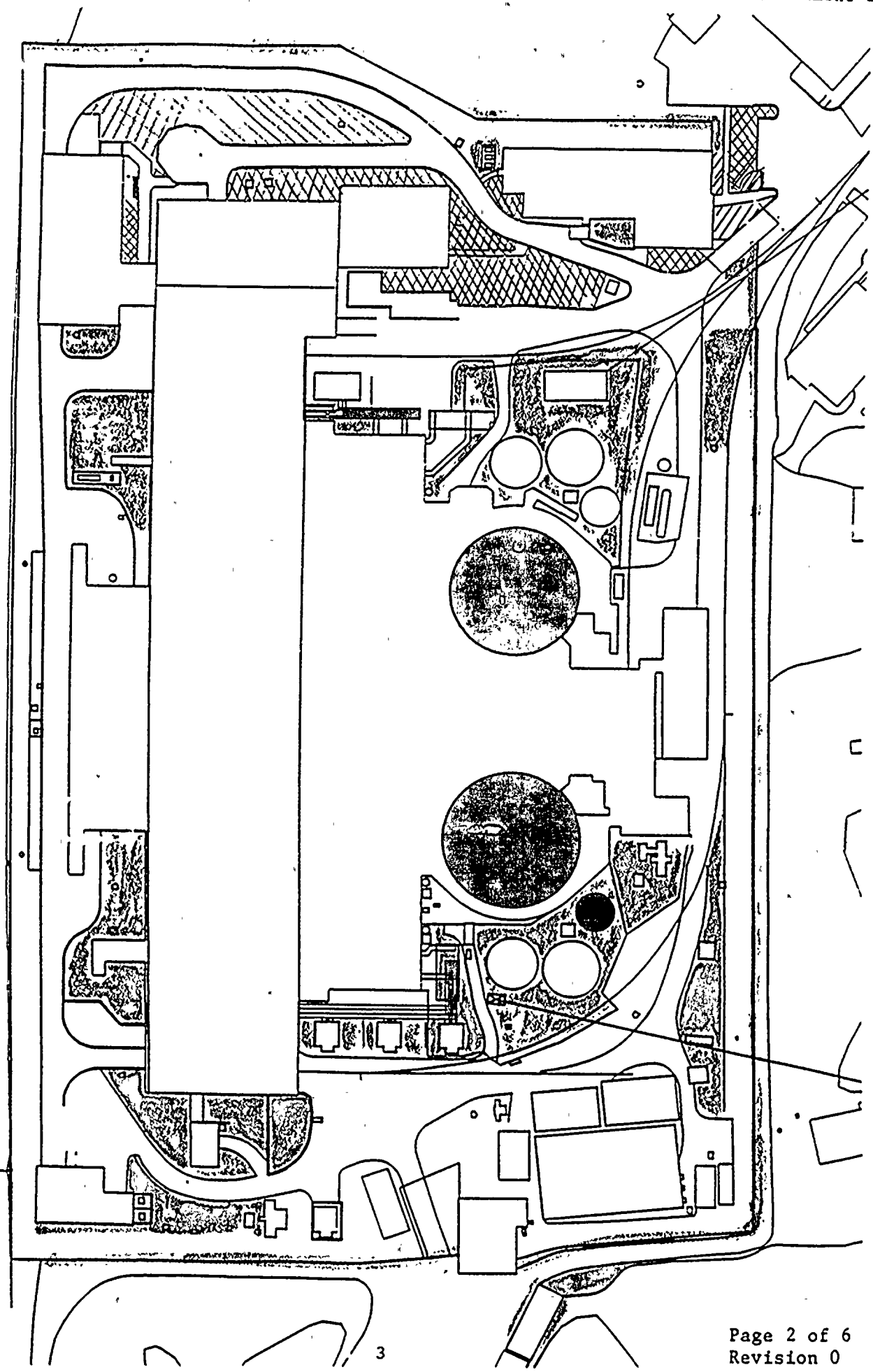
On September 3, 1996, the mortality of this herbicide application was assessed at 80-90%. The areas around the Oil Building and the PM&IS Steel Yard were assessed at 15% effective. The fence opening between the 345KV and 765 KV yards indicated no application had occurred in this area. The effect on small (<3') saplings was minimal and these are quite numerous in the 765KV yard. The protected area had a very high mortality, with only a few plants noted in the microwave zone.

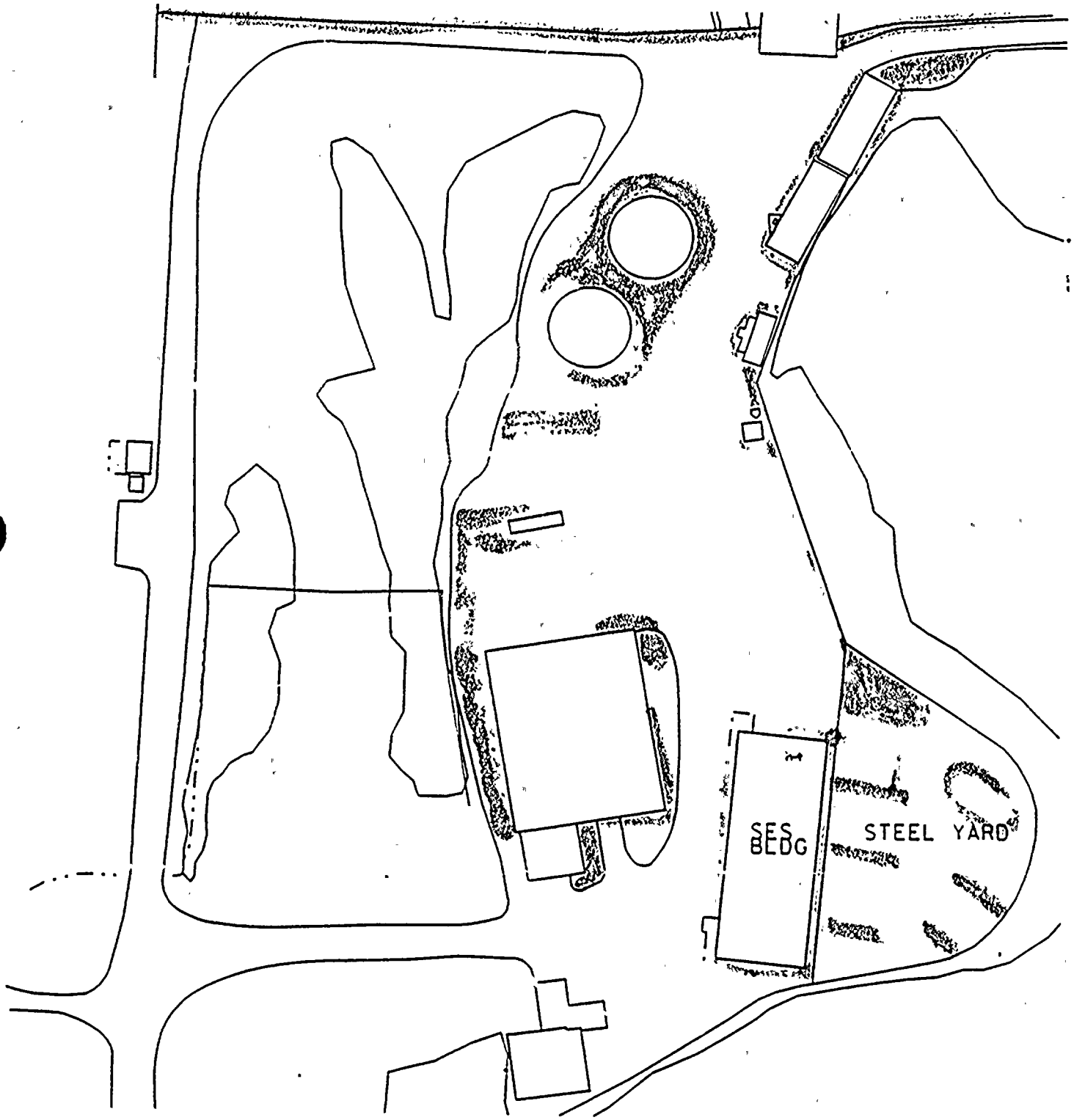
On August 8, 9, and 22, 1996 Preen was used for weed control in planting beds around the North Guardhouse entrance, Training Building, and Visitor's Parking Lot. The herbicide was applied by a licensed applicator from the Maintenance ANR Buildings & Grounds Crew. The herbicide was 80-90% effective and controlled weeds in the planting beds cutting back on weeding time.

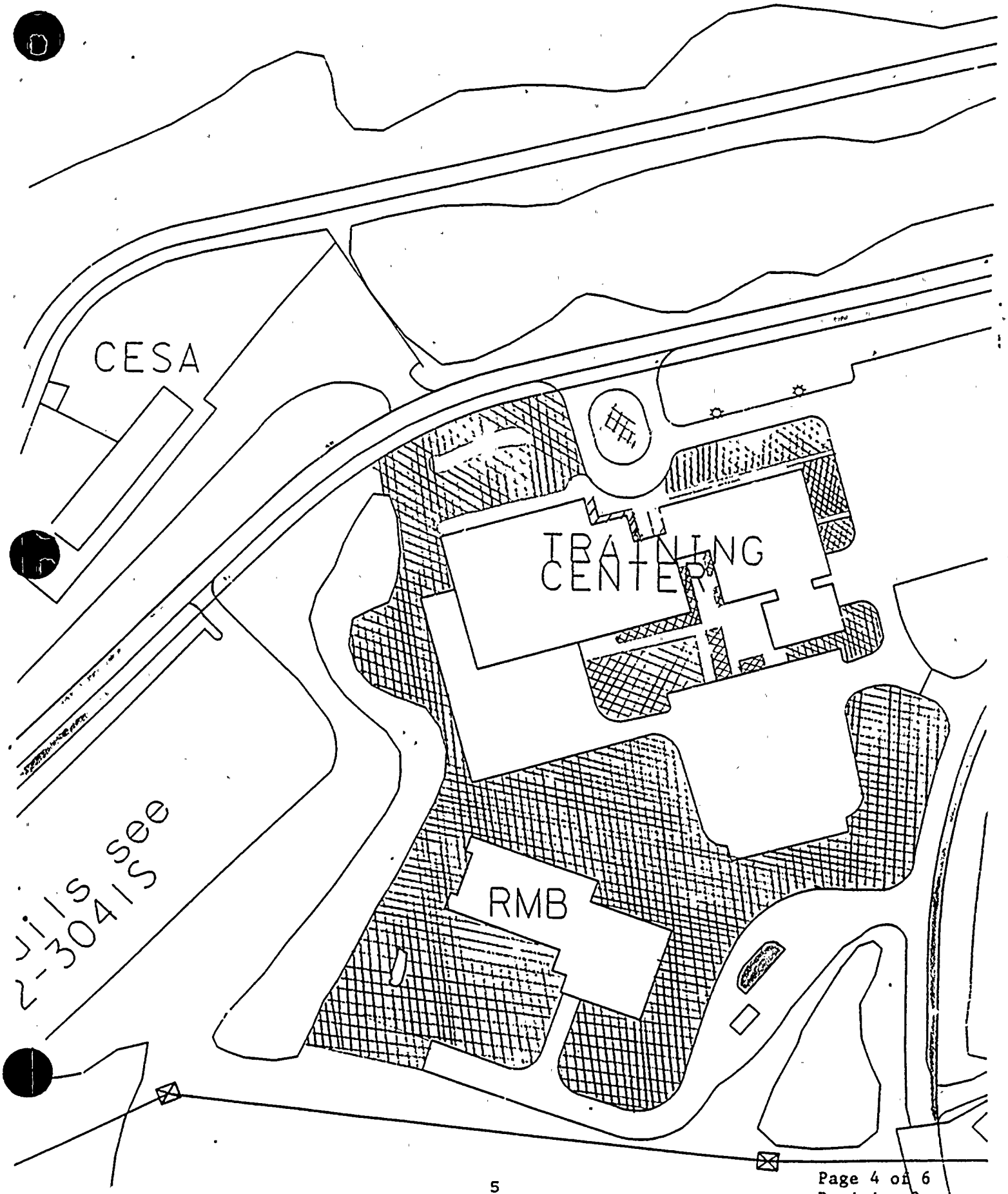
On July 18, 26, 31 and August 1, 27, 28, and 29, 1996 Weed-B-Gon was used for weed control on the lawns around the plant site. The herbicide was applied by a licensed applicator from the Maintenance ANR Buildings & Grounds Crew. The herbicide was 20-30% effective in controlling weeds in the Plant's lawns. The reason for this low efficacy was that the herbicide was applied in summer as opposed to early spring.

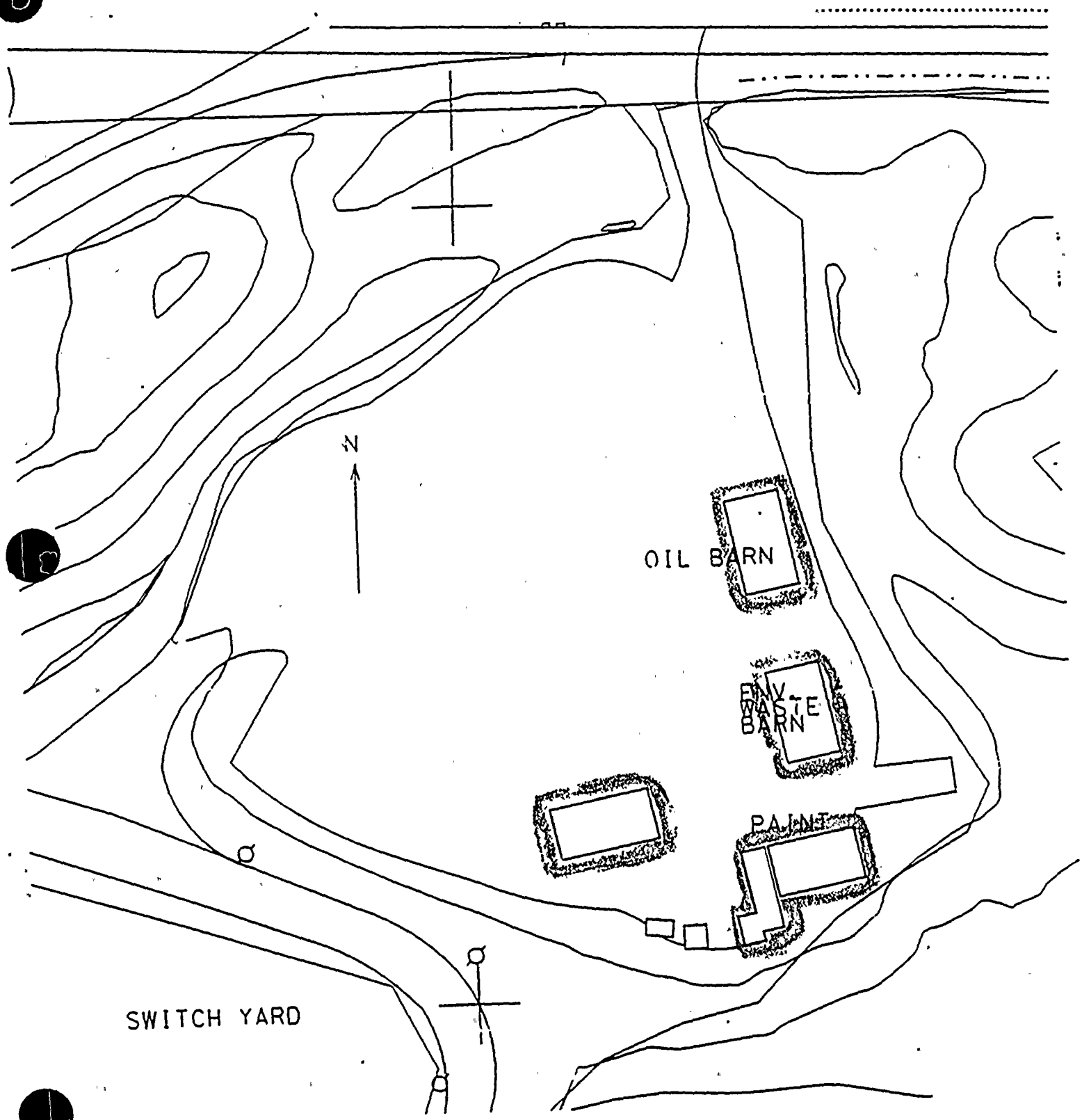
In summary, based upon our review of the application records, manufacturer specifications, material safety data sheets (MSDSs) and observations of the treated areas, the herbicides were applied according to the manufacturer's labeled instructions and according to Federal and State requirements. A certified applicator was used as required. No signs of over spray or spillage were observed or noted. No adverse environmental effects occurred.

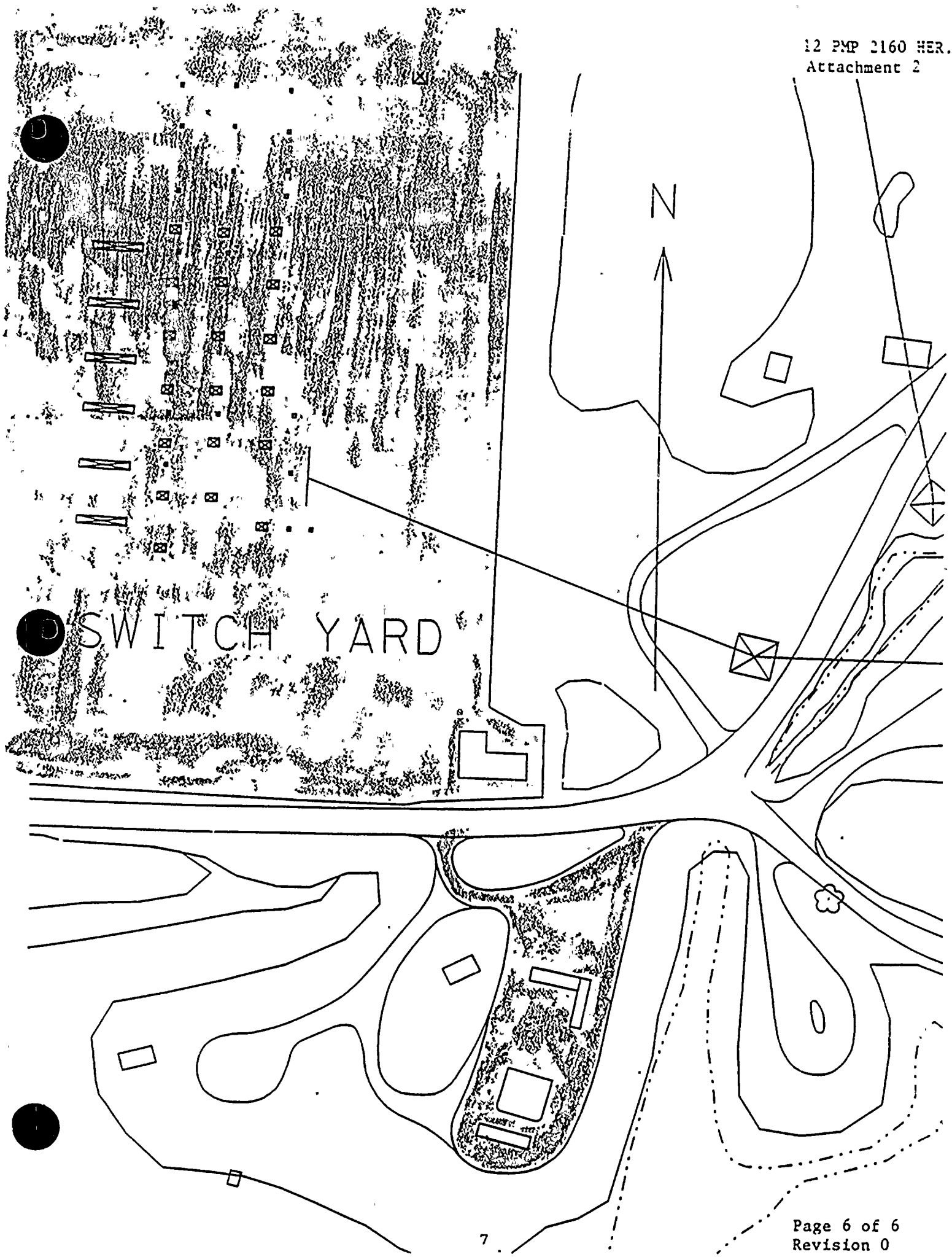

KEY
Round-up Pro Oust
Preen
Weed-B-Gon
CESA
See drawing 12-3041L




SES
BLDG
STEEL YARD


CESA
TRAINING CENTER
RMB
Jils see
2-3041S


N
OIL BARN
ENV.
WASTE
BARN
PAINT
SWITCH YARD


N
SWITCH YARD

APPENDIX IV

MOLLUSC BIOFOULING MONITORING

1996

Cook Nuclear Plant
1996 Zebra Mussel Monitoring
and Control Report

INTRODUCTION

The plant's zebra mussel monitoring and control program is presented in the following report. Chlorine, molluscicides, mechanical cleaning, and changes in plant design remain the zebra mussel control strategy at the Cook Plant. Monitoring efforts continue to assess the threat of zebra mussel infestation and determine the effectiveness of plant control techniques. Zebra mussels which slough from the intake pipelines continue to present a challenge to the screenwash and traveling screen system, service water pump strainers, plant condensers, and the miscellaneous sealing and cooling water system. The plant is working aggressively on design changes to alleviate these zebra mussel related problems.

ERADICATION AND CONTROL MEASURES

The 1996 control strategy consisted of the use of continuous and intermittent chlorination of the service water, miscellaneous sealing and cooling water, and circulating water systems, and mechanical cleaning. Plant design changes to mitigate zebra mussel related problems constituted a large portion of zebra mussel control efforts in 1996.

MECHANICAL CLEANING

Mechanical cleaning of the Unit 2 intake forebay and Unit 2 essential service water pump bays was performed by divers during the Unit 2 refueling outage in 1996. The Unit 2 main condenser inlet tunnel was inspected and cleaned during the Unit 2 refueling outage. Cleaning and flushing of small bore piping and strainers in the service water systems and low volume water systems was continued in 1996.

All three intake cribs were cleaned in the fall of 1996 to minimize the impact of the intakes on diving ducks. Intake crib cleaning has been an effective means to mitigate duck entrainment into the plant.

MOLLUSCICIDE TREATMENT RESULTS

There were no proprietary molluscicide treatments in 1996.

CHLORINATION TREATMENT RESULTS

A vendor supplied chlorination system was again used to continuously chlorinate the service water and miscellaneous sealing and cooling water systems, and intermittently chlorinate the circulating water system. Continuous chlorination of the service water systems and the miscellaneous sealing and cooling water system at a target feed rate of 0.3 to 0.6 ppm end-of-pipe residual, was effective in controlling the settlement of zebra mussels in these systems.

Corrosion coupon monitoring studies have begun to indicate corrosion of yellow metals (0.2-1.5 mils./yr.) and mild steel (8.6 mils./yr.) in the service water systems. However, we have not observed actual corrosion indication in engineering inspections to date. The plant=s corrosion rate objectives for the service water systems are <0.2 mils./yr. for yellow metals and <5 mils./yr. for mild steel.

Intermittent chlorination of the circulating water system at 0.2 ppm for 155 minutes per day in May and shortened to 60 minutes per day in June thru early December was effective in minimizing slime growth in the main and feed pump condensers. The non-essential service water system was cross-connected to the miscellaneous sealing and cooling water system to continuously treat the system. Though the miscellaneous sealing and cooling water system was continuously chlorinated via the non-essential service water cross-connection, the system still experienced some blockage by silt and shell fragments in the small bore piping downstream of the miscellaneous sealing and cooling water pump strainers. There has been a noticeable reduction in frequency of small bore piping blockage since the system was first continuously chlorinated during the zebra mussel spawning season in 1995.

FOULING FROM THE INTAKE PIPELINES

Zebra mussels continue to slough from the intake pipelines especially when flow velocities and patterns are changed by cycling the center intake gate valve WMO-30 and

circulating water pumps. This operation presents a challenge to the traveling screens and screenwash system in their ability to handle the influx of zebra mussels sloughing off from the intake tunnels. Any carryover that occurs, must be handled by the service water pump strainers or is impinged on the condenser tube sheets. The continuous operation of the traveling screens contributed to a large diver maintenance effort in 1996.

DESIGN CHANGES

Traveling Screens

Modifications of the traveling screen spraywash system begun in 1995 from a single to a dual spray header with improved nozzle design was completed in 1996 under PM-873. The dual spray header return piping was routed to the traveling screen trash trough to facilitate flushing of the spray headers and nozzles. In addition to the spray header and spray nozzle changes, the screen panels on traveling screen 2-OME-43-7 were replaced with a flatter stainless steel wire mesh. The improved design effectively removed the debris from the traveling screens. The old galvanized dipped screen panels are systematically being replaced on the remaining traveling screen units by the stainless steel panels as the old panels wear out. A component evaluation, CE-95-0345, performed on the north screenwash pump strainer in August of 1996, reduced the strainer mesh size from 1/8" to 5/64" to prevent the traveling screenwash nozzles from plugging.

Miscellaneous Sealing & Cooling Water Pump Strainer and Filter Upgrade

In the fall of 1996, the 2" miscellaneous sealing & cooling water pump strainers were replaced with 4" Hayward self cleaning strainers. In addition, two Ontario Hydro Industries 40 micron filters were installed to run in parallel. The new filters will become operational in 1997 when the filter backwash routing can be changed from the screenwash pump stainer backwash lines to the 30" turbine room sump overflow line to the intake forebay.

Chemical Injection Pipeline

A design has been issued under DCP-108 for installation of two chemical injection pipeline systems to be run through the center intake tunnel and branching at the center intake crib to the north and south intake cribs. This design is scheduled to be installed in May 1997. Chemicals will be delivered out to the intake cribs effectively controlling zebra mussel colonization in the intake pipelines.

CONCLUSION

For the foreseeable future, proprietary molluscicides will continue to be used for zebra mussel control. Mechanical cleaning can supplement chemical control methods in the circulating water system. Plant design changes including strainers, filters, screens, and chemical delivery systems, will work to resolve the plant=s zebra mussel related problems. Continuous chlorination has proven to be effective in controlling zebra mussels in the service water and the miscellaneous sealing & cooling water systems. Corrosion coupon studies in the service water systems have shown that alternatives to chlorine should be sought to minimize corrosion. A zebra mussel monitoring program utilizing side-stream and artificial substrate monitors, along with diver and heat exchanger inspections, will continue to be used to evaluate the effectiveness of chemical and physical control measures.

Prepared for

AMERICAN ELECTRIC POWER
Donald C. Cook Nuclear Plant
One Cook Place
Bridgman, Michigan

MOLLUSC BIOFOULING MONITORING DURING 1996

March 1997

LMSE-97/0091&673/003

Prepared by:

LAWLER, MATUSKY & SKELLY ENGINEERS LLP
Environmental Science & Engineering Consultants
10207 Lucas Road
Woodstock, Illinois 60098

TABLE OF CONTENTS

	Page No.
LIST OF FIGURES	ii
LIST OF TABLES	iii
EXECUTIVE SUMMARY	ES-1
1 INTRODUCTION	1-1
1.1 Past History	1-1
1.2 Objectives	1-1
2 METHODS	2-1
2.1 Whole-Water Sampling	2-1
2.2 Artificial Substrates	2-2
2.2.1 Periodic Settlement	2-2
2.2.2 Cumulative Settlement	2-3
2.2.3 Periodic and Cumulative Sample Analysis	2-3
2.3 Quality Assurance / Quality Control	2-4
3 RESULTS AND DISCUSSION	3-1
3.1 Whole-Water Sampling	3-1
3.2 Artificial Substrate Sampling	3-2
3.2.1 Circulating Water System	3-2
3.2.2 Service and Miscellaneous Sealing and Cooling Water Systems	3-3
3.3 Quality Assurance / Quality Control Samples	3-8
4 SUMMARY AND RECOMMENDATIONS	4-1
4.1 Summary	4-1
4.2 Recommendations	4-2
4.3 References	4-3

LIST OF FIGURES

Table No.	Title	Following Page
3-1	Whole Water Sampling Program Veligers Per Cubic Meter, D.C. Cook, 1996	3-1A
3-2	Artificial Substrate Settlement-Forebay Numbers Per Square Meter, D.C. Cook, 1996	3-2A
3-3	Artificial Substrate Settlement-Periodic Service Water and Miscellaneous Cooling Water Systems Postveliger Density Per Square Meter, D.C. Cook, 1996	3-3A
3-4	Wholewater Veliger Density and Periodic Settlement in the Service Water System, D.C. Cook, 1996	3-4A
3-5	Artificial Substrate Settlement-Cumulative Service Water and Miscellaneous Cooling Water Systems Postveliger Density Per Square Meter, D.C. Cook, 1996	3-7A

LIST OF TABLES

Table No.	Title	Page No.
2-1	Sampling Schedule for Zebra Mussel Monitoring, D.C. Cook, 1996	2-1A
3-1	Whole Water Sampling Program Veligers Per Cubic Meter, D.C. Cook, 1996	3-1B
3-2	Zebra Mussel Density, Average Size, and Size Range of Settled Postveligers from Periodic Sampling, D.C. Cook, 1996	3-2B
3-3	Chlorination Data for the Service Water Systems, D.C. Cook, 1996	3-4B
3-4	Zebra Mussel Density, Average Size, and Size Range of Settled Postveligers from Cumulative Sampling, D.C. Cook, 1996	3-7B
3-5	Results of QA/QC Samples, D.C. Cook, 1996	3-8A

EXECUTIVE SUMMARY

Biofouling Studies have been conducted at the Donald C. Cook Nuclear Plant since 1983. In 1991, monitoring of zebra mussels in the circulating water, essential service water (ESW), and nonessential service water (NESW) systems was added to the program. The objectives of this monitoring are to detect the presence and density of zebra mussel veligers in the circulating water system and postveliger settlement in the forebay and service water systems.

Veligers were present in the forebay from 9 May through 12 December 1996. Peak densities occurred on 10 October and 26 September 1996, with the major peak occurring on the October date (292,750/m^3). Secondary peaks were observed on 17, 24 and 31 October 1996. This period of peak abundance is typical for the lower Great Lakes which normally experience peak densities during the September-October period.

Settlement occurred in the forebay on all periodic sampling dates in 1996, except 6 June and 25 July. Size information indicates that settlement during the 6 June to 11 July period was partially composed of translocators. First evidence of 1996 spawned postveliger settlement was observed on 20 June. Heaviest settlement occurred between 5 September and 21 November with the peak occurring between 19 September and 31 October. This is typical for the lower Great Lakes and is similar to results reported for the 1992, 1993, and 1994 monitoring programs.

There were no proprietary molluscicide treatments in 1996. Therefore, the objective of comparing cumulative settlement in the forebay after treatment with that of the entire season could not be met.

Settlement of live postveligers first appeared on the artificial substrates set in the service water systems during the latter half of October. Observation of location of individuals on slides, number of half shells, no cilia or internal movement, and size data indicated that results recorded from June through the first half of October reflected the effects of the continuous chlorination, i.e., primarily dead organisms were entrained on the slides.

Peak densities on the periodic artificial substrates which were placed on the service water systems occurred during the latter half of October for all service water systems. This followed the peak densities in the wholewater samples by one to two weeks, as expected. Densities of postveligers on the cumulative artificial substrate samples were low from 23 May through 22 August and peaked at ESWR-1, ESWR-2, and the miscellaneous sealing and cooling water systems during the latter half of October. The highest density reported for NESW occurred on 12 December.

Several unexpected observations were made during the 1996 sampling season. These includes:

- Veligers were present in the wholewater samples through 12 December.
- Size data for artificial substrate samples (both periodic and cumulative) indicated that small postveligers were present through 12 December and that these specimens were alive on the substrates collected on the November and December sampling dates.

A number of possible explanations are presented for these observations. No one explanation by itself is considered to be the answer; but rather some combination of these factors is thought to be responsible for the unexpected results. These possible explanations include:

- The abnormally warm lake water, as measured at the intake, during October (particularly the latter half of the month) most likely extended the peak spawning season for zebra mussels until the first part of November.
- The efficacy of the chlorine may have been reduced by the combination of colder water and high pH during November and/or the possible presence of chloramines in the system.
- Zebra mussel metabolic rates slowed down with the decrease in water temperature during November; therefore, they were not as susceptible to chlorine as during the warmer weather months.
- Results may reflect presence of quagga mussels in the vicinity of the offshore intake. These relatives of zebra mussels continue to spawn at much colder water temperatures than zebra mussels and are known to be present in the Great Lakes.

CHAPTER 1

INTRODUCTION

1.1 PAST HISTORY

American Electric Power Company (AEP) has been conducting zebra mussel monitoring studies at the Donald C. Cook Nuclear Plant since 1991. The purpose of the studies is to monitor the presence of zebra mussel veliger and postveliger settlement densities in the circulating water, essential service water (ESW), and nonessential service water (NESW) systems to help determine the effectiveness of zebra mussel control programs.

The 1996 monitoring program conducted by Lawler, Matusky & Skelly Engineers LLP (LMS) was designed to detect the timing of spawning and settling of zebra mussels at the Cook Nuclear Plant and to collect and determine densities for: (1) wholewater samples for planktonic veligers; and (2) artificial substrates set within the circulating water, ESW, NESW, and miscellaneous sealing and cooling systems for periodic and cumulative postveliger settlement.

1.2 OBJECTIVES

Specific objectives for the 1996 biofouling monitoring program were as follows:

- Whole-water sampling of the circulating water system was conducted weekly (June-October), bimonthly (May and November), or monthly (April and December) to determine the presence and density of larval zebra mussels.

- Artificial substrates were deployed in the intake forebay and service water systems to detect settlement of post-veligers. Samples were collected every two weeks from June through October and once every three weeks during November and December.

CHAPTER 2

METHODS

2.1 WHOLE-WATER SAMPLING

Whole-water sampling of the circulating water system was conducted from 25 April to 12 December 1996 according to the schedule presented in Table 2-1. Samples were collected from mid-depth in the intake forebay by pumping lake water through an in-line flowmeter into a plankton net. The sampling location was consistent with that of previous studies. Two replicates (2000 liters each) were collected during each sampling event.

A Myers Model 2JF-51-8 well pump, rated to deliver 8 gpm, was connected to an in-line flowmeter assembly (Signet Model #P58640) and pumped water into a plankton net for approximately 45 minutes. To minimize organism abrasion, measured flow was directed into a No. 20 plankton net that was suspended in a partially filled 55-gal plastic barrel. Valves were adjusted to reduce flow, thus preventing the plankton net from overflowing when heavy sediment loads or plankton concentrations were present.

Samples were washed down gently into the cod-end bucket using filtered, circulating water system water and then transferred into a 1 liter plastic jar. If needed, filtered water was added to the jar to ensure that a full liter was analyzed. After the second replicate was taken, both samples were transported to the on-site laboratory and analyzed immediately.

Samples were initially mixed thoroughly for 3 minutes using a magnetic stir plate. Then, using a calibrated disposable Pasteur pipette, a 1-ml aliquot of mixed sample was placed into a Sedgewick-Rafter cell for counting, using an Olympus SZ-1145 binocular microscope (18-110X) equipped with cross-polarizing filters. Ten replicates were counted, and the average was extrapolated to determine the number of individuals per cubic meter. This process was repeated for the second replicate and the mean of the two values was calculated to yield a final density value. The density was calculated as follows.

TABLE 2-1

SAMPLING SCHEDULE FOR ZEBRA MUSSEL MONITORING, D.C. COOK, 1996

DATE		WHOLEWATER	ARTIFICIAL SUBSTRATE PERIODIC	ARTIFICIAL SUBSTRATE CUMULATIVE
April	25	X		
May	9	X		
	23	X		
June	6	X	X	
	13	X		
	20	X	X	X
	27	X		
July	3	X		
	11	X	X	
	18	X		
	25	X	X	X
August	1	X		
	8	X	X	
	15	X		
	22	X	X	X
	29	X		
September	5	X	X	
	12	X		
	19	X	X	X
	26	X		
October	3	X	X	
	10	X		
	17	X	X	X
	24	X		
	31	X	X	
November	7	X		
	21	X	X	X
December	12	X	X	X

$$\text{Density } (\#/m^3) = (\text{average } \#*DF) / 0.001L * 1L / 2000L * 1000L / m^3$$

Size measurements were recorded for up to 50 organisms from each sample. Veliger length (μm) was measured using an ocular micrometer that was calibrated to a stage micrometer.

2.2 ARTIFICIAL SUBSTRATES

To determine zebra mussel settlement in the circulating water, ESW, and NESW systems, artificial substrates were placed in the intake forebay upstream of the trash racks; sidestream samplers were set on the return side of both service water systems and on the miscellaneous sealing and cooling system. Monitors were equipped with modified test-tube racks designed to hold slides for periodic and cumulative sampling. (*Periodic settlement* is defined as short-term monitoring, either two- or three-week periods, depending on the month. *Cumulative settlement* is long-term monitoring that extends from initial deployment [23 May] to the end of the sampling season.) Both periodic and cumulative sampling dates are presented in Table 2-1.

2.2.1 Periodic Settlement

Artificial substrates that were designed to measure periodic settlement were placed in the intake forebay and consisted of cinderblocks with test-tube racks secured inside the openings. Periodic samplers were deployed by rope in the central location at approximately mid-depth.

Sidestream monitors were placed on the return side of the service water systems (ESW and NESW) and the miscellaneous sealing and cooling water system. Each monitor contained two modified test-tube racks that held all slides above the monitor base. This allowed silt and sediment to fall out before they could influence postveliger settlement. Monitors were covered with a plant-approved fireproof fabric to limit light exposure. Plant personnel checked the monitors periodically to ensure that adequate flow was available, and flow was adjusted as necessary. On each sampling date 10 slides from each location were retrieved and replaced with clean slides. These were labeled as periodic settlement. Slides were placed in labeled

racks, covered with a plastic bag, and transported to the on-site laboratory where they were analyzed immediately.

2.2.2 Cumulative Settlement

A sufficient number of substrates were initially placed in the biobox samplers to allow 10 slides to be removed once per month at the service water and miscellaneous sealing and cooling water locations. These slides were not replaced. Cumulative settlement was monitored in the forebay using two pieces of PVC pipe that were each six inches long and had an inside diameter of two inches. Each pipe was cut in half lengthwise, rejoined using hose clamps, and attached to a rope at intervals of about three feet. These were deployed at the central location at mid-depth. One sampler was intended to be exposed to ClamTrol CT-2 and the other was not to be exposed to the toxicant during the Clamtrol treatment. Cumulative monitoring was designed to provide information on accumulated infestation throughout the growing season. There were no proprietary molluscide treatments in 1996.

2.2.3 Periodic and Cumulative Sample Analysis

Analysis was conducted with an Olympus SZ-1145 binocular microscope (18-110X) equipped with cross-polarizing filters. After one side of the slide was scraped clean, the slide was placed on the microscope so that the attached postveligers could be counted. When slides became heavily infested, a subsampling technique was followed:

- The slides were subsampled using a splitter that permitted either half or a quarter of the slide to be counted. Counts were then proportionally extrapolated to one square meter.

Settlement rates were computed by taking the average value of the 10 slides and multiplying this value by 533.34 to obtain the density of zebra mussels per square meter. (One postveliger/microscope slide equals 533.34 veligers per square meter.)

Shell diameters were measured for up to 50 selected and random individuals for both unsubsampled and subsampled slides to obtain maximum, minimum, and mean sizes. Diameters were measured using an ocular micrometer calibrated to a stage micrometer.

2.3 QUALITY ASSURANCE / QUALITY CONTROL

A total of three sampling dates were reanalyzed by Mr. Jeffrey Mensinger (who conducted this zebra mussel monitoring program for LMS during the period 1992 through 1994) for precision and accuracy of the counting procedures. Samples were shipped to an off-site laboratory and analyzed using the same procedures as the original analysis. Dates reanalyzed included 27 June, 31 October, and 12 December 1996. One liter of wholewater and one slide from each sampling site (both cumulative and periodic artificial substrates) were reinspected.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 WHOLE-WATER SAMPLING

Sampling of planktonic veligers in the circulating water system was initiated on 25 April 1996 and completed on 12 December 1996. Fifty-six samples were taken (two per sampling date) from the station's intake forebay. The monitoring system performed up to expectations. The continued use of an electronic flowmeter provided data comparable to those of the 1993, 1994, and 1995 monitoring programs. As a result, direct comparisons with those data can be made.

Results of sampling are presented in Figure 3-1 and Table 3-1. With the exception of the 25 April sampling date, veligers were present in all samples collected. The major density peak was observed on 10 October (292,750/m^3). Lesser peaks of abundance occurred on 26 September (92,250/m^3), 17 October (57,250/m^3), 24 October (53,450/m^3), and 31 October (55,650/m^3).

As was observed in previous years, veliger presence throughout the monitoring program (except for April) suggests that substantial densities of veligers are in the water column for more than six months of the year. Heaviest spawning activity occurred during the mid-October period. During the seven weeks from mid-September through the end of October, mean veliger densities were approximately 85,280/m^3, which was about 84,000/m^3 greater than the same period in 1995 and similar to densities recorded in 1994. In 1993 and 1995, the peak abundances were recorded during this seven week period; while in 1994, peak abundance occurred atypically in June. The late September-October period of peak abundance is more typical for the lower Great Lakes (O'Neil, personal communication). It is thought that the June 1994 peak was more the result of unusually hot weather that occurred during the first two weeks of June than environmental differences between the early fall periods amongst the years of record.

FIGURE 3-1

WHOLE-WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER, D.C. COOK, 1996

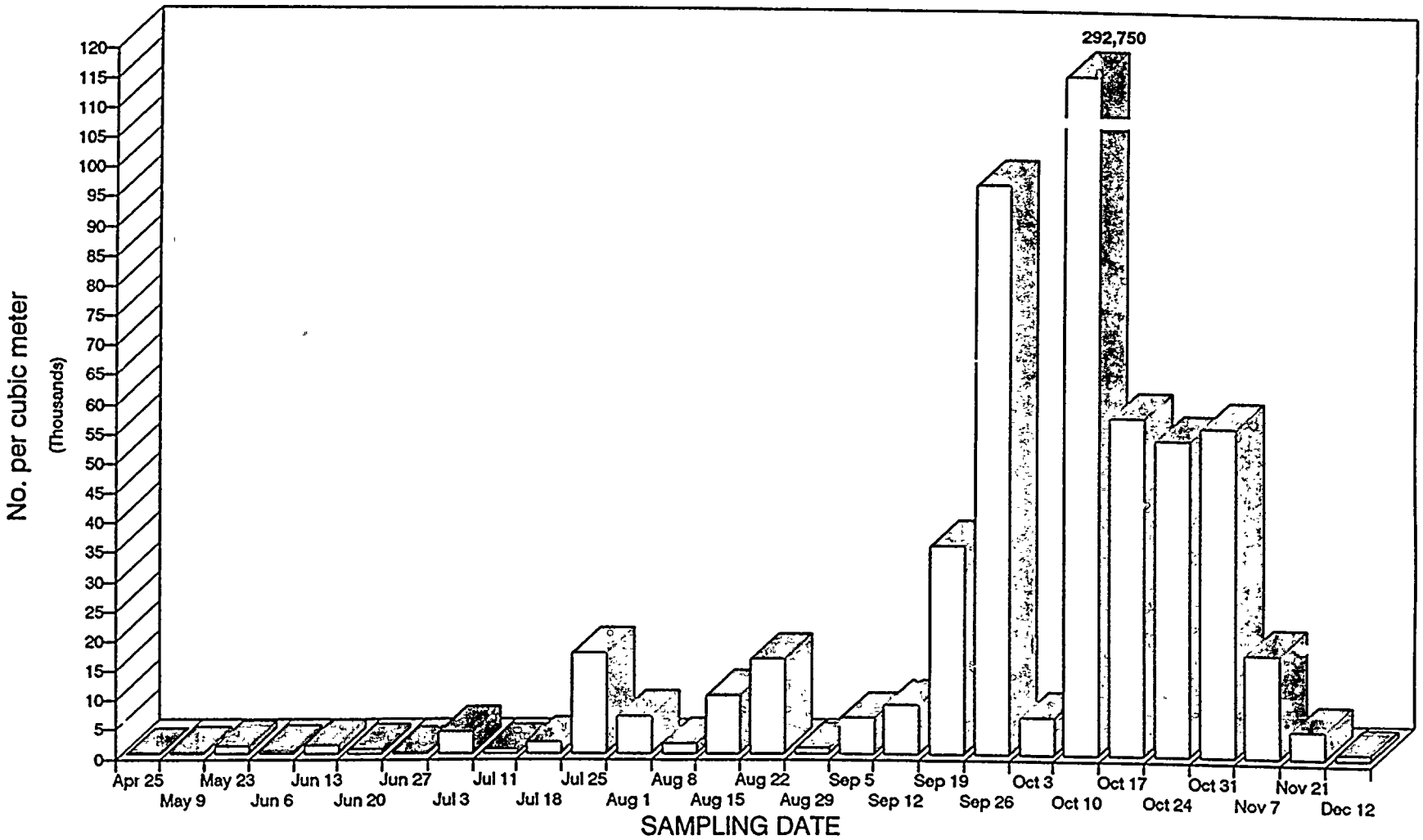


TABLE 3-1

WHOLE WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER, D.C. COOK, 1996

DATE	DENSITY (No./m^3)	SIZE RANGE (µm)	MEAN SIZE (µm)
4/25/96	0	-	-
5/09/96	150	100 - 160	130
5/23/96	1,175	75 - 625	118
6/06/96	250	120 - 500	213
6/13/96	1,375	80 - 130	100
6/20/96	500	90 - 330	140
6/27/96	25	125	125
7/03/96	3,625	90 - 320	105
7/11/96	625	100 - 150	114
7/18/96	1,950	90 - 130	103
7/25/96	17,000	90 - 180	110
8/01/96	6,325	90 - 200	142
8/08/96	1,700	100 - 230	193
8/15/96	9,675	90 - 330	138
8/22/96	15,925	100 - 330	158
8/29/96	975	100 - 260	174
9/05/96	5,975	90 - 230	150
9/12/96	8,275	100 - 260	174
9/19/96	35,425	90 - 300	144
9/26/96	96,250	100 - 300	165
10/03/96	6,200	100 - 390	189
10/10/96	292,750	90 - 330	197
10/17/96	57,250	90 - 330	219
10/24/96	53,450	100 - 400	216
10/31/96	55,650	100 - 430	202
11/07/96	17,475	130 - 330	216
11/21/96	4,600	100 - 560	232
12/12/96	925	100 - 560	363

Size data for the 1996 sampling season shows that translocators were active in the forebay on 23 May and 6 June. Spawning commenced between 25 April and 9 May and continued through the middle of December as indicated by the lower portion of the size range data. Size range data also show that translocators were present in the water column from 23 May through 6 June but then were absent from the samples for the remainder of the sampling season. On most other dates, the upper end of the size range exceeded the size of settlement (200-225μm) and was in or exceeded this range on every sampling date from 1 August through 12 December. However, mean size did not approach this settlement size range until October.

In summary, zebra mussel veligers were present in the water column on all sampling dates except 25 April. Spawning commenced between 25 April and 9 May and continued through mid-December. Peak veliger densities occurred during the seven week period from mid-September to the end of October which is typical for the lower Great Lakes and has been reported at the Cook Plant for three of the last four years (1993, 1995, and 1996).

3.2 ARTIFICIAL SUBSTRATE SAMPLING

3.2.1 Circulating Water System

Artificial substrate monitoring was conducted at the center forebay location (which is protected by a deflector wall) from 23 May to 12 December 1996. Periodic settlement rates for the circulating water system (forebay) are shown in Figure 3-2. Table 3-2 provides density and size information for settled postveligers.

Settlement in the forebay occurred on all periodic sampling dates in 1996 except 6 June and 25 July. Density information presented in Table 3-2 indicates that settlement was low from 6 June through 5 September (0-8600/m^2). Several translocators settled on the substrates during the 6 June to 11 July period. First evidence of settlement of 1996 spawned zebra mussels was observed on 20 June. Heaviest settlement occurred between 5 September and 21 November with the peak occurring during the 3 October to 17 October period. This is typical for the lower Great Lakes and is consistent with results reported for the 1992, 1993, and 1994

FIGURE 3-2

ARTIFICIAL SUBSTRATE SETTLEMENT-FOREBAY NUMBERS PER SQUARE METER, D.C. COOK, 1996

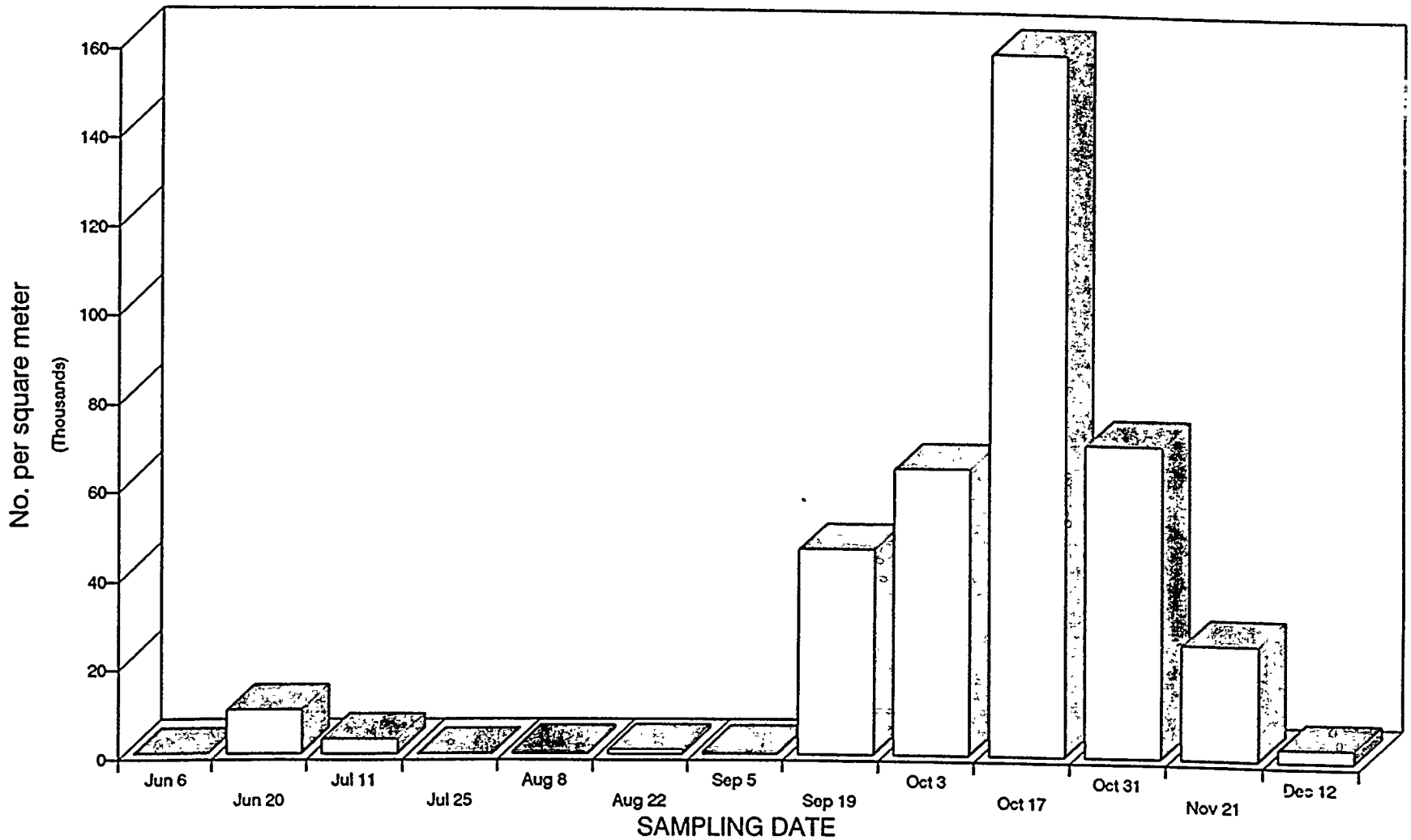


TABLE 3-2

ZEBRA MUSSEL DENSITY, AVERAGESIZE, AND SIZE RANGE OF SETTLED POSTVELIGERS FROM PERIODIC SAMPLING, D.C. COOK, 1996

	PERIODIC SAMPLES														
	FOREBAY			NESW			MS&C			ESW R-1			ESW R-2		
DATE	Density (No/.m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)
6/06/96	0	-	-	53	220	220	53	130	130	53	200	200	0	-	-
6/20/96	9,600	193	140-260[a]	0	-	-	0	-	-	1,600	263	130-400	0	-	-
7/11/96	3,200	415	140-1,475	1,600	150	120-180	533	130	130	0	-	-	533	120	120
7/25/96	0	-	-	53	230	230	267	238	200-330	853	98	90-100	160	100	100
8/08/96	640	291	260-340	480	120	100-160	373	126	100-160	160	117	100-130	267	126	100-160
8/22/96	747	262	130-390	1,600	125	100-160	3,520	116	90-230	480	117	100-130	747	124	100-160
9/05/96	480	251	200-330	533	155	140-200	533	167	140-200	373	137	100-170	693	153	100-200
9/19/96	46,453	245	200-330	2,720	175	100-280	6,347	199	100-260	3,147	193	100-230	2,080	212	100-260
10/03/96	64,533	395	100-480	4,253	249	130-360	2,240	148	100-330	1,173	221	100-440	2,560	192	100-330
10/17/96	158,613	285	200-460	5,600	207	100-260	12,053	235	100-660	5,920	239	180-300	9,280	226	100-500
10/31/96	70,560	274	200-400	31,680	252	130-330	4,000	223	100-330	20,480	268	160-360	4,960	194	100-330
11/21/96	25,867	283	180-400	1,707	199	130-300	1,173	230	100-360	320	233	100-300	2,720	386	200-1,050
12/12/96	2,880	290	200-460	5,173	310	100-760	693	271	90-400	1,813	210	100-430	5,387	337	200-630

[a] One translocator at 4620 (μm) not inlcluded.

monitoring programs (LMS 1993, 1994, 1995), but later than 1995 when settlement in the forebay peaked between 13 July and 17 September (GLEC 1996). Similar to 1994 and 1995 results, very little settlement occurred during the late November to mid-December period. Based on size data, the majority of those individuals settling during this period were postveligers whose average size ranged from 283 to 290 μm.

Two six inch long pieces of PVC (ID 2 in.) were suspended in the forebay to monitor cumulative settlement. The objective of this program element is to compare the post Clamtrol treatment settlement to that of the entire sampling season. Data collected in previous years indicates that much of the annual settlement occurs after the treatment. This program objective was not met in 1996 because molluscicide treatment was not administered and the samples were lost.

3.2.2 Service and Miscellaneous Sealing and Cooling Water Systems

The return sides of the ESW and NESW systems were monitored during 1996. The ESW systems of both Units 1 and 2 were monitored throughout the sampling period; but only the Unit 1 NESW system was sampled in 1996. A sidestream biobox monitor was also placed on the miscellaneous sealing and cooling water system which draws its water from a source separate from that of the service water systems. The ESW, NESW, and miscellaneous sealing and cooling water systems were scheduled for chlorination from mid-May to the end of November.

Periodic settlement densities for the service water systems and the miscellaneous sealing and cooling water system are shown in Table 3-2 and Figure 3-3. Settlement occurred in low densities at NESW R-1, ESW R-1, and miscellaneous sealing and cooling water system on the first retrieval date (6 June), but did not appear on artificial substrates set at ESW R-2 until 11 July. Density and size information (Table 3-2) shows that settlement was sparse at all locations during June with densities ranging from 0 to 1600/m^2. Size data indicate that most postveligers collected in June were spawned during May, with several translocators also appearing on the substrates.

FIGURE 3-3

ARTIFICIAL SUBSTRATE SETTLEMENT-PERIODIC SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER DENSITY PER SQUARE METER, D.C. COOK 1996

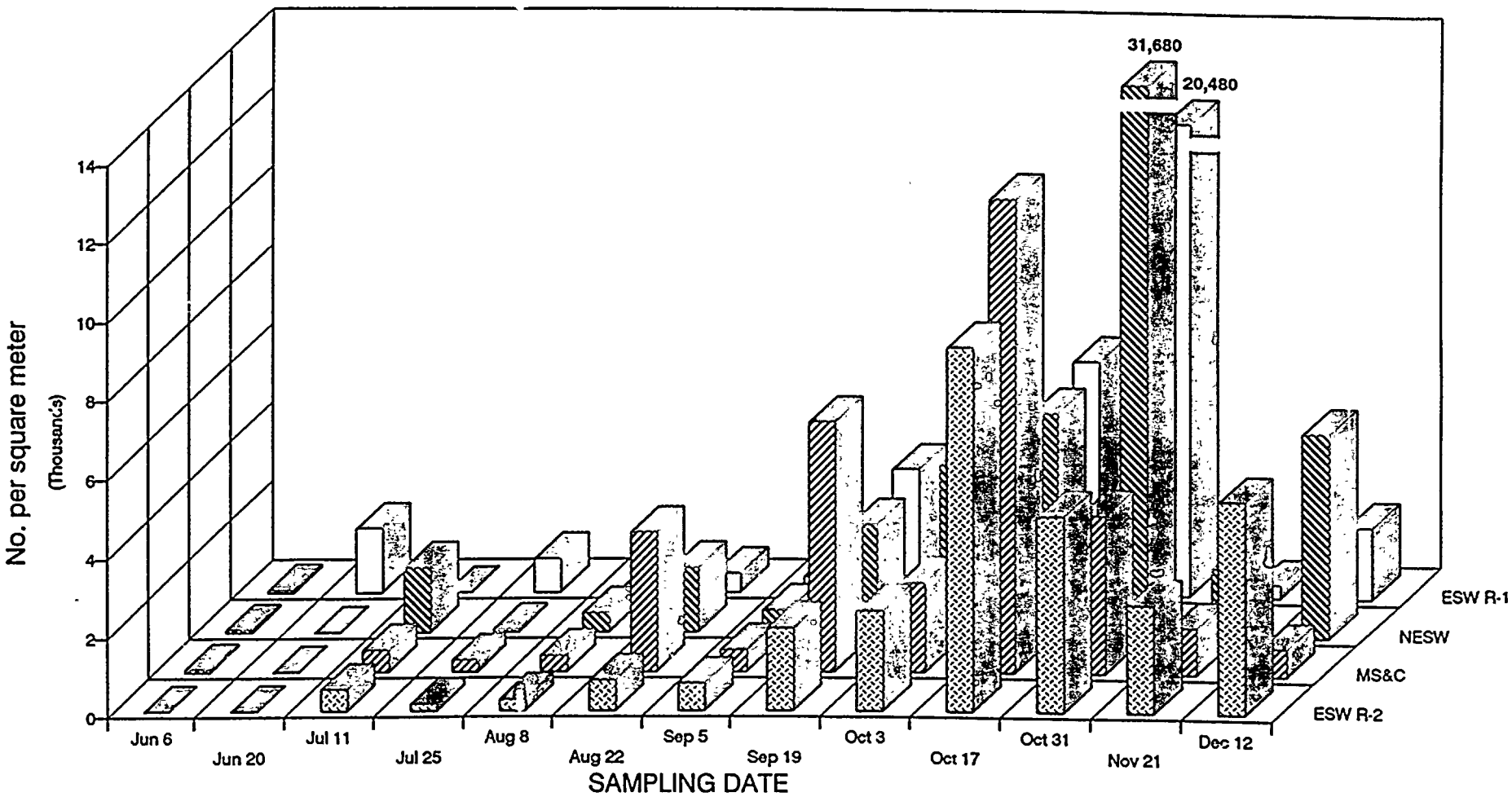


Figure 3-4 presents the comparison of periodic settlement densities with those of wholewater veligers for the sampling season. As expected, these data show that periods of increased settlement in the systems monitored lag increases in wholewater densities by about one to two weeks. This is particularly evident during the mid-September to end of October period. Because total residual chlorine data are not available for the last two weeks of October, it can not be determined whether the settlement was the result of insufficient availability of chlorine to prevent settlement.

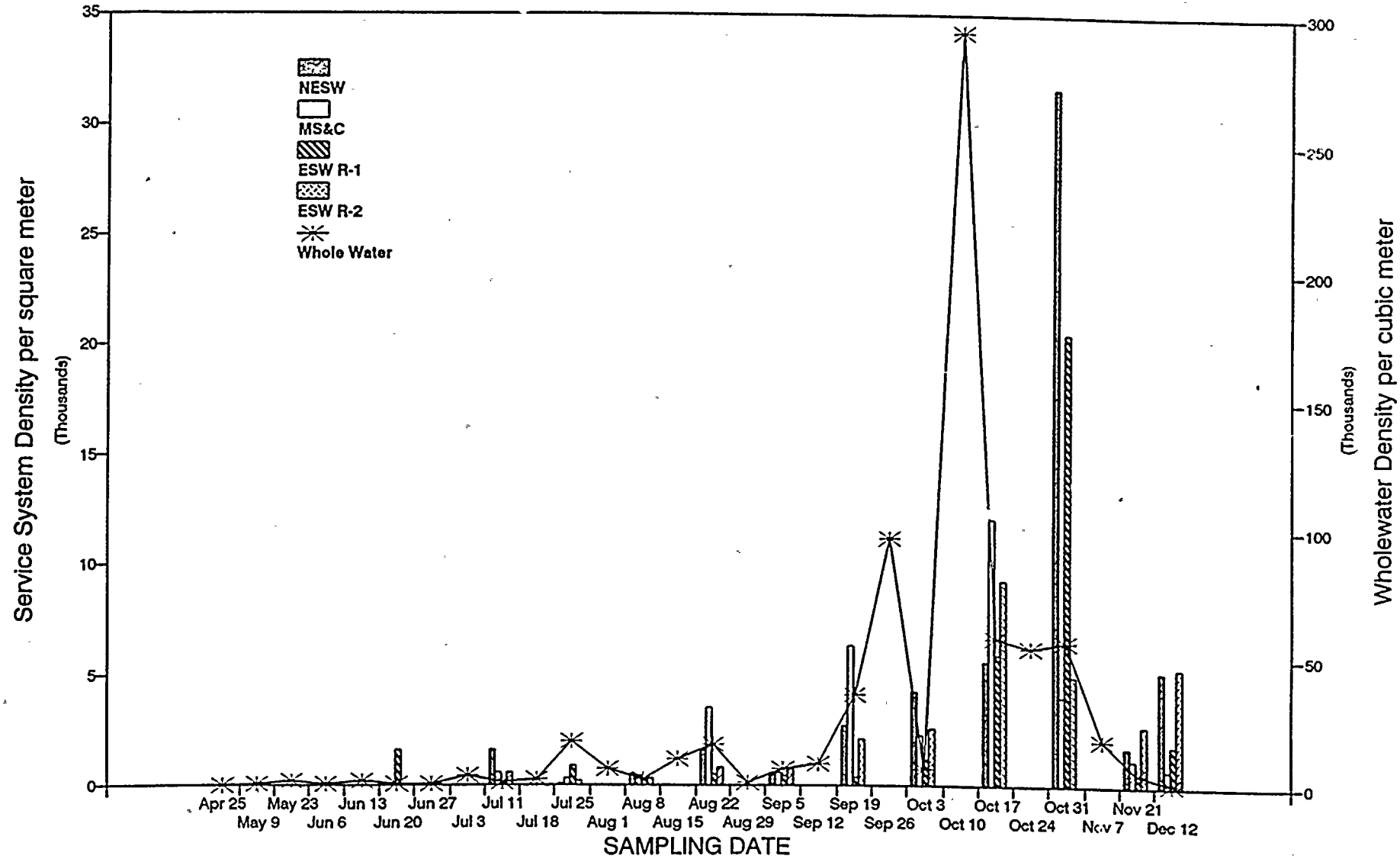
Chlorine was administered continuously to the treated systems for the entire season in 1996. Total residual chlorine data were reported on a weekly basis (Table 3-3). There were several occasions during the season when no data are available. These include 18 July and 25 and 31 October. The October dates coincide with the latter part of the peak spawning period and inadequate chlorination may be responsible for the high densities recorded at both NESW (31,680/m^2) and ESW R-1 (20,480/m^2) locations on 31 October. Conversely, lower densities were recorded at miscellaneous sealing and cooling and ESW R-2 locations on 31 October than on the previous sampling date (17 October) when peak settlement occurred at both locations. Inspection of the discharge monitoring report (DMR) for October indicates that chlorination was continuously applied to the systems from 19 through 31 October. This suggests that either the dosage was low on the efficacy of the chlorine had been reduced by condition beyond the control of plant staff.

The ESW systems are cross connected downstream of the one chlorine injection point that serves both ESW systems. The separate chlorine inject location that serves the NESW system also serves the miscellaneous sealing and cooling system. Considering these cross connections, the data are somewhat confounding. One possible explanation is that chlorine is not being equally distributed through the cross connections.

Inspection of the remainder of the data indicates that settlement was prevented/controlled from May through the fifth of September. Then, as the peak spawning occurred and large numbers of postveligers of settlement size came into the systems, densities on the periodic artificial substrates increased until the peaks were reached in the latter half of October (which coincided

FIGURE 3-4

WHOLE WATER VELIGER DENSITY AND PERIODIC SETTLEMENT IN THE SERVICE WATER SYSTEM, D.C. COOK, 1996



3-4A

TABLE 3-3

CHLORINATION DATA FOR THE SERVICE WATER SYSTEMS, D.C. COOK, 1996

	UNIT 1			UNIT 2
DATE	NESW ppm	ESW ppm	MS&C ppm	ESW ppm
May 17	0.49	0.47	ND[a]	0.11
May 23	0.22	0.78	0.06	0.93
May 30	0.51	0.38	<0.01	0.24
Jun 6	0.48	0.02	<0.01	0.40
Jun 13	0.29	0.30	0.13	0.31
Jun 21	0.82	ND	0.71	ND
Jun 27	0.30	0.73	0.58	0.64
Jul 3	0.76	0.30	0.38	0.41
Jul 11	0.50	0.41	0.85	0.57
Jul 25	0.09	0.08	0.14	0.13
Aug 1	0.48	0.26	0.29	0.42
Aug 8	0.39	0.15	0.47	0.81
Aug 15	0.27	0.14	0.29	0.45
Aug 22	0.25	0.13	0.31	0.28
Aug 29	0.47	0.40	0.60	0.89
Sep 5	0.41	0.04	0.55	1.12
Sep 12	0.28	0.21	0.01	0.23
Sep 24	0.01	0.09	0.03	0.15
Sep 27	0.04	0.01	0.42	ND
Oct 2	0.08	0.62	1.11	0.58
Oct 10	0.52	1.04	0.08	0.92
Oct 17	0.53	0.01	0.65	0.01
Nov 6	0.47	0.03	0.02	0.85
Nov 21	0.89	0.02	0.88	0.05
Nov 28	0.65	0.78	0.67	0.60

[a] ND - No data

with lack of chlorination data). Size data show that the mean size of postveligers on the substrates were generally below the threshold for settlement until 19 September. Inspection of the smaller individuals that were collected revealed that they were dead which indicated that the chlorine was effective. It was not until the latter part of October that truly settled, live individuals were observed on the substrates. These continued to appear on the substrates until the end of the sampling season.

For the first time in this monitoring program, settlement of postveligers continued in all the systems through November until the program was concluded in mid-December. The observation of an increase in density at three of the four in-plant monitoring locations between 21 November and 12 December was unexpected. This appears to be a combination of the densities of veligers in the intake water and the efficiency of the chlorine at cooler water temperatures in water that typically exhibits high pH. Figure 3-4 presents information showing wholewater veliger and periodic settlement densities for the sampling season. Wholewater densities continued to be above 50,000/m^3 until the first week of November and remained above 17,000/m^3 through 7 November. These veligers continued to grow and became postveligers of settleable size by the third week of November. Most likely, veligers were present in the lake water after 21 November and these then were included in the unexpected periodic densities recorded on 12 December. Wholewater densities recorded during the 1993 through 1995 programs for the November-December sampling periods were less than 1000/m^3 for sampling conducted after 3 November. This suggests that spawning continued into the late fall/early winter period in 1996. This is atypical in the vicinity of D.C. Cook Plant based on four years of data. A preliminary review of chlorine chemistry indicates that pH may have a greater influence driving the reaction than temperature as shown in the following table.

Percent Hyperchlorous Acid in Solution

Temperature	pH 7.5	pH 8.0
5 °C	64.3	36.3
10 °C	60.9	33.0

Activity rates of reaction are influenced by temperature and those activities are influenced by pH. Any difference between years in temperature and/or pH will modify the effectiveness of the chlorine.

Comparison of daily water temperatures recorded on the DMR's for the months of October, November, and December for 1993 through 1996 indicates that intake water temperatures in October 1996 were considerably warmer than the previous three years, particularly during the second half of the month. November and December (first 15 days) mean intake water temperatures in 1996 were similar to those of 1993 and 1994 but warmer than in 1995. As can be seen in the table below, December mean intake water temperatures recorded in 1996 were cooler for this period than in both 1993 and 1994.

Mean Intake Water Temperatures °F

Year	Oct(1-15)	Oct(16-31)	Nov	Dec(1-15)
1993	59.8	56.7	49.0	44.6
1994	56.7	55.6	48.1	43.4
1995	60.1	55.1	45.8	38.8
1996	63.4	59.8	48.9	42.2

Mean intake water temperatures reflect lake conditions which were more conducive to zebra mussel spawning during both halves of October in 1996 than they were in the previous years. However, the data for both November and the first half of December do not suggest that intake water temperatures in 1996 would have been conducive to continued spawning during the November-December period. Therefore, it is reasonable to conclude that the favorable spawning temperatures during the second half of October 1996 were at least partially responsible for the settlement observed on the artificial substrates in both November and December.

Changes may also have occurred in the water quality constituents that use chlorine as an oxidant, e.g., iron, manganese, and ammonia. Ammonia is particularly important because it forms chloramines with chlorine. These often are measured in the TRC readings suggesting that the target is being met. However, chloramines are not as reactive as free chlorine (therefore, not as effective) although they are more persistent in the water column. In the case

of Cook Plant, this would reduce the effectiveness because the flow through the service water systems remains relatively rapid, that is, it does not remain in the system long enough for the chloramines to be effective.

Another possible explanation for the veligers and postveliger settlement observed during November and December is that the individuals were early life stages of quagga mussels (*Dreissena bugensis*), a relative of zebra mussels. Quagga mussels tend to inhabit deeper, colder waters and spawning is not limited by colder water temperatures. Therefore, it is feasible that, as lake water temperatures decreased during November and December, these mussels (if present) continued to spawn and the early life forms were collected. Early life stages of mussels believed to be quagga mussels have begun to appear during cold weather months at other sampling sites along the Great Lakes during the last two to three years (L. Ray Tuttle, personal communication). It is plausible that an adult population of quagga mussels has become established in the vicinity of the Cook Plant intake and has reached sufficient numbers such that the effects of their spawning is beginning to be observed in this project.

A second set of data was collected from each of the service water systems and miscellaneous sealing and cooling water system for the purpose of determining the effectiveness of chlorination during the entire sampling season. These cumulative densities and associated size information are presented in Figure 3-5 and Table 3-4. Artificial substrates used for cumulative analyses were set on 23 May and sets of 10 slides were retrieved from each location at monthly intervals throughout the sampling season beginning on 20 June. Results were evaluated in conjunction with periodic data to better understand postveliger settlement in the systems.

Density data indicate that few postveligers were on the artificial substrates collected from 20 June through 22 August at NESW, ESW R-2, and miscellaneous sealing and cooling systems. Concentrations at the ESW R-1 location was somewhat higher than the other locations during this period. Size information shows that, with the exception of several translocators collected at the miscellaneous sealing and cooling water location, most of the individuals on the slides at all locations were below the threshold size for settlement. Furthermore, these specimens

FIGURE 3-5

ARTIFICIAL SUBSTRATE SETTLEMENT-CUMULATIVE SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER DENSITY PER SQUARE METER, D.C. COOK 1996

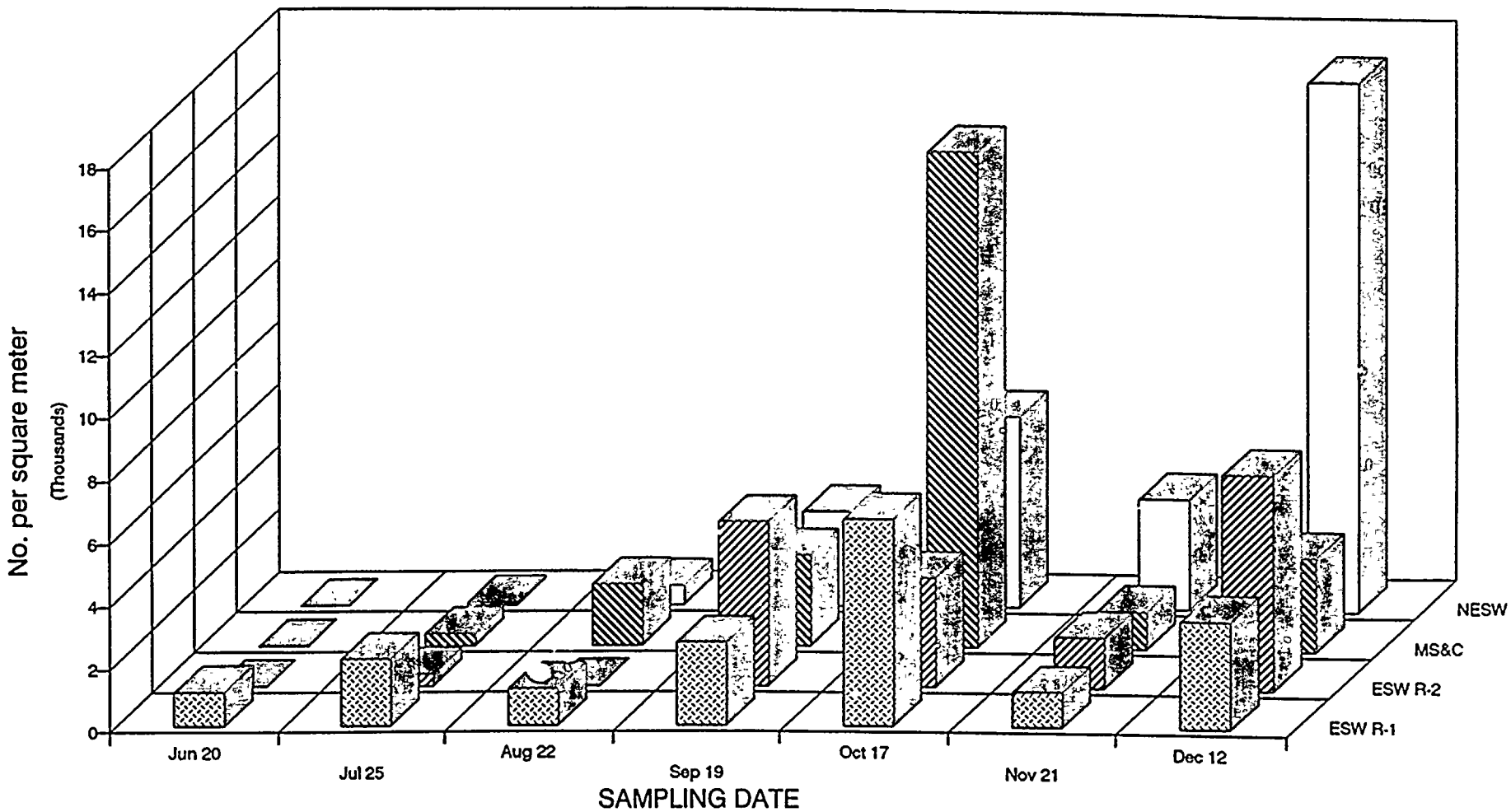


TABLE 3-4

ZEBRA MUSSEL DENSITY, AVERAGESIZE, AND SIZE RANGE OF SETTLED POSTVELIGERS FROM CUMULATIVESAMPLING, D.C. COOK, 1996

	CUMULATIVE SAMPLES											
	NESW			MS&C			ESW R-1			ESW R-2		
DATE	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)	Density (No./m^2)	Avg. Size (μm)	Range (μm)
6/20/96	0	-	-	0	-	-	1,067	155	130-200	0	-	-
7/25/96	53	230	230	373	279	170-460	2,133	103	90-120	373	103	100-120
8/22/96	587	113	90-160	1,920	121	90-390	1,173	119	100-160	0	-	-
9/19/96	2,987	221	100-300	2,880	203	100-300	2,667	174	100-260	5,227	199	130-260
10/17/96	6,080	232	100-450	15,893	218	90-400	6,613	246	100-700	3,467	246	100-500
11/21/96	3,520	387	200-1,030	1,173	380	180-880	1,120	327	160-690	1,600	307	160-460
12/12/96	17,013	425	200-800	2,987	314	100-660	3,466	376	200-730	6,880	415	200-860

exhibited no signs of life (beating cilia and stomach movement). The reasonable conclusion is that the chlorine was very effective throughout the summer.

As the densities of veligers increased in wholewater samples during the fall, densities on the cumulative artificial substrates also increased as might be expected. The observation that peak density occurred at the miscellaneous sealing and cooling water systems and the ESW R-1 systems on 17 October was not surprising because wholewater densities peaked on 10 October. However, peak densities occurred at the other two locations on 12 December with the NESW density being the highest (17,013/m^2) for the year for all cumulative samples. This was unexpected and may have been the result of a lack of sufficient chlorination that seems to have occurred during the latter half of October. The discussion regarding efficacy of chlorine during this late fall period which is presented above (periodic artificial substrate results) applies to the cumulative results as well.

Size data show two expected and one unexpected results. Mean sizes progressively increased throughout the fall period at all locations (except for the last sampling at the miscellaneous sealing and cooling system); and generally, the high end of the size ranges also increased during the fall period. The somewhat unexpected result was the low end of the size ranges which indicated that recently hatched postveligers continued to settle on these substrates until the middle of December. The presence of these smaller veligers suggests that settlement may have continued at some low rate after the monitoring program was discontinued for the season. Furthermore, most of those organisms observed on the artificial substrates in December were alive. It is reasonable to conclude that chlorination was not very effective during the late fall period in 1996.

3.3 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

The results of the QA/QC samples analyzed in 1996 are summarized in Table 3-5. These reinspections included both original analyzers used for this project and were conducted by a third analyzer. Because one slide from each set of 10 analyzed on each sampling date was randomly selected for re-analysis, no statistics were applied. However, results were compared

TABLE 3-5

RESULTS OF QA/QC SAMPLES, D.C. COOK, 1996

SAMPLE DATE	SAMPLE TYPE	SAMPLE LOCATION	ONSITE DENSITY	QA/QC DENSITY	% AGREEMENT
Jun 27	Wholewater	Forebay	25	25	100.0
Oct 31	Wholewater	Forebay	56,000	59,400	94.3
	Periodic	Forebay	53,866	44,800	83.2
	Periodic	ESW R-1	21,333	19,733	92.5
	Periodic	ESW R-2	4,780	4,267	89.3
	Periodic	NESW	25,600	a	-
	Periodic	MS&C	4,800	4,800	100.0
Dec 12	Wholewater	Forebay	925	750	81.1
	Periodic	Forebay	3,200	3,200	100.0
	Periodic	ESW R-1	3,200	2,667	83.3
	Periodic	ESW R-2	3,733	3,733	100.0
	Periodic	NESW	3,200	3,200	100.0
	Periodic	MS&C	533	533	100.0
	Periodic	Circ. H_2O	1,066	2,133	50.0
	Cumulative	ESW R-1	5,333	5,333	100.0
	Cumulative	ESW R-2	3,200	2,667	83.3
	Cumulative	NESW	6,933	6,400	92.3
	Cumulative	MS&C	3,200	3,200	100.0

[a] Slide broken in transit.

for percent agreement between the two analyses. In each case where artificial substrate results fell below 100%, the reinspection result was lower than the original. It was observed by the QC inspector that specimens were lying free, i.e., off the slide, in the packaging. The conclusion is that a few individuals on those slides were not solidly attached, perhaps even dead, and fell from the slides during shipping. Given this explanation of differences, the artificial substrate data reported in this program are acceptable. The difference in the wholewater analyses for the 12 December sample is attributed to low numbers of veligers in the sample. These may have settled in the liter bottle during shipment and not resuspended when agitated by the QC inspector. Wholewater results are deemed to be acceptable.

CHAPTER 4

SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

The 1996 zebra mussel sampling was initiated on 25 April and continued to 12 December. The major spawning peak occurred during the first week of October with lesser peaks occurring during the third week of September and the latter half of October. The magnitude of the peak was two orders of magnitude greater than the 1995 peak, which was atypically low, and about 60% of the peak reported for 1994.

Peak postveliger settlement in the forebay occurred during the 3-17 October period which followed peak wholewater densities by about eight to 10 days as expected. Secondary peaks in settlement were observed for the periods both just before and after the major settlement peak. Fall spawning and settlement peaks are typical for the lower Great Lakes. Cumulative settlement observations were not made following molluscicide treatment because treatment was not administered in 1996.

Periods of heaviest periodic settlement occurred during the mid-September to end of October period in all plant systems monitored. This corresponded to peak periods of spawning as measured in the wholewater samples. During the early part of this period (mid-September to mid-October), few live mussels were observed on the substrates. However, from mid-October through to the end of the monitoring season, live specimens were observed on the slides, particularly in November and December. This suggests that chlorination was less effective during this period than earlier in the season.

Cumulative settlement in the service water and miscellaneous sealing and cooling systems was essentially prevented from May through the first part of September. The few specimens on the substrates were dead which is indicative of effective chlorination. Then as peak spawning occurred, densities increased peaking in mid-October in the miscellaneous sealing and cooling

and ESW R-1 systems. This corresponded to peaks in periodic settlement. However, settlement unexpectedly peaked at NESW and ESW R-2 on 12 December. Many of these specimens were alive reflecting the reduced level of effectiveness of the chlorination program during the November-December period. Growth of settled postveligers also occurred during this period reinforcing the conclusion that the effectiveness of the chlorination program was reduced during this period.

4.2 RECOMMENDATIONS

Based on observations made during the course of this program, LMS is making several recommendations:

- Whole-water sampling should continue to be initiated in April to determine the presence of veligers in the water column.
- Studies of postveliger settlement substrates should continue to be conducted from May through December. Inspection of the substrates should include attempting to move the postveligers with a probe to determine whether they are still motil or have begun to lay down byssal threats for permanent attachment.
- The chlorination system should be maintained to ensure appropriate intermittent or continuous delivery of chlorine to control postveliger settlement (1 May-1 December), particularly in light of the 1996 results.
- Based on settlement data from the early part of the program (May-June), chlorine should be delivered to the service water systems beginning during the first half of May. This should reduce/eliminate the translocators from establishing residency in the critical service water systems.
- Daily chlorination data should be made available to allow more meaningful interpretation of results.
- Several other water quality parameters including pH and ammonia should be monitored at the intake to aid in determination of efficacy of chlorine. Also, concentration of chloramines should be determined downstream of the bioboxes for the same reason.

REFERENCES

Lawler, Matusky, & Skelly Engineers LLP. 1994. Mollusc biofouling monitoring during 1993, Donald C. Cook Nuclear PLant: Final Report. 46 pp.

Lawler, Matusky, & Skelly Engineers LLP. 1995 Mollusc biofouling monitoring during 1994 Donald C. Cook Nuclear Plant: Final Report. 52 pp.

Great Lakes Environmental Center. 1996. A zebra mussel (*Dreissena*) monitoring survey for the Donald C. Cook Nuclear Plant. Final Report. 37 pp.

APPENDIX V

SPECIAL REPORTS

APPENDIX V.A

No special reports were identified during the 1996 reporting period.

APPENDIX VI

ANNUAL REPORT:

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1996

DONALD C. COOK NUCLEAR PLANT

UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1996 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1996

Prepared by

Indiana Michigan Power Company

and

Teledyne Brown Engineering

April 15, 1997

TABLE OF CONTENTS

SECTION	TITLE	PAGE
	Summary	1
I.	Introduction	3
II.	Sampling and Analysis Program	6
III.	Summary and Discussion of 1996 Analytical Results	15
	A. Airborne Particulates	16
	B. Airborne Iodine	18
	C. Direct Radiation - TLDs	19
	D. Surface Water	19
	E. Groundwater	21
	F. Drinking Water	25
	G. Sediment	25
	H. Milk	27
	I. Broadleaf Vegetation	27
	J. Fish	27
	K. Food Products	28
IV.	Conclusions	29
V.	References	33

TABLE OF CONTENTS (Cont)

APPENDICES

APPENDIX A - Radiological Environmental Monitoring Program Summary - 1996 35

APPENDIX B - Data Tables 40

APPENDIX C - Analytical Procedures Synopsis 67

APPENDIX D - Summary of EPA Interlaboratory Comparisons 77

APPENDIX E - REMP Sampling and Analytical Exceptions 107

APPENDIX F - Land Use Census 111

APPENDIX G - Summary of the Preoperational Radiological Monitoring Program 118

APPENDIX H- Summary of the Spike and Blank Sample Program 122

APPENDIX I - TLD Quality Control Program 135

TABLE OF CONTENTS (Cont)

LIST OF FIGURES

1. Onsite REMP Monitoring Locations 12
2. Offsite REMP Monitoring Locations 13
3. Fish Sampling Locations 14
4. Milk Farm Survey Table 114
5. Residental Land Use Survey Table 115
6. Milk Farm Survey Map 116
7. Residential Survey Map 117

LIST OF TRENDING GRAPHS

1. Average Monthly Gross Beta in Air Particulates 17
2. Direct Radiation - Quarterly TLD's 20
3. Tritium in Groundwater 22
4. Tritium in Drinking Water 26
5. EPA Cross Check Program 83
6. Quality Control TLDs 137

LIST OF TABLES

TABLE	TITLE	PAGE
B-1	Concentrations of Gross Beta Emitters in Weekly Airborne Particulates	41
B-2	Concentrations of Gamma Emitters in Quarterly Composites of Airborne Particulate Samples	45
B-3	Concentrations of Iodine-131 in Weekly Air Cartridge Samples	47
B-4	Direct Radiation Measurements - Quarterly TLD Results	51
B-5	Concentrations of Iodine, Tritium and Gamma Emitters in Surface Water	52
B-6	Concentrations of Tritium and Gamma Emitters in Groundwater	54
B-7	Concentrations of Gross Beta, Iodine, Tritium and Gamma Emitters in Drinking Water	57
B-8	Concentrations of Gamma Emitters in Sediment	59
B-9	Concentrations of Iodine and Gamma Emitters in Milk	60
B-10	Concentrations of Iodine and Gamma Emitters in Broadleaf Vegetables	61
B-11	Concentrations of Gamma Emitters in Fish	63
B-12	Concentrations of Gamma Emitters in Food/Vegetation	64
B-13	Gamma Spec LLDs and Reporting Levels	65

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 1996 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 discernible impact of the Donald C. Cook Nuclear Plant on the environment. The analysis of air particulate filters, charcoal cartridges, direct radiation by thermoluminescent dosimeters, fish, water, milk 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.

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 Guide 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 Radiological Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1, 1996 through December 31, 1996.

A. The Donald C. Cook Nuclear Plant of American Electric 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, 1030 MWE and Unit 2, 1100 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.

During 1996 the following changes were made to the Offsite Dose Calculation Manual (ODCM)

The changes became effective on 10/22/96 and included:

* Adding an attachment which approved on-site storage of contaminated concrete

* Changed Unit Ventilation H-3 requirement from continuous to weekly grab samples.

* Removed emergency plan values due to upcoming implementation of revised Emergency Action Levels (EAL).

* Clarified section describing collection of broadleaf vegetation samples in lieu of milk samples.

* Corrected error in numbering of electrical pole where TLD station #OFT-11 is located.

* Eliminated the need for compensatory sampling of Essential Service Water (ESW) system when respective radiation monitors are inoperable unless the containment spray heat exchangers are in service.

II. SAMPLING AND ANALYSIS PROGRAM

II. SAMPLING AND ANALYSIS PROGRAM

Table 1 summarizes the sampling and analysis program for the Donald C. Cook Nuclear Plant for 1996. 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 the sampling locations are shown on Figures 1 and 2. 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- 1996

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Environmental (TLD's)						
ONS-1	(T-01)	1945 ft.		18°	Quarterly	Direct Radiation/Quarterly
ONS-2	(T-02)	2338 ft.		48°		
ONS-3	(T-03)	2407 ft.		90°		
ONS-4	(T-04)	1852 ft.		118°		
ONS-5	(T-05)	1895 ft.		189°		
ONS-6	(T-06)	1917 ft.		210°		
	(T-07)	2103 ft.		36°		
	(T-08)	2208 ft.		82°		
	(T-09)	1368 ft.		149°		
	(T-10)	1390 ft.		127°		
	(T-11)	1969 ft.		11°		
	(T-12)	2292 ft.		63°		
New Buffalo	(NBF)	15.6 mi	SSW			
South Bend	(SBN)	26.2 mi	SE			
Dowagiac	(DOW)	24.3 mi	ENE			
Coloma	(COL)	18.9 mi	NNE			
Intersection of Red Arrow Hwy. & Marquette Woods Rd. Pole #B294-44	(OFT-1)	4.5 mi	NE			
Stevensville Substation	(OFT-2)	3.6 mi	NE			
Pole #B296-13	(OFT-3)	5.1 mi	NE			
Pole #B350-72	(OFT-4)	4.1 mi	E			
Intersection of Shawnee & Cleveland. Pole #B387-32	(OFT-5)	4.2 mi	ESE			
Snow Rd., East of Holden Rd., #B426-1	(OFT-6)	4.9 mi	SE			
Bridgman Substation	(OFT-7)	2.5 mi	S			
California Rd., Pole #B424-20	(OFT-8)	4.0 mi	S			
Ruggles Rd., Pole B369-214	(OFT-9)	4.4 mi	ESE			
Intersection of Red Arrow Hwy., & Hildebrant Rd.,Pole #B422-152	(OFT-10)	3.8 mi	S			
Intersection of Snow Rd. & Baldwin Rd., Pole #B423-12	(OFT -11)	3.8 mi	S			

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1996

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)	1945 ft.		18°	Weekly	Gross Beta/Weekly
ONS-2	(A-2)	2338 ft.		48°		I-131/Weekly
ONS-3	(A-3)	2407 ft.		90°		Gamma Isotopic/
ONS-4	(A-4)	1852 ft.		118°		Quarterly Composite
ONS-5	(A-5)	1895 ft.		189°		
ONS-6	(A-6)	1917 ft.		210°		
New Buffalo	(NBF)	15.6 mi	SSW			
South Bend	(SBN)	26.2 mi	SE			
Dowagiac	(DOW)	24.3 mi	ENE			
Coloma	(COL)	18.9 mi	NNE			
Groundwater						
Onsite	(W-1)	1969 ft.		11°	Quarterly	Gamma Isotopic/Quarterly
Onsite	(W-2)	2292 ft.		63°		Tritium/Quarterly
Onsite	(W-3)	3279 ft.		107°		
Onsite	(W-4)	418 ft.		301°		
Onsite	(W-5)	404 ft.		290°		
Onsite	(W-6)	424 ft.		273°		
Onsite	(W-7)	1895 ft.		189°		
Onsite	(W-8)	1279 ft.		53°		
Onsite	(W-9)	1447 ft.		22°		
Onsite	(W-10)	4216 ft.		129°		
Onsite	(W-11)	3206 ft.		153°		
Onsite	(W-12)	2631 ft.		162°		
Onsite	(W-13)	2152 ft.		182°		
Onsite	(W-14)	1780 ft.		164°		
Steam Generator Groundwater						
Steam Generator Storage Facility	(SG-1)	0.8 mi		95°	Quarterly	Gross Beta/Quarterly
Steam Generator Storage Facility	(SG-2)	0.7 mi		92°		Gross Alpha/Quarterly
Steam Generator Storage Facility	(SG-4)	0.7 mi		93°		Gamma Isotopic/Quarterly
Steam Generator Storage Facility	(SG-5)	0.7 mi		92°		

TABLE 1 (Cont)

DONALD C. COOK NUCLEAR PLANT- 1996

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)	0.4 mi	S			Tritium/Quarterly Composite
Surface Water							
Condenser Circulating Water Intake		SWL-1	Intake			Daily	Gamma Isotopic/Monthly
Lake Michigan Shoreline		SWL-2	500 ft.	S			Composite
Lake Michigan Shoreline		SWL-3	500 ft.	N			Tritium/Quarterly Composite
Sediment							
Lake Michigan Shoreline		SL-2	500 ft.	S			
Lake Michigan Shoreline		SL-3	500 ft.	N		Semi-annually	Gamma Isotopic/Semi-Annual
Milk-Indicator (a)							
Freehling Farm	Buchanan	Freehling	7.0 mi	SE		14 Days	Gamma Isotopic/Sample I-131/Sample
Milk-Background (a)							
Wyant Farm	Dowagaic	Wyant	20.7 mi	E		14 Days	Gamma Isotopic/Sample
Livinghouse Farm	La Porte	Livinghouse	20.0 mi	S			I-131/ Sample
Broadleaf Vegetation (a)							
3 Indicator Samples 1 Control Sample		Within 8 miles of plant 15-25 miles distant		Highest D/Q Land Sector Less prevalent wind direction		Monthly when available	Gamma Isotopic/Monthly I-131/Monthly

(a) No milk samples were obtained in 1996 as 2 of 3 indicator farms dropped from program and no replacements could be found. Broadleaf vegetation samples were obtained in lieu of milk in 1996.

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1996

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Fish						
Lake Michigan	ONS-N	.3 mi	N		2/year	Gamma Isotopic/
Lake Michigan	ONS-S	.4 mi	S			2 per year
Lake Michigan	OFS-N	3.5mi	N			
Lake Michigan	OFS-S	5.0 mi	S			
Grapes/Broadleaf						
Nearest sample to Plant in highest D/Q land sector containing media.			Sector D		At time of harvest	Gamma Isotopic at time of harvest.
Grapes						
In a land sector containing grapes approximately 20 miles from the Plant in one of the less prevalent D/Q land sectors.			Sector K		At time of harvest	Gamma Isotopic at time of harvest.

- Composite samples of Drinking and Surface water shall be collected at least daily.
- 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:

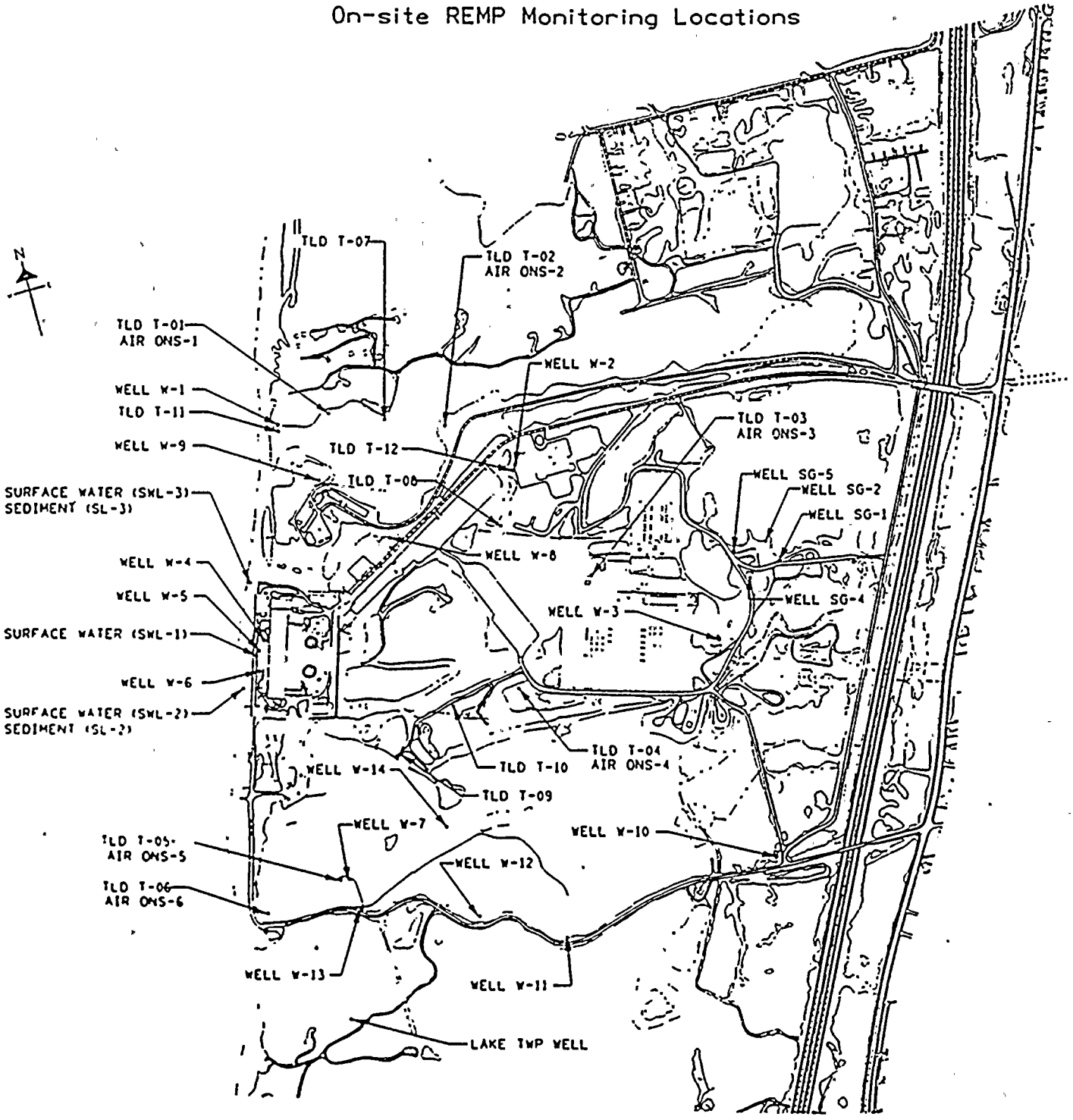
Weekly - at least once every seven (7) days

Monthly - at least once every (31) days

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

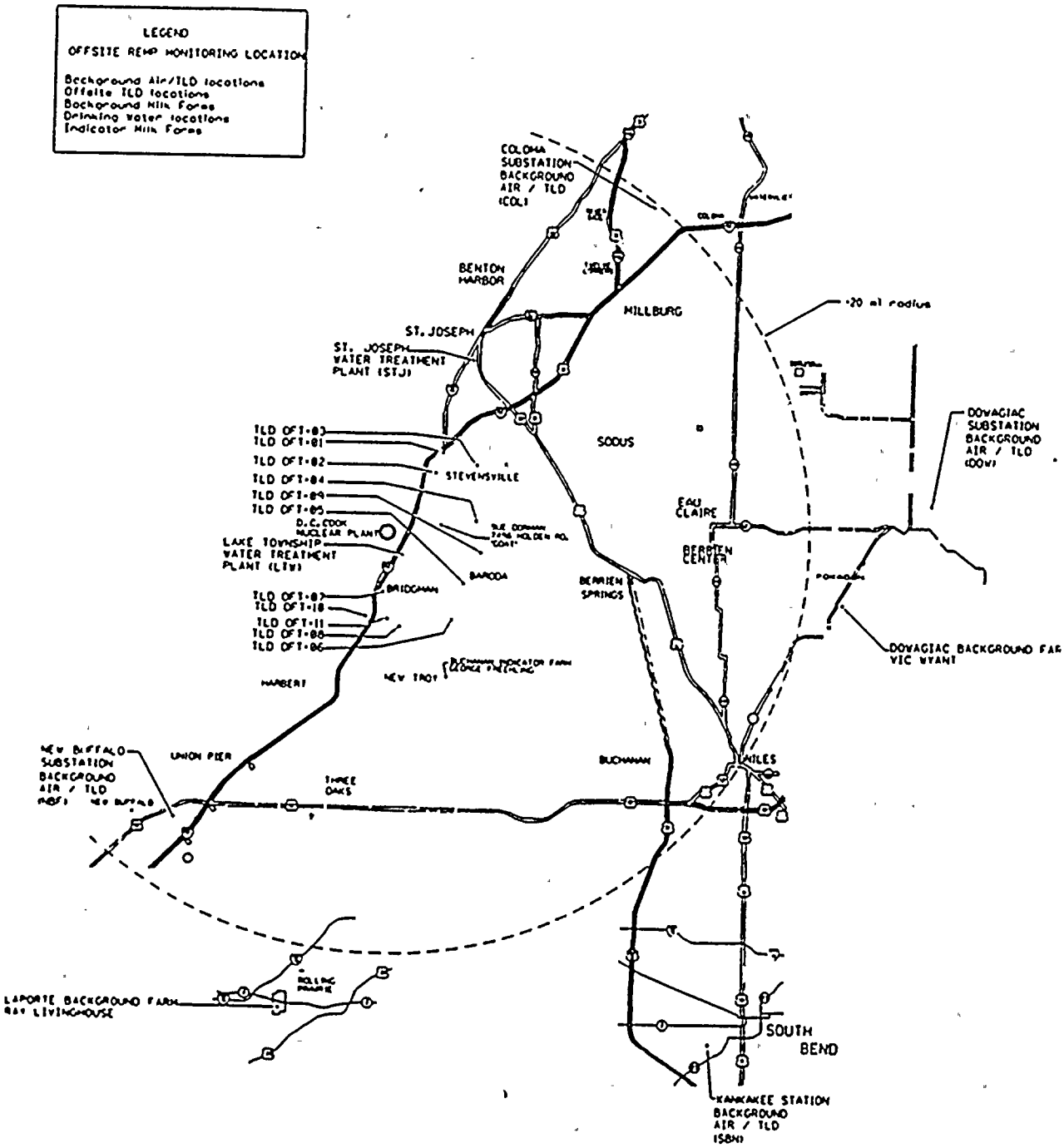
Semi-annually - at least once every one hundred eighty-four (184) days

On-site REMP Monitoring Locations



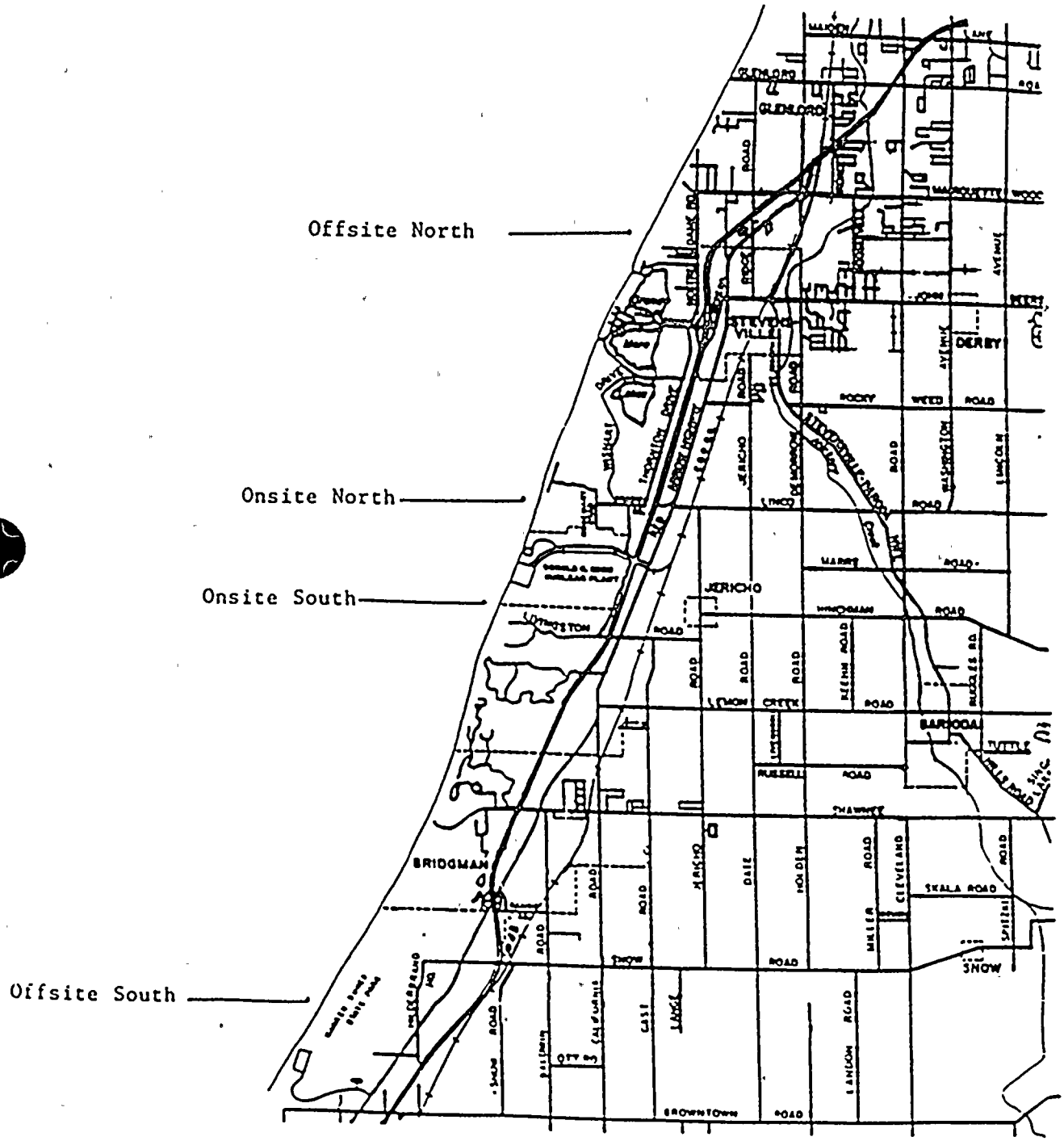
LEGEND

ONS-1 - ONS-6: Air Sampling Stations
T-01 - T-12: TLD Sampling Stations
W-1 - W-14: REMP T/S Groundwater Wells
SG-1, SG-2, SG-4, SG-5: REMP Non T/S Groundwater Wells
SWL-1, 2, 3: Surface Water Sampling Stations
SL-2, 3: Sediment Sampling Stations


LEGEND
OFFSITE REMP MONITORING LOCATION
Background Air/TLD locations
Offsite TLD locations
Background Milk Farms
Drinking Water locations
Indicator Milk Farms
COLOMA SUBSTATION BACKGROUND AIR / TLD (COL)
BENTON HARBOR
HILLBURG
ST. JOSEPH
ST. JOSEPH WATER TREATMENT PLANT (STJ)
SODUS
STEVENSVILLE
TLD OFT-03
TLD OFT-01
TLD OFT-02
TLD OFT-04
TLD OFT-09
TLD OFT-05
D.C. COOK NUCLEAR PLANT
LAKE TOWNSHIP WATER TREATMENT PLANT (LTW)
BARODA
BRIDGMAN
TLD OFT-07
TLD OFT-10
TLD OFT-11
TLD OFT-08
TLD OFT-06
HARBERT
NEW TROY
EAU CLAIRE
BERRIEN CENTER
BERRIEN SPRINGS
20 mi radius
DOWAGIAC SUBSTATION BACKGROUND AIR / TLD (DOW)
DOWAGIAC BACKGROUND FAR VIC WYANT
NEW BUFFALO SUBSTATION BACKGROUND AIR / TLD (NBF)
UNION PIER
THREE OAKS
BUCHANAN
NILES
LAPORTE BACKGROUND FARM RAY LIVINGHOUSE
SOUTH BEND
KANKAKEE STATION BACKGROUND AIR / TLD (SBN)

SAMPLING LOCATIONS

FISH COLLECTED FOR RADIOLOGICAL ANALYSIS



III. SUMMARY AND DISCUSSION OF 1996 ANALYTICAL RESULTS

III. SUMMARY AND DISCUSSION OF 1996 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 for 1996 were analyzed by Teledyne Brown Engineering, Inc. (TI) in Westwood, New Jersey. The procedures and specifications followed at Teledyne Brown Engineering are in accordance with the Teledyne Brown Engineering Quality Assurance Manual and are explained in the Teledyne Brown Engineering Analytical Procedures. A synopsis of analytical procedures used for the environmental samples 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.

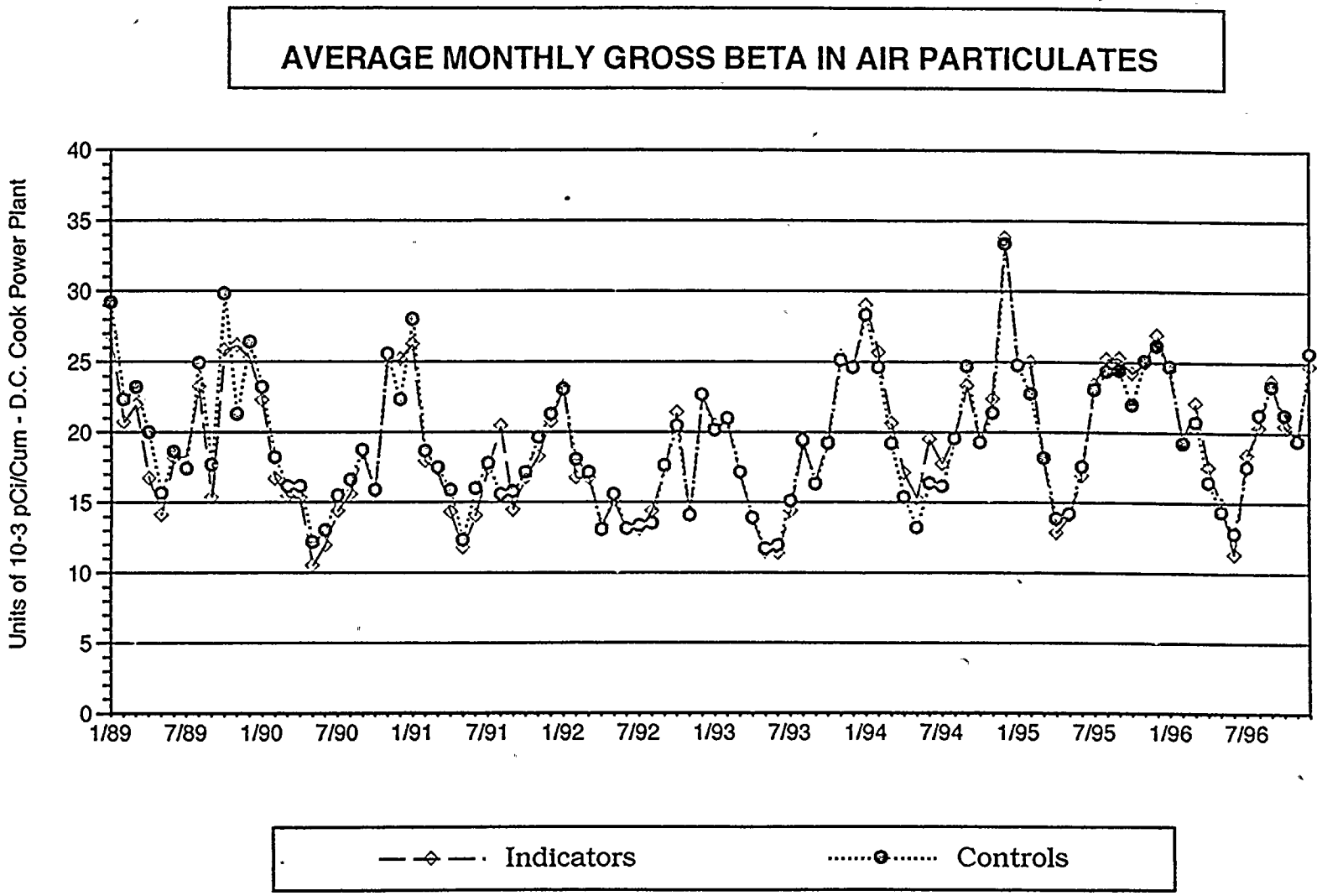
Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. Teledyne Brown Engineering analytical methods meet or exceed the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring, Revision 1, 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. Airborne Particulates

Airborne particulate samples are collected with an oil less pump at approximately 56 LPM using a 47 mm particulate filter. Results of

Trending Graph - 1



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 0.020 pCi/m^3 with a range of individual values between 0.007 and 0.036 pCi/m^3. The average gross beta concentration of the four control locations was 0.020 pCi/m^3 with a range between 0.007 and 0.033 pCi/m^3. In Trending Graph 1 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 1996 were lower than at the end of the preoperational period when the effects of 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. Results are presented in Table B-2. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation, was measured in all forty samples. The average concentration for the control locations was 0.128 pCi/m^3 and the values ranged from 0.088 to 0.154 pCi/m^3. The average concentration for the indicator locations was 0.139 pCi/m^3 with a range of 0.075 to 0.195 pCi/m^3. These values are typical of beryllium-7 measured at various locations throughout the United States. Naturally occurring potassium-40 was measured in seven of the twenty-four indicator quarterly composites with an average concentration of 0.005 pCi/m^3 and a range of 0.004 to 0.009 pCi/m^3. Potassium-40 was measured in four of the sixteen control quarterly composites with a concentration of 0.004 pCi/m^3 and a range of 0.003 to 0.004 pCi/m^3. No other gamma emitting radioactivity was detected.

B. Airborne Iodine

Airborne iodine samples are collected with an oil less pump at approximately 56 LPM using a charcoal filter cartridge. 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 of 0.07 pCi/m^3 with no positive activity detected.

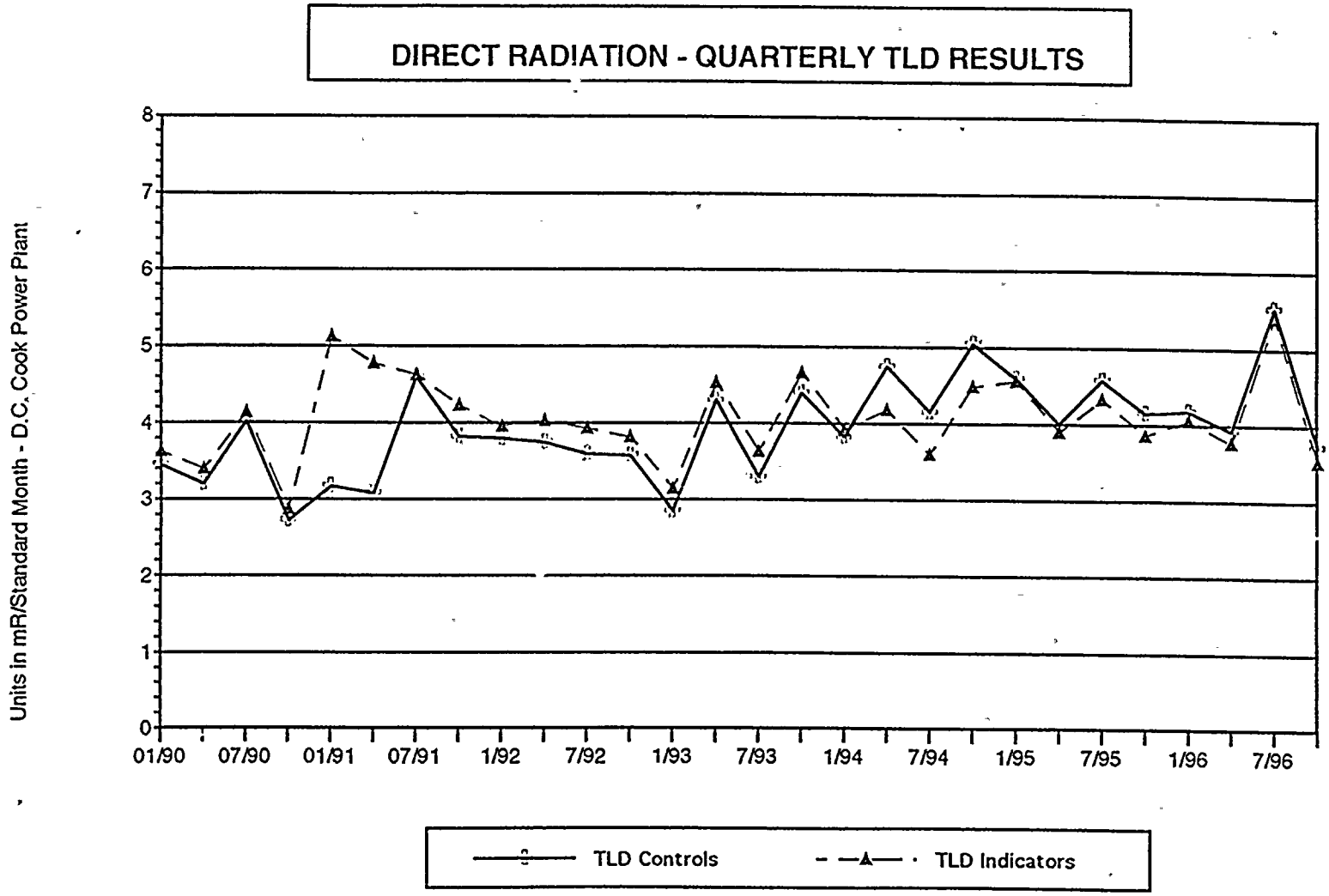
C. Direct Radiation - Thermoluminescent Dosimeters

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 station and direct radiation from the power station. The TLDs record exposure from all of these potential sources. The TLDs are deployed quarterly at 27 locations in the environs surrounding the D. C. Cook Nuclear Plant. The average value of the four areas of each dosimeter (calibrated individually after each field exposure period for response to a known exposure and for transit exposure) are presented in Table B-4. Those exposure rates are quite typical of observed rates at many other locations in the country. The average annual measurement for the control samples was 4.34 mR/standard month with a range of 3.0 to 6.6 mR/standard month. The annual accumulation of indicator samples had a measurement of 4.17 mR/standard month with a range of 2.8 to 6.6 mR/standard month. The 1996 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. The results of the indicator and control TLDs are in good agreement and are plotted in Trending Graph 2.

D. Surface Water

A 125 milliliter surface water sample is collected from the intake forebay and from two shoreline locations, all within 0.3 mile of the two reactors and were composited daily over a monthly period. The thirty samples were analyzed for iodine-131 by the radiochemical technique described on page 73. All results were less than the lower limit of detection of 1 pCi/l. The quarterly composite was analyzed for

Trending Graph - 2



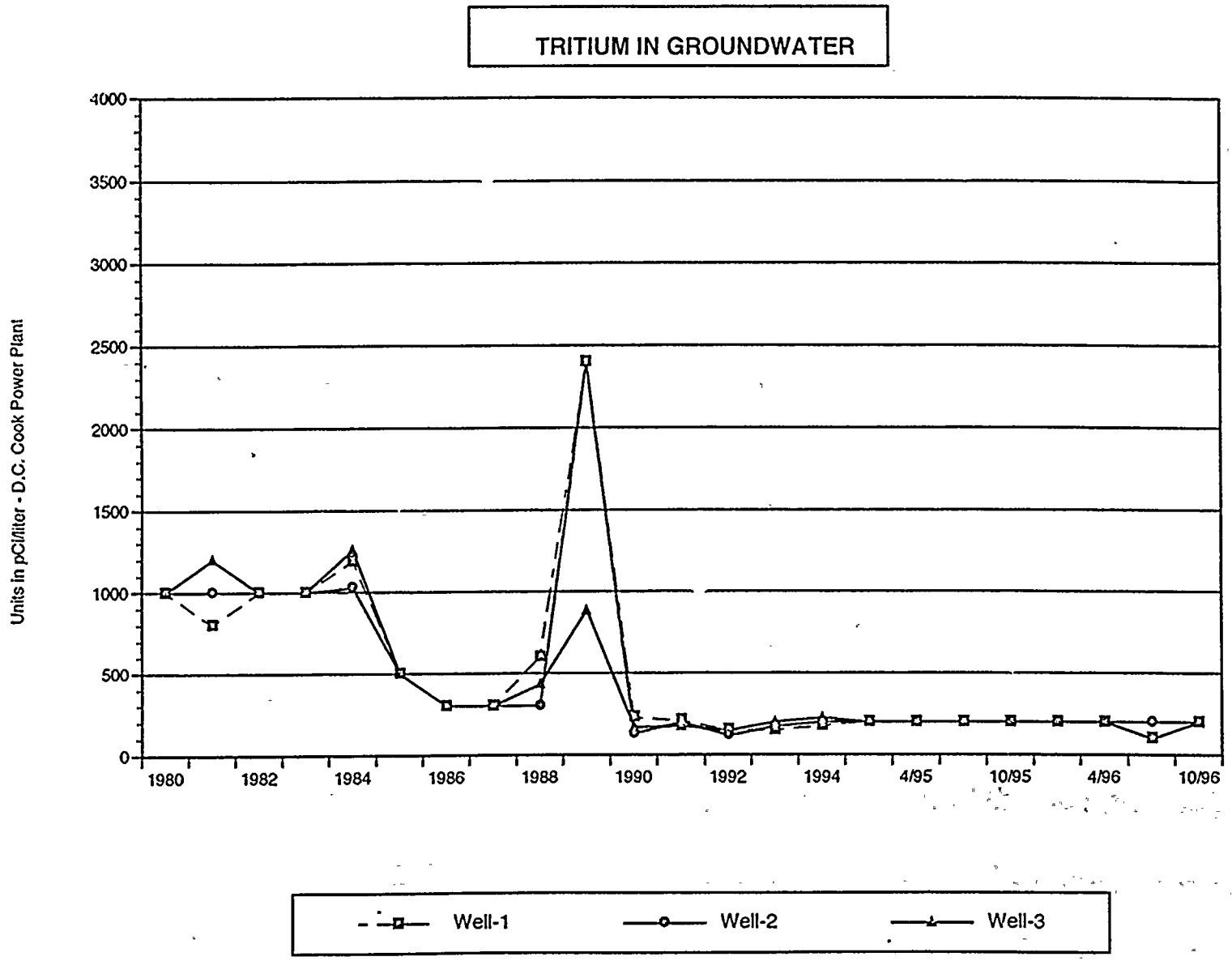
tritium by liquid scintillation method described on page 70. Results are presented in Table B-5. Tritium was detected in 2 of the 10 samples analyzed with an average concentration of 520 pCi/liter and a range of 130 to 910 pCi/liter. This is slightly higher than the 3 measurements in 1995 which had an average concentration of 310 pCi/liter. During the preoperational period tritium was measured in surface water samples at concentrations of approximately 400 pCi/liter. Naturally occurring potassium-40 and cesium-137 were not measured during 1996. Naturally occurring gamma emitting isotopes were detected using gamma ray spectroscopy.

E. Groundwater

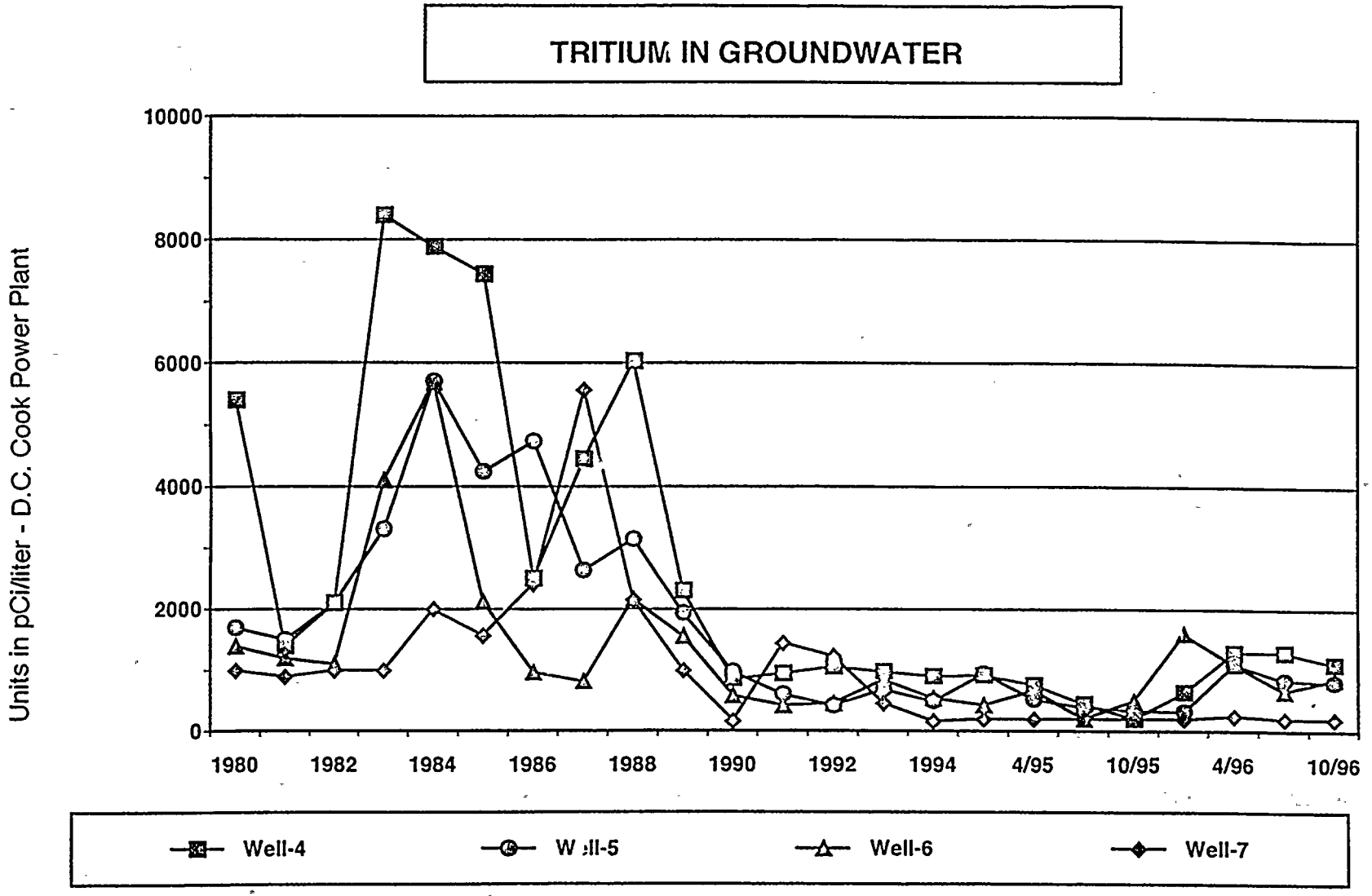
Water samples are collected quarterly from fourteen wells, all within 4300 feet of the reactors. First, a static water elevation is determined and three well bore volumes are purged from the well using a groundwater pump, or equivalent. A two liter sample is then obtained. The samples are analyzed for gamma emitters and tritium. The results are presented in Table B-6. Naturally occurring potassium-40 was not measured during 1996 nor were there any other gamma emitting isotopes measured. The groundwater wells W-4, W-5, W-6, W-7, W-9, W-11, W-13 and W-14 had measurable tritium activity throughout 1996. Tritium was measured in 21 of the 56 samples at the loca .ons with an average concentration of 1659 pCi/liter and a range of 210 to 14000 pCi/liter. The annual concentrations of tritium in wells W-1 through W-7 are plotted in Trending Graph 3. An additional six wells were added to the program during 1992 and one well in 1993. The results are plotted quarterly for 1996 in Trending Graph 3.

Tritium concentration in groundwater wells during the preoperational period typically averaged 400 pCi/liter.

Trending Graph - 3

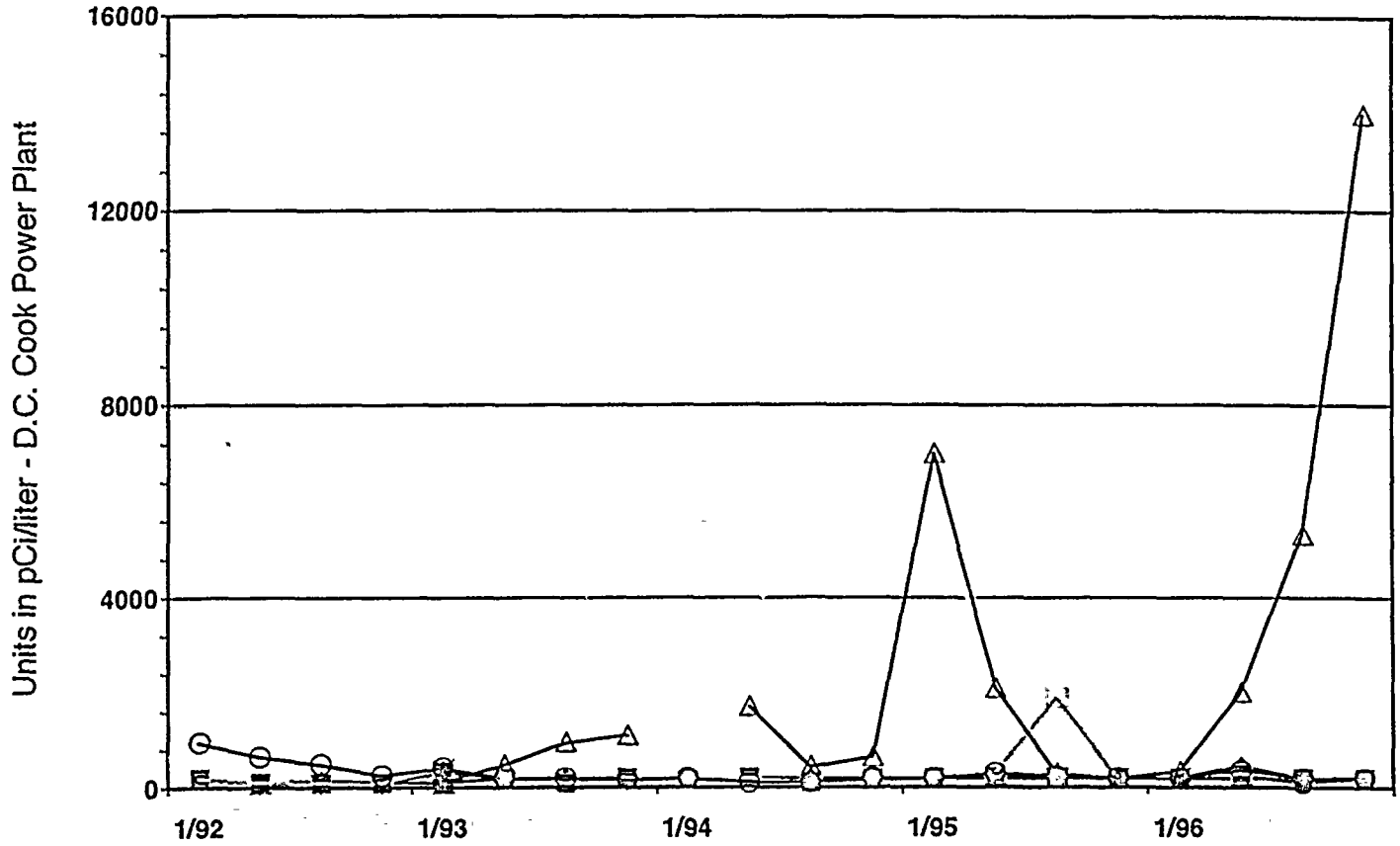


Trending Graph - 3 (Cont.)



Trending Graph - 3 (Cont.)

TRITIUM IN GROUNDWATER



Well 14 added to the program in 1993.
No sample collected January 1994.

Well-8 Well-9 Well-10 Well-11 Well-12 Well-13 Well-14

F. Drinking Water

Daily samples are collected at the intake of the purification plants for St. Joseph and Lake Township. The 500 ml daily samples at each location are composited and analyzed for gross beta, iodine-131, and gamma emitters. On a quarterly basis the daily samples are composited and analyzed for tritium. The results of analyses of drinking water samples are shown in Table B-7.

Gross beta activity was measured in all twenty-six samples from the Lake Township intake with an average concentration of 3.41 pCi/liter and a range from 2.1 to 5.1 pCi/liter. Gross beta activity was measured in all twenty-six samples from the St. Joseph intake with an average concentration of 3.35 pCi/liter and a range from 1.8 to 5.7 pCi/liter. No gamma emitting isotopes or iodine-131 were detected. Tritium was not measured in any of the four samples from either location. Tritium (or LLD values) in drinking water are plotted in Trending Graph 4.

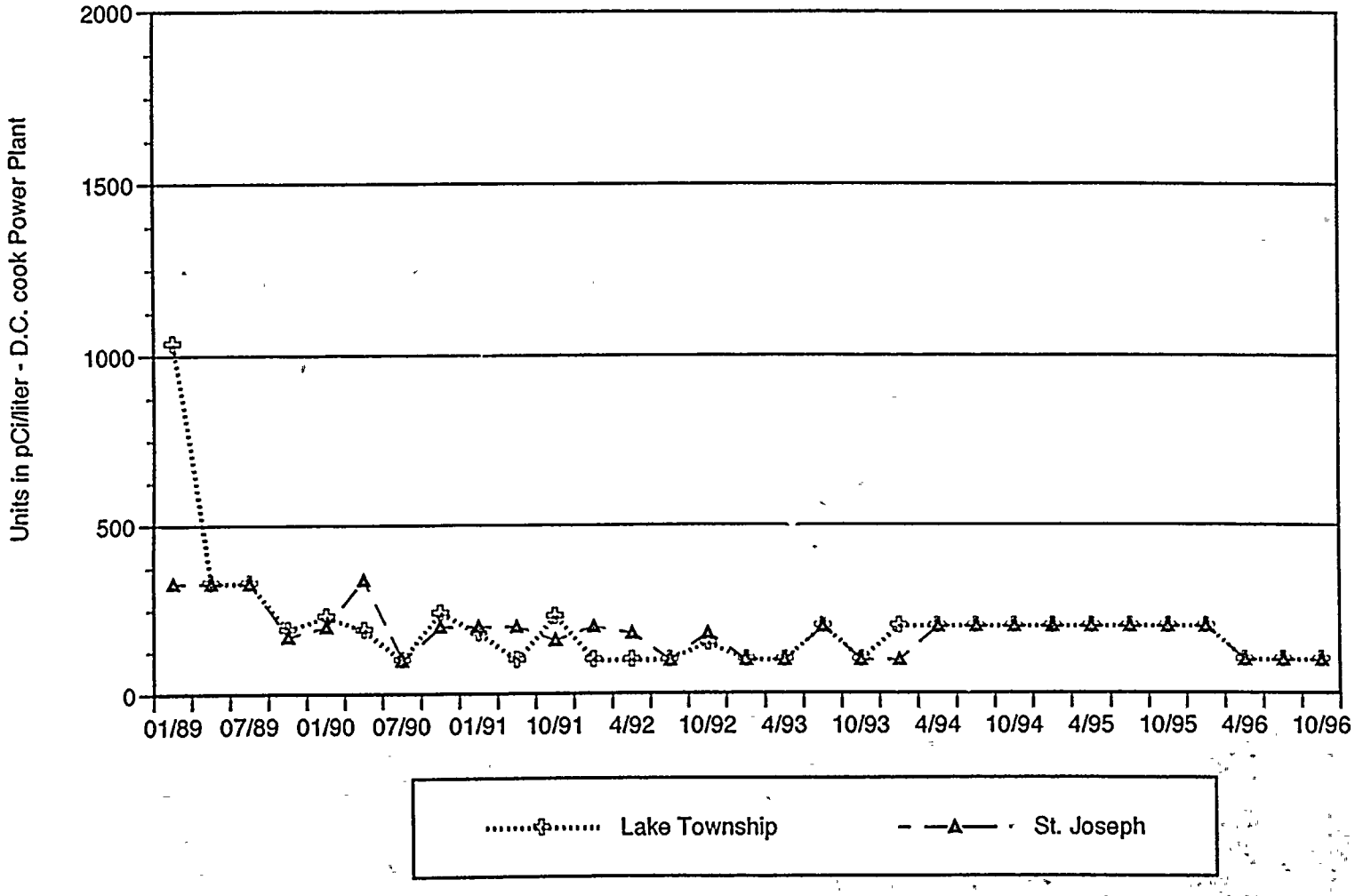
There were no drinking water analyses performed in the preoperational program.

G. Sediment

Sediment samples are collected semiannually along the shoreline of Lake Michigan at the same two locations as the surface water samples. Two liters of lake sediment are collected using a small dredge in an area covered part time by wave action. The sediment samples are analyzed by gamma ray spectroscopy, the results of which are shown in Table B-8. In April and October one sample was collected from location SL-2 and SL-3. Gamma ray spectroscopy detected naturally occurring potassium-40 in all four samples. The average potassium-40 concentration was 4695 pCi/kg (dry weight) with a range from 3420 to 6510 pCi/kg (dry weight). Thorium-228, also naturally occurring was measured in all samples with an average concentration of 443 pCi/kg (dry weight) with a range from 91.8 to 846 pCi/kg (dry weight). Radium-226 was measured in two samples

Trending Graph - 4

TRITIUM IN DRINKING WATER



with an average activity of 667 pCi/kg and a range of 440 to 894 pCi/kg (dry weight). All other gamma emitters were below the lower limits of detection.

H. Milk

During 1996, the requirements of two samples from different locations could not be met. The sampling of food samples was increased to offset the milk.

I. Broadleaf Vegetation

Broadleaf vegetation was collected in lieu of milk during 1996. Thirty one samples were collected and results are presented in Table B-10. Naturally occurring potassium-40 was measured in all samples with an average concentration of 4018 pCi/kg (wet weight) and a range of 2220 to 6740 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in all samples with an average concentration of 1275 pCi/kg (wet weight) and a range of 324 to 4460 pCi/kg (wet weight). Cesium-137 was measured in seven samples with an average concentration of 87.4 pCi/kg (wet weight) and a range of 27.3 to 298 pCi/kg (wet weight).

J. Fish

Using gill nets in approximately twenty feet of water in Lake Michigan, 4.5 pounds of fish are collected 2 times per year from each of four locations. The samples were then analyzed by gamma ray spectroscopy. Results are presented in Table B-11. Naturally occurring potassium-40 was measured in all samples with an average concentration of 3463 pCi/kg (wet weight) and a range of 2810 to 4200 pCi/kg (wet weight). Cesium-137 was measured in five of the seven fish samples with an average concentration of 50.8 pCi/kg (wet weight) and a range of 28.7 to 72.0 pCi/kg (wet weight).

K. Food Products

Food samples are collected annually at harvest, as near the site boundary as possible, and approximately twenty miles from the plant. Each sample consists of 3 pounds of grapes and 3 pounds of broadleaves. There were four food samples collected during 1996 and results are presented in Table B-12. Naturally occurring potassium-40 was measured in all four samples with an average concentration of 2163 pCi/kg (wet weight) and a range of 1630 to 2650 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in three of the four samples with an average concentration of 1583 pCi/kg (wet weight) and a range of 58.6 to 3280 pCi/kg (wet weight). All other gamma emitters were below the lower limits of detection.

IV. CONCLUSIONS

IV. CONCLUSIONS

The results of the 1996 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 1996 appear to follow the gross beta concentrations at the control locations. The concentration levels are actually lower than during the preoperational period. 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 1996. No iodine-131 was detected in charcoal filters in 1996.

Thermoluminescent dosimeters (TLDs) 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 radioactive airborne releases and direct radiation from the power plant. The average annual TLD results were at normal background exposure levels.

Surface water samples are collected daily from the intake forebay and two locations in Lake Michigan. The samples are analyzed quarterly for tritium, and monthly for gamma emitting isotopes. No gamma emitters were detected during 1996. Tritium was measured and the concentrations were at normal background levels.

Groundwater samples were collected quarterly at fourteen wells, all within 4300 feet of the reactors. The three wells within 500 feet had measurable tritium which is attributed to the operation of the plant. The highest concentration measured in 1996 was 14000 pCi/liter while the

highest concentration measured during 1995 was 7000 pCi/liter. The increased tritium concentration is attributed to draining portions of the Component Cooling Water (CCW) system to the turbine room sump which discharges into the onsite absorption pond. Well W-14 is adjacent to the pond and monitors the aquifer at this location. Potassium-40, a naturally occurring nuclide was not observed during 1996. No other 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 daily over a two week period are analyzed for iodine-131, gross beta, and measured for gamma emitting isotopes. Samples are also analyzed quarterly for tritium. No iodine-131 or gamma emitting isotopes were detected. Gross beta was measured in all fifty-two samples at normal background concentrations. Tritium was not measured in any of the eight quarterly composite samples collected during 1996.

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 two locations in close proximity of the reactors. The samples were analyzed by gamma ray spectroscopy and only naturally occurring gamma emitters were detected. There is no evidence of station discharges affecting Lake Michigan, either in the sediments or in the water, as previously discussed.

Milk samples were not analyzed during 1996 due to lack of participants in the program. Broadleaf sampling was performed in lieu of milk collection in 1996. Cesium-137 was measured in 7 of 31 broadleaf samples. No other gamma emitting isotopes were measured in broadleaf samples in 1996.

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 found in low concentrations in five samples.

Food products, consisting of grapes, and broadleaf vegetation were collected and analyzed by gamma ray spectroscopy. No gamma emitting isotopes were measured during 1996

The results of the analyses have been presented. Based on the evidence of the Radiological Environmental Monitoring Program the Donald C. Cook Nuclear Plant is operating within regulatory limits. Tritium in seven on-site wells appears to be the only radionuclide which can be directly correlated with the plant. However the associated groundwater does not provide a direct dose pathway to man.

V. REFERENCES

V. REFERENCES

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

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

3. American Electric Power, 12 PMP 6010 OSD.001, Offsite Dose Calculation Manual.

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

5. 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.

6. United States Nuclear Regulatory Commission, Regulatory Guide 1.4 "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants", April 1975.

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

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, 1996

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 MEASUREMENTS
Air Iodine (pCi/m^3)	I-131	525	-(0/313)			-(0/213)	0
Airborne Particulates (1E-03 pCi/m^3)	Gross Beta (Weekly)	524	19.8(313/313) (7.2-36)	ONS-1 Onsite 1945 ft.	20.9(53/53) (8.6-36)	19.7(212/212) (7.0-33)	0
	Gamma	40					
	Be-7	40	139(24/24) (74.7-195)	ONS-6 Onsite 1917 ft.	152(4/4) (104-195)	128(16/16) (88.3-154)	0
	K-40	40	5.0.9(7/24) (3.95-9.39)	ONS-2 Onsite 2338 ft.	7.06(2/4) (4.72-9.39)	3.84(4/16) (2.91-4.47)	0
Direct Radiation (mR/Standard Month)	Gamma Dose Quarterly	109	4.17(92/92) (2.8-6.6)	SBN 26.2 mi SE	5.15(4/4) (4.5-6.6)	4.34(16/16) (3.0-6.6)	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, 1996

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 MEASUREMENTS
Surface Water (pCi/liter)	Gamma	30	/30) -	N/A		(0/0) -	0
	H-3	10	520(2/10) (130-910)	SWL-1 Intake	910(1/4) -	-(0/0) -	0
Groundwater (pCi/liter)	Gamma	56					
	K-40	56	-(0/56) -	N/A		-(0/0) -	0
	Th-228	56	-(0/56) -	N/A		-(0/0) -	0
	H-3	56	1659(21/56) (210-14000)	Well 14 1780 ft.	5410(4/4) (340-14000)	-(0/0) -	0
Drinking Water (pCi/liter)	Gross Beta	52	3.35(52/52) (1.8-5.7)	LTW 0.4 mi S	3.41(26/26) (2.1-5.1)	-(0/0)	0
	I-131	52	-(0/52) -	N/A	N/A	-(0/0) -	0
	Gamma	52	-(0/52) -	N/A	N/A	-(0/0) -	0
	H-3	8	-(0/8) -	N/A	N/A	-(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, 1996

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 MEASUREMENTS
Sediment (pCi/kg dry)	Gamma	4					
	K-40	4	4965(4/4) (3420-6510)	SL-2 0.3 mi S	5000(2/2) (3490-6510)	-(0/0) -	0
	Cs-137	4	-(0/4) -	N/A		-(0/0) -	0
	Ra-226	4	667(2/4) (440-894)	SL-2 0.3 mi S	894(1/2) -	-(0/0) -	0
	Th-228	4	443(4/4) (91.8-846)	SL-3 0.2 mi N	479(2/2) (112-846)	-(0/0) -	0
Broadleaf/ Vegetation (pCi/kg wet)	Gamma	31					
	Be-7	31	1275(31/31) (324-4460)	Various	1275(31/31) (324-4460)	-(0/0) -	0
	K-40	31	4018(31/31) (1206-2411)	Various	4018(31/31) (1206-2411)	-(0/0) -	0
	Cs-137	31	87.4(7/31) (27.3-298)	Various	87.4(7/31) (27.3-298)	-(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, 1996

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 MEASUREMENTS
Fish (pCi/kg wet)	Gamma	7					
	K-40	7	3463(7/7) (2810-4200)	ONS-North 5.0 mi S	3780(2/2) (3360-4200)	-(0/0) -	0
	Cs-137	7	50.8(5/7) (28.7-72.0)	ONS-South 5.0 mi S	58.2(2/2) (51.8-64.6)	-(0/0) -	0
Food/Vegetation (pCi/kg wet)	Gamma	4					
	Be-7	4	1583(3/4) (58.6-3280)	ONS-V	3280(1/1) -	-(0/0) -	0
	K-40	4	2163(4/4) (1630-2650)	OFS-V	2650(1/1) -	-(0/0) -	0
	Cs-137	4	-(0/4) -		-(0/4) -	-(0/0) -	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 ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL	Averag ± 2 s.
JANUARY 96											
01/08/96	29 ± 2	25 ± 2	28 ± 2	29 ± 2	27 ± 2	26 ± 2	26 ± 2	29 ± 2	30 ± 3	27 ± 2	28 ±
01/12/96	36 ± 4	28 ± 3	26 ± 3	28 ± 4	32 ± 4	30 ± 4	27 ± 4	26 ± 4	33 ± 4	27 ± 3	29 ±
01/18/96	26 ± 3	23 ± 3	26 ± 3	24 ± 3	28 ± 3	27 ± 3	26 ± 3	27 ± 3	23 ± 3	24 ± 3	25 ±
01/24/96	21 ± 2	17 ± 2	18 ± 2	20 ± 2	19 ± 2	19 ± 2	20 ± 2	(a)	23 ± 3	18 ± 2	19 ±
01/31/96	19 ± 2	20 ± 2	20 ± 2	23 ± 2	19 ± 2	20 ± 2	22 ± 2	22 ± 2	20 ± 2	19 ± 2	20 ±
FEBRUARY											
02/07/96	24 ± 2	24 ± 2	26 ± 2	27 ± 2	23 ± 2	23 ± 2	21 ± 2	27 ± 2	23 ± 2	26 ± 2	24 ±
02/14/96	21 ± 2	20 ± 2	16 ± 2	19 ± 2	17 ± 2	17 ± 2	19 ± 2	19 ± 2	15 ± 2	17 ± 2	18 ±
02/21/96	17 ± 2	16 ± 2	15 ± 2	16 ± 2	20 ± 2	16 ± 2	17 ± 2	19 ± 2	16 ± 2	17 ± 2	17 ±
02/28/96	21 ± 2	19 ± 2	16 ± 2	17 ± 2	20 ± 2	16 ± 2	20 ± 2	18 ± 2	15 ± 2	18 ± 2	18 ±
MARCH											
03/06/96	24 ± 2	22 ± 2	22 ± 2	20 ± 2	(b)	(b)	21 ± 2	22 ± 2	21 ± 2	19 ± 2	21 ±
03/13/96	25 ± 2	24 ± 2	21 ± 2	16 ± 2	28 ± 3	22 ± 2	23 ± 2	28 ± 3	21 ± 2	20 ± 2	23 ±
03/20/96	20 ± 2	19 ± 2	18 ± 2	21 ± 2	19 ± 2	28 ± 2	19 ± 2	17 ± 2	19 ± 2	17 ± 2	20 ±
03/27/96	26 ± 2	21 ± 2	20 ± 2	25 ± 2	22 ± 2	23 ± 2	20 ± 2	21 ± 2	22 ± 2	21 ± 2	22 ±
Quarter Avg.	**24 ± 10**	**21 ± 7**	**21 ± 9**	**22 ± 9**	**23 ± 10**	**22 ± 10**	**22 ± 6**	**23 ± 9**	**22 ± 11**	**21 ± 8**	**22 ± 9**

(a) Gale wind; sample blown and not available.
(b) Power off. Sample not 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 ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL	Averag ± 2 s.d
APRIL											
04/03/96	24 ± 2	22 ± 2	20 ± 2	23 ± 2	20 ± 2	18 ± 2	23 ± 2	20 ± 2	21 ± 2	21 ± 2	21 ± 4
04/10/96	22 ± 2	18 ± 3	16 ± 2	18 ± 2	16 ± 2	13 ± 2	15 ± 2	16 ± 2	14 ± 2	15 ± 2	16 ± 5
04/17/96	22 ± 2	19 ± 2	16 ± 2	19 ± 2	16 ± 2	15 ± 2	16 ± 2	17 ± 2	16 ± 2	16 ± 2	17 ± 4
04/24/96	17 ± 2	15 ± 2	17 ± 2	17 ± 2	16 ± 2	13 ± 2	16 ± 2	13 ± 2	16 ± 2	16 ± 2	16 ± 3
05/01/96	18 ± 2	16 ± 2	15 ± 2	15 ± 2	15 ± 2	14 ± 2	14 ± 2	15 ± 2	14 ± 2	14 ± 2	15 ± 3
MAY											
05/08/96	19 ± 2	15 ± 2	15 ± 2	17 ± 2	15 ± 2	14 ± 2	16 ± 2	16 ± 2	15 ± 2	16 ± 2	16 ± 3
05/15/96	15 ± 2	15 ± 2	12 ± 2	14 ± 2	13 ± 2	12 ± 2	12 ± 2	14 ± 2	12 ± 2	14 ± 2	13 ± 3
05/22/96	16 ± 2	15 ± 2	15 ± 2	16 ± 2	14 ± 2	15 ± 2	15 ± 2	15 ± 2	16 ± 2	17 ± 2	15 ± 2
05/29/96	18 ± 2	16 ± 2	13 ± 2	14 ± 2	14 ± 2	15 ± 2	15 ± 2	7.5 ± 1.8	15 ± 2	13 ± 2	14 ± 6
JUNE											
06/05/96	14 ± 2	12 ± 2	11 ± 2	11 ± 2	12 ± 2	12 ± 2	13 ± 2	13 ± 2	13 ± 2	13 ± 2	12 ± 2
06/12/96	8.6 ± 1.7	7.4 ± 1.6	7.8 ± 1.5	8.3 ± 1.6	7.2 ± 1.5	7.5 ± 1.6	7.4 ± 1.6	8.8 ± 1.8	7.9 ± 1.6	7.2 ± 1.6	7.8 ± 1.
06/19/96	16 ± 2	14 ± 2	14 ± 2	15 ± 2	15 ± 2	12 ± 2	25 ± 2	14 ± 2	14 ± 2	13 ± 2	15 ± 7
06/26/96	12 ± 2	10 ± 2	9.9 ± 1.7	12 ± 2	12 ± 2	11 ± 2	16 ± 2	13 ± 2	13 ± 2	13 ± 2	12 ± 4
Quarterly Avg.	**17 ± 8**	**15 ± 7**	**14 ± 6**	**15 ± 7**	**14 ± 6**	**13 ± 5**	**16 ± 9**	**14 ± 7**	**14 ± 6**	**14 ± 6**	**14 ± 7**

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 ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL	Aver ± 2 s
JULY											
07/03/96	23 ± 2	22 ± 2	21 ± 2	24 ± 2	21 ± 2	22 ± 2	26 ± 2	21 ± 2	21 ± 2	22 ± 2	22 ±
07/10/96	19 ± 2	20 ± 2	17 ± 2	20 ± 2	16 ± 2	18 ± 2	7.0 ± 1.5	19 ± 2	14 ± 2	18 ± 2	17 ±
07/17/96	21 ± 2	19 ± 2	22 ± 2	18 ± 2	17 ± 2	19 ± 2	19 ± 2	17 ± 2	20 ± 2	18 ± 2	19 ±
07/24/96	15 ± 2	16 ± 2	14 ± 2	15 ± 2	14 ± 2	16 ± 2	18 ± 2	15 ± 2	15 ± 2	16 ± 2	15 ±
07/31/96	16 ± 2	18 ± 2	13 ± 2	17 ± 2	18 ± 2	21 ± 2	20 ± 2	13 ± 2	14 ± 2	17 ± 2	17 ±
AUGUST											
08/07/96	18 ± 2	17 ± 2	17 ± 2	17 ± 2	19 ± 2	18 ± 2	19 ± 2	21 ± 2	20 ± 2	20 ± 2	19 ±
08/14/96	(a)	20 ± 2	14 ± 2	16 ± 2	18 ± 2	19 ± 2	18 ± 2	18 ± 2	17 ± 2	18 ± 2	18 ±
08/21/96	23 ± 2	25 ± 2	19 ± 2	22 ± 2	23 ± 2	23 ± 2	24 ± 2	24 ± 2	25 ± 2	23 ± 2	23 ±
08/28/96	26 ± 2	23 ± 2	20 ± 2	24 ± 2	24 ± 2	23 ± 2	24 ± 2	22 ± 2	22 ± 2	25 ± 2	23 ±
SEPTEMBER											
09/04/96	33 ± 3	32 ± 3	26 ± 2	32 ± 2	35 ± 2	29 ± 2	30 ± 2	33 ± 2	29 ± 2	32 ± 2	31 ±
09/11/96	33 ± 3	34 ± 3	25 ± 2	32 ± 2	33 ± 2	34 ± 2	33 ± 2	32 ± 2	30 ± 2	30 ± 2	32 ±
09/18/96	12 ± 2	9.2 ± 1.6	7.8 ± 1.4	9.7 ± 1.5	11 ± 2	9.6 ± 1.5	11 ± 2	9.6 ± 1.5	9.9 ± 1.5	9.7 ± 1.5	10 ±
09/25/96	23 ± 2	24 ± 2	20 ± 2	24 ± 2	26 ± 2	25 ± 2	19 ± 2	27 ± 2	23 ± 2	22 ± 2	23 ±
10/02/96	23 ± 2	22 ± 2	18 ± 2	21 ± 2	25 ± 2	22 ± 2	22 ± 2	20 ± 2	23 ± 2	20 ± 2	22 ±
Quarterly Avg.	**22 ± 13**	**22 ± 13**	**18 ± 10**	**21 ± 12**	**21 ± 14**	**21 ± 12**	**21 ± 14**	**21 ± 13**	**20 ± 12**	**21 ± 11**	**21 ±**

(a) Pump off. Sample not collected.

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 ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL	Averag ± 2 s.d
OCTOBER											
10/09/96	17 ± 2	14 ± 1	13 ± 2	13 ± 2	16 ± 2	17 ± 2	17 ± 2	21 ± 2	17 ± 2	16 ± 2	16 ± 5
10/16/96	22 ± 2	27 ± 3	23 ± 2	25 ± 2	26 ± 2	25 ± 2	24 ± 2	26 ± 2	26 ± 2	26 ± 2	25 ± 3
10/23/96	20 ± 2	34 ± 7 (a)	17 ± 2	19 ± 2	18 ± 2	18 ± 2	21 ± 2	21 ± 2	20 ± 2	20 ± 2	21 ± 1
10/30/96	23 ± 2	20 ± 2	19 ± 2	23 ± 2	21 ± 2	22 ± 2	21 ± 2	19 ± 2	24 ± 2	21 ± 2	21 ± 3
NOVEMBER											
11/06/96	23 ± 2	23 ± 2	21 ± 2	23 ± 2	18 ± 2	23 ± 2	< 10 (a)	20 ± 2	21 ± 2	21 ± 2	21 ± 4
11/13/96	14 ± 2	8.5 ± 1.6	13 ± 2	16 ± 2	(a)	(a)	16 ± 2	13 ± 2	12 ± 2	16 ± 2	14 ± 5
11/20/96	19 ± 2	21 ± 2	23 ± 2	23 ± 2	20 ± 3	22 ± 2	22 ± 2	24 ± 2	20 ± 2	23 ± 2	22 ± 3
11/27/96	13 ± 2	12 ± 2	11 ± 2	16 ± 2	12 ± 2	15 ± 2	13 ± 2	14 ± 2	15 ± 2	15 ± 2	14 ± 3
12/04/96	27 ± 2	24 ± 2	23 ± 2	30 ± 2	24 ± 2	30 ± 2	25 ± 2	24 ± 2	25 ± 2	29 ± 2	26 ± 5
DECEMBER											
12/11/96	19 ± 2	20 ± 2	20 ± 2	25 ± 2	21 ± 2	26 ± 2	25 ± 2	21 ± 2	23 ± 2	25 ± 2	26 ± 5
12/18/96	23 ± 2	23 ± 2	21 ± 2	27 ± 2	24 ± 2	26 ± 2	25 ± 2	27 ± 2	25 ± 2	24 ± 2	25 ± 4
12/23/96	26 ± 3	28 ± 3	26 ± 3	29 ± 3	24 ± 3	28 ± 3	29 ± 3	27 ± 3	29 ± 3	29 ± 3	28 ± 3
12/30/96	26 ± 2	25 ± 2	24 ± 2	28 ± 2	27 ± 2	28 ± 3	27 ± 2	23 ± 2	26 ± 2	25 ± 2	26 ± 3
Quarter Avg.	**21 ± 9**	**22 ± 14**	**20 ± 9**	**23 ± 11**	**21 ± 9**	**23 ± 9**	**22 ± 10**	**22 ± 9**	**22 ± 10**	**22 ± 9**	**22 ± 1**
Annual Avg.	**21 ± 11**	**20 ± 12**	**18 ± 10**	**20 ± 11**	**20 ± 12**	**20 ± 12**	**20 ± 11**	**20 ± 12**	**20 ± 11**	**20 ± 11**	**20 ± 1**

(a) Low sample volume.
(b) No power; blown fuse. Sample not collected.

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 10^{-3} pCi/m^3 ± 2 sigma

Stations	Nuclides	First Quarter 01/01/96-04/03/96	Second Quarter 04/03/96-07/03/96	Third Quarter 07/03/96-10/02/96	Fourth Quarter 10/02/96-12/30/96	Average ±2 s.d.
ONS-1	Be-7	176 ± 18	153 ± 15	159 ± 16	93.4 ± 9.3	145 ± 72
	K-40	< 6	4.33 ± 2.03	< 5	< 5	4.33 ± 2.03
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.3	-
ONS-2	Be-7	139 ± 14	152 ± 15	160 ± 16	96.4 ± 9.6	137 ± 57
	K-40	< 4	9.39 ± 2.26	< 6	4.72 ± 2.21	7.06 ± 6.6
	Cs-134	< 0.2	< 0.2	< 0.4	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.2	-
ONS-3	Be-7	180 ± 18	124 ± 12	114 ± 11	74.7 ± 7.5	123 ± 8.7
	K-40	3.95 ± 2.28	< 10	< 7	< 7	3.95 ± 2.83
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
ONS-4	Be-7	172 ± 17	163 ± 16	147 ± 15	95.4 ± 9.5	144 ± 68
	K-40	< 6	< 6	< 4	< 10	-
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.3	-
ONS-5	Be-7	132 ± 13	140 ± 14	146 ± 15	101 ± 10	130 ± 40
	K-40	< 7	4.70 ± 2.00	< 5	< 5	4.70 ± 2.00
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.2	-

* Typical LLDs are found in Table B-12. All other gamma emitters were <LLD.

TABLE B-2 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIRBORNE PARTICULATES

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

Stations	Nuclides	First Quarter 01/01/96-04/03/96	Second Quarter 04/03/96-07/03/96	Third Quarter 07/03/96-10/02/96	Fourth Quarter 10/02/96-12/30/96	Average ± 2 s.d.
ONS-6	Be-7	195 ± 19	165 ± 16	144 ± 14	104 ± 10	152 ± 76
	K-40	4.39 ± 1.98	< 5	< 4	4.14 ± 1.55	4.27 ± 0.4
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.2	-
NBF	Be-7	153 ± 15	105 ± 11	127 ± 13	116 ± 12	125 ± 41
	K-40	< 5	2.91 ± 1.48	< 10	< 5	2.91 ± 1.48
	Cs-134	< 0.3	< 0.2	< 0.4	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.3	-
SBN	Be 7	154 ± 15	148 ± 15	115 ± 12	101 ± 10	130 ± 51
	K-40	3.51 ± 1.69	< 4	< 6	< 5	3.51 ± 1.69
	Cs-134	< 0.2	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.2	-
DOW	Be-7	146 ± 15	136 ± 14	152 ± 15	97.8 ± 9.8	133 ± 49
	K-40	< 8	< 4	< 6	< 6	-
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.3	-
COL	Be-7	154 ± 15	133 ± 13	122 ± 12	88.3 ± 8.8	124 ± 55
	K-40	< 4	4.47 ± 2.38	4.46 ± 2.43	< 7	4.47 ± 0.0
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.2	-

* Typical LLDs are found in Table B-12. All other gamma emitters were <LLD.

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

COLLECTION DATES	STATION CODES ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
JANUARY 96										
01/08/96	< 20	< 10	< 20	< 20	< 7	< 10	< 20	< 10	< 20	< 9
01/12/96	< 20	< 20	< 30	< 30	< 10	< 20	< 30	< 30	< 30	< 10
01/18/96	< 10	< 10	< 10	< 10	< 7	< 10	< 10	< 10	< 10	< 8
01/24/96	< 10	< 10	< 10	< 10	< 10	< 10	< 20	< 20	< 20	< 10
01/31/96	< 10	< 10	< 10	< 10	< 8	< 20	< 20	< 20	< 20	< 10
FEBRUARY										
02/07/96	< 9	< 8	< 9	< 9	< 6	< 9	< 10	< 10	< 9	< 6
02/14/96	< 7	< 7	< 7	< 7	< 5	< 10	< 10	< 10	< 10	< 7
02/21/96	< 9	< 8	< 8	< 9	< 6	< 10	< 10	< 10	< 10	< 8
02/28/96	< 7	< 7	< 7	< 7	< 5	< 10	< 10	< 10	< 10	< 8
MARCH										
03/06/96	< 7	< 7	< 7	< 7	(a)	(a)	< 10	< 10	< 10	< 8
03/13/96	< 10	< 10	< 10	< 10	< 8	< 9	< 7	< 8	< 7	< 5
03/20/96	< 10	< 10	< 10	< 10	< 6	< 6	< 7	< 7	< 7	< 5
03/27/96	< 10	< 10	< 10	< 10	< 6	< 6	< 7	< 7	< 7	< 5

(a) Power off; sample not 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	STATION CODES ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
APRIL										
04/03/96	< 20	< 20	< 20	< 20	< 9	< 20	< 20	< 20	< 20	< 10
04/10/96	< 20	< 30	< 20	< 20	< 9	< 20	< 20	< 20	< 20	< 10
04/17/96	< 10	< 10	< 10	< 10	< 6	< 7	< 8	< 8	< 7	< 5
04/24/96	< 10	< 10	< 10	< 10	< 6	< 6	< 7	< 7	< 7	< 5
05/01/96	< 10	< 10	< 10	< 10	< 6	< 6	< 8	< 8	< 8	< 5
MAY										
05/08/96	< 10	< 9	< 8	< 9	< 6	< 10	< 10	< 10	< 10	< 6
05/15/96	< 10	< 10	< 10	< 10	< 6	< 7	< 8	< 8	< 8	< 5
05/22/96	< 10	< 10	< 10	< 10	< 8	< 10	< 10	< 10	< 10	< 6
05/29/96	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 10	< 10	< 8
JUNE										
06/05/96	< 10	< 10	< 8	< 10	< 7	< 10	< 10	< 10	< 10	< 6
06/12/96	< 10	< 10	< 10	< 10	< 6	< 8	< 8	< 8	< 7	< 5
06/19/96	< 10	< 10	< 10	< 10	< 6	< 8	< 8	< 8	< 7	< 5
06/26/96	< 10	< 20	< 10	< 20	< 10	< 20	< 20	< 20	< 20	< 10

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	STATION CODES ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
JULY										
07/03/96	< 20	< 20	< 20	< 20	< 9	< 10	< 10	< 10	< 10	< 8
07/10/96	< 10	< 10	< 10	< 10	< 7	< 8	< 8	< 7	< 8	< 5
07/17/96	< 10	< 10	< 10	< 10	< 6	< 10	< 10	< 10	< 10	< 9
07/24/96	< 6	< 6	< 6	< 6	< 5	< 10	< 10	< 9	< 10	< 7
07/31/96	< 9	< 9	< 8	< 9	< 6	< 10	< 10	< 10	< 10	< 10
AUGUST										
08/07/96	< 10	< 10	< 10	< 10	< 8	< 9	< 9	< 7	< 9	< 6
08/14/96	(a)	< 8	< 8	< 8	< 6	< 10	< 10	< 10	< 10	< 6
08/21/96	< 10	< 10	< 10	< 10	< 6	< 7	< 8	< 7	< 8	< 5
08/28/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7	< 5
SEPTEMBER										
09/04/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7	< 5
09/11/96	< 6	< 6	< 5	< 5	< 4	< 9	< 10	< 10	< 10	< 7
09/18/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7	< 5
09/25/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7	< 5
10/02/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 9	< 7	< 7

(a) Pump off. Sample not collected.

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	STATION CODES ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
OCTOBER										
10/09/96	< 6	< 4	< 6	< 5	< 4	< 9	< 10	< 10	< 10	< 7
10/16/96	< 10	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7	< 5
10/23/96	< 10	< 20 (a)	< 10	< 10	< 10	< 6	< 7	< 7	< 7	< 7
10/30/96	< 6	< 6	< 6	< 7	< 5	< 10	< 10	< 10	< 10	< 7
NOVEMBER										
11/06/96	< 8	< 8	< 7	< 8	< 6	< 8	< 40 (a)	< 8	< 9	< 6
11/13/96	< 20	< 20	< 20	< 20	(a)	(a)	< 20	< 20	< 20	< 20
11/20/96	< 8	< 8	< 8	< 9	< 8	< 9	< 8	< 9	< 8	< 6
11/27/96	< 10	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 10
12/04/96	< 7	< 7	< 7	< 7	< 5	< 10	< 10	< 10	< 10	< 7
DECEMBER										
12/11/96	< 10	< 10	< 10	< 10	< 6	< 10	< 10	< 10	< 10	< 8
12/18/96	< 20	< 10	< 10	< 10	< 7	< 8	< 9	< 9	< 8	< 6
12/23/96	< 8	< 8	< 8	< 8	< 6	< 8	< 8	< 8	< 8	< 6
12/30/96	< 10	< 10	< 10	< 10	< 5	< 7	< 6	< 6	< 6	< 4

(a) Low sample volume
(b) No power; blown fuse. Sample not collected.

TABLE B-4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

Results in Units of mR/standard month

STATION CODES	FIRST QUARTER 01/01/96-04/02/96	SECOND QUARTER 04/02/96-07/02/96	THIRD QUARTER (a) 07/02/96-10/02/96	FOURTH QUARTER 10/02/96-01/02/97	AVERAGE ± 2 s.d.
A-1	4.1 ± 0.3	4.7 ± 1.9	5.2 ± 0.4	3.3 ± 0.3	4.3 ± 1.6
A-2	4.0 ± 0.7	3.6 ± 0.5	5.1 ± 0.3	3.3 ± 0.3	4.0 ± 1.6
A-3	3.3 ± 0.3	3.3 ± 1.3	4.6 ± 0.2	2.9 ± 0.2	3.5 ± 1.5
A-4	4.6 ± 1.3	3.9 ± 0.3	5.5 ± 0.4	3.5 ± 0.3	4.4 ± 1.8
A-5	3.8 ± 0.7	3.4 ± 0.3	5.0 ± 0.3	3.4 ± 0.4	3.9 ± 1.5
A-6	3.8 ± 0.4	3.3 ± 0.4	5.0 ± 0.3	3.4 ± 0.5	3.9 ± 1.6
A-7	4.0 ± 0.4	3.4 ± 0.3	5.1 ± 0.2	3.1 ± 0.4	3.9 ± 1.8
A-8	3.9 ± 0.5	3.9 ± 0.3	5.1 ± 0.4	3.7 ± 0.6	4.2 ± 1.3
A-9	4.0 ± 0.9	3.6 ± 0.4	5.3 ± 0.4	3.5 ± 0.3	4.1 ± 1.7
A-10	3.4 ± 0.5	3.1 ± 0.3	4.6 ± 0.2	2.8 ± 0.2	3.5 ± 1.6
A-11	4.1 ± 0.9	3.5 ± 0.5	5.2 ± 0.2	3.4 ± 0.4	4.1 ± 1.7
A-12	4.3 ± 0.4	3.7 ± 0.3	5.8 ± 1.7	3.5 ± 0.4	4.3 ± 2.1
OFS-1	3.7 ± 0.3	3.7 ± 0.4	5.2 ± 0.3	3.2 ± 0.4	4.0 ± 1.7
OFS-2	3.6 ± 0.3	3.5 ± 0.5	5.2 ± 0.5	3.2 ± 0.1	3.9 ± 1.8
OFS-3	3.9 ± 0.3	3.3 ± 0.5	5.5 ± 0.6	3.9 ± 1.1	4.2 ± 1.9
OFS-4	4.1 ± 0.4	3.7 ± 0.3	5.6 ± 0.2	3.6 ± 0.4	4.3 ± 1.9
OFS-5	4.2 ± 0.3	4.0 ± 0.4	5.5 ± 0.6	3.7 ± 0.4	4.4 ± 1.6
OFS-6	4.8 ± 0.4	4.5 ± 0.5	6.6 ± 0.8	4.4 ± 0.7	5.1 ± 2.1
OFS-7	4.2 ± 0.8	3.8 ± 0.7	5.7 ± 0.5	3.5 ± 0.5	4.3 ± 2.0
OFS-8	4.7 ± 0.3	4.2 ± 0.7	6.1 ± 0.4	4.2 ± 0.6	4.8 ± 1.8
OFS-9	4.3 ± 0.0	4.3 ± 1.9	6.0 ± 1.2	3.9 ± 0.6	4.6 ± 1.9
OFS-10	3.8 ± 0.4	3.7 ± 0.9	5.3 ± 0.8	3.3 ± 0.2	4.0 ± 1.8
OFS-11	4.7 ± 0.3	4.5 ± 0.5	6.1 ± 0.6	4.4 ± 0.4	4.9 ± 1.6
NBF	4.4 ± 0.6	4.1 ± 0.3	5.7 ± 0.5	4.0 ± 0.5	4.6 ± 1.6
SBN	4.9 ± 0.3	4.6 ± 0.5	6.6 ± 0.5	4.5 ± 0.6	5.2 ± 2.0
DOW	3.9 ± 0.3	3.7 ± 1.1	5.0 ± 0.7	3.4 ± 0.3	4.0 ± 1.4
COL	3.5 ± 0.3	3.3 ± 0.4	4.8 ± 0.4	3.0 ± 0.4	3.7 ± 1.6
Average ± 2 s.d.	**4.1 ± 0.8**	**3.8 ± 0.9**	**5.4 ± 1.1**	**3.6 ± 0.9**	**4.2 ± 1.7**

* Standard month = 30.4 days.

(a) Transit dose not subtracted from totals as TLD had not been placed in shielded TLD holder.

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	K-40	Tritium
SWL-1 (Condenser Circ.)	01/31/96	< 1	< 80	910 ± 160
	02/29/96	< 1	< 50	
	03/31/96	< 0.7	< 70	
	04/30/96	< 1	< 100	< 100
	05/31/96	< 0.5	< 70	
	06/30/96	< 0.3	< 40	
	07/31/96	< 0.8	< 50	< 100
	08/31/96	< 0.4	< 40	
	09/30/96	< 0.8	< 50	
	10/31/96	< 0.4	< 90	< 100
	11/30/96	< 1	< 50	
	12/31/96	< 0.9	< 100	
SWL-2 (South Comp)	01/31/96	(a)		
	02/29/96	(a)		
	03/31/96	(a)		
	04/30/96	< 1	< 60	< 100
	05/31/96	< 0.5	< 60	
	06/30/96	< 0.4	< 80	
	07/31/96	< 0.8	< 50	< 200
	08/31/96	< 0.4	< 70	
	09/30/96	< 0.9	< 50	
	10/31/96	< 0.4	< 30	130 ± 80
	11/30/96	< 0.1	< 90	
	12/18/96	< 1	< 100	

(a) Sample not collected.
* Typical LLDs are found in Table B-12. All other gamma emitters were below <LLD.

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	K-40	Tritium
SWL-3 (North Comp)	01/31/96	(a)		
	02/29/96	(a)		
	03/31/96	(a)		
	04/30/96	< 1	< 50	< 100
	05/31/96	< 0.5	< 60	
	06/30/96	< 0.4	< 100	
	07/31/96	< 0.9	< 50	< 100
	08/31/96	< 0.4	< 90	
	09/30/96	< 0.8	< 50	
	10/31/96	< 0.3	< 40	< 100
	11/30/96	< 1	< 100	
	12/18/96	< 2 (b)	< 80	

(a) Sample not collected.
(b) LLD for I-131 not met due to the low sample volume received.
* Typical LLDs are found in Table B-12. All other gamma emitters were below <LLD.

TABLE B-6

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN GROUNDWATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	K-40	Tritium
Well W-1	01/26/96	< 0.4	< 90	< 200
	04/25/96	< 1	< 50	< 200
	07/25/96	< 0.8	< 50	< 100
	10/24/96	< 0.4	< 60	< 200
Well W-2	01/25/96	< 0.4	< 50	< 200
	04/25/96	< 1	< 70	< 200
	07/25/96	< 0.9	< 70	< 200
	10/24/96	< 1	< 60	< 200
Well W-3	01/26/96	< 0.4	< 50	< 200
	04/25/96	< 1	< 100	< 200
	07/25/96	< 0.8	< 60	< 100
	10/25/96	< 0.4	< 70	< 200
Well W-4	01/30/96	< 0.4	< 90	640 ± 140
	04/25/96	< 0.9	< 100	1300 ± 200
	07/26/96	< 0.8	< 60	1300 ± 200
	10/24/96	< 0.5	< 50	1110 ± 200
Well W-5	01/30/96	< 0.4	< 40	320 ± 140
	04/26/96	< 1	< 50	1100 ± 200
	07/26/96	< 0.9	< 60	840 ± 130
	10/24/96	< 0.4	< 50	810 ± 150
Well W-6	01/30/96	< 0.4	< 100	1600 ± 200
	04/26/96	< 1	< 80	1100 ± 200
	07/26/96	< 0.7	< 50	660 ± 120
	10/24/96	< 0.3	< 70	860 ± 140

* Footnotes located at end of table.

TABLE B-6 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN GROUNDWATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	K-40	Tritium
Well W-7	01/26/96	< 0.4	< 100	< 200
	04/25/96	< 1	< 60	250 ± 140
	07/25/96	< 0.8	< 60	< 200
	10/25/96	< 0.4	< 100	< 200
Well W-8	01/26/96	< 0.4	< 100	< 200
	04/25/96	< 1	< 60	< 200
	07/25/96	< 0.9	< 40	< 200
	10/24/96	< 0.5	< 50	< 200
Well W-9	01/25/96	< 0.4	< 50	< 200
	04/25/96	< 1	< 70	260 ± 140
	07/25/96	< 0.8	< 100	< 100
	10/24/96	< 0.6	< 70	< 200
Well W-10	01/25/96	< 0.4	< 80	< 200
	04/24/96	< 1	< 100	< 200
	07/25/96	< 1	< 100	< 200
	10/24/96	< 0.5	< 50	< 200
Well W-11	01/25/96	< 0.4	< 50	< 200
	04/24/96	< 1	< 50	460 ± 60
	07/25/96	< 0.8	< 50	< 200
	10/24/96	< 0.5	< 100	< 200
Well W-12	01/25/96	< 0.4	< 50	< 200
	04/24/96	< 1	< 50	< 300
	07/26/96	< 0.7	< 50	< 200
	10/24/96	< 0.4	< 90	< 200

* Footnotes located at end of table.

TABLE B-6 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN GROUNDWATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	K-40	Tritium
Well W-13	01/26/96	< 0.5	< 100	< 200
	04/24/96	< 1	< 50	370 ± 170
	07/25/96	< 0.8	< 80	< 200
	10/25/96	< 0.4	< 60	210 ± 140
Well W-14	01/26/96	< 0.5	< 90	340 ± 110
	04/25/96	< 1	< 100	2000 ± 200
	07/25/96	< 0.7	< 90	5300 ± 300
	10/25/96	< 0.5	< 70	14000 ± 1000 (a)
Average ± 2 s.d.				1659 ± 6060

(a) Tritium results confirmed by a reanalysis.

* Typical LLDs are found in Table B-12. All other gamma emitters were LLD.

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
LTW				
01/17/96	4.0 ± 1.0	< LLD	< 0.2	< 200
01/31/96	2.8 ± 1.0	< LLD	< 0.3	
02/14/96	3.5 ± 0.9	< LLD	< 0.3	
02/28/96	2.6 ± 0.9	< LLD	< 0.3	
03/13/96	3.6 ± 1.1	< LLD	< 0.5	
03/27/96	4.2 ± 1.0	< LLD	< 0.3	
04/10/96	3.6 ± 1.1	< LLD	< 0.3	< 100
04/24/96	3.6 ± 1.1	< LLD	< 0.4	
05/08/96	3.7 ± 1.0	< LLD	< 0.3	
05/22/96	3.6 ± 1.0	< LLD	< 0.4	
06/05/96	3.7 ± 1.1	< LLD	< 0.2	
06/19/96	3.2 ± 1.0	< LLD	< 0.4	
07/03/96	4.2 ± 1.2	< LLD	< 0.5	< 100
07/17/96	3.6 ± 1.0	< LLD	< 0.2	
07/31/96	2.9 ± 1.0	< LLD	< 0.2	
08/14/96	3.7 ± 1.0	< LLD	< 0.3	
08/28/96	5.1 ± 1.1	< LLD	< 0.3	
09/11/96	3.7 ± 1.2	< LLD	< 0.3	
09/25/96	3.1 ± 0.9	< LLD	< 0.3	
10/09/96	3.0 ± 1.0	< LLD	< 0.3	< 100
10/23/96	3.2 ± 0.9	< LLD	< 0.4	
11/06/96	2.5 ± 0.9	< LLD	< 0.3	
11/20/96	3.2 ± 1.0	< LLD	< 0.3	
12/04/96	2.1 ± 0.9	< LLD	< 0.3	
12/18/96	3.4 ± 1.1	< LLD	< 0.3	
12/30/96	2.9 ± 1.1	< LLD	< 0.4	
Average ± 2 s. d.	3.4 ± 1.2			

* Typical LLDs are found in table B-12.

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
STJ				
01/17/96	3.7 ± 1.0	< LLD	< 0.2	< 200
01/31/96	2.9 ± 1.1	< LLD	< 0.2	
02/14/96	4.4 ± 1.1	< LLD	< 0.4	
02/28/96	2.8 ± 0.9	< LLD	< 0.3	
03/13/96	3.0 ± 1.1	< LLD	< 0.4	
03/27/96	3.7 ± 1.0	< LLD	< 0.4	
04/10/96	5.7 ± 1.2	< LLD	< 0.3	< 100
04/24/96	2.3 ± 1.0	< LLD	< 0.4	
05/08/96	4.3 ± 1.1	< LLD	< 0.3	
05/22/96	3.4 ± 1.0	< LLD	< 0.4	
06/05/96	2.6 ± 1.0	< LLD	< 0.1	
06/19/96	3.9 ± 1.0	< LLD	< 0.4	
07/03/96	1.8 ± 1.1	< LLD	< 0.5	< 100
07/17/96	3.4 ± 1.0	< LLD	< 0.2	
07/31/96	3.8 ± 1.1	< LLD	< 0.2	
08/14/96	3.0 ± 1.0	< LLD	< 0.4	
08/28/96	3.7 ± 1.0	< LLD	< 0.3	
09/11/96	2.6 ± 1.1	< LLD	< 0.3	
09/25/96	4.1 ± 1.0	< LLD	< 0.2	
10/09/96	3.9 ± 1.1	< LLD	< 0.3	< 100
10/23/96	3.5 ± 1.0	< LLD	< 0.3	
11/06/96	4.1 ± 1.1	< LLD	< 0.3	
11/20/96	3.1 ± 1.0	< LLD	< 0.3	
12/04/96	2.0 ± 0.9	< LLD	< 0.3	
12/18/96	3.0 ± 1.1	< LLD	< 0.3	
12/30/96	2.5 ± 1.1	< LLD	< 0.2	
Average ± 2 s. d.	3.4 ± 1.7			

* Typical LLDs are found in table B-12.

TABLE B-8

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN SEDIMENT

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

Station	Collection Date	Be-7	K-40	Cs-137	Ra-226	Th-228
SL-2	04/16/96	< 200	6510 ± 650	< 20	< 400	91.8 ± 29.6
SL-3	04/16/96	< 200	3420 ± 390	< 30	< 700	846 ± 85
SL-2	10/15/96	< 200	3490 ± 350	< 20	894 ± 317	724 ± 72
SL-3	10/15/96	< 200	5360 ± 540	< 20	440 ± 239	112 ± 20
Average ± 2 s.d.			4695 ± 3014		667 ± 642	443 ± 795

* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

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 FREEHLING	LIVINGHOUSE	WYANT

There were no milk analyses completed during 1996 due to lack of participants to meet the minimum requirements of the REMP program. In lieu of milk, food and vegetation samples were increased.

TABLE B-10

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN BROADLEAF VEGETATION COLLECTED IN LIEU OF MILK

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

COLLECTION DATE	Station	Description	Be-7	K-40	I-131	Cs-137
04/24/96	New Buffalo	Broadleaf	2790 ± 280	4960 ± 500	< 20	< 10
04/24/96	ONS-1	Broadleaf	770 ± 101	3620 ± 360	< 20	< 10
04/24/96	ONS-2	Broadleaf	4460 ± 450	5000 ± 500	< 20	298 ± 30
04/24/96	ONS-8	Broadleaf	4210 ± 420	4230 ± 420	< 20	< 20
05/22/96	New Buffalo	Broadleaf	969 ± 126	4650 ± 460	< 10	< 20
05/22/96	ONS-1	Broadleaf	324 ± 167	3390 ± 340	< 10	< 20
05/22/96	ONS-2	Broadleaf	404 ± 74	4630 ± 460	< 10	74.6 ± 9.7
05/22/96	ONS-8	Broadleaf	378 ± 82	6740 ± 670	< 10	< 10
05/24/96	Sector J - 20 miles	Broadleaf	461 ± 86	4310 ± 430	< 10	< 10
05/24/96	Sector A - Beach	Broadleaf	372 ± 107	4980 ± 500	< 10	< 10
05/24/96	Sector A - Cabin	Broadleaf	398 ± 101	4160 ± 420	< 10	< 20
06/19/96	Sector A - Beach	Broadleaf	995 ± 111	3600 ± 360	< 6	< 20
06/19/96	Sector A - Beach	Broadleaf	1720 ± 170	4900 ± 490	< 7	< 10
06/19/96	Sector A - Cabin	Broadleaf	1510 ± 150	4480 ± 450	< 6	41.5 ± 12.0
06/19/96	Livinghouse Farm	Broadleaf	749 ± 80	5030 ± 500	< 6	< 10
07/17/96	Sector A - Beach	Broadleaf	628 ± 104	2400 ± 240	< 5	< 10
07/17/96	Sector A - ONS-1	Broadleaf	1220 ± 150	4090 ± 410	< 5	< 20
07/17/96	Sector A - Cabin	Broadleaf	1830 ± 210	6490 ± 650	< 5	< 30
07/17/96	Sector J - Farm	Broadleaf	456 ± 204	4800 ± 480	< 4	< 30
08/14/96	Sector A - Beach	Broadleaf	822 ± 106	3220 ± 320	< 6	< 10
08/14/96	Sector A - Trail E	Broadleaf	875 ± 111	2430 ± 240	< 6	< 20
08/14/96	Sector A - ONS-1	Broadleaf	1020 ± 110	2570 ± 260	< 5	< 10
08/14/96	Sector J - Farm	Broadleaf	828 ± 83	4580 ± 460	< 8	< 10
09/11/96	Sector J - Farm	Broadleaf	1480 ± 150	4950 ± 490	< 4	< 10

* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-10 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN BROADLEAF VEGETATION COLLECTED IN LIEU OF MILK

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

COLLECTION DATE	Station	Description	Be-7	K-40	I-131	Cs-137
09/11/96	Sector A - Beach	Broadleaf	1440 ± 180	2980 ± 300	< 4	42.5 ± 19.1
09/11/96	Sector A - E. Beach	Broadleaf	553 ± 109	2220 ± 220	< 5	< 20
09/11/96	Sector A - Cabin	Broadleaf	758 ± 88	2390 ± 240	< 4	< 10
10/09/96	Sector J - Farm	Broadleaf	3420 ± 340	4870 ± 490	< 5	< 20
10/09/96	Sector A - Trail Boundary	Broadleaf	929 ± 185	2330 ± 260	< 4	70.4 ± 22.5
10/09/96	Sector A - Beach	Broadleaf	2210 ± 220	3230 ± 320	< 4	57.6 ± 18.4
10/09/96	Sector A - Trail	Broadleaf	555 ± 134	2340 ± 230	< 5	27.3 ± 15.4
Average ± 2 s.d.			1275 ± 2183	4018 ± 2411		87.4 ± 189

* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-11

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	Be-7	K-40	Cs-137	Ra-226	Th-228
05/31/96	OFS-S (a)						
05/31/96	OFS-N	Steelhead/Sucker	< 100	3510 ± 350	< 20	< 300	< 20
05/31/96	ONS-N	Longnose Sucker	< 100	4200 ± 420	37.1 ± 13.4	< 300	< 20
05/31/96	ONS-S	Lake Trout	< 100	2810 ± 280	64.6 ± 13.1	< 300	< 20
09/10/96	OFS-N	Walleye	< 100	3500 ± 350	< 20	< 300	< 30
09/10/96	ONS-N	Walleye	< 100	3360 ± 340	72.0 ± 16.9	< 400	< 40
09/10/96	OFS-S	Bass/Walleye	< 100	3490 ± 350	28.7 ± 12.5	< 300	< 20
09/10/96	ONS-S	Bass/Walleye	< 100	3370 ± 340	51.8 ± 12.3	< 300	< 30
Average ± 2 s.d.				**3463 ± 814**	**50.8 ± 36.3**		

(a) Sample not collected.
* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-12

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	Be-7	K-40	I-131	Cs-137
09/18/96	Sector D - ONS-G	Grapes	58.6 ± 31.6	1750 ± 180	< 6	< 6
09/18/96	Sector J - OFS-G	Grapes	< 50	1630 ± 160	< 6	< 6
09/18/96	Sector D - ONS-V	Leaves	3280 ± 330	2620 ± 260	< 20	< 10
09/18/96	Sector J - OFS-V	Leaves	1410 ± 140	2650 ± 270	< 10	< 10
Average ± 2 s.d.			1583 ± 3235	2163 ± 1096		

* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-13

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GAMMA SPECTROMETRY LOWER LIMITS OF DETECTION AND REPORTING LEVELS

Isotope	TI LLD	Tech Spec LLD	Rept Level	TI LLD	Tech Spec LLD	Rept Level
	Vegetation - pCi/Kg-wet			Water - pCi/liter		
Cerium-144	60	N/A	N/A	30	N/A	N/A
Barium/La-140	10	N/A	N/A	50/10	60/15	200
Cesium-134	10	60	1000	7	15	30
Ru,Rh-106	80	N/A	N/A	50	N/A	N/A
Cesium-137	10	60	2000	6	18	50
Zr,Nb-95	10	N/A	N/A	10/15	30/15	400
Manganese-54	10	N/A	N/A	5	15	1000
Iron-59	15	N/A	N/A	15	30	400
Zinc-65	20	N/A	N/A	10	30	300
Cobalt-60	10	N/A	N/A	5	15	300
Cobalt-58	10	N/A	N/A	5	15	1000
Iodine-131	20	60	100	10	1	2
'odine-131 (a)				1	1	
	Milk - pCi/liter			Air Filter - pCi/m3		
Cerium-144	30	N/A	N/A	0.007	N/A	N/A
Barium/La-140	50/10	60/15	300	0.005	N/A	N/A
Cesium-134	7	15	60	0.002	0.06	10
Ru,Rh-106	50	N/A	N/A	0.010	N/A	N/A
Cesium-137	6	18	70	0.002	0.06	20
Zr,Nb-95	20	N/A	N/A	0.002	N/A	N/A
Manganese-54	5	N/A	N/A	0.002	N/A	N/A
Iron-59	15	N/A	N/A	0.002	N/A	N/A
Zinc-65	10	N/A	N/A	0.002	N/A	N/A
Cobalt-60	5	N/A	N/A	0.002	N/A	N/A
Cobalt-58	5	N/A	N/A	0.002	N/A	N/A
Iodine-131	10	1	3	0.040	0.07	0.9
Iodine-131 (a)	1	1				

(a) Analysis by radiochemistry and based on the assumptions in Procedure PRO-032-11.
• Charcoal Trap

TABLE B-13 (cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GAMMA SPECTROMETRY LOWER LIMITS OF DETECTION AND REPORTING LEVELS

Isotope	TI LLD	Tech Spec LLD	Rept Level	TI LLD	Tech Spec LLD	Rept Level
	FISH - pCi/Kg-wet (b)			Sediment/Soil - pCi/Kg-dry		
Cerium-144	200	N/A	N/A	150	N/A	N/A
Barium/La-140	200	N/A	N/A	5	N/A	N/A
Cesium-134	20	130	1000	30	150	N/A
Ru,Rh-106	200	N/A	N/A	200	N/A	N/A
Cesium-137	20	150	2000	30	180	N/A
Zr,Nb-95	40	N/A	N/A	40	N/A	N/A
Manganese-54	20	130	30000	9	N/A	N/A
Iron-59	40	260	10000	50	N/A	N/A
Zinc-65	40	260	20000	60	N/A	N/A
Cobalt-60	20	130	10000	20	N/A	N/A
Cobalt-58	20	130	30000	20	N/A	N/A
Iodine-131	100	N/A	N/A	30	N/A	N/A
	Gross Beta/Tritium LLDs and Reporting Levels					
	Gross Beta					
Air Particulates	0.01 pCi/m^3	0.01 pCi/m^3	N/A			
Drinking Water	2 pCi/l	4.0 pCi/l	N/A			
	Tritium - pCi/l					
Surface Water	200	2000	20,000			
Ground Water	200	2000	20,000			
Drinking Water	200	2000	20,000			

(b) Based on the assumptions in procedure PRO-042-5.

APPENDIX C
ANALYTICAL PROCEDURES SYNOPSIS

ANALYTICAL PROCEDURES SYNOPSIS

Appendix C is a synopsis of the analytical procedures performed during 1996 on samples collected for the Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by American Electric Power and Teledyne Brown Engineering and include those recommended by the USNRC Regulatory Guide 4.8,BTP, Rev. 1, November 1979.

ANALYSIS TITLE	PAGE
Gross Beta Analysis of Air Particulate Samples	69
Gross Beta Analysis of Water Samples	70
Analysis of Samples for Tritium (Liquid Scintillation)	72
Analysis of Samples for Iodine-131	73
Milk or Water	73
Gamma Spectrometry of Samples	74
Milk and Water	74
Dried Solids other than Soils and Sediment	74
Fish	74
Soils and Sediments	74
Charcoal Cartridges (Air Iodine)	74
Airborne Particulates	74
Environmental Dosimetry	76

GROSS BETA ANALYSIS OF SAMPLES

Airborne Particulates

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

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

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

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

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

where:

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

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

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. 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.

ANALYSIS OF SAMPLES FOR TRITIUM

(Liquid Scintillation)

Water

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

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

RESULT = $(N-B)/(2.22\ V\ E)$

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

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

where:

N	=	the gross cpm of the sample
B	=	the background of the detector in cpm
2.22	=	conversion factor changing dpm to pCi
V	=	volume of the sample in ml
E	=	efficiency of the detector
Δt	=	counting time for the sample

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

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

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

RESULT		=	$(N/\Delta t-B)/(2.22\ E\ V\ Y\ DF)$
TWO SIGMA ERROR		=	$2((N/\Delta t+B)/\Delta t)^{1/2}(2.22\ E\ V\ Y\ DF)$
LLD		=	$= 4.66(B/\Delta t)^{1/2}/(2.22\ E\ V\ Y\ DF)$
where:	N	=	total counts from sample (counts)
	Δt	=	counting time for sample (min)
	B	=	background rate of counter (cpm)
	2.22	=	dpm/pCi
	V	=	volume or weight of sample analyzed
	Y	=	chemical yield of the mount or sample counted
	DF	=	decay factor from the collection to the counting date
	E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
	E	=	$E_s(\exp-0.0085M)/(\exp-0.0085M_s)$
	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 analysis.

Airborne Particulates

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

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

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

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

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

where:

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

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

t = length of time in minutes the sample was counted

2.22 = dpm/pCi

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

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

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

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

ENVIRONMENTAL DOSIMETRY

Teledyne Brown Engineering uses a $CaSO_4$:Dy thermoluminescent dosimeter (TLD) which the company manufactures. This material has a high light output, negligible thermally induced signal loss (fading), and negligible self dosing. The energy response curve (as well as all other features) satisfies NRC Reg. Guide 4.13. Transit doses are accounted for by use of separate TLDs.

Following the field exposure period the TLDs are placed in a Teledyne 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 $\doteq 2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$

WHERE:

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

D_1 = $I_1 K/R_1 - A$

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

K = the known exposure by the Cs-137 source

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

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

D = the average net mR of all 4 areas of the TLD.

APPENDIX D
SUMMARY OF EPA INTERLABORATORY COMPARISONS

EPA Interlaboratory Comparison Program

Teledyne Brown Engineering 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. Beginning with 1996 the US EPA discontinued providing milk and air particulate filter samples. For replacements, we have purchased comparable spiked samples from Analytics, Inc.

In this section 1996 data summary tables are presented for isotopes in the various sample media applicable to the Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases and the steps taken to prevent reoccurrence.

EPA INTERLABORATORY COMPARISON PROGRAM 1996
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)	
01/23/96	Water	Sr-89	73.0 ±	5.0	73.67 ±	3.21	0.23	
		Sr-90	5.0 ±	5.0	5.00 ±	0.00	0.00	
01/26/96	Water	Gr-Alpha	12.1 ±	5.0	19.00 ±	1.00	2.39	(d)
		Gr-Beta	7.0 ±	5.0	7.13 ±	0.21	0.05	
02/02/96	Water	I-131	67.0 ±	7.0	71.67 ±	3.06	1.15	
03/08/96	Water	H-3	22002.0 ±	2200.0	22000.00 ±	0.00	0.00	
04/16/96	Water	Gr-Beta	166.9 ±	25.0	160.00 ±	0.00	-0.48	
		Sr-89	43.0 ±	5.0	41.33 ±	2.31	-0.58	
		Sr-90	16.0 ±	5.0	15.33 ±	0.58	-0.23	
		Co-60	31.0 ±	5.0	31.67 ±	1.15	0.23	
		Cs-134	46.0 ±	5.0	42.33 ±	1.53	-1.27	
		Cs-137	50.0 ±	5.0	52.33 ±	1.53	0.81	
		Gr-Alpha	74.8 ±	18.7	63.67 ±	2.89	-1.03	
		Ra-226	3.0 ±	0.5	3.40 ±	0.00	1.39	
		Ra-228	5.0 ±	1.3	3.63 ±	0.61	-1.82	
06/07/96	Water	Co-60	99.0 ±	5.0	99.00 ±	1.73	0.00	
		Zn-65	300.0 ±	30.0	309.33 ±	2.08	0.54	
		Cs-134	79.0 ±	5.0	69.67 ±	1.53	-3.23	(e)
		Cs-137	197.0 ±	10.0	202.00 ±	2.65	0.87	
		Ba-133	745.0 ±	75.0	711.00 ±	71.42	-0.79	
06/21/96	Water	Ra-226	4.9 ±	0.7	5.50 ±	0.26	1.48	
		Ra-228	9.0 ±	2.3	9.73 ±	0.46	0.55	
07/12/96	Water	Sr-89	25.0 ±	5.0	22.67 ±	1.53	-0.81	
		Sr-90	12.0 ±	5.0	12.33 ±	1.15	0.12	
07/19/96	Water	Gr-Alpha	24.4 ±	6.1	22.67 ±	0.58	-0.49	
		Gr-Beta	44.8 ±	5.0	45.33 ±	2.08	0.18	
08/09/96	Water	H-3	10879.0 ±	1088.0	9800.00 ±	346.41	-1.72	
09/27/96	Water	Ra-226	14.0 ±	2.1	14.00 ±	1.00	0.00	
		Ra-228	4.7 ±	1.2	6.20 ±	0.50	2.17	(f)
10/02/96	Water	I-131	27.0 ±	6.0	26.33 ±	2.31	-0.19	
10/15/96	Water	Gr-Alpha	59.1 ±	14.8	55.671 ±	5.03	-0.40	
		Ra-226	9.9 ±	1.5	10.00 ±	0.00	0.12	
		Ra-228	5.1 ±	1.3	5.47 ±	0.31	0.49	
		Gr-Beta	111.8 ±	16.8	110.0 ±	0.00	-0.19	
		Sr-89	10.0 ±	5.0	9.00 ±	0.00	-0.35	
		Sr-90	25.0 ±	5.0	26.00 ±	1.00	0.35	
		Co-60	15.0 ±	5.0	14.67 ±	1.53	-0.12	
		Cs-134	20.0 ±	5.0	19.67 ±	1.15	-0.12	
		Cs-137	30.0 ±	5.0	29.33 ±	1.15	-0.23	

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)
10/25/96	Water	Gr-Alpha	10.3 ±	5.0	9.03 ±	0.72	-0.44
		Gr-Beta	34.6 ±	5.0	39.67 ±	0.58	1.76
11/08/96	Water	Co-60	44.0 ±	5.0	44.67 ±	0.58	0.23
		Zn-65	35.0 ±	5.0	38.67 ±	0.58	1.27
		Cs-134	11.0 ±	5.0	12.00 ±	0.00	0.35
		Cs-137	19.0 ±	5.0	20.67 ±	1.15	0.58
		Ba-133	64.0 ±	6.0	56.67 ±	3.21	-2.12 (g)
12/06/96	Water	Ra-226	20.1 ±	3.0	20.33 ±	0.58	0.13
		Ra-228	10.2 ±	2.6	10.33 ±	0.58	0.09

Footnotes:

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

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

(c) Normalized deviation from the known.

(d) The variation was due to self-absorption properties of the EPA sample matrix. On future EPA water samples of this type, we will determine the overall alpha counting efficiency by spiking the matrix with Th-230 in accordance with their recent advisory.

(e) To verify the cause for the deviation, a Cs-134 standard has been purchased. If the Cs-134 efficiency is lower than the efficiency at 604 KeV and 795 KeV, then rather than change those efficiencies (which may be needed for other isotopes of comparable energies), the Cs-134 branching intensity shall be adjusted.

(f) Erroneously low cerium yields were obtained in back-extraction from HDEHP. Greater care to be taken during back-extraction. If this operation is incomplete, the cerium carrier yield becomes lower than the Ac-228 yield. The procedure had been revised to require additional back-extractions for longer periods of time to ensure that proper cerium carrier yields are obtained. The procedure is under review to determine if additional back-extractions are required.

(g) The cause for the deviation could not be specifically determined. Samples were analyzed in triplicate on three different HPGe detectors providing results with good precision (less than 11% deviation). The values calculated by the software for each discrete energy line of Ba-133 were also in agreement indicating an excellent efficiency versus energy calibration fit. Use of a valid branching ratio in the calculation was verified. The initial aliquot was verified and the Co-60, Cs-134, and Cs-137 values were in excellent agreement with the known. A specific trend over time was not apparent in the data, however the normalized deviation calculated from the EPA appears to decrease as the known activity increases. No corrective actions are anticipated at this time. Future analyses will be monitored to identify any potential trend toward an "out of control" condition.

ANALYTICS CROSS CHECK COMPARISON PROGRAM 1996

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)	Analytics Result	Ratio (b)
E0633-396	Water	I-131	39 ± 5	36 ± 2	1.08
TI #11912		Ce-141	89 ± 9	88 ± 4	1.01
03/12/96		Cr-51	330 ± 30	322 ± 16	1.02
		Cs-134	53 ± 5	58 ± 3	0.91
		Cs-137	65 ± 7	64 ± 3	1.02
		Co-58	49 ± 5	48 ± 2	1.02
		Mn-54	37 ± 4	31 ± 2	1.19
		Fe-59	93 ± 9	83 ± 4	1.12
		Zn-65	100 ± 10	97 ± 5	1.03
		CO-60	81 ± 8	76 ± 4	1.07
E0635-396	Milk	I-131	16 ± 6	13 ± 1	1.23
TI #11914		Ce-141	240 ± 20	234 ± 12	1.03
03/12/96		Cr-51	880 ± 90	858 ± 43	1.03
		Cs-134	150 ± 20	154 ± 8	0.97
		Cs-137	180 ± 20	170 ± 9	1.06
		Co-58	140 ± 10	128 ± 6	1.09
		Mn-54	93 ± 9	84 ± 4	1.11
		Fe-59	250 ± 30	223 ± 11	1.12
		Zn-65	260 ± 30	260 ± 13	1.00
		Co-60	220 ± 20	204 ± 10	1.08
E0632-396	Water	Sr-89	30 ± 4	24 ± 1	1.25
TI #11911		Sr-90	23 ± 2	21 ± 1	1.10
03/12/96					
E0634-396	Milk	Sr-89	30 ± 4	31 ± 2	0.97
TI #11914		Sr-90	17 ± 1	16 ± 1	1.06
03/12/96					
E0636-396	Water	H-3	2800 ± 200	2982 ± 149	0.94
TI #11913					
03/12/96					
E0746-396	Air Filter	Gross Alpha	37 ± 3	35 ± 2	1.06
TI #19220		Gross Beta	150 ± 10	144 ± 7	1.04
06/19/96					
E0747-396	Air Filter	Ce-141	500 ± 50	400 ± 20	1.25
TI #19221		Cr-51	1200 ± 100	1048 ± 52	1.15
06/19/96		Cs-134	310 ± 30	310 ± 16	1.00
		Cs-137	910 ± 90	764 ± 38	1.19
		Co-58	210 ± 20	173 ± 9	1.21
		Mn-54	690 ± 70	559 ± 28	1.23
		Fe-59	190 ± 20	144 ± 7	1.32
		Zn-65	140 ± 10	108 ± 5	1.30
		Co-60	180 ± 20	156 ± 8	1.15

ANALYTICS CROSS CHECK COMPARISON PROGRAM 1996

Sample ID	Media	Nuclide	Teledyne Brown Engineering Result (a)		Analytics Result		Ratio (b)
E0748-396 TI #19222 06/19/96	Air Filter	Sr-90	71 ±	3	74 ±	4	0.96
E0749-396 TI #19223 06/19/96	Air Filter	Sr-90	46 ±	3	49 ±	2	0.94
E0750-396 TI #19224 06/19/96	Air Filter	Sr-90	66 ±	4	63 ±	3	1.05

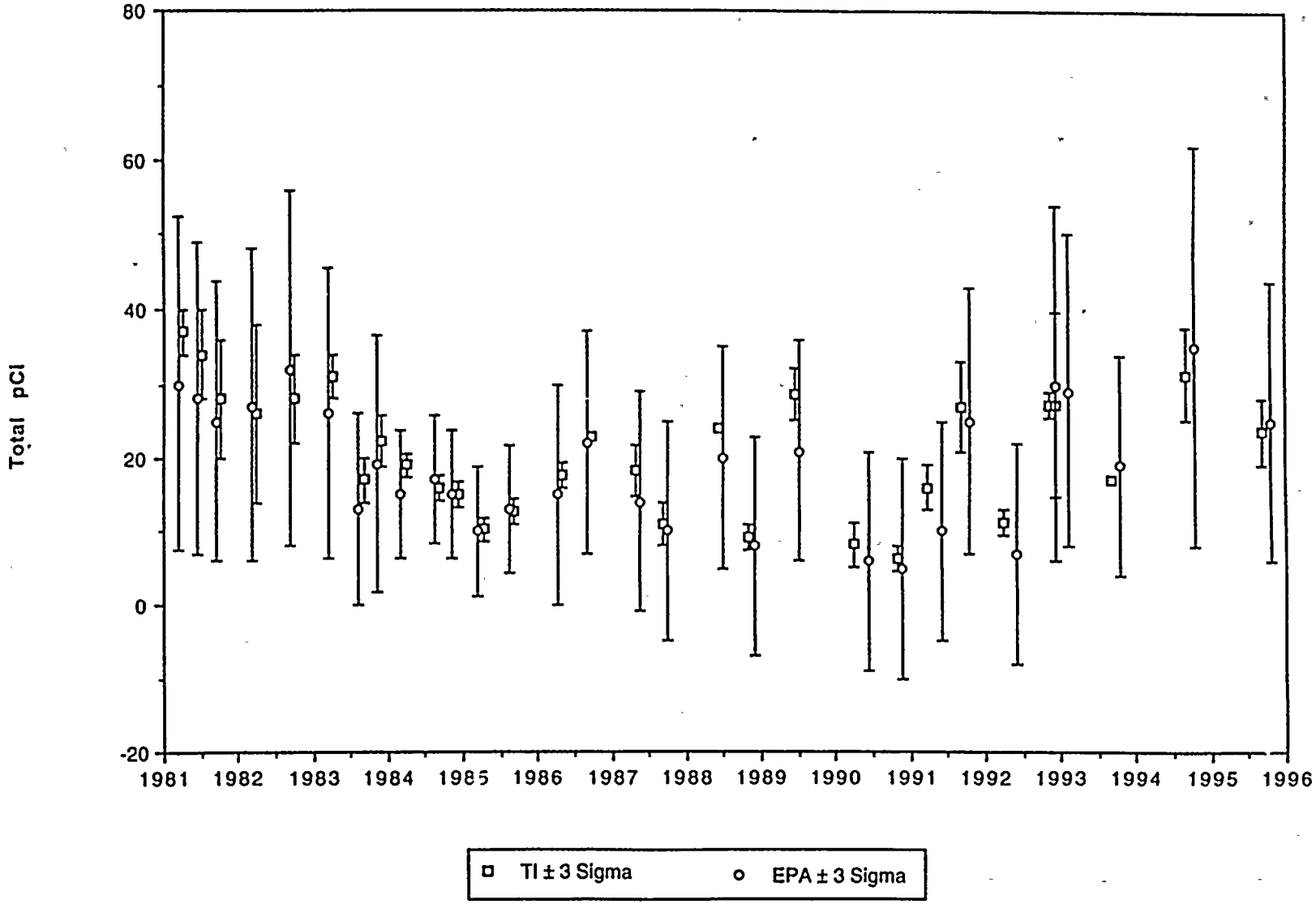
Footnotes:

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

(b) Ratio of Teledyne Brown Engineering to Analytics results.

EPA CROSS CHECK PROGRAM

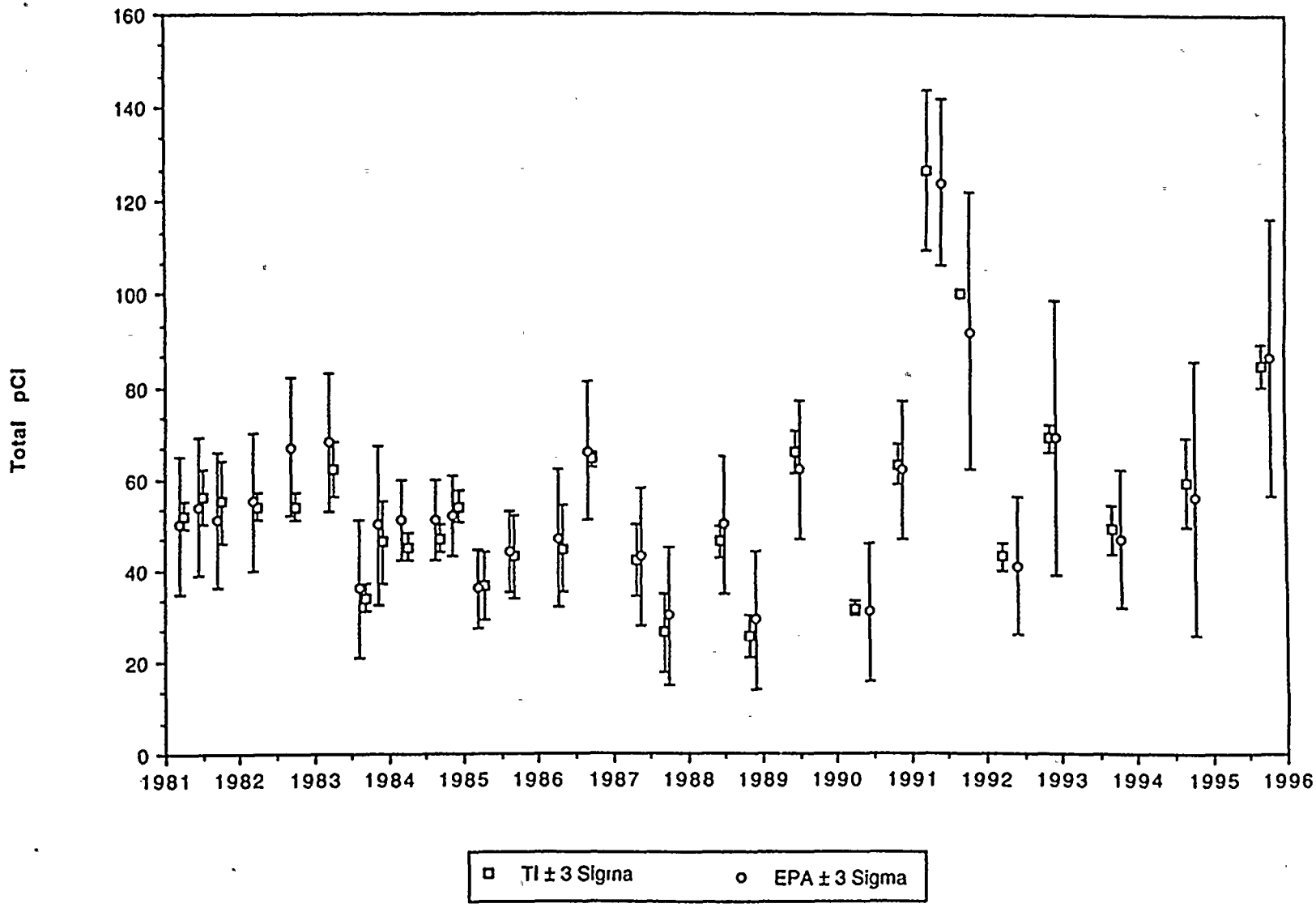
GROSS ALPHA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

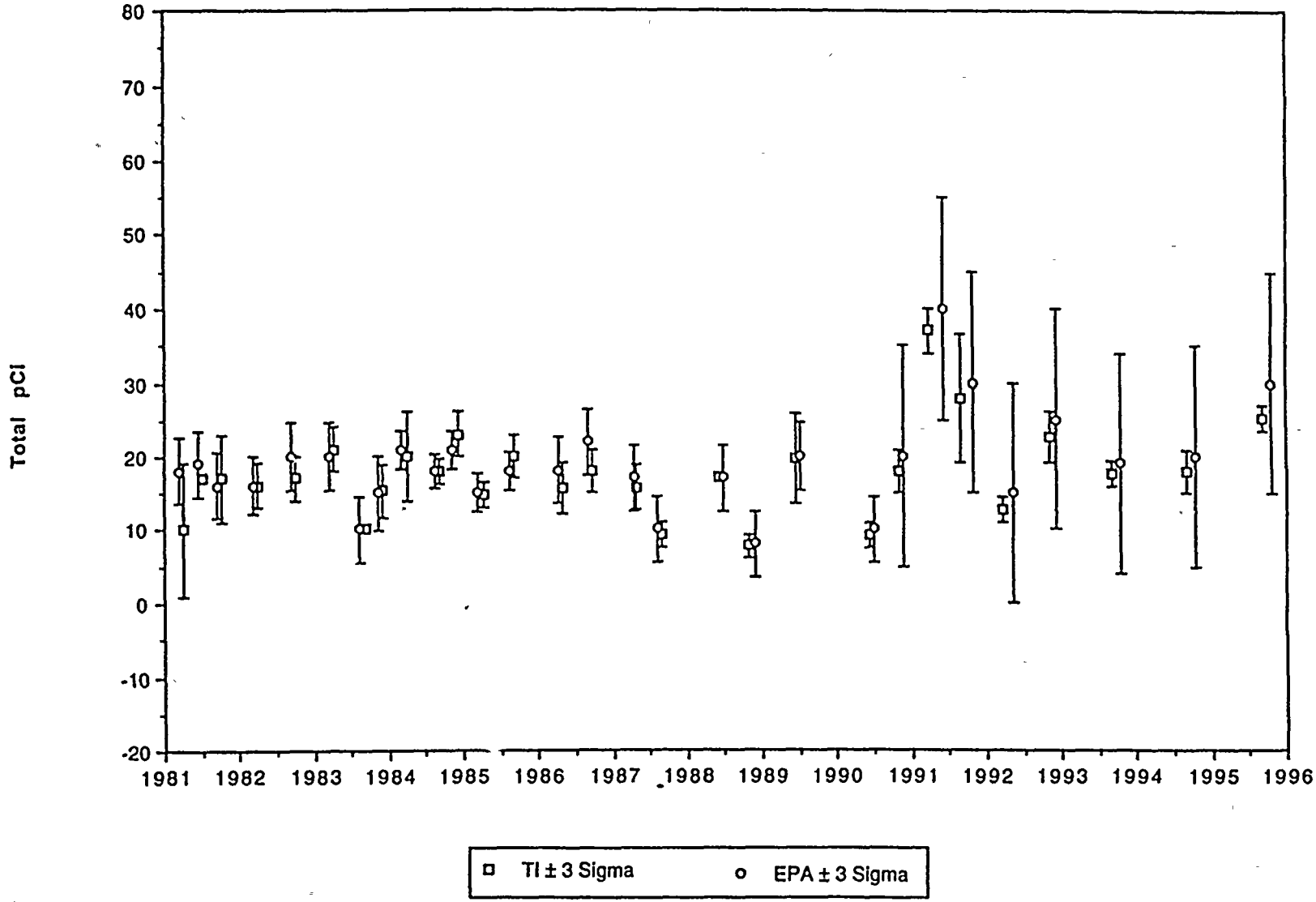
GROSS BETA IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

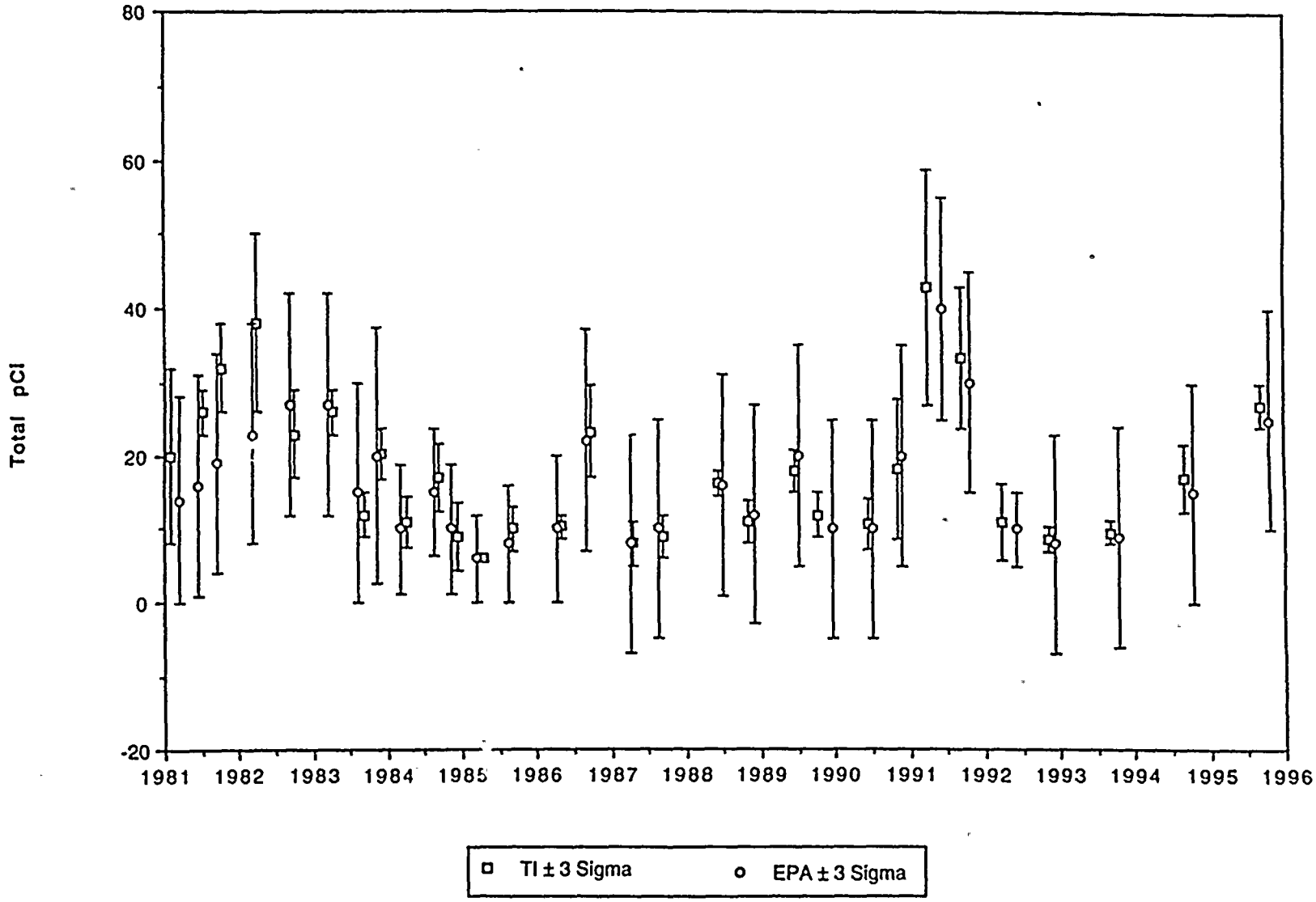
STRONTIUM-90 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samaples in 1996.

EPA CROSS CHECK PROGRAM

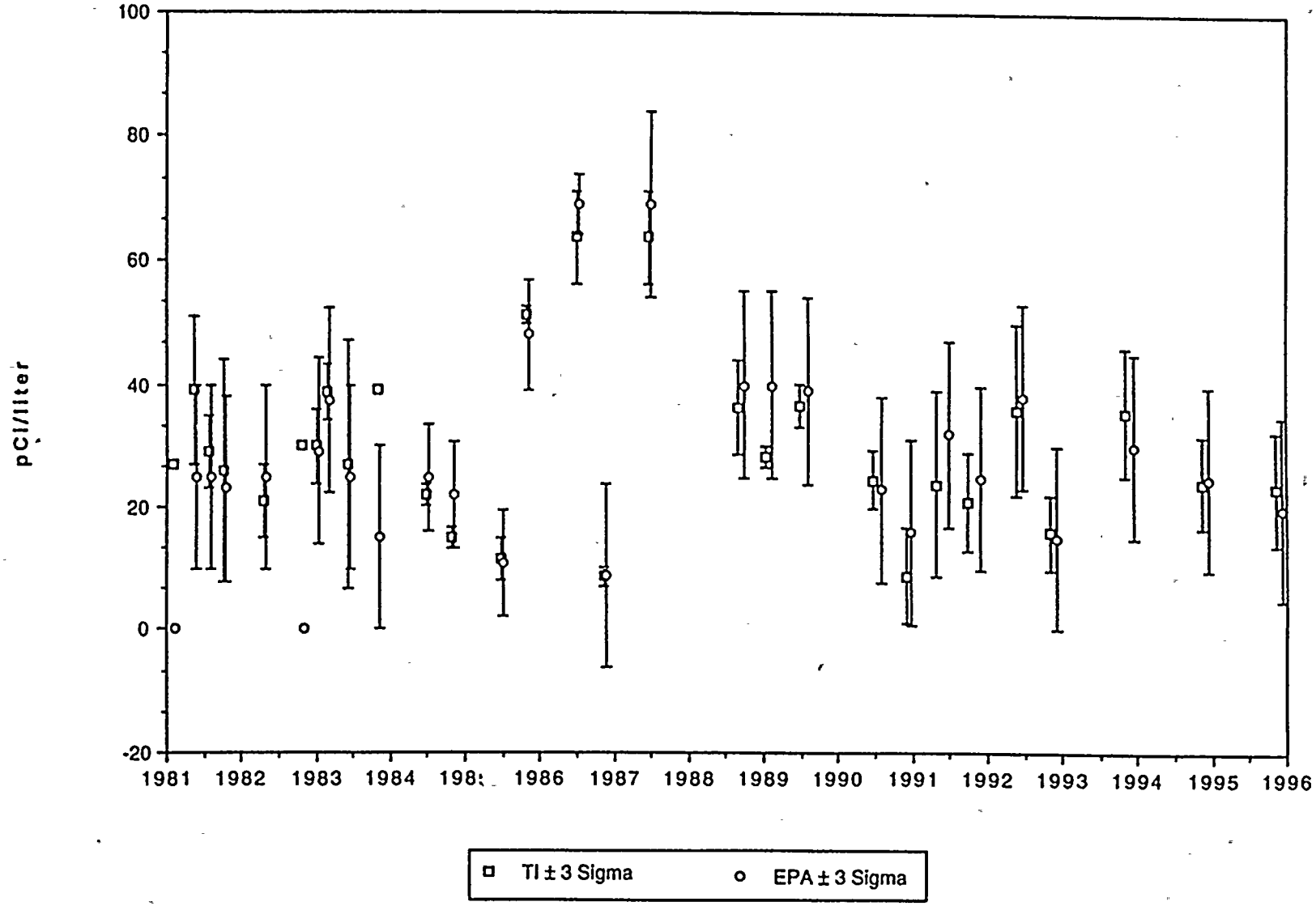
CESIUM-137 IN AIR PARTICULATES (pg. 1 of 1)



The US EPA discontinued air particulate filter samples in 1996.

EPA CROSS CHECK PROGRAM

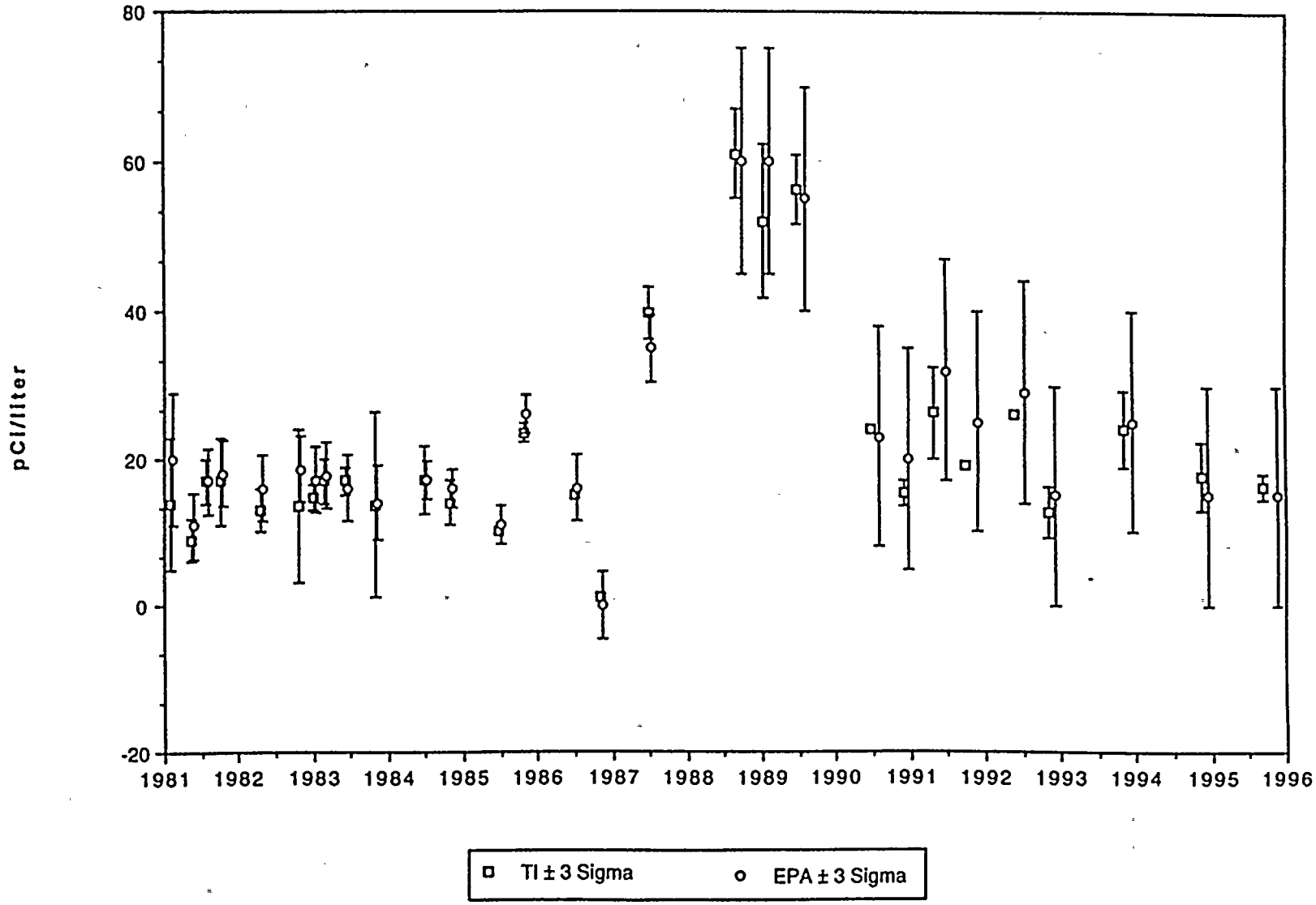
STRONTIUM-89 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

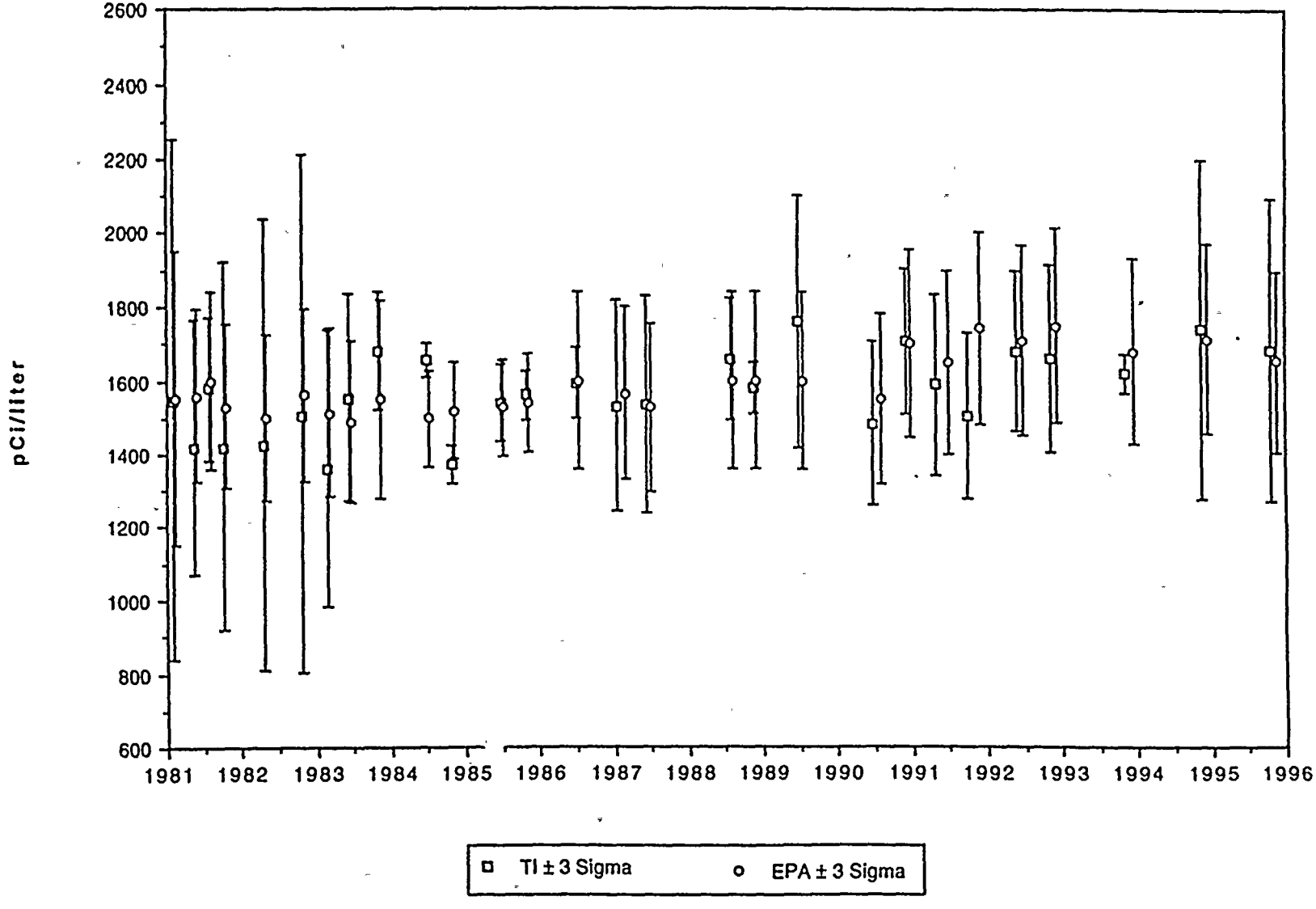
STRONTIUM-90 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

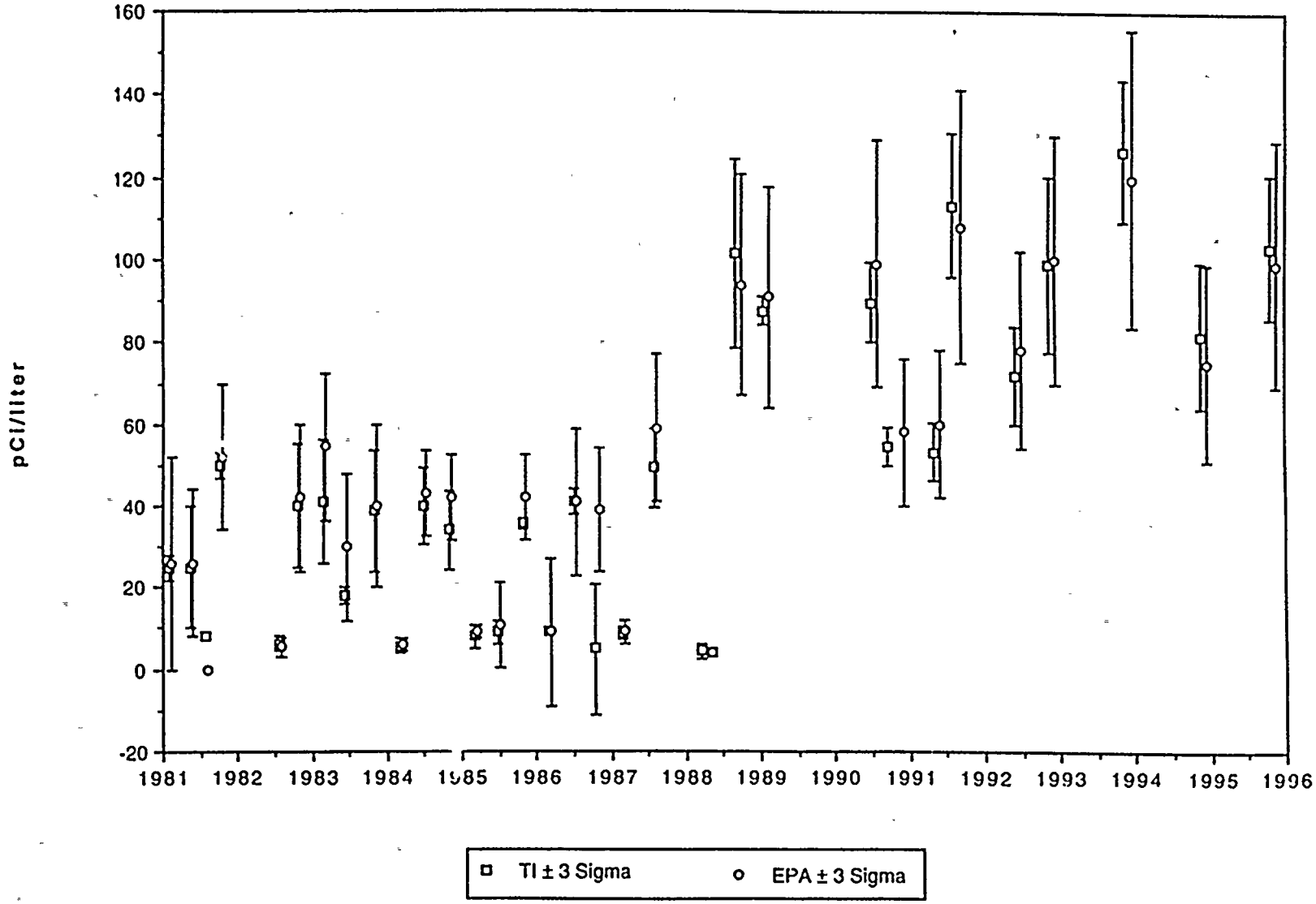
POTASSIUM-40 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

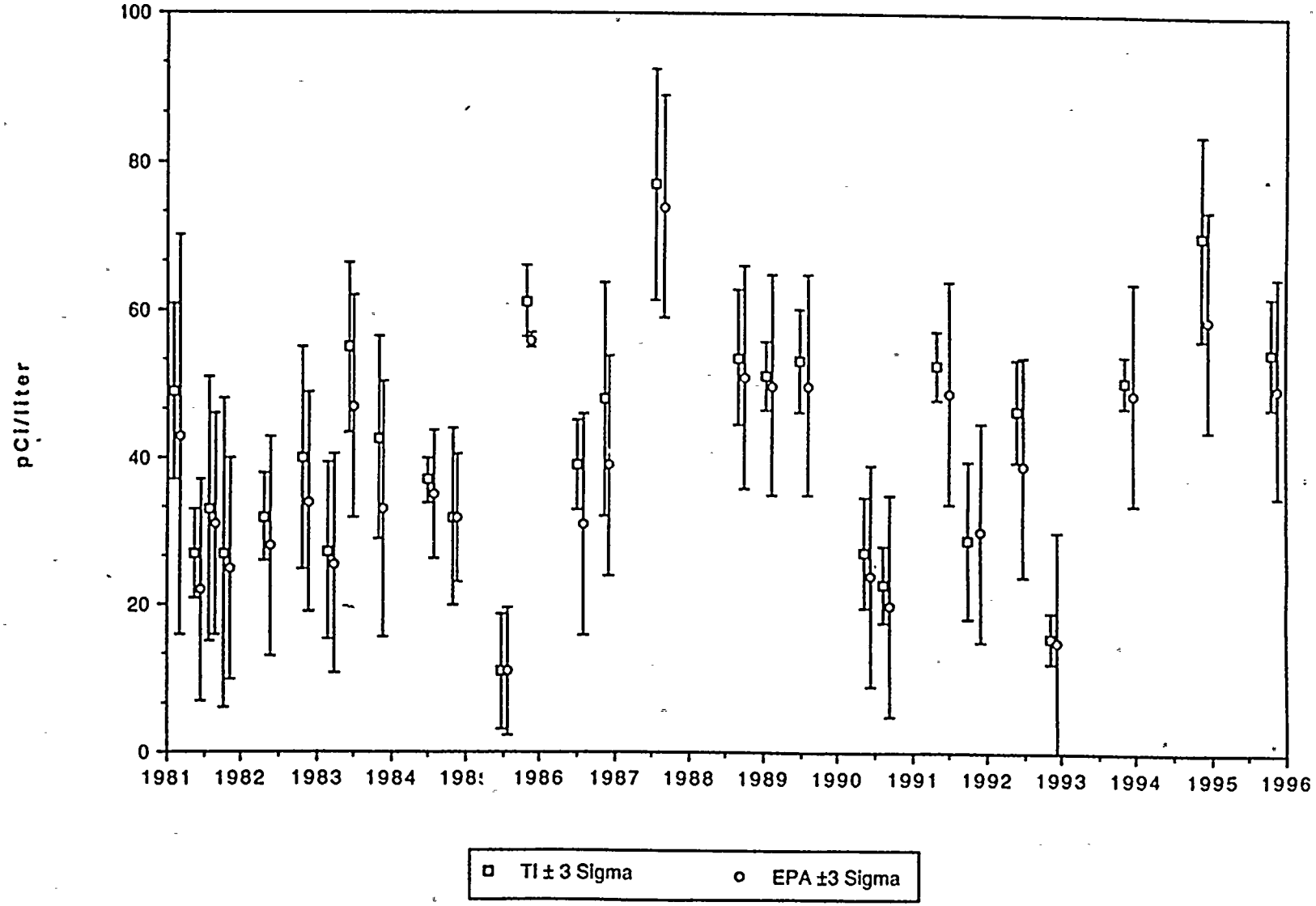
IODINE-131 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

EPA CROSS CHECK PROGRAM

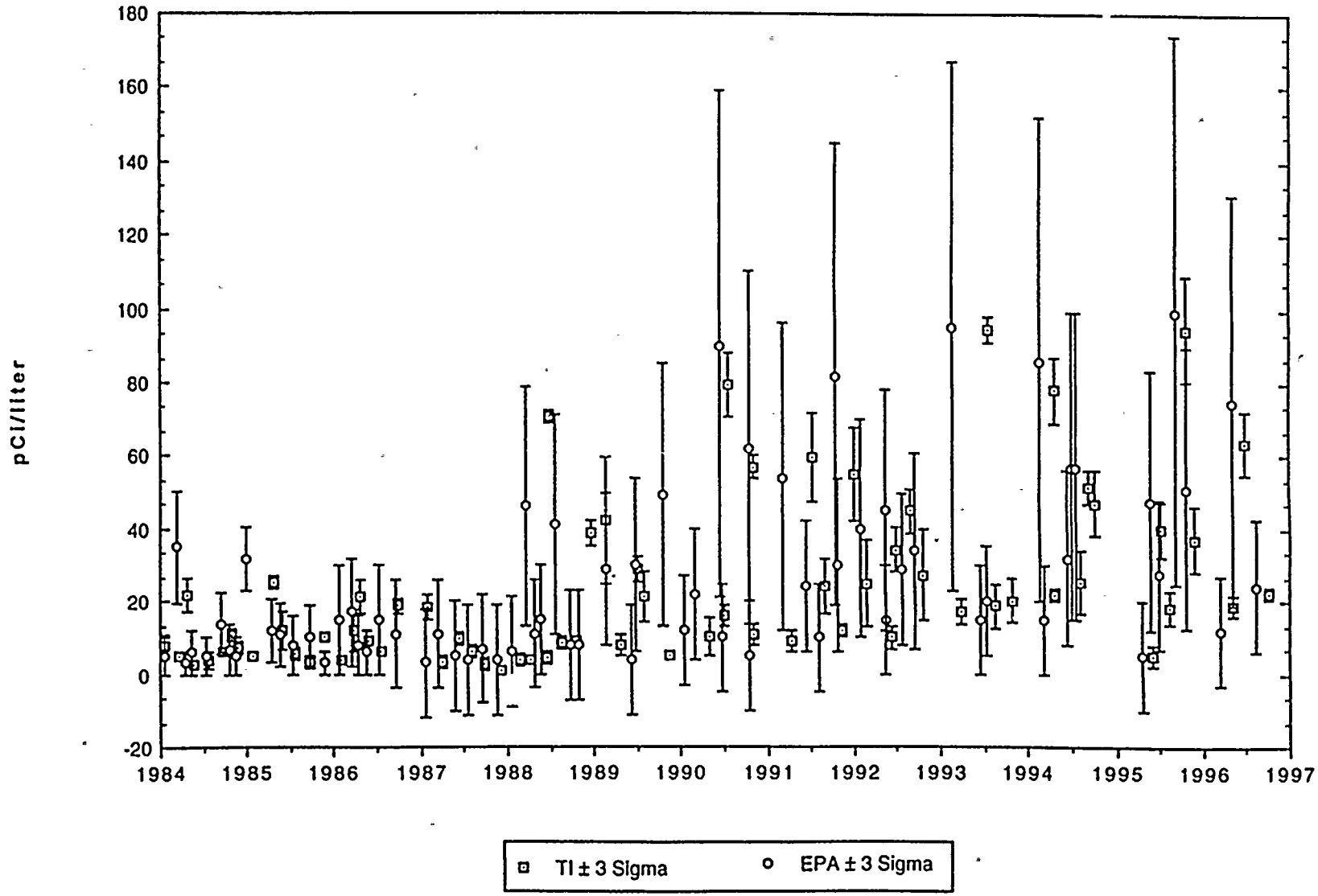
CESIUM-137 IN MILK (pg. 1 of 1)



The US EPA discontinued milk samples in 1996.

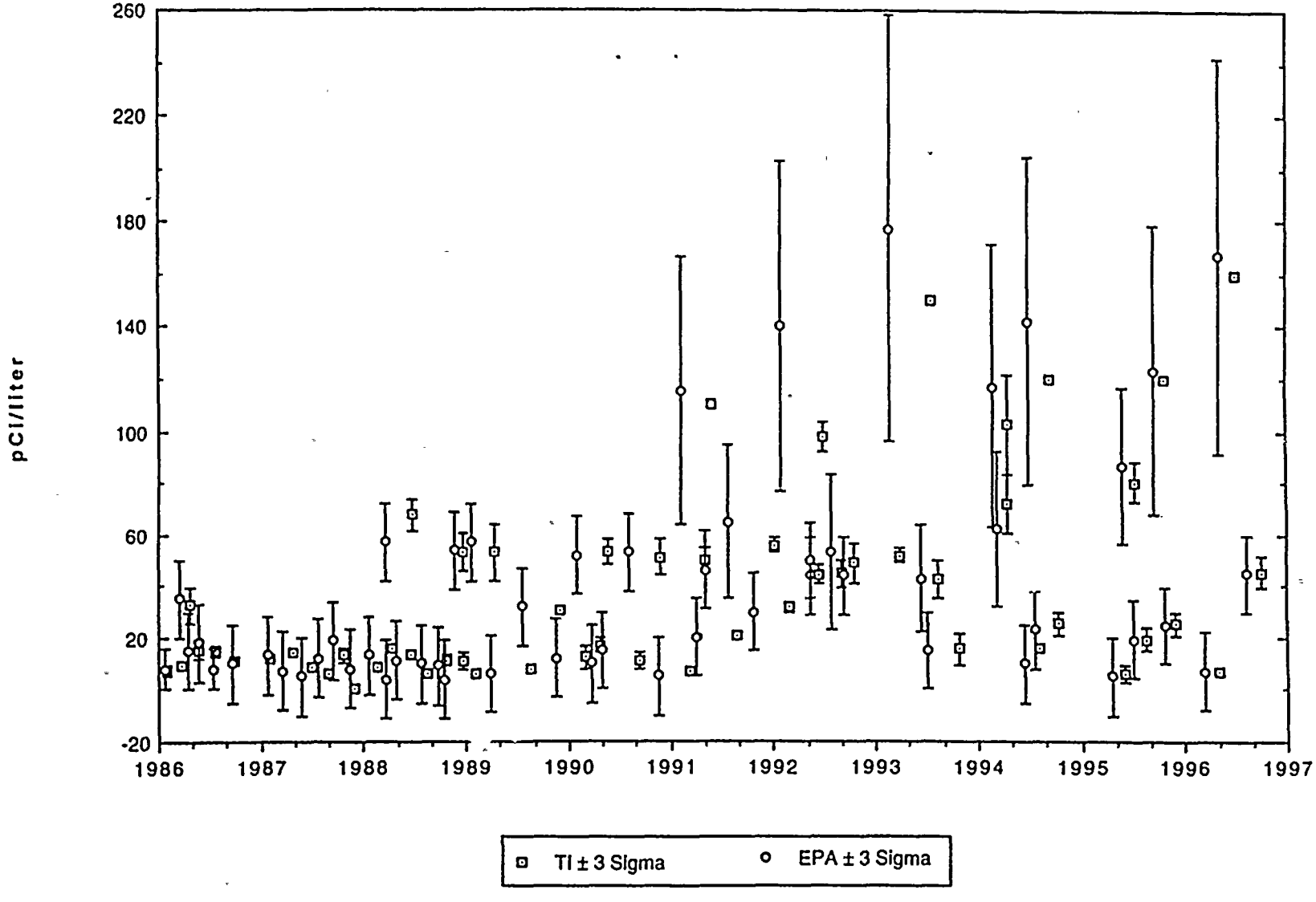
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)



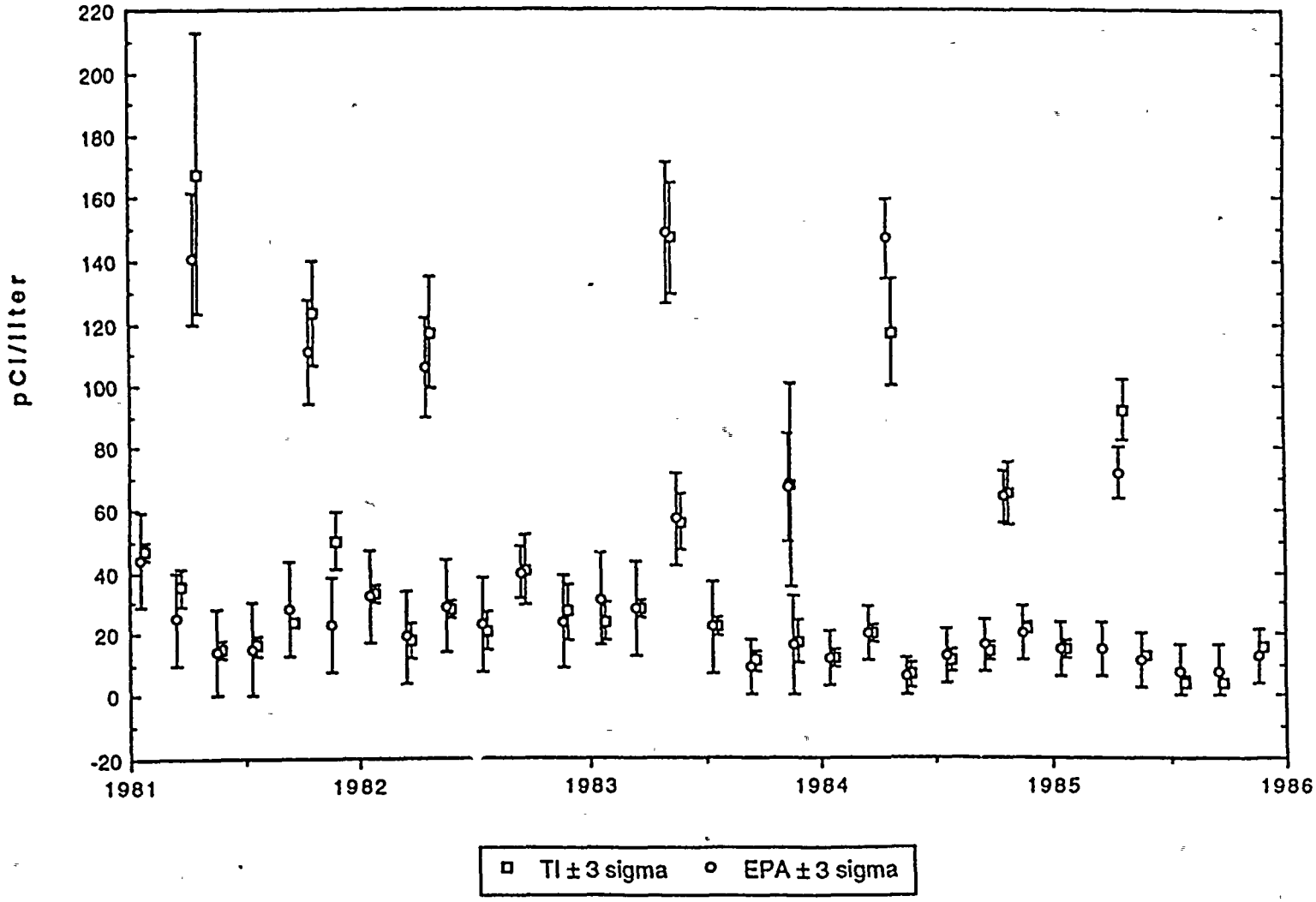
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 2 of 2)



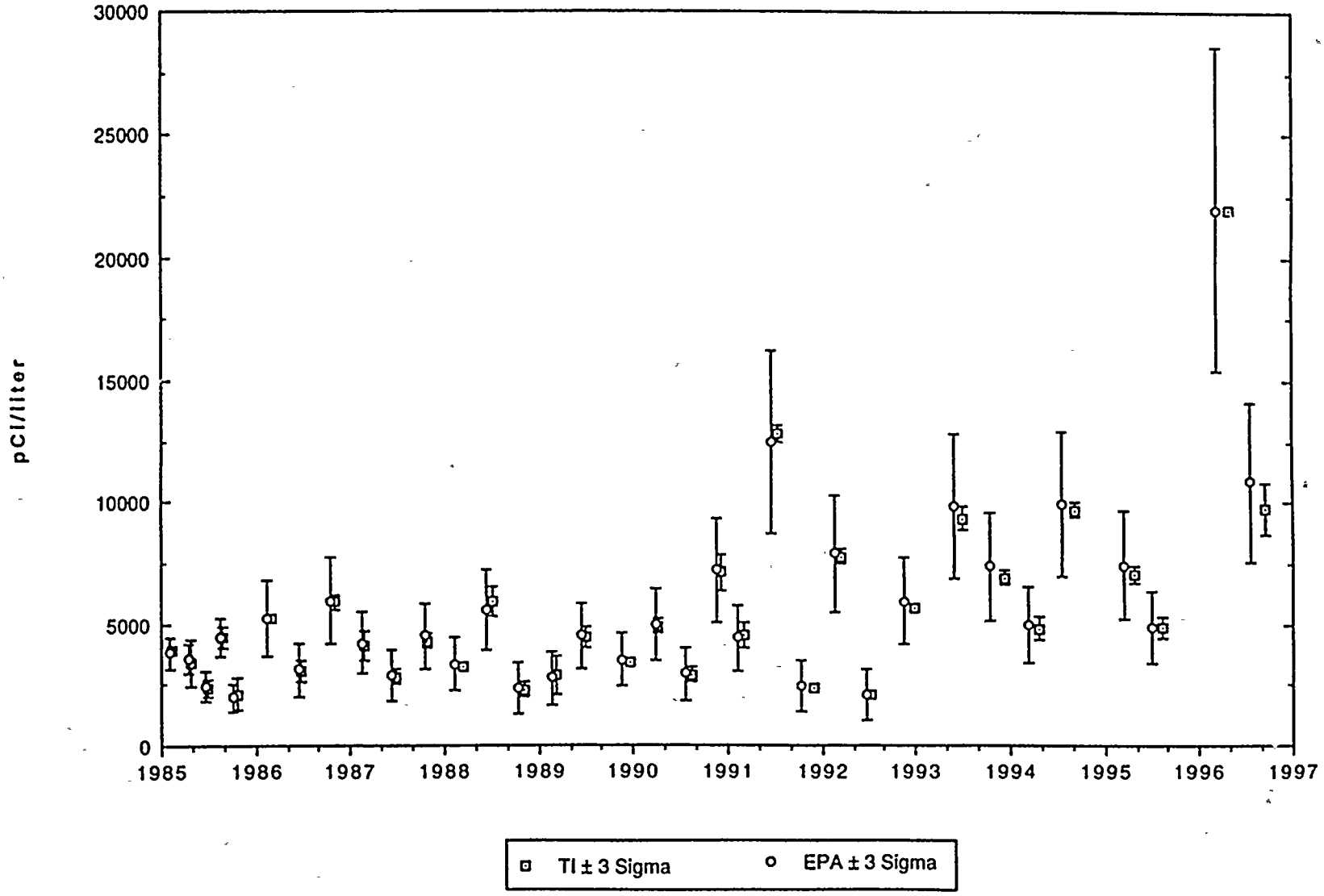
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)



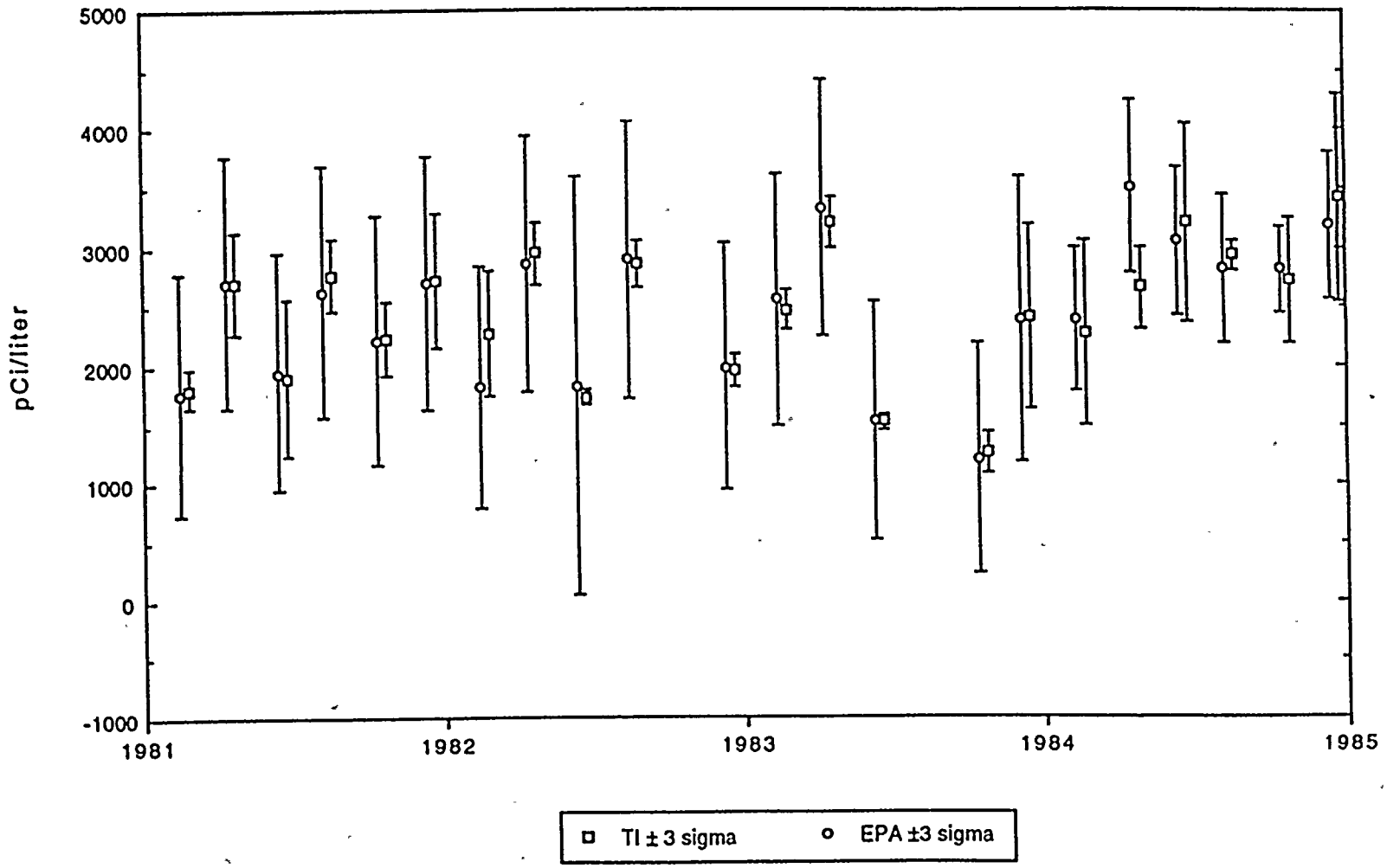
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 2 of 2)



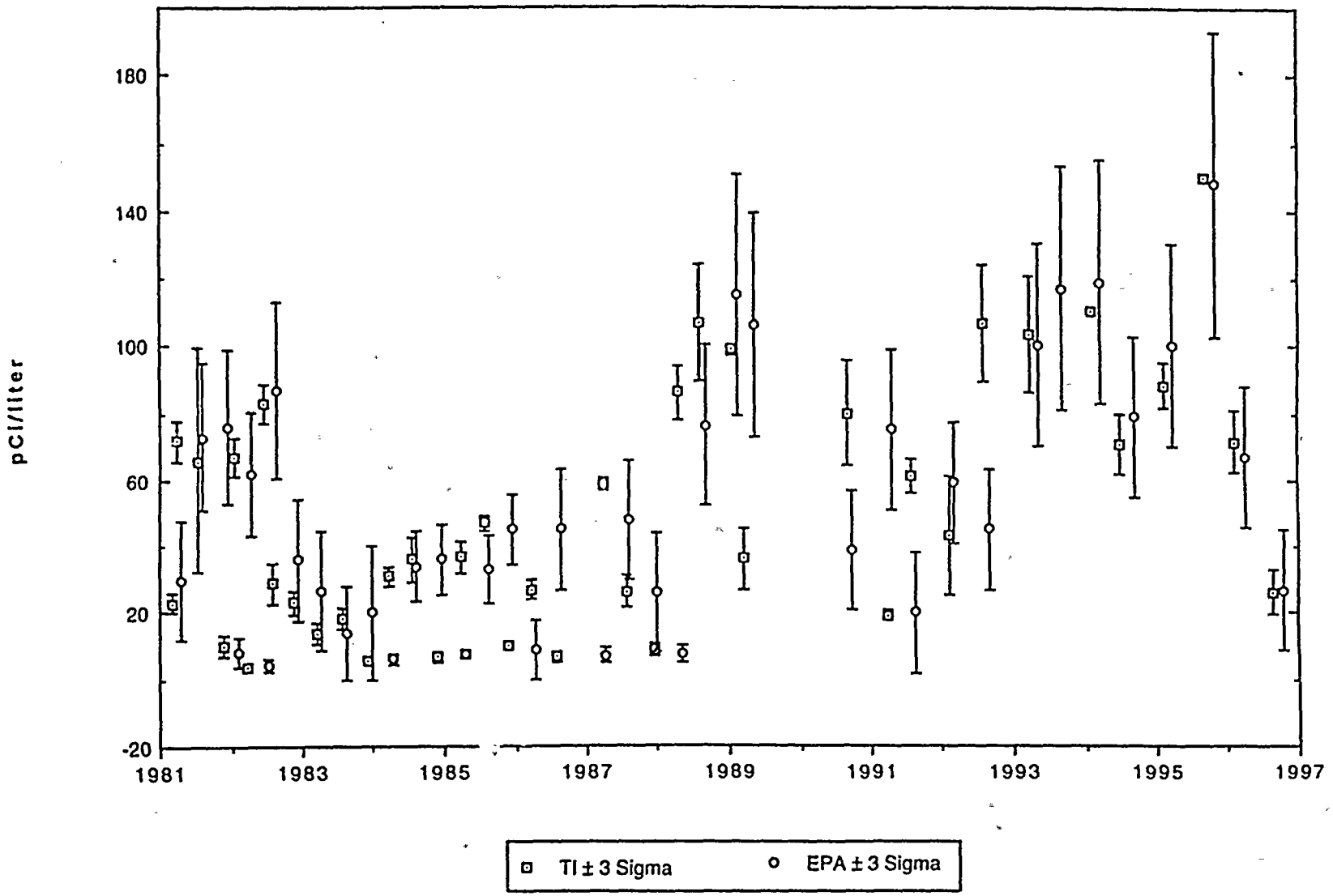
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



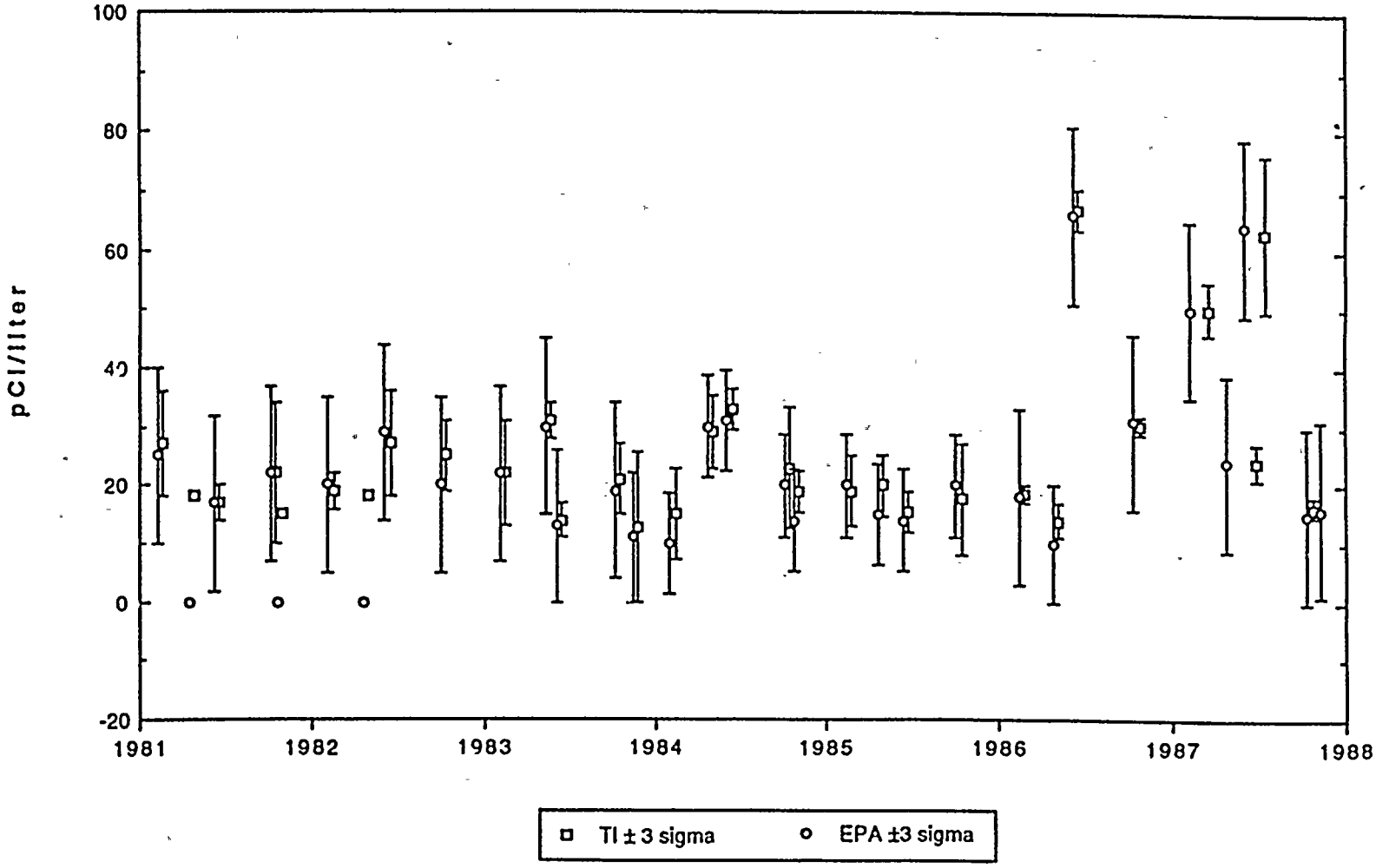
EPA CROSS CHECK PROGRAM

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



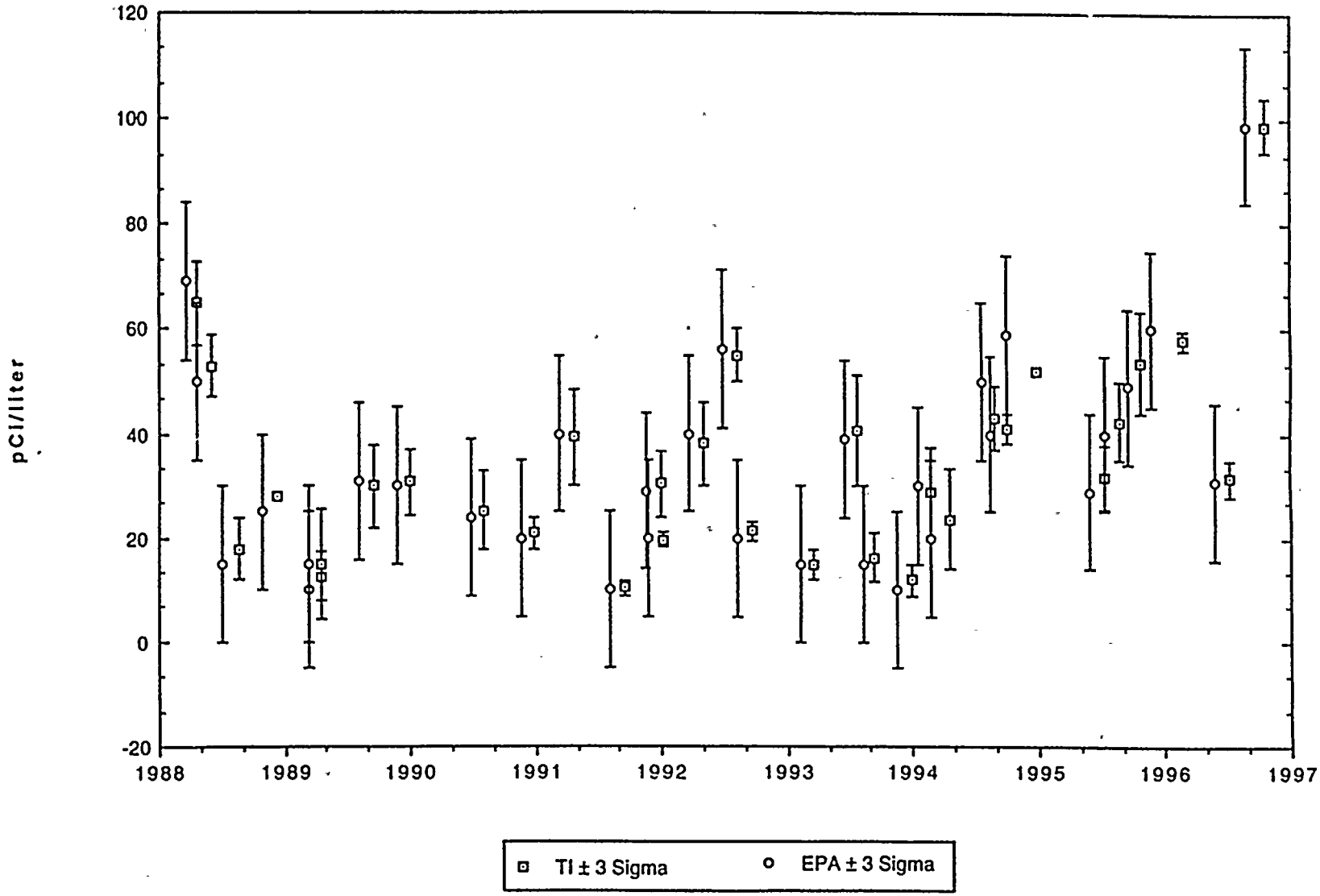
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



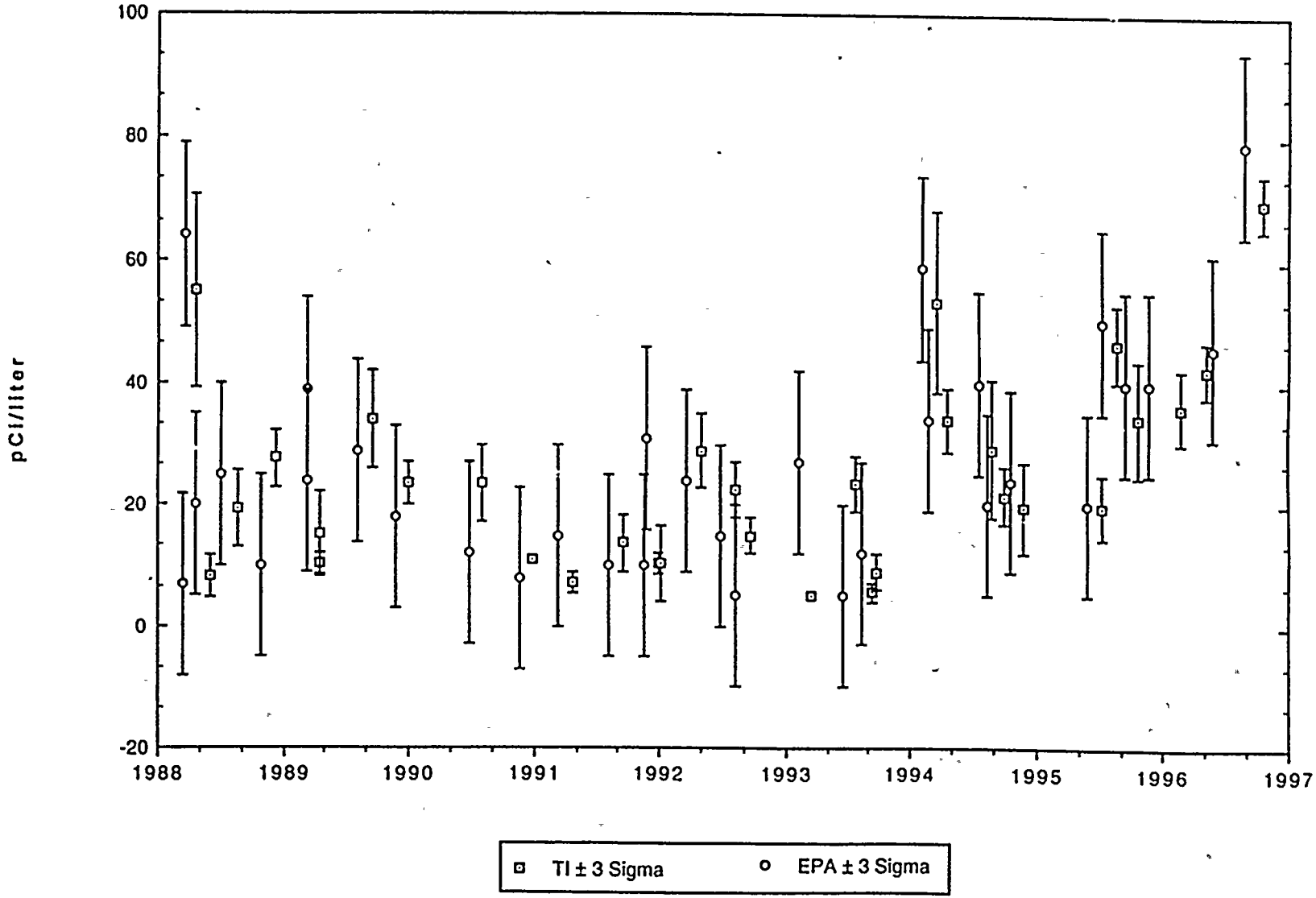
EPA CROSS CHECK PROGRAM

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



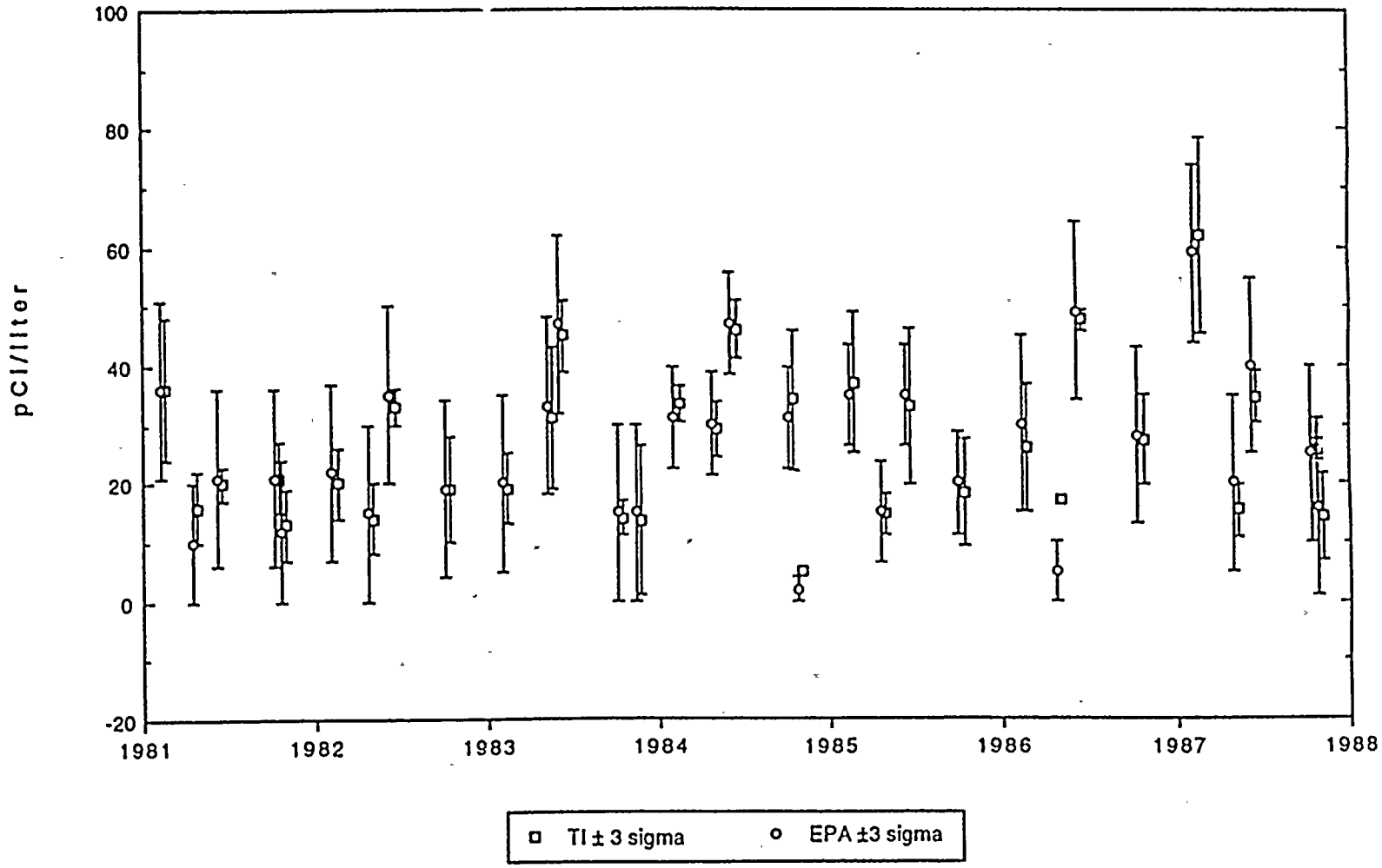
EPA CROSS CHECK PROGRAM

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



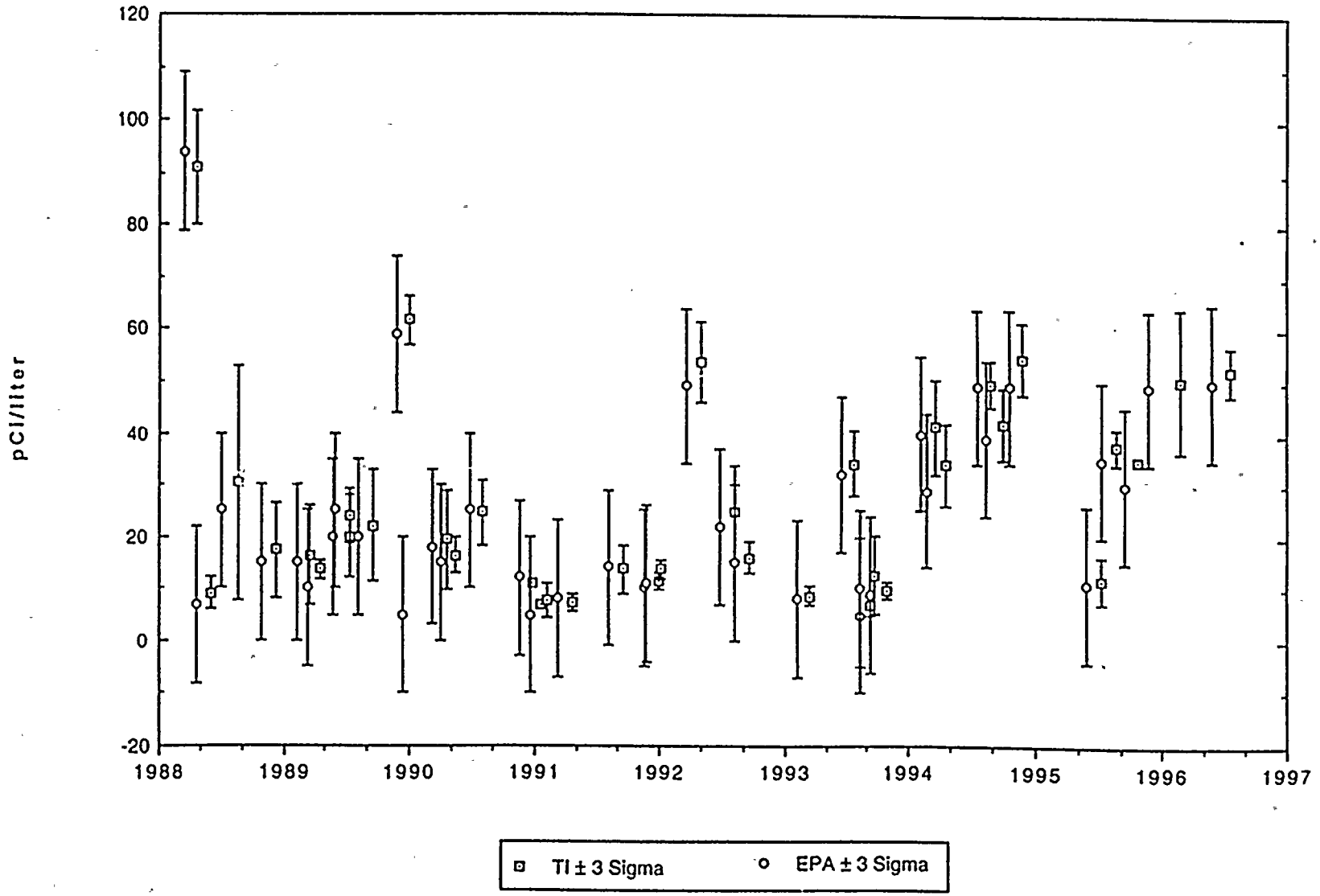
EPA CROSS CHECK PROGRAM

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



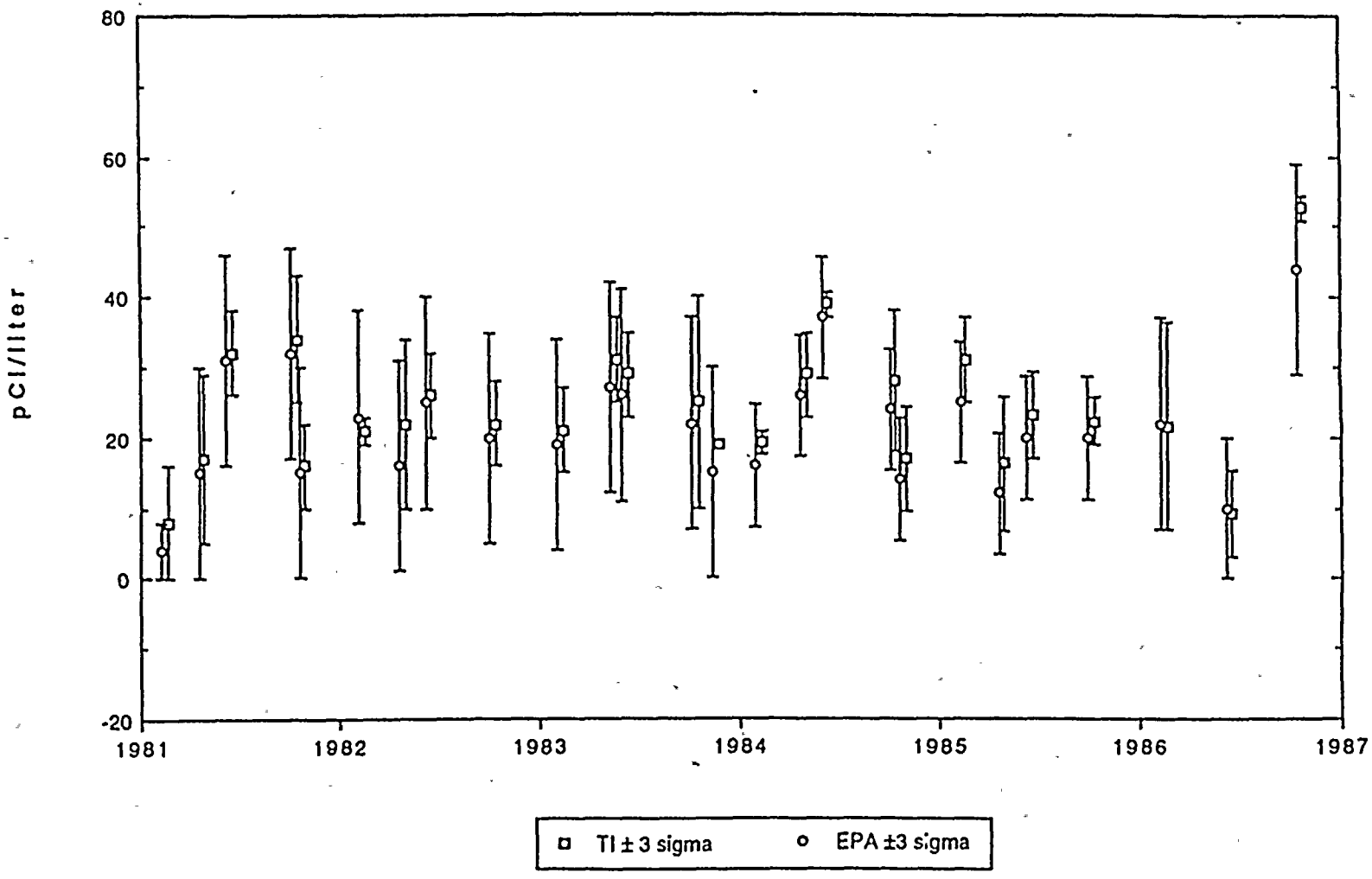
EPA CROSS CHECK PROGRAM

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



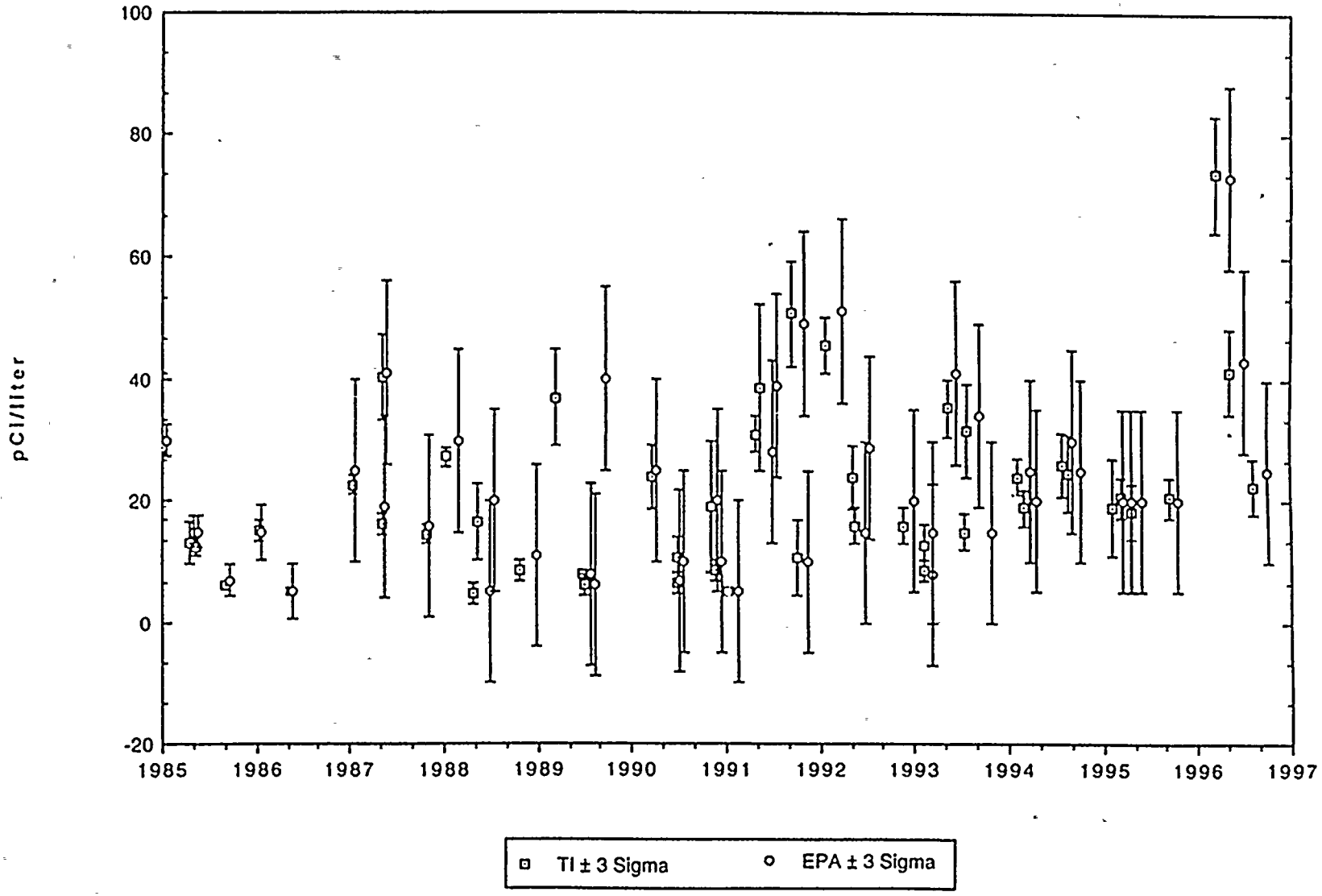
EPA CROSS CHECK PROGRAM

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



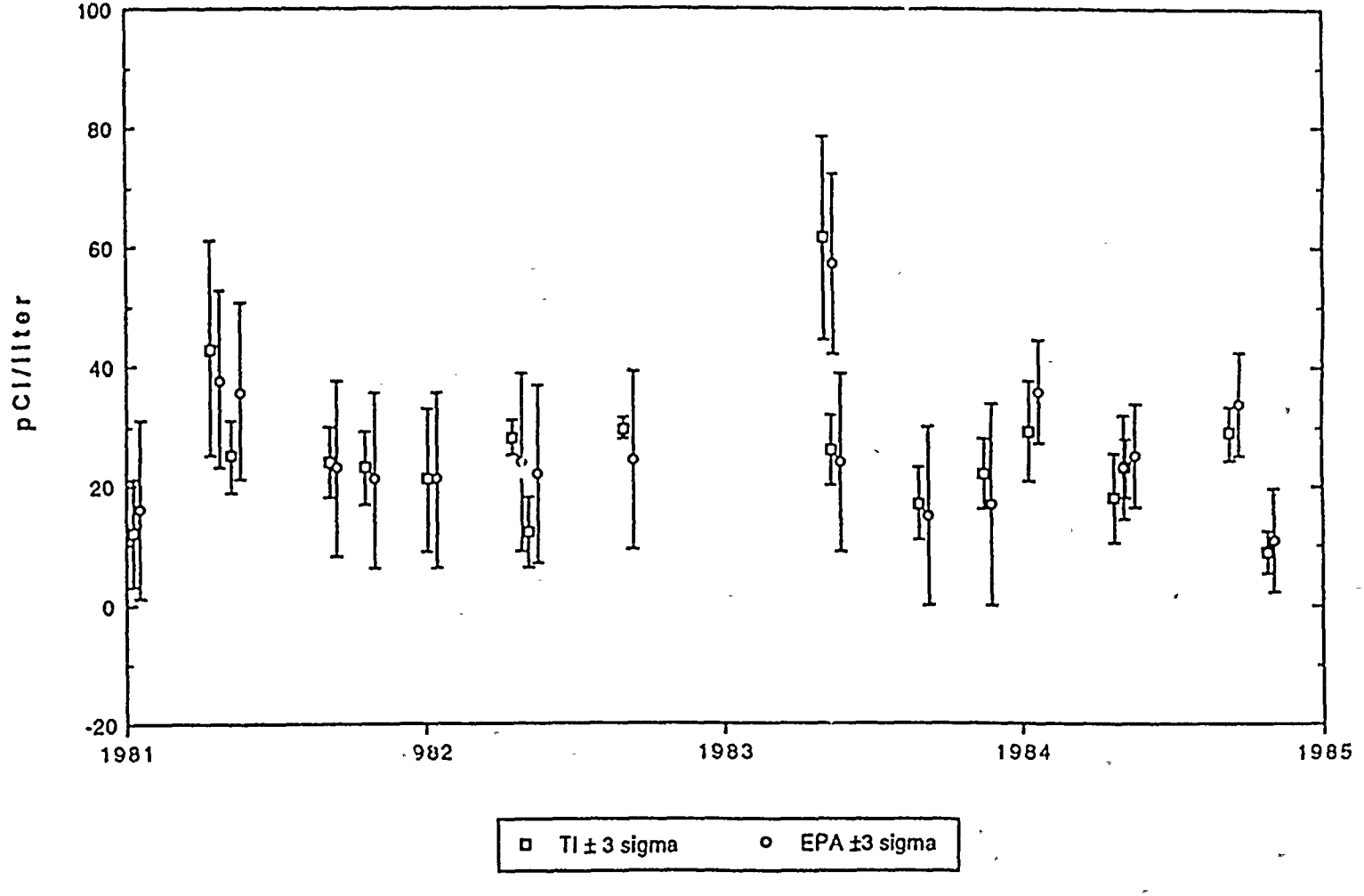
EPA CROSS CHECK PROGRAM

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



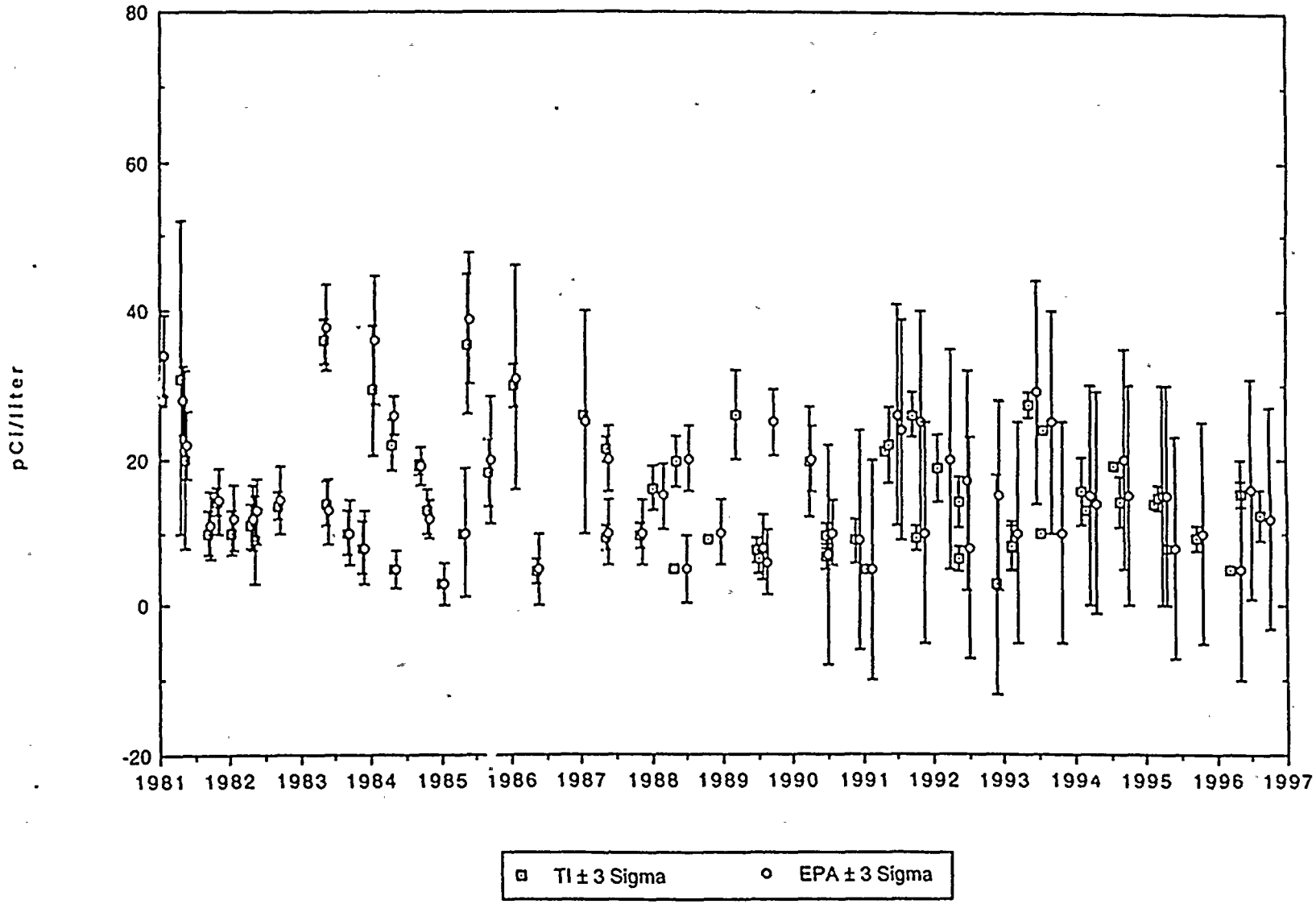
EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER (pg. 1 of 2)



EPA CROSS CHECK PROGRAM

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



APPENDIX E
REMP SAMPLING AND ANALYTICAL EXCEPTIONS

PROGRAM EXCEPTIONS

AIR PARTICULATES

On 01/24/96, at the South Bend air station, a strong wind gust blew the particulate filter from the sampler head and the filter was lost. An enhancement was added to the procedure directing the user to pre-load sample heads or change filters inside the vehicle if inclement weather conditions exist.

On 03/06/96, it was discovered that electric power was off at air stations ONS-5 and ONS-6. A technician walked down the power line and discovered that the line fuse was open.

On 08/14/96, the ONS-1 sample pump lost power. The particulate and 12 samples were not obtained.

On 10/23/96, the ONS-2 pump was found with the breaker tripped. The sample pump only ran for 34 hours.

On 11/06/96 the air particulate and 12 results from New Buffalo were considered invalid as the sample pump pulled an average of 7.6 LPM during the 7 day monitoring period.

On 11/13/96 power was lost at stations ONS-5 and ONS-6 due to a tripped fuse line. No particulate or 12 samples were obtained.

Throughout the year, the air particulate gross beta results did not meet the ODCM LLD of .01 pCi/m^3. This is consistent with historical results.

SURFACE WATER

Winter icing conditions on Lake Michigan prevented surface water sample collections at beach locations (SWL-2 and SWL-3) from 01/01/96 to 03/31/96. Winter ice cleared and sampling resumed on 04/01/96.

Inclement weather prevented sample collection on 10/30/96 at locations SWL-2 and SWL-3. Beginning on 12/18/96 through the end of the year, surface water samples were not obtained from locations SWL-2 and SWL-3 due to the return of ice at the shoreline.

On 01/22/97 Teledyne Brown Eng. reported that the iodine-131 result for station SWL-3 was more than 1.0 pCi/liter (2.0 pCi/liter) in December. This was attributed to the decreased amount of sample water sent to the lab for analysis.

GROUND WATER

On 01/26/96 well samples W1, W3, W4, W5, W6, W7, W8, W13, W14, SG-2, SG-4 and SG-5 were not collected due to inclement weather and electric power availability. However, all were subsequently sampled within the 25% grace period.

Gross beta results from stations SG-1, SG-2, SG-4, and SG-5 on 01/25, 04/25, 07/26, and 10/25/96 were higher than the ODCM LLD of 4.0 pCi/liter. This is consistent with historical data.

On 07/25/96, groundwater from well-14 measured a tritium result of 5,300 pCi/liter and on 10/25/96 the result from well-14 was 14,000 pCi/liter. This exceeded the ODCM LLD of 2000 pCi/liter.

DRINKING WATER

On several occasions the gross beta LLD failed to meet the ODCM LLD of 4.0 pCi/liter at the St. Joseph and Lake Township Facilities. This is consistent with historical information. It applies to composite samples from St. Joseph: 02/02-02/14, 03/28-04/10, 04/25-05/08, 09/12-09/25 and 10/24-11/06. From Lake Township facility the composite samples were: 03/14-03/27, 06/20-07/03, and 08/15-08/28.

In addition, the Lake Township drinking water sample from 04/30/96 was not collected. The sample collector failed to obtain the sample. This was only the second incident of a missed drinking water sample since 1987 and the incident was attributed to water lab technician oversight.

BROADLEAF SAMPLES IN LIEU OF MILK SAMPLES

During 1996 no milk samples were obtained because two of the three indicator farms dropped from the program. No replacement farms could be located. Per the Offsite Dose Calculation Manual, broadleaf samples were substituted in lieu of milk samples. Monthly broadleaf samples were not obtained during the first quarter of 1996 due to season unavailability. In April broadleaf sampling began.

In May it was discovered that procedural directions, in the ODCM, indicating where to obtain the indicator broadleaf samples were misinterpreted during April sample collection. Broadleaf samples had been obtained from the three highest D/Q land sectors instead of obtaining three indicator samples from the highest D/Q land sector. This was corrected for the May broadleaf samples.

Broadleaf cesium-137 LLD results from station ONS-2 was 298.0 pCi/kg on 04/24/96 and 74.6 pCi/kg on 05/22/96. The ODCM LLD is 60 pCi/kg for cesium-137. All other gamma emitting radionuclides results met respective LLDs for May 1996.

On 10/09/96, the broadleaf cesium-137 result was > 60 pCi/kg (70.4 pCi/kg) in sector A. The other two sample locations in sector A showed results < 60 pCi/kg.

Broadleaf samples were not obtained in November and December 1996 due to season unavailability.

FISH

No fish were collected at location OFS-S on 05/31/96.

TLDs

The transit does was not subtracted from totals for the third quarter TLDs. The transit TLD was inadvertently not placed in the shielded TLD holder.

APPENDIX F
1996 LAND USE CENSUS

APPENDIX F
SUMMARY OF THE 1996 LAND USE CENSUS

The Land Use Census is performed to ensure that significant changes in the areas in the immediate vicinity of the plant site are identified. Any identified changes are evaluated to determine whether modifications must be made to the REMP or other related programs. No such changes were identified during the 1996 Land Use Census. The following is a summary of the 1996 results.

Milk Farm Survey

The milk farm survey is performed to update the list of milk farms located in the plant area, to identify the closest milk farm in each land sector, and to identify the nearest milk animal whose milk is used for human consumption. The milk farm survey for the Donald C. Cook Nuclear Plant was conducted on July 2, 1996.

In 1996 there were two deletions to the Michigan Department of Agriculture's list of dairy farms in Berrien County Michigan. One of the deleted farms had previously participated in the REMP Milk Sampling Program.

The previously identified milk animal, a goat owned by Sue Dorman continues to be the closest milk producing animal to the Donald C. Cook Nuclear Plant whose milk is used for human consumption. The closest edge of the animals pasture is 13,425 feet from the Plant's centerline axis.

Residential Survey

The residential survey is performed to identify the closest residence in each land sector surrounding the Donald C. Cook Nuclear Plant. The residential survey was completed on July 2, 1996. There was one new residential building permits issued by Lake Township during 1996. In addition a door-to-door survey was then conducted using a local area map. The closest residence to the Donald C. Cook Nuclear Plant in each sector remains unchanged from the previous year.

Broadleaf Survey

In accordance with Offsite Dose Calculation Manual, broadleaf vegetation sampling is performed in lieu of a garden census. Broadleaf sampling is performed to monitor for plant impact on the environment. The samples are obtained at the site boundary. The broadleaf analytical results for 1996 were less than the Technical Specification LLDs.

Figure 4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Milk Farm Survey - 1996

Sector	Survey Year	Distance Miles	Name	Address
A	a	N/A	No milk farms	N/A
	b	N/A	No milk farms	N/A
B	a	N/A	No milk farms	N/A
	b	N/A	No milk farms	N/A
C	a	N/A	No milk farms	N/A
	b	N/A	No milk farms	N/A
D	a	13.9	William Nimtz	3445 Park Rd., Eau Claire
	b	5.1	Gerald Totzke	6744 Totzke Rd., Baroda
E	a	10.5	Andrews University	Berrien Springs
	b	10.5	Andrews University	Berrien Springs
F	a	6.8	Lee Nelson	RFD 1, Box 390A, Snow Rd. Baroda
	b	6.8	Lee Nelson	RFD 1, Box 390A, Snow Rd. Baroda
G	a	4.1	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda
	b	4.1	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda
H	a	7.0	George Freehling	2221 W. Glendora Rd., Buchanan
	b	7.0	George Freehling	2221 W. Glendora Rd., Buchanan
J	a	7.7	Jerry Warmbein	14143 Mill Rd., Three Oaks
	b	7.7	Jerry Warmbein	14143 Mill Rd., Three Oaks
K	a	12	Kenneth Tappan	Rt. 2, Kruger Rd, Three Oaks
	b	12	Kenneth Tappan	Rt. 2, Kruger Rd, Three Oaks

All other sectors are over water.
(a) Reporting Year
(b) Year prior to reporting year.

Figure 5

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

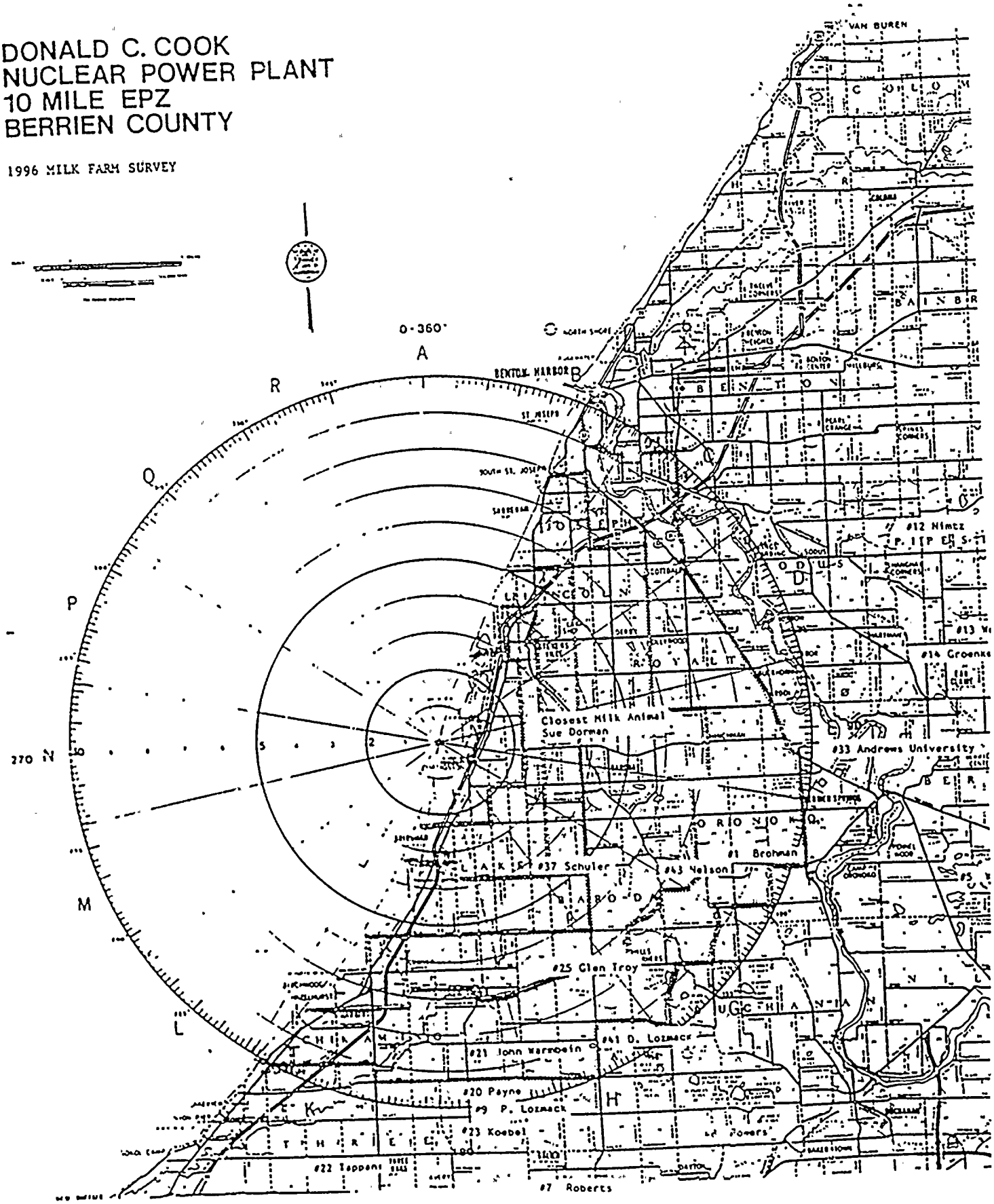
Residential Land Use Survey - 1996

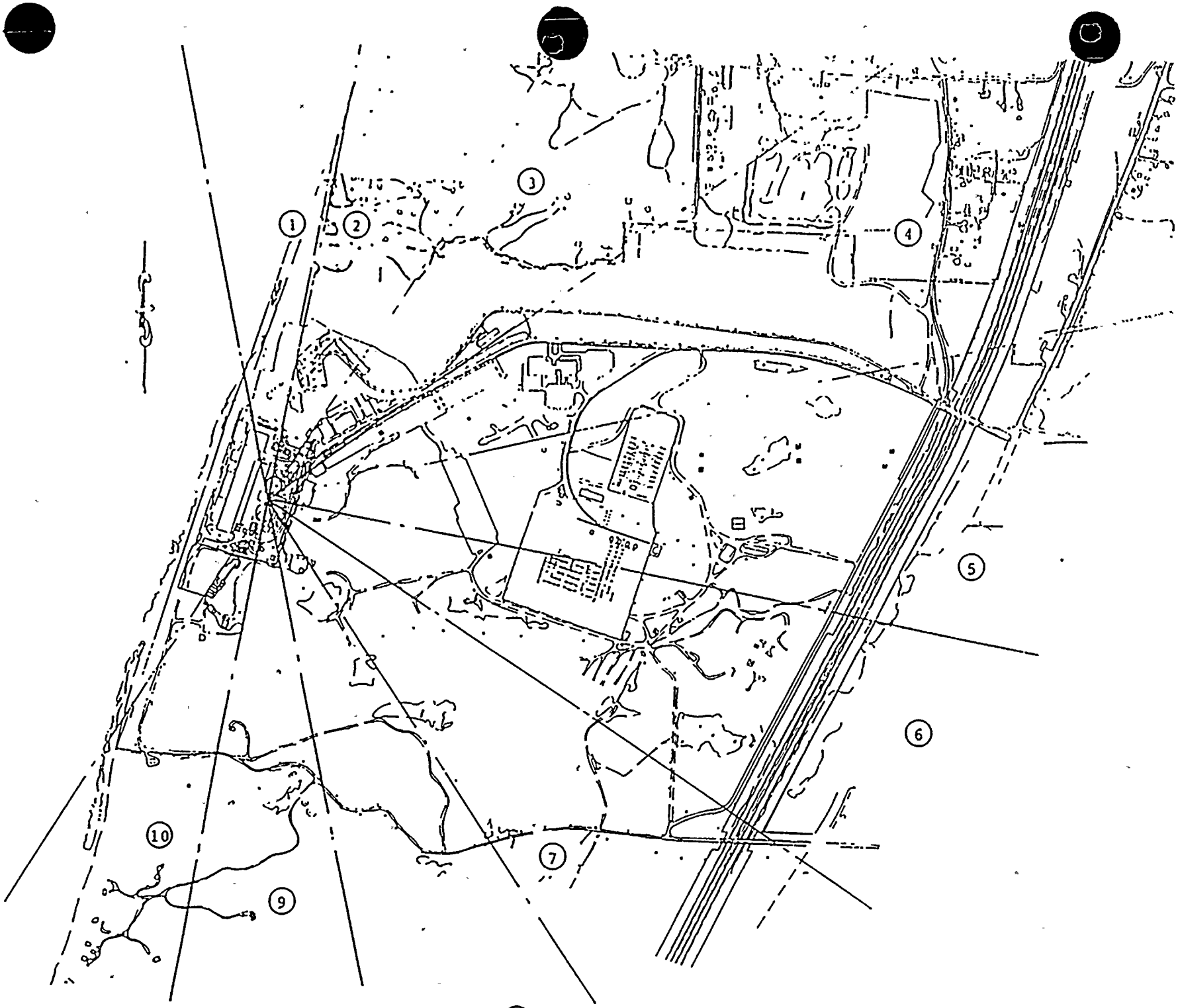
Sector	Year	House (1)	In Feet	Property #	Street Address
A	a	1	216.	11-11-0006-0004-01-7	Iler Drive, Rosemary Beach
	b	1	2161	11-11-0006-0004-01-7	Iler Drive, Rosemary Beach
B	a	2	2165	11-11-0006-0004-09-2	Iler Drive, Rosemary Beach
	b	2	2165	11-11-0006-0004-09-2	Iler Drive, Rosemary Beach
C	a	3	3093	11-11-6800-0028-00-0	Lake Road, Rosemary Beach
	b	3	3093	11-11-6800-0028-00-0	Lake Road, Rosemary Beach
D	a	4	5733	11-11-0005-0036-01-8	7500 Thorton Drive
	b	4	5733	11-11-0005-0036-01-8	7500 Thorton Drive
E	a	5	5631	11-11-0005-0009-07-0	7927 Red Arrow Highway
	b	5	5631	11-11-0005-0009-07-0	7927 Red Arrow Highway
F	a	6	5392	11-11-0008-0015-03-1	8197 Red Arrow Highway
	b	6	5392	11-11-0008-0015-03-1	8197 Red Arrow Highway
G	a	7	3728	11-11-0007-0013-01-4	Livingston Road
	b	7	3728	11-11-0007-0013-01-4	Livingston Road
H	a	8	4944	11-11-8600-0004-00-1	Wildwood
	b	8	4944	11-11-8600-0004-00-1	Wildwood
J	a	9	3366	11-11-0007-0010-02-3	Livingston Hills
	b	9	3366	11-11-0007-0010-02-3	Livingston Hills
K	a	10	3090	11-11-0007-0010-03-1	Livingston Hills
	b	10	3090	11-11-0007-0010-03-1	Livingston Hills

(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.

DONALD C. COOK NUCLEAR POWER PLANT 10 MILE EPZ BERRIEN COUNTY

1996 MILK FARM SURVEY





1996 RESIDENTIAL LAND USE SURVEY

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 Donald C. Cook Nuclear 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 Donald C. Cook Nuclear Plant during the pre-start up of Unit 1 and the radioactivity measured in 1996.

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 during

1996. Analyses performed during the preoperational but not required in 1996, 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-40 and traces of cesium-137, the latter attributed to fallout.

Drinking water analysis was not part of the preoperational program.

APPENDIX H

SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

TELEDYNE BROWN ENGINEERING QUALITY CONTROL PROGRAM

The goal of the quality control program at Teledyne Brown Engineering is to produce analytical results which are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50, Appendix B, Nuclear Regulatory Guide 4.15 and the program as described in Quality Assurance Manual IWL-0032-395 and Quality Control Manual IWL-0032-365.

All measuring equipment is calibrated for efficiency at least annually using standard reference material traceable to NIST. For alpha and beta counting, check sources are prepared and counted every day the counter is in use. Control charts are maintained with three sigma limits specified. Control of the alpha-beta counting equipment is described in procedure PRO-032-27, "Calibration and Control of Alpha/Beta Counters". Backgrounds are usually measured at least once per week.

The gamma spectrometers are calibrated annually with a NIST traceable standard reference material selected to cover the energy range of the nuclides to be monitored and to include all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency were plotted at two energy levels on charts and held within three sigma control limits. From January 1, 1996 December 31, 1996 the energy levels were 59.5 and 1332 KeV. This procedure is described in PRO-042-44, "Calibration and Control of Gamma Ray Spectrometers".

The efficiency of the liquid scintillation counters is determined at least annually by counting NIST traceable standards which have been diluted in a known amount of distilled water and various amounts of quenching agent. The procedure is described in PRO-052-35, "Determination of Tritium by Liquid Scintillation". The background of each counter is measured with each batch of samples. A control chart is maintained for the background and check source measurements as a stability check.

Preparation of carrier solutions and acceptability criteria are contained in procedure PRO-032-49 "Standardization of Radio-chemical Carrier

Solutions". Preparation of efficiency calibration standards and check sources is described in procedure PRO-032-27, "Calibration and Control of Alpha/Beta Counters".

Results are reviewed before being entered into the data system by the Quality Assurance or Laboratory Manager, or supervisors for reasonableness of the parameters (background, efficiency, decay, etc.). Any results which are suspect, being higher or lower than results in the past, are returned to the laboratory for recount. If a longer count, decay check, recount on another system or recalculation does not give acceptable results based on experience, a new aliquot is analyzed. The complete information about the sample is contained on the work sheet(s).

No deviations from written procedures occurred during 1996.

Results of Duplicate Analyses for 1996

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates Results in Units of 10^{-3} pCi/m^3	Gr-Beta	2.5 ± 0.2 E-02	2.4 ± 0.2 E-02
	"	2.6 ± 0.3 E-02	2.3 ± 0.3 E-02
	"	2.3 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	1.7 ± 0.2 E-02	1.7 ± 0.2 E-02
	"	1.6 ± 0.2 E-02	1.6 ± 0.2 E-02
	"	2.3 ± 0.2 E-02	2.1 ± 0.2 E-02
	"	2.1 ± 0.2 E-02	2.2 ± 0.2 E-02
	"	1.4 ± 0.2 E-02	1.4 ± 0.2 ± -02
	"	1.6 ± 0.2 E-02	1.6 ± 0.2 E-02
	"	1.9 ± 0.2 E-02	1.9 ± 0.2 E-02
	"	1.5 ± 0.2 E-02	1.5 ± 0.2 E-02
	"	1.1 ± 0.2 E-02	1.3 ± 0.2 E-02
	"	1.5 ± 0.2 E-02	1.5 ± 0.2 E-02
	"	2.1 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	1.9 ± 0.2 E-02	2.1 ± 0.2 E-02
	"	2.0 ± 0.2 E-02	2.1 ± 0.2 E-02
	"	1.8 ± 0.2 E-02	2.0 ± 0.2 E-02
	"	3.0 ± 0.2 E-02	3.0 ± 0.2 E-02
	"	2.2 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	1.7 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	1.7 ± 0.2 E-02	1.8 ± 0.2 E-02
	"	2.1 ± 0.2 E-02	1.8 ± 0.2 E-02
	"	2.3 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	1.2 ± 0.2 E-02	1.4 ± 0.2 E-02
	"	2.6 ± 0.2 E-02	2.6 ± 0.2 E-02
	"	2.9 ± 0.3 E-02	2.7 ± 0.3 E-02
	"	3.6 ± 0.4 E-02	3.6 ± 0.5 E-02
Air Particulates/ Charcoal Filters Results in Units of 10^{-3} pCi/m^3	Iodine-131	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 6. E-03
	"	L. T. 5. E-03	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 7. E-03	L. T. 2. E-02
	"	L. T. 7. E-03	L. T. 9. E-03
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 5. E-03	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 5. E-03
	"	L. T. 1. E-02	L. T. 8. E-03
	"	L. T. 8. E-03	L. T. 6. E-03
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 9. E-03	L. T. 9. E-03
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 6. E-03

• Footnotes located at end of table.

Results of Duplicate Analyses for 1996 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates/ Charcoal Filters Results in Units of 10^{-3} pCi/m^3	Iodine-131	L. T. 6. E-03	L. T. 8. E-03
	"	L. T. 7. E-03	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 5. E-03	L. T. 9. E-03
	"	L. T. 6. E-03	L. T. 9. E-03
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 7. E-03	L. T. 1. E-02
	"	L. T. 9. E-03	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 8. E-03	L. T. 1. E-02
	"	L. T. 3. E-02	L. T. 2. E-02
Surface Water Results in Units of pCi/liter	H-3	L. T. 1. E 02	L. T. 2. E 02
	H-3		
Ground Water Results in Units of pCi/liter	Gamma	(a)	(a)
	H-3	3.4 ± 1.1 E 02	2.9 ± 1.1 E 02
	Gr-Alpha	(a)	(a)
	Gr-Beta	7.3 ± 2.2 E 00	6.7 ± 2.1 E 00
	Gamma	(a)	(a)
	H-3	(a)	(a)
	I-131	(a)	(a)
	Gamma	(a)	(a)
	H-3	(a)	(a)
	Gamma	(a)	(a)
	H-3	(a)	(a)
	I-131	(a)	(a)
	Gamma	(a)	(a)
	H-3	(a)	(a)
Drinking Water Results in Units of pCi/liter	Gr-Beta	3.6 ± 1.0 E 00	2.9 ± 1.0 E 00
	I-131	(a)	(a)
	Gamma	(a)	(a)
	Gr-Beta	3.5 ± 1.0 E 00	3.4 ± 1.1 E 00
	I-131	(a)	(a)
	Gamma	(a)	(a)

- Footnotes located at end of table.

Results of Duplicate Analyses for 1996 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Food	Gamma	(a)	(a)
Results in Units of	K-40	2.39 ± 0.24 E 03	1.72 ± 0.17 E 03
pCi/kg (wet)	Be-7	7.58 ± 0.88 E 02	3.28 ± 0.91 E 02
	Cs-137	(b)	2.55 ± 1.91 E 01 (c)

(a) All gamma results less than the detection limit (LLD).
(b) Result positive but associated error made it suspect.
(c) Confirmed by a reanalysis.

Teledyne Brown Engineering In-House Spiked Sample Results - 1996

Water

Analysis	Spike Levels (pCi/L)	Acceptable Range (pCi/l)
Gross Alpha	1.1 ± 0.5 E 01	0.6 - 1.6 E 01
Gross Beta	2.2 ± 0.7 E 01	1.5 - 2.9 E 01
Gamma (Cs-137)	2.2 ± 0.3 E 04	1.9 - 2.5 E 04 (1/3-1/31/96)
Gamma (Cs-137)	2.0 ± 0.3 E 04	1.7 - 2.3 E 04 (2/7-12/26/96)
H-3 (LS)	1.4 ± 0.4 E 03	1.0 - 1.8 E 03

TI #	Analysis Date	Gross Beta Activity (pCi/l)
06806	01/03/96	1.3 ± 0.2 E 01
07409	01/10/96	2.5 ± 0.2 E 01
07850	01/17/96	2.5 ± 0.2 E 01
08541	01/24/96	2.6 ± 0.2 E 01
09080	01/31/96	2.0 ± 0.1 E 01
09408	02/07/96	2.1 ± 0.2 E 01
09906	02/14/96	1.7 ± 0.1 E 01
10406	02/21/96	2.2 ± 0.2 E 01
10832	02/28/96	1.4 ± 0.1 E 01
11184	03/06/96	1.8 ± 0.1 E 01
11882	03/13/96	1.9 ± 0.2 E 01
12380	03/20/96	2.3 ± 0.2 E 01
12895	03/27/96	2.2 ± 0.2 E 01
13312	04/03/96	1.8 ± 0.1 E 01
13932	04/10/96	1.6 ± 0.1 E 01
14631	04/17/96	2.3 ± 0.2 E 01
15107	04/24/96	2.1 ± 0.2 E 01
15514	05/01/96	1.6 ± 0.1 E 01
16003	05/08/96	1.8 ± 0.1 E 01
16618	05/15/96	2.1 ± 0.2 E 01
16838	05/22/96	1.8 ± 0.1 E 01
17371	05/29/96	2.3 ± 0.2 E 01
17754	06/05/96	2.3 ± 0.2 E 01
18334	06/12/96	2.1 ± 0.2 E 01
18831	06/19/96	2.3 ± 0.2 E 01
19455	06/26/96	2.3 ± 0.2 E 01
20049	07/03/96	1.8 ± 0.1 E 01
20672	07/10/96	2.3 ± 0.2 E 01
21098	07/17/96	2.0 ± 0.1 E 01
21890	07/24/96	2.3 ± 0.2 E 01
22420	07/31/96	2.3 ± 0.2 E 01
22727	08/07/96	1.6 ± 0.1 E 01
23137	08/14/96	2.0 ± 0.1 E 01

TI #	Analysis Date	Gross Beta Activity (pCi/l)
23840	08/21/96	2.1 ± 0.2 E 01
24181	08/28/96	2.1 ± 0.2 E 01
24743	09/04/96	1.6 ± 0.1 E 01
25119	09/11/96	2.3 ± 0.2 E 01
25775	09/18/96	2.1 ± 0.1 E 01
26263	09/25/96	1.9 ± 0.1 E 01
26820	10/02/96	2.5 ± 0.2 E 01
27434	10/09/96	2.4 ± 0.2 E 01
28206	10/16/96	2.4 ± 0.2 E 01
28965	10/23/96	2.5 ± 0.2 E 01
29362	10/30/96	2.4 ± 0.2 E 01
29808	11/06/96	2.6 ± 0.2 E 01
30605	11/13/96	2.2 ± 0.2 E 01
31203	11/20/96	2.6 ± 0.2 E 01
31650	11/27/96	2.7 ± 0.8 E 00 (a)
32143	12/04/96	2.1 ± 0.2 E 01
32713	12/11/96	2.7 ± 0.2 E 01
33254	12/18/96	2.2 ± 0.2 E 01
33811	12/26/96	2.3 ± 0.2 E 01

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
06811	01/03/96	2.2 ± 0.2 E 04
07414	01/10/96	2.3 ± 0.2 E 04
07855	01/17/96	2.2 ± 0.2 E 04
08546	01/24:96	2.14 ± 0.21 E 04
09085	01/31/96	2.32 ± 0.2[illegible] E 04
09413	02/07/96	2.06 ± 0.21 E 04
09911	02/14/96	2.05 ± 0.21 E 04
10411	02/21/96	2.09 ± 0.21 E 04
10837	02/28/96	2.09 ± 0.21 E 04
11189	03/06/96	2.42 ± 0.24 E 04
11887	03/13/96	2.45 ± 0.25 E 04
12385	03/20/96	2.08 ± 0.21 E 04
12889	03/27/96	2.08 ± 0.25 E 04
13308	04/03/96	2.11 ± 0.21 E 04
13926	04/10/96	2.09 ± 0.21 E 04
14627	04/17/96	2.07 ± 0.21 E 04
15102	04/24/96	2.21 ± 0.22 E 04
15997	05/08/96	2.12 ± 0.21 E 04

(a) The gross alpha and gross beta recoveries for spiked sample 31650 were approximately 10%. Errors in counting, data entry or calculation have been ruled out as a cause to the best of our ability. Possible pipetting error is spiking the sample can not be confirmed or denied, but is unlikely. Subsequent spiked samples were in control.

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
16614	05/15/96	2.09 ± 0.21 E 04
16835	05/22/96	2.06 ± 0.21 E 04
17368	05/29/96	2.06 ± 0.21 E 04
17751	06/05/96	2.08 ± 0.21 E 04
18828	06/19/96	2.14 ± 0.21 E 04
19452	06/26/96	2.02 ± 0.20 E 04
20046	07/03/96	2.04 ± 0.20 E 04
20669	07/10/96	2.11 ± 0.21 E 04
21095	07/17/96	2.07 ± 0.21 E 04
21887	07/24/96	2.07 ± 0.21 E 04
22417	07/31/96	2.07 ± 0.21 E 04
22724	08/07/96	2.05 ± 0.21 E 04
23134	08/14/96	2.03 ± 0.20 E 04
23837	08/21/96	2.07 ± 0.21 E 04
24178	08/28/96	2.02 ± 0.20 E 04
24740	09/04/96	2.10 ± 0.21 E 04
25116	09/11/96	2.06 ± 0.21 E 04
25772	09/18/96	2.13 ± 0.21 E 04
26260	09/25/96	2.11 ± 0.21 E 04
26817	10/02/96	2.05 ± 0.21 E 04
27431	10/09/96	2.03 ± 0.20 E 04
28203	10/16/96	2.04 ± 0.20 E 04
28962	10/23/96	2.08 ± 0.21 E 04
29359	10/30/96	2.06 ± 0.21 E 04
29805	11/06/96	2.08 ± 0.21 E 04
30093	11/08/96	2.05 ± 0.21 E 04
30602	11/13/96	2.03 ± 0.20 E 04
31200	11/20/96	2.08 ± 0.21 E 04
31458	11/22/96	2.02 ± 0.20 E 04
31647	11/27/96	2.04 ± 0.20 E 04
32140	12/04/96	2.08 ± 0.21 E 04
32710	12/11/96	2.09 ± 0.21 E 04
33251	12/18/96	2.07 ± 0.21 E 04
33570	12/20/96	2.10 ± 0.21 E 04
33808	12/26/96	2.04 ± 0.20 E 04

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
06808	01/03/96	1.44 ± 0.15 E 03
07411	01/10/96	1.56 ± 0.17 E 03
07852	01/17/96	1.49 ± 0.15 E 03
08543	01/24/96	1.19 ± 0.14 E 03
09082	01/31/96	1.39 ± 0.15 E 03
09410	02/07/96	1.35 ± 0.16 E 03

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
09908	02/14/96	1.38 ± 0.16 E 03
10408	02/21/96	1.37 ± 0.16 E 03
10834	02/28/96	1.63 ± 0.17 E 03
11186	03/06/96	1.37 ± 0.16 E 03
11884	03/13/96	1.44 ± 0.16 E 03
12382	03/20/96	1.47 ± 0.16 E 03
12899	03/27/96	1.43 ± 0.17 E 03
13316	04/03/96	1.46 ± 0.19 E 03
13936	04/10/96	1.51 ± 0.18 E 03
14635	04/17/96	1.66 ± 0.20 E 03
15111	04/24/96	1.35 ± 0.17 E 03
15516	05/01/96	1.32 ± 0.15 E 03
16005	05/08/96	1.33 ± 0.15 E 03
16620	05/15/96	1.52 ± 0.16 E 03
16842	05/22/96	1.33 ± 0.15 E 03
17375	05/29/96	1.39 ± 0.11 E 03
17758	06/05/96	1.71 ± 0.20 E 03
18338	06/12/96	1.37 ± 0.15 E 03
18835	06/19/96	1.35 ± 0.15 E 03
19459	06/26/96	1.28 ± 0.15 E 03
20053	07/03/96	1.19 ± 0.16 E 03
20676	07/10/96	1.32 ± 0.17 E 03
21102	07/17/96	1.34 ± 0.15 E 03
21894	07/24/96	1.39 ± 0.15 E 03
22424	07/31/96	1.27 ± 0.15 E 03
22731	08/07/96	1.24 ± 0.15 E 03
23156	08/14/96	1.36 ± 0.15 E 03
23844	08/21/96	1.32 ± 0.15 E 03
24185	08/28/96	1.13 ± 0.15 E 03
24747	09/04/96	1.40 ± 0.16 E 03
25123	09/11/96	1.30 ± 0.16 E 03
25779	09/18/96	1.41 ± 0.16 E 03
26267	09/25/96	1.22 ± 0.15 E 03
26824	10/02/96	1.23 ± 0.14 E 03
27438	10/09/96	1.41 ± 0.19 E 03
28210	10/16/96	1.26 ± 0.15 E 03
28969	10/23/96	1.14 ± 0.17 E 03
29366	10/30/96	1.43 ± 0.17 E 03
29812	11/06/96	1.09 ± 0.15 E 03
30609	11/13/96	1.13 ± 0.16 E 03
31207	11/20/96	1.24 ± 0.16 E 03
31654	11/27/96	1.17 ± 0.17 E 03
32147	12/04/96	1.25 ± 0.16 E 03
32717	12/11/96	1.28 ± 0.17 E 03
33258	12/18/96	1.26 ± 0.18 E 03
33815	12/26/96	1.55 ± 0.18 E 03

Teledyne Brown Engineering In-House Blanks Sample Results - 1996
Water

GROSS BETA BLANKS

TI #	Analysis Date	Gross Beta Activity (pCi/l)
06805	01/03/96	L. T. 8. E-01
07408	01/10/96	L. T. 8. E-01
07849	01/17/96	L. T. 8. E-01
08540	01/24/96	L. T. 9. E-01
09079	01/31/96	L. T. 9. E-01
09407	02/07/96	L. T. 8. E-01
09905	02/14/96	L. T. 1. E 00
10405	02/21/96	L. T. 9. E-01
10831	02/28/96	L. T. 8. E-01
11183	03/06/96	L. T. 9. E-01
11881	03/13/96	L. T. 8. E-01
12379	03/20/96	L. T. 7. E-01
12894	03/27/96	L. T. 8. E-01
13311	04/03/96	L. T. 7. E-01
13931	04/10/96	L. T. 8. E-01
14630	04/17/96	L. T. 7. E-01
15106	04/24/96	L. T. 9. E-01
15513	05/01/96	L. T. 1. E 00
16002	05/08/96	L. T. 8. E-01
16617	05/15/96	L. T. 8. E-01
16837	05/22/96	L. T. 8. E-01
17370	05/29/96	L. T. 8. E-01
17753	06/05/96	L. T. 9. E-01
18333	06/12/96	L. T. 8. E-01
18830	06/19/96	L. T. 8. E-01
19454	06/26/96	L. T. 8. E-01
20048	07/03/96	L. T. 8. E-01
20671	07/10/96	L. T. 8. E-01
21097	07/17/96	L. T. 7. E-01
21889	07/24/96	L. T. 8. E-01
22419	07/31/96	L. T. 8. E-01
22726	08/07/96	L. T. 8. E-01
23136	08/14/96	L. T. 9. E-01
23839	08/21/96	L. T. 9. E-01
24180	08/28/96	L. T. 8. E-01
24742	09/04/96	L. T. 8. E-01
25118	09/11/96	L. T. 9. E-01
25774	09/18/96	L. T. 8. E-01
26262	09/25/96	L. T. 8. E-01

GROSS BETA - BLANKS (Cont.)

TI #	Analysis Date	Gross Beta Activity (pCi/l)
26819	10/02/96	L. T. 8. E-01
27433	10/09/96	L. T. 8. E-01
28205	10/16/96	L. T. 8. E-01
28964	10/23/96	L. T. 8. E-01
29807	11/06/96	L. T. 9. E-01
30604	11/13/96	L. T. 9. E-01
31202	11/20/96	L. T. 8. E-01
31649	11/27/96	L. T. 8. E-01
32142	12/04/96	L. T. 7. E-01
32712	12/11/96	L. T. 7. E-01
33253	12/18/96	L. T. 9. E-01
33810	12/26/96	L. T. 8. E-01

TRITIUM - (H-3) - BLANKS

TI #	Analysis Date	Activity (pCi/l)
06810	01/03/96	L. T. 1.43 E 02
07413	01/10/96	L. T. 1.57 E 02
07854	01/17/96	L. T. 1.48 E 02
08545	01/24/96	L. T. 1.60 E 02
09084	01/31/96	L. T. 1.53 E 02
09412	02/07/96	L. T. 1.65 E 02
09910	02/14/96	L. T. 1.90 E 02
10410	02/21/96	L. T. 1.84 E 02
10836	02/28/96	L. T. 2.14 E 02
11188	03/06/96	L. T. 2.00 E 02
11886	03/13/96	L. T. 1.60 E 02
12384	03/20/96	L. T. 1.79 E 02
12897	03/27/96	L. T. 1.90 E 02
13314	04/03/96	L. T. 2.24 E 02
13934	04/10/96	L. T. 2.26 E 02
14633	04/17/96	L. T. 2.38 E 02
15109	04/24/96	L. T. 1.81 E 02
15518	05/01/96	L. T. 1.51 E 02
16007	05/08/96	L. T. 1.61 E 02
16622	05/15/96	L. T. 1.42 E 02
16840	05/22/96	L. T. 1.53 E 02
17373	05/29/96	L. T. 1.09 E 02
17756	06/05/96	L. T. 1.62 E 02
18336	06/12/96	L. T. 1.43 E 02
18833	06/19/96	L. T. 1.61 E 02
19457	06/26/96	L. T. 1.51 E 02

TRITIUM - (H-3) - BLANKS (Cont.)

TI #	Analysis Date	Activity (pCi/l)
20051	07/03/96	L. T. 1.75 E 02
20674	07/10/96	L. T. 1.66 E 02
21100	07/17/96	L. T. 1.40 E 02
21892	07/24/96	L. T. 1.50 E 02
22422	07/31/96	L. T. 1.55 E 02
22729	08/07/96	L. T. 1.48 E 02
23155	08/14/96	L. T. 1.46 E 02
23842	08/21/96	L. T. 1.50 E 02
24183	08/28/96	L. T. 1.60 E 02
24745	09/04/96	L. T. 1.63 E 02
25121	09/11/96	L. T. 1.69 E 02
25777	09/18/96	L. T. 1.56 E 02
26265	09/25/96	L. T. 1.56 E 02
26822	10/02/96	L. T. 1.48 E 02
27436	10/09/96	L. T. 2.34 E 02
28208	10/16/96	L. T. 1.57 E 02
28967	10/23/96	L. T. 1.74 E 02
29364	10/30/96	L. T. 1.80 E 02
29810	11/06/96	L. T. 1.69 E 02
30607	11/13/96	L. T. 1.74 E 02
31205	11/20/96	L. T. 1.74 E 02
31652	11/27/96	L. T. 1.91 E 02
32145	12/04/96	L. T. 1.74 E 02
32715	12/11/96	L. T. 1.87 E 02
33256	12/18/96	L. T. 2.00 E 02
33813	12/26/96	L. T. 1.72 E 02

APPENDIX I
TLD QUALITY CONTROL PROGRAM

TLD QUALITY CONTROL PROGRAM

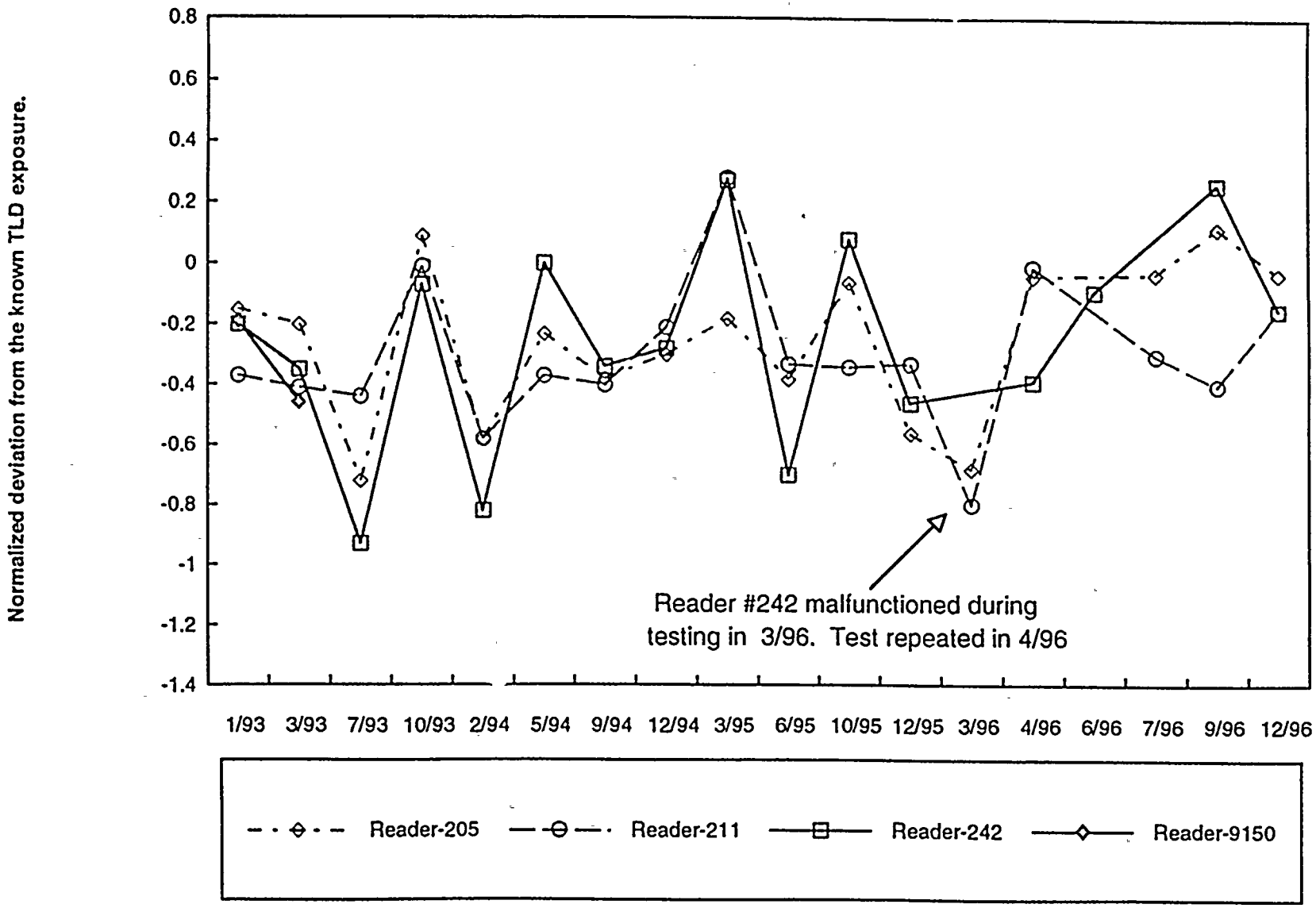
Teledyne Brown Engineering performs an in-house quality assurance testing program for the environmental TLD laboratory. On a quarterly basis the QA manager or a qualified designate exposes groups of TLDs to three different doses using a known exposure rate from a cesium-137 source.

Typical exposures are between 20 and 80 mR. The TLDs are read 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 laboratory.

For 1996 all results were within the requirements of Regulatory Guide 4.13, Section C. The standard deviations of three measurements at each exposure for each reader was less than 7.5%. The percent deviation of the average of the three measurements from the known exposure at each exposure for each reader was less than 30%. The accompanying graphs indicate the normalized deviations of the average measurements from the known exposures at each exposure for each reader.

QUALITY CONTROL - TLDs

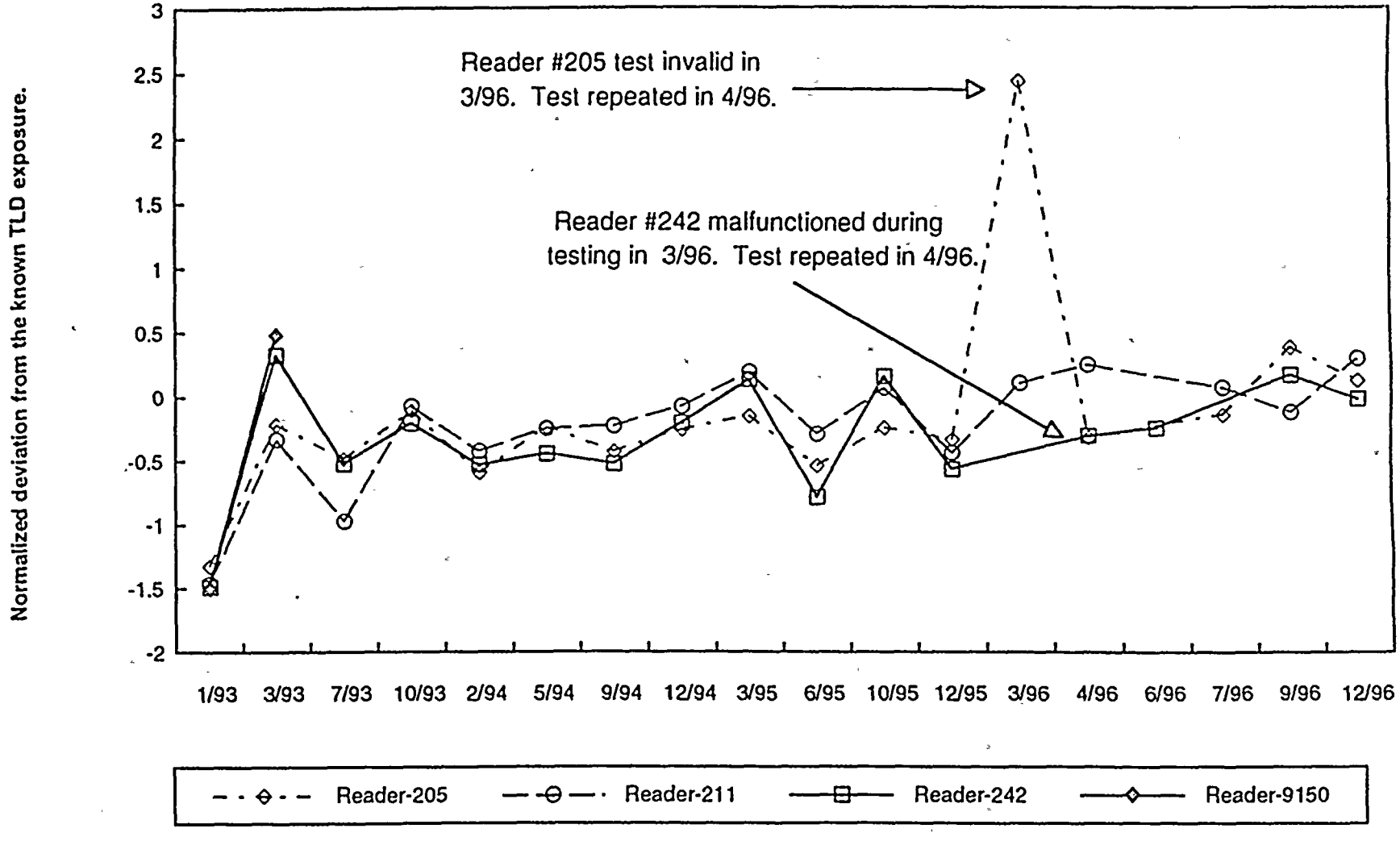
HIGH DOSE



Reader-9150 permanently removed from service during the first quarter 1993.

QUALITY CONTROL - TLDs

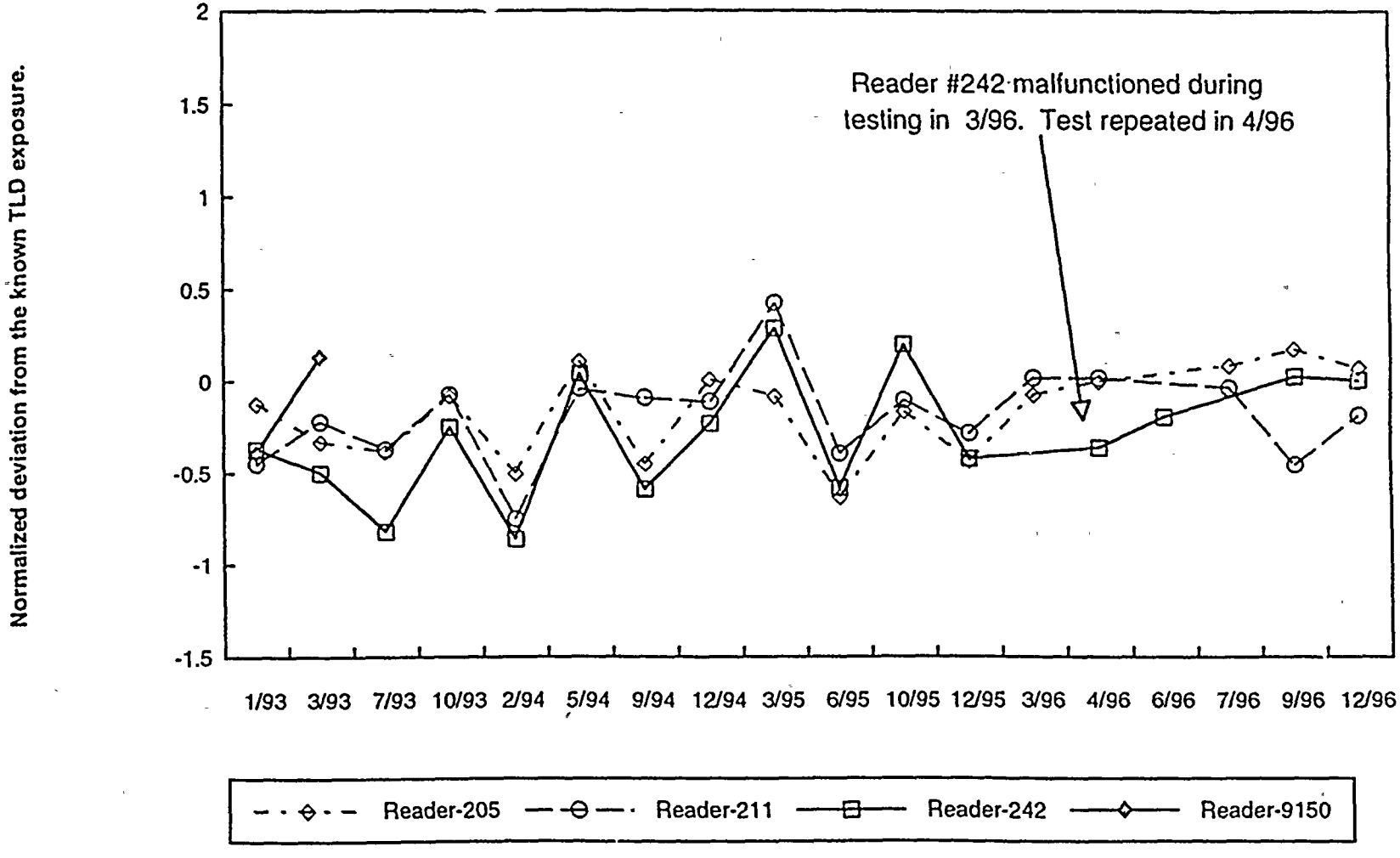
LOW DOSE



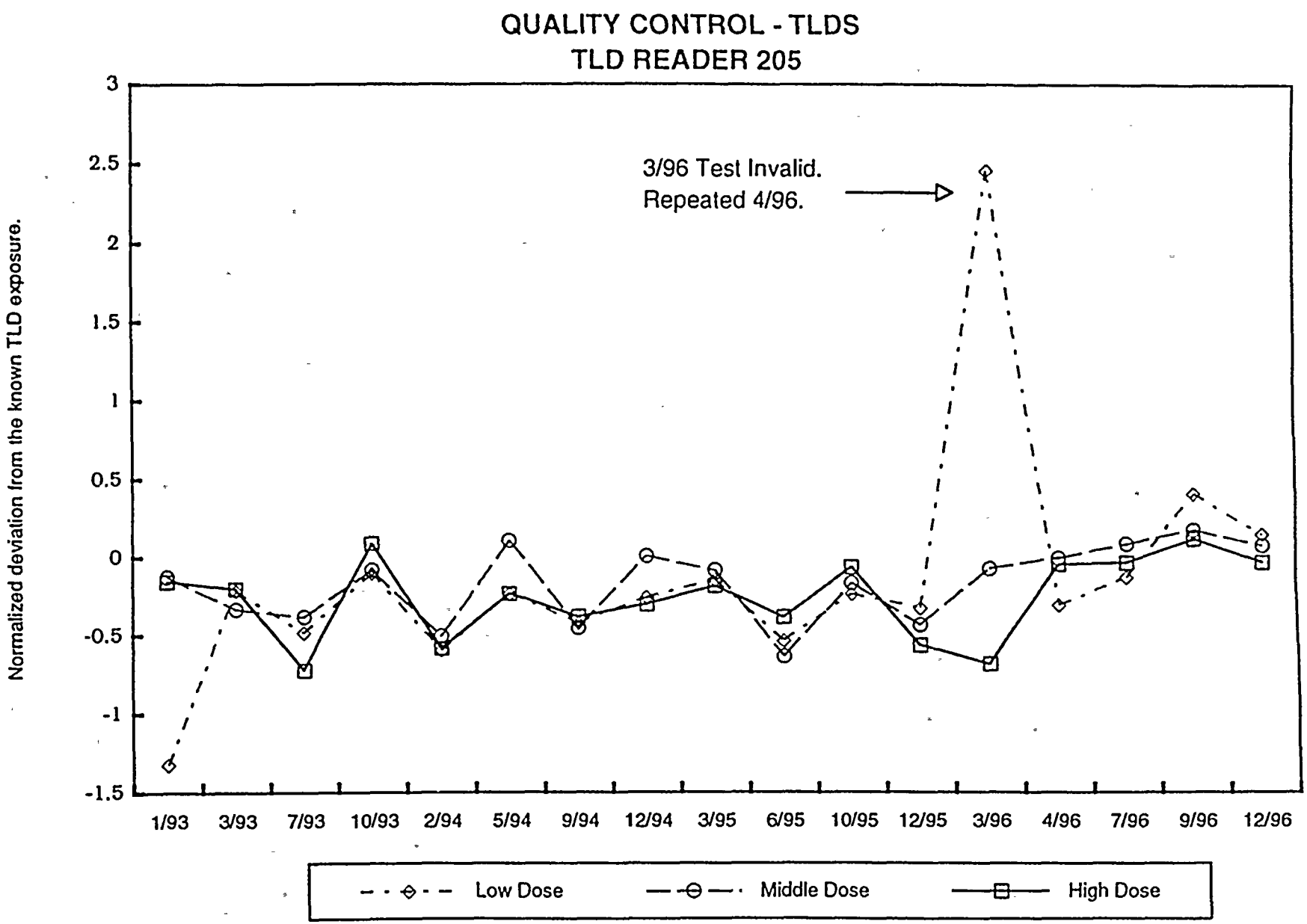
Reader-9150 was permanently removed from service during the first quarter 1993.

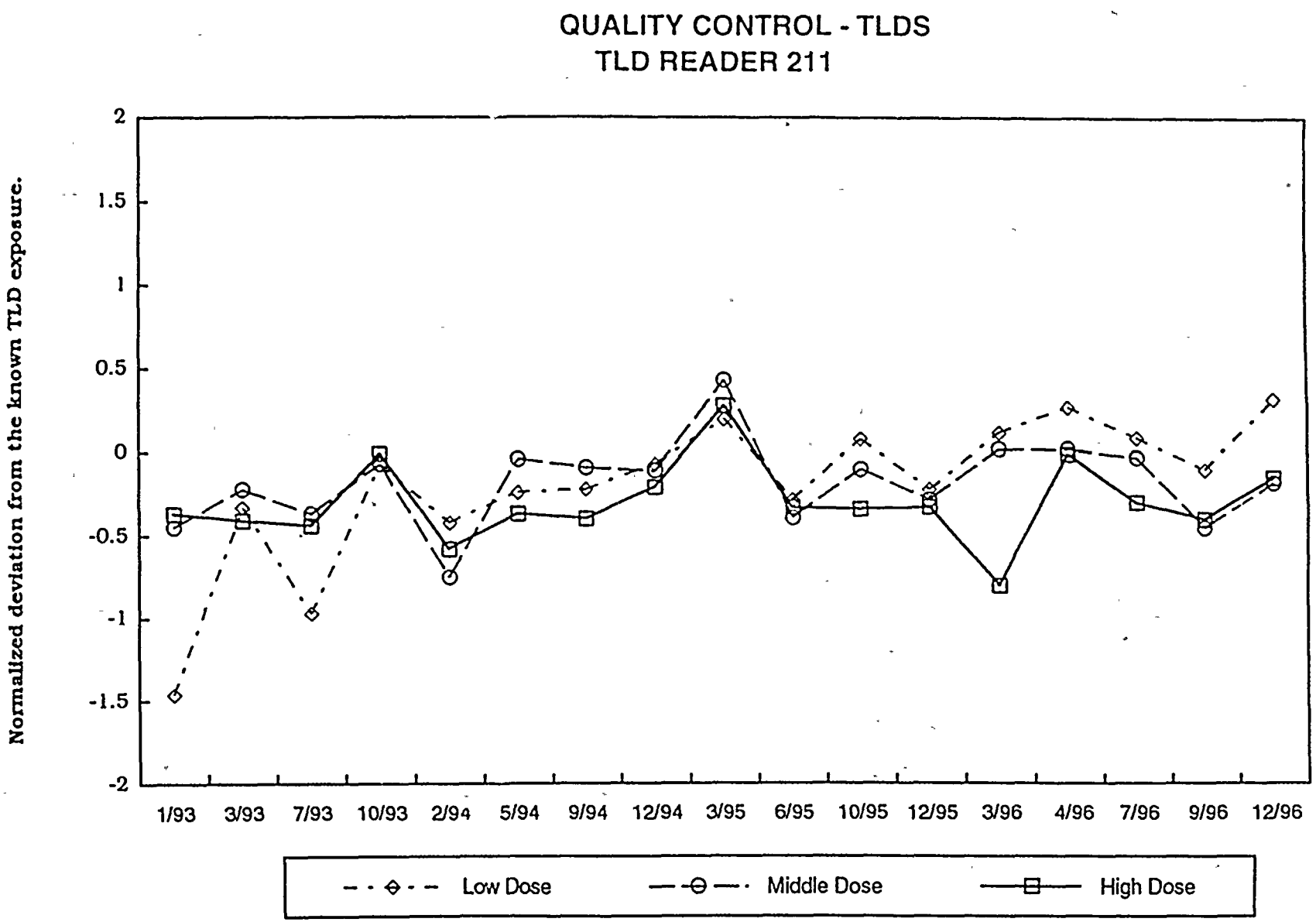
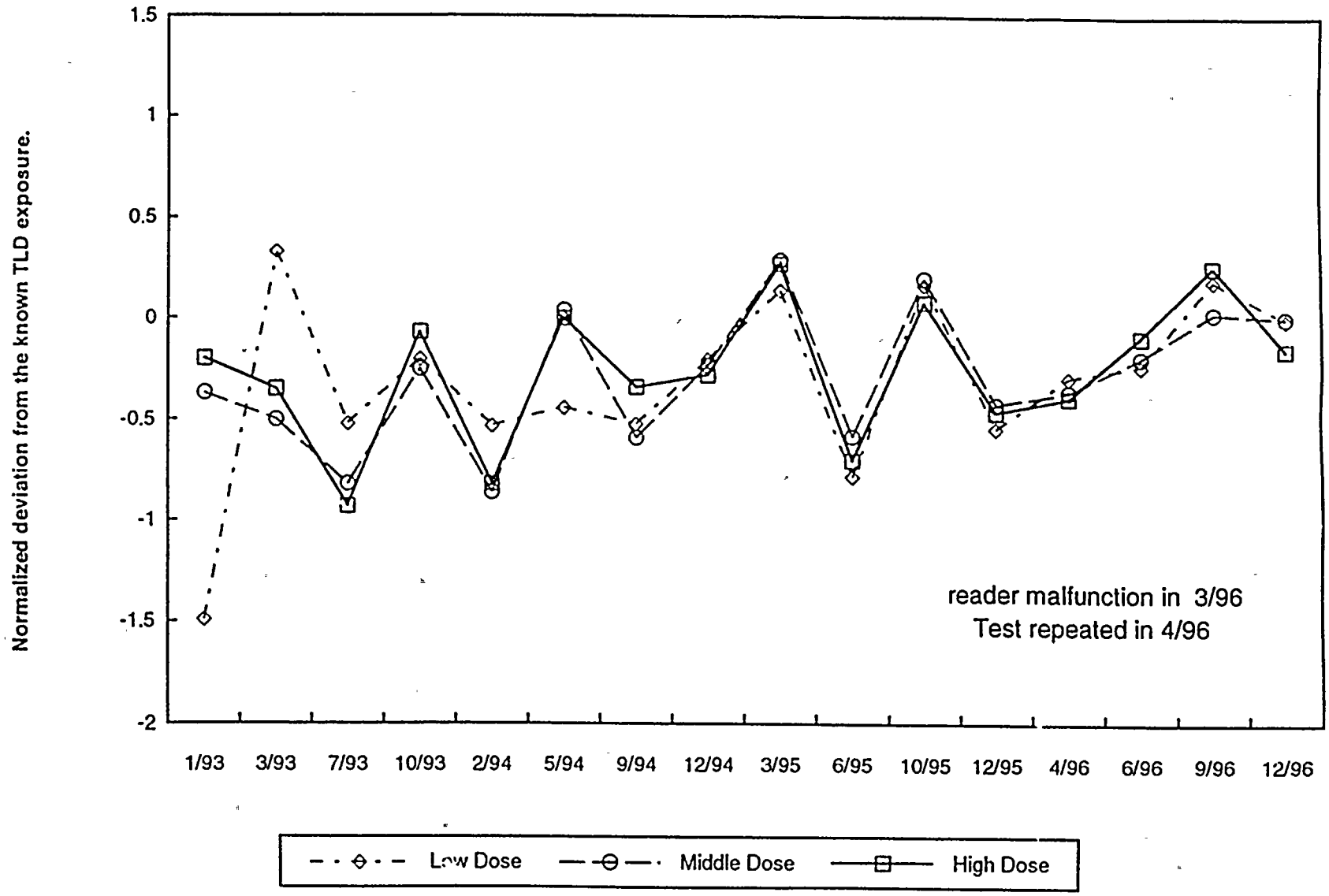
QUALITY CONTROL - TLDs

MIDDLE DOSE



Reader-9150 was permanently removed from service during the first quarter 1993.


QUALITY CONTROL - TLDS
TLD READER 205
Normalized deviation from the known TLD exposure.
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
3/96 Test Invalid.
Repeated 4/96.
1/93
3/93
7/93
10/93
2/94
5/94
9/94
12/94
3/95
6/95
10/95
12/95
3/96
4/96
7/96
9/96
12/96
Low Dose
Middle Dose
High Dose


QUALITY CONTROL - TLDS
TLD READER 211
Normalized deviation from the known TLD exposure.
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1/93
3/93
7/93
10/93
2/94
5/94
9/94
12/94
3/95
6/95
10/95
12/95
3/96
4/96
7/96
9/96
12/96
Low Dose
Middle Dose
High Dose

QUALITY CONTROL - TLDs
TLD READER 242