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INDIANA MICHIGAN POWER

April 24, 1996 AEP:NRC:0806P

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, 1995, TO DECEMBER 31, 1995

Attached herewith is the Donald C. Cook Nuclear Plant Annual Environmental Operating Report for the year 1995. 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,

for W. G. Smith
E. E. Fitzpatrick
Vice President

blb

Attachment

c: A. A. Blind
G. Charnoff
H. J. Miller
NFEM Section Chief
NRC Resident Inspector - Bridgman
J. R. Padgett

IE25 1/1

Donald C. Cook Nuclear Plant • Units 1 & 2

Annual Environmental Operating Report

January 1 through December 31, 1995

Indiana Michigan Power Company
Bridgman, Michigan

Docket Nos. 50-315 & 50-316
License Nos. DPR-58 & DPR-74

Donald C. Cook Nuclear Plant • Units 1 & 2

Annual Environmental Operating Report

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Indiana Michigan Power Company
Bridgman, Michigan

Docket Nos. 50-315 & 50-316
License Nos. DPR-58 & DPR-74

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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 serves 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, 1995.

During 1995, 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)	5,606,930	8,899,370
Unit Service Factor (%)	66.3	94.4
Unit Capacity Factor - MDC* Net (%)	61.6	92.6

* Maximum Dependable Capacity

II. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

There were no environmental Technical Specification changes in 1995.

III. NON-RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

A. Plant Design and Operation

During 1995, 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 were two environmental screenings during the reporting period. Copies of these screenings are 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 1995 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 1995.

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 were two environmental screenings during the reporting period. Copies of these screenings are located in Appendix II of this report. The screenings 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 controlled by plant procedure 12THP6020.ENV.104.

A summary of the 1995 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. Macrofouler Monitoring and Control Program, and Whole Effluent Toxicity Testing

Macrofouler monitoring and control activities, and whole effluent toxicity testing during 1995 are discussed in Appendix IV of this report. Zebra Mussels remained under control in 1995. Whole effluent toxicity testing studies showed no adverse environmental impact.

G. Special Reports

Three special reports are included in Appendix V. The first demonstrates the acceptability of increased heat addition to lake Michigan. The second describes molluscicide treatment during toxicity testing. The third presents the results of a six-week chlorination study.

IV. <u>RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT</u>

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

The description and conduct of the Radiological Environmental Monitoring Program was moved from Technical Specifications to the Offsite Dose Calculation Manual during 1995. This move was approved on February 10, 1995, amendment no. 189 to Facility Operating License no. DPR-58 and amendment no. 175 to Facility Operating License no. DPR-74.

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

This report summarizes the collection and analysis of various environmental sample media in 1995 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, 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.

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 and Well Report

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. One change was identified during the 1995 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 1995.

V. CONCLUSION

Based upon the results of the radiological environmental monitoring program and the radioactive effluent release reports for the 1995 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

1995

1995 Non-Routine Events

February 5-16, 1995, - Thirty-three (33) wild ducks were entrained in the intake cribs and collected on the intake screens within the screenhouse.

March 1, 1995 - The turbine room sump by-passed its normal flowpath, Outfall OOD and was discharged directly to the intake forebay via the emergency overflow piping.

May 30,.1995 - Approximately 1 gallon of antifreeze (ethylene glycol) was spilled to the ground when meter probes became entangled in the fan blades, puncturing the radiator coils on an engine-powered portable welding machine.

June 20, 1995 - Approximately 1 quart of antifreeze (ethylene glycol) leaked to the ground from the radiator of an engine-driven air compressor.

June 30, 1995 - Approximately 200 gallons of treated sewage effluent leaked to the ground when a flexible pipe coupling failed during excavation.

July 24, 1995 - Daily average and single sample Total Residual Oxidant (TRO) limits for Outfall 001 were exceeded during intermittent chlorination.

August 15, 1995 - An estimated 36.3 gallons of High Expansion Foam, containing 104 pounds of ethylene glycol monobutyl ether mixed with fire suppression water reached the ground when a lightning strike caused a spurious discharge of the fire suppression system at an onsite warehouse.

August 20, 1995 - Approximately 600 gallons of non-PCB mineral oil were released when the Unit 1 Main Transformer experienced a phase-to-phase internal arc over, which caused a catastrophic failure of the transformer. Of the approximate 600 gallons release, 50 gallons were spilled to the ground.

August 29, 1995 - Approximately 2 gallons of hydraulic oil spilled into the intake forebay, when a hydraulic line on equipment used to remove zebra mussels burst.

August 31, 1995 - Monethanolamine (ETA) concentration discharged from Outfall OOC (heating boiler blowdown) exceeded the concentration reported in our NPDES application.

September 16, 1995 - Unnatural turbidity was observed during a molluscide treatment at Outfalls 001 and 002. The observed turbidity was caused by bentonite clay being fed into the discharge vaults for Units 1 and 2.

October, 1995 - Outfall OOD continuous pH monitoring was interrupted on October 24, 25 and 31. The interruptions were caused by fouling problems associated with the glass pH electrode.

APPENDIX II

ENVIRONMENTAL SCREENING REPORTS

1995

There were two environmental screenings during the reporting period. The following documents are copies of these screenings. These environmental screenings determined that there were no unreviewed environmental questions.

DEN 6870.1

AMERICAN ELECTRIC POWER

Date September 14, 1995

Subject Environmental Screening
Unit 1 Generator Step-Up Transformer

From W. T. MacRae

To J. D. Pollock

Introduction

Design change 1-DCP-0804 was initiated to replace the Unit 1 Generator Step-Up (GSU) transformer. The transformer to be used is a 950MVA ASEA unit which was a spare at the Amos Plant. This is a temporary condition for once a new 1300MVA transformer can be procured in approximately 12 months, it will be used to replace the ASEA unit.

In addition to the installation of the ASEA transformer, the change will modify the instrumentation and control circuits, the fire protection system and the oil containment pit to fit with the new transformer.

This letter documents the environmental screening to determine if an unreviewed environmental question exists for the design change.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) permit and Appendix B of the Technical Specifications were reviewed in support of this screening to determine the potential environmental impact of this proposed design change.

Will this proposed activity result in a significant increase in any adverse environmental impact previously evaluated in the FES?

No. This proposed design change for the replacement of the GSU transformer will not result in a significant increase in any adverse environmental impact previously evaluated in the FES.

The FES recognizes the potential effects of the impact of plant operation and construction activities - on land, water, and human resources. The replacement, whereas it does add a transformer with more oil in it, does not change the conclusions from the existing FES. The environmental risks associated with the replacement transformer remain the same.

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

No. Similar transformers have been used on the site since the plant was first constructed. This type of use has been accepted by the FES.

Will the proposed activity result in a significant change in the constituent or quantity of effluents?

No. Significant change in the constituent or quantity of effluents is unaffected.

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

No. The authorized power level of Unit 1 and Unit 2 is unaffected by this change.

Will a previously undisturbed area be impacted by this activity?

No. The replacement transformer will be put into the place for the existing transformer.

Will a initiation or implementation of the proposed activity require modifications to existing permits?

No. The proposed design changes will not require modifications to existing permits.

Conclusion

Based on this review of the proposed design change to replace the GSU transformer, Nuclear Licensing and Fuels concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications, Appendix B
2) NPDES Permit
3) Final Environmental Statement, August 1973

Keywords

GSU transformer
Environmental

Approved by: D. H. Malin 9/14

D. H. Malin, Manager
Nuclear Licensing and Fuels

plt

cc: S. J. Brewer
C. A. Dickey
D. M. Fitzgerald/J. Carlson
D. H. Malin
J. P. Novotny
DC-N-6370.1
PRONET

AMERICAN ELECTRIC POWER

Date January 6, 1995

Subject D. C. Cook Nuclear Plant Units One and Two
Environmental Screening: Proposed Secondary Systems Chemistry Control Enhancements, Revision 1

From G. P. Arent

To M. J. O'Keefe

Introduction

This revision supercedes my December 18, 1994 memorandum to you on proposed chemistry control enhancements. The purpose of this revision is to update the ethanolamine concentrations anticipated at the plant outfalls (001, 002 and OOC) based on calculations provided in your January 4, 1995 memo (reference 12) and correct a typographical error. The changes resulting from this revision do not affect the conclusions reached in the December 18, 1994 memo. All changes have been marginally marked.

In an effort to improve protection of systems surfaces and reduce corrosion in secondary systems (feedwater, condensate, etc.), the plant heating boiler and the auxiliary steam system, the AEPNO Radiological and Chemistry Support Section (NSRP) has developed several chemical additive matrices for use at Cook Nuclear Plant. The additives proposed in the matrices (hydrazine, carbohydrazide, ammonia and ethanolamine) have already received Michigan Department of Natural Resources (MDNR) approval for use at Cook Nuclear Plant. The uses proposed by NSRP would be to vary the concentrations of the previously approve additives to enhance their effectiveness on secondary system chemistry control.

Review Action Taken

The Final Environmental Statement (FES), the National Pollutant Discharge Elimination System (NPDES) Permit, and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential environmental impact of varying the concentrations of hydrazine, carbohydrazide, ammonia and ethanolamine in secondary plant systems to improve system chemistry control.

In addition to the above documents, reviews were conducted of previous environmental evaluations and communications with the MDNR related to the above chemicals. A brief history of each chemicals approved usage follows:

1) Hydrazine: Hydrazine has been in use a Cook Nuclear Plant since initial plant licensing and is discussed in the Final Environmental Statement. The use of high concentrations of hydrazine was approved for plant use by the MDNR in 1993. Cook Nuclear Plant submitted requests to utilize hydrazine in concentrations up to 150 ppb in the feedwater system. The matrices proposes to increase hydrazine level to 300 ppb for normal feedwater and condensate system operation.

2) Carbohydrazide: Based on an environmental screening performed on April 13, 1994 (see reference 10), it was concluded that the use of carbohydrazide for oxygen scavenging and the protection of system surfaces at Cook Nuclear Plant did not result in a condition inconsistent with the existing environmental assumptions. The MDNR was notified of carbohydrazide usage on March 25, 1994.

   Use of carbohydrazide at the time of the above submittal was limited to the flushing of condensate and feedwater systems. The highest expected level of carbohydrazide in the effluent exiting the plant at outfall 001 was 0.34 ppb and outfall 002 was 0.005 ppb. Carbohydrazide usage proposed by the matrices would include, the addition of carbohydrazide to the plant heating boiler and steam generators (during layup) and increasing the normal concentration in the feedwater and condensate systems. The maximum concentration of carbohydrazide would be 40 ppm for boiler and steam generator layup conditions and less than 300 ppb for normal feedwater and condensate system operation.

3) Ethanolamine (ETA): an environmental screening (see reference 11) performed in October of 1993 determined that the use of ETA for pH control at D. C. Cook would not result in a condition inconsistent with the existing environmental assumptions made in the Cook Nuclear Plant Final Environmental Statement. The MDNR was informed of the use of ETA in the March 15, 1993 correspondence which included the high concentration of hydrazine notification (see reference 6). The self-imposed limit for ETA in the secondary system in the March 1993 submittal was less than 20 mg/l (20 ppm). Communications with the MDNR in April of 1994 stated the estimated ETA concentrations at the plant outfalls would average less than 10 ppb and not exceed a 100 ppb maximum. The proposed concentration of ETA in heating boiler and steam generators as defined in the matrices is 50 ppm, this would correlate to an estimated 79.4 ppb level (worst case conditions from steam generator starup blowdown) at the plant outfalls.

4) Ammonia: As discussed in your memo of November 29, 1994, ammonia constitutes a thermal decomposition product of both carbohydrazide and hydrazine. Additionally, ammonia is utilized for pH control. Increases in ammonia concentrations as a result of increased hydrazine levels were indicated to the MDNR in the March 1993 memo discussed previously. The increased ammonia concentrations indicated in the matrices remain below the value (50 ppm) approved in the 1990 revision to the National Pollution Discharge Elimination System Permit.

In accordance with procedure 661000-LTG-2200-01, Revision 0, "Preparation and Distribution of Environmental Evaluations, an Environmental Evaluation Check Sheet (Attachment No. 2) was performed. The conclusions of this check sheet follow:

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

No. The use of hydrazine, carbohydrazide, ethanolamine, and ammonia as a water treatment additives were not identified as a contributor to an adverse environmental impact in the FES. The FES assumed that water treatment additives would be found in the wastes streams of both surface water and ground water at Cook Nuclear Plant. As discussed previously, the use of these chemicals has previously been approved at different concentrations and or applications (e.g., use in the plant heating boiler similar to the steam generator application). The proposed use of these chemicals by the NSRP matrices does not constitute a change in the previously approved uses which would result in a significant, adverse environmental impact previously evaluated in the FES.

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

No. While carbohydrazide and ethanolamine (ETA) were not originally identified as a water treatment additive in the FES, hydrazine (which is a breakdown product of carbohydrazide at temperatures greater than 275° Fahrenheit) and morpholine (of which ETA is a breakdown product) were identified. Both products provide a similar function in that carbohydrazide acts an oxygen scavenger and ETA is utilized to control pH. As identified previously, the use of both carbohydrazide and ETA has been approved for use in other applications at Cook Nuclear Plant. Additionally, the use of carbohydrazide and ETA has been included in our 1994 application submittal for the Cook Nuclear Plant NPDES permit renewal. Therefore, the use of carbohydrazide and ETA does not constitute a matter not previously evaluated in the FES (i.e., chemical additives for oxygen scavenging and pH control).

Ammonia and hydrazine, as noted previously, have been utilized at Cook Nuclear Plant since initial licensing. The FES evaluated their use directly.

The potential discharge of these chemical additives via the turbine room sump to the absorption pond has also been addressed in both the original FES and the 1994 NPDES renewal application.

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

No. The use of the proposed chemical additives has been addressed in both the 1994 application submittal for the Cook Nuclear Plant NPDES permit renewal and previous communications with the MDNR. The proposed usage levels of hydrazine, carbohydrazide, ammonia and ethanolamine are bounded by the steam generator layup concentrations which are provided in the NPDES permit application as follows:

"The layup water contains a maximum concentration of 400 ppm hydrazine and/or 40 ppm carbohydrazide, 50 ppm ammonia and/or ETA and 20 ppm boron."

Regarding the discharge to groundwater systems, as stated previously, the original FES and the 1994 NPDES permit application addressed the potential discharge of chemical additives via the turbine room sump to the absorption pond. While it is expected during initial usage optimization, that the chemical concentration may be higher, the application states:

"The environmental benefits of these additives include utilization of more benign corrosion control products or products requiring lower effective concentrations."

Therefore, the waste strength of the proposed use of these chemical additives is not expected to exceed the values identified above for surface effluent or groundwater discharge in our NPDES permit application. As a result, the proposed activity will not result in a significant change in the constituent or quantity of effluent.

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity ?

No. The proposed use of carbohydrazide does not result in activities related to site grounds therefore, undisturbed areas will not be impacted.

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

No. The NPDES Permit will not be formally changed to allow for the proposed use of hydrazine, carbohydrazide, ammonia or ethanolamine. The current NPDES application submittal currently contains the proposed uses of these chemical additives, therefore, no change to the NPDES Permit is required.

> Notification of the use of carbohydrazide in the plant heating boiler applications and the increased concentrations of carbohydrazide, ethanolamine and hydrazine to the Michigan Department of Natural Resources (MDNR) in accordance with Part II.A.2 of our permit will be required prior to the proposed use of these additives.

Based on the above screening, it has been determined that the use of the use of carbohydrazide, hydrazine, ammonia and ethanolamine for the protection of system surfaces at Cook Nuclear Plant does not result in a condition inconsistent with the existing environmental assumptions. In support of this determination, discussions were held with Messrs. M. J. O'Keefe of the Radiological and Chemical Support Section on December 16, 1994. Based on these discussions and the information provided therein, the use of the above chemical additives in the condensate, feedwater, steam generator and plant heating boiler systems is considered acceptable.

<u>Open Item(s)</u>

It was noted in discussions with Mr. M. J. O'Keefe (NSRP) that the MDNR has not been notified, with the exception of our 1994 NPDES application submittal, of the proposed uses of hydrazine, carbohydrazide, ammonia and ethanolamine as described in the matrices.

If verbal or written approval of the use of these chemical additives, as described in the matrices, has been received from the MDNR as part of their NPDES application review, usage of the additives may begin immediately.

If verbal or written approval has not been received, then notification of the use of carbohydrazide in the plant heating boiler applications and the increased concentrations of carbohydrazide, ethanolamine and hydrazine to the Michigan Department of Natural Resources (MDNR) in accordance with Part II.A.2 of our permit will be required prior to the proposed use of the additives.

<u>Conclusion</u>

Based on this review of the proposed use of carbohydrazide, hydrazine, ammonia and ethanolamine in the condensate, feedwater, steam generator and plant heating boiler systems, the Nuclear Licensing and Fuels Section concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973
4) Memo, M. J. O'Keefe to J. B. Kingseed, Donald C. Cook Nuclear Plant Safety Review of Carbohydrazide as an Oxygen Scavenger During Condensate Flushing, April 13, 1994.
5) Memo, D. L. Baker to Mr. Fred Morley, Donald C. Cook Nuclear Plant NPDES Permit No. MI 0005827, (Topic: Use of Carbohydrazide), March 25, 1994.
6) Memo, M. J. O'Keefe to E. E. Fitzpatrick, et al, "Field Evaluation of Ethanolamine for Secondary Side pH Control for Unit 1 and 2", August 16, 1993.
7) Memo, D. L. Baker to Mr. Fred Morley and Mr. Thomas Leep, "NPDES Permit No. MI0005827 Cook Nuclear Plant, Bridgman, Michigan", March 15, 1993.
8) Application Transmittal, D. L. Baker to Mr. William E. McCracken, "Indiana Michigan Power Company, Donald C. Cook Nuclear Plant NPDES Permit No. MI 0005827 Renewal Application." Dated March 31, 1994.
9) Application Transmittal, D. L. Baker to Mr. J. B. Beauboeuf, "Donald C. Cook Nuclear Plant, Ground Water Discharge Permit Application." Dated March 11, 1994.
10) Memo, G. P. Arent to J. P. Carlson, "Cook Nuclear Plant, Environmental Screening Memorandum, Use of Carbohydrazide in Condensate and Feedwater Systems." Dated April 13, 1994.
11) Memo, G. P. Arent to 12-THP 6020.LAB.041, CS-22 Packet, "Environmental Screening Change Sheet No. 22, 12-THP 6020.LAB.041, Datasheet Instructions." Dated October 25, 1993.
12) Memo, M. J. O'Keefe to J. Carlson, "Ethanolamine Discharge Levels." Dated: January 5, 1995.

Keywords

condensate
feedwater
carbohydrazide
hydrazine
ethanolamine
ammonia
npdes permit
plant heating boiler

Approved by: DHM
D. H. Malin, Manager
Nuclear Licensing and Fuels

c: S. J. Brewer
D. M. Fitzgerald/J. Carlson/J. Lewis
M. J. O'Keefe
D. O. Morey/R. Claes
J. P. Novotny
DC-N-6370.1

APPENDIX III

HERBICIDE APPLICATION REPORT

1995

INDIANA
MICHIGAN
POWER

Date March 1, 1996

Subject 1995 Herbicide Spray Report - Cook Nuclear Plant

From J.S. Lewis

To J.P. Carlson

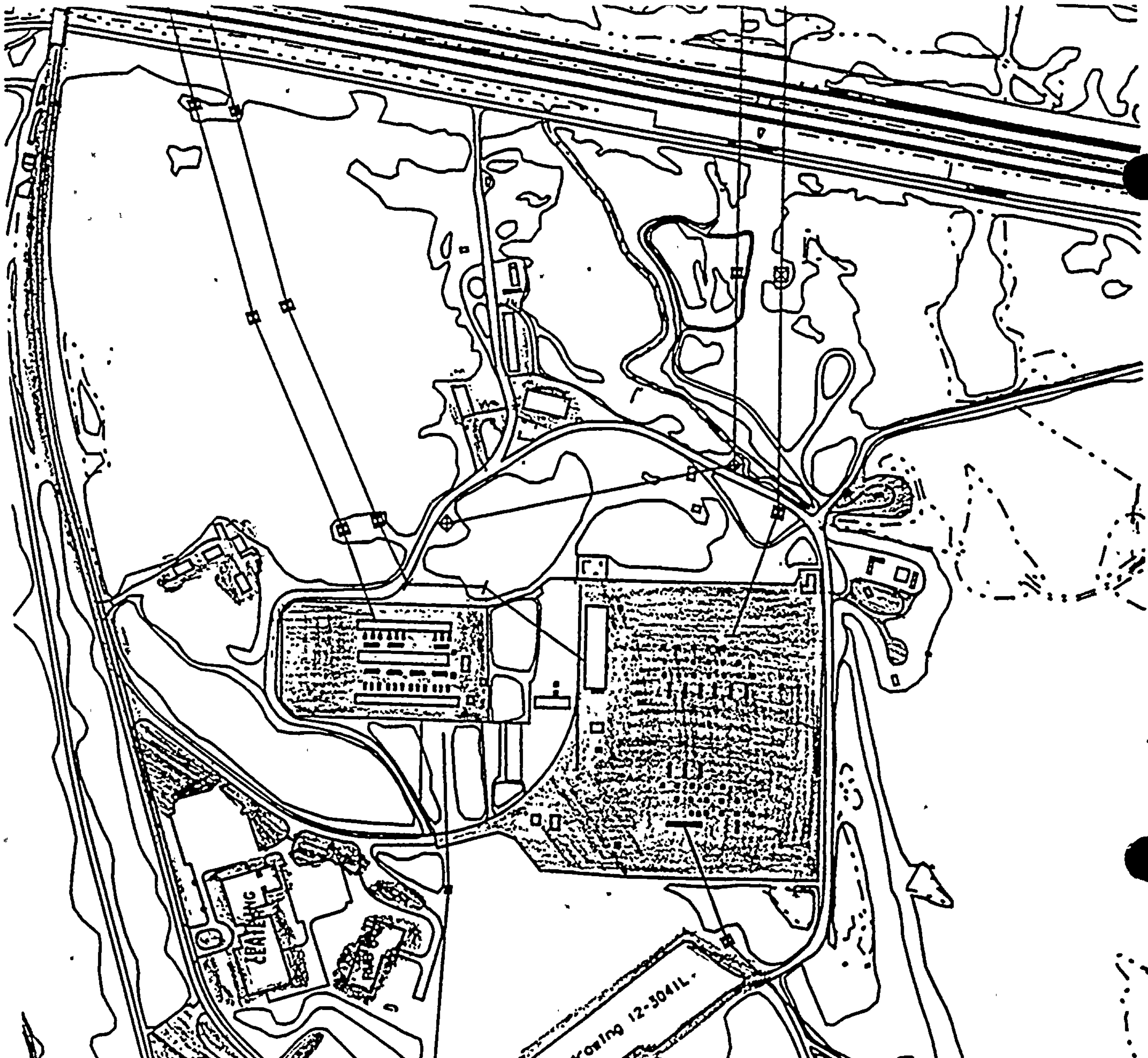
The following herbicides were applied on Cook Nuclear Plant property during 1995:

- Trimec 899 Broadleaf Herbicide
- Oust Herbicide
- Lesco Pre-M 3.3 EC Herbicide

Site areas that were treated with herbicides are highlighted on the attached maps.

Based on our review of the application records, manufacturer specifications, material safety data sheets (MSDSs) and observations of the treated areas, the herbicides were applied according the manufacturer label recommendations and according to Federal and State requirements. A certified applicator was used as required. No signs of overspray or spillage were observed or noted. No adverse environmental effects occurred.

Intra-System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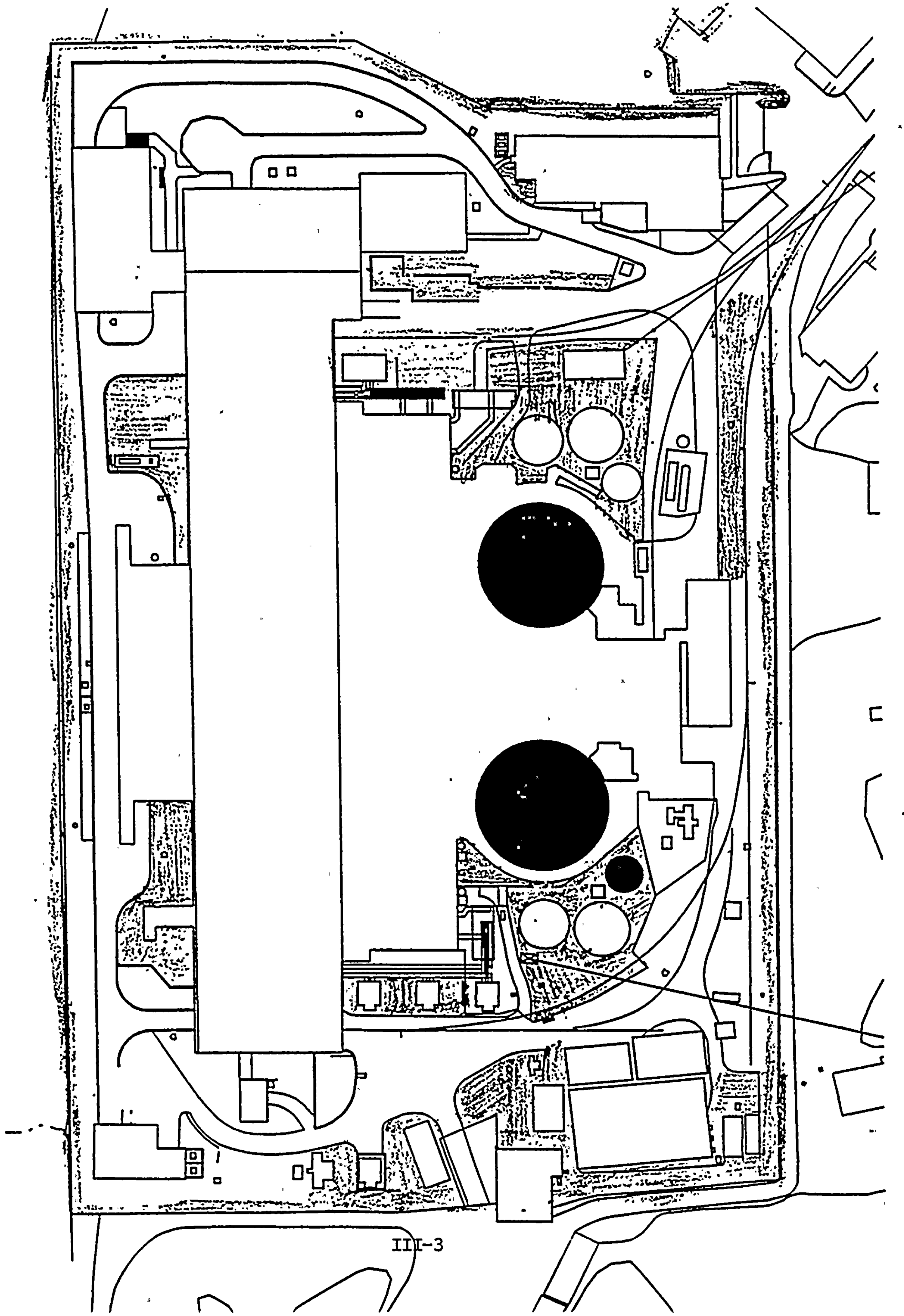
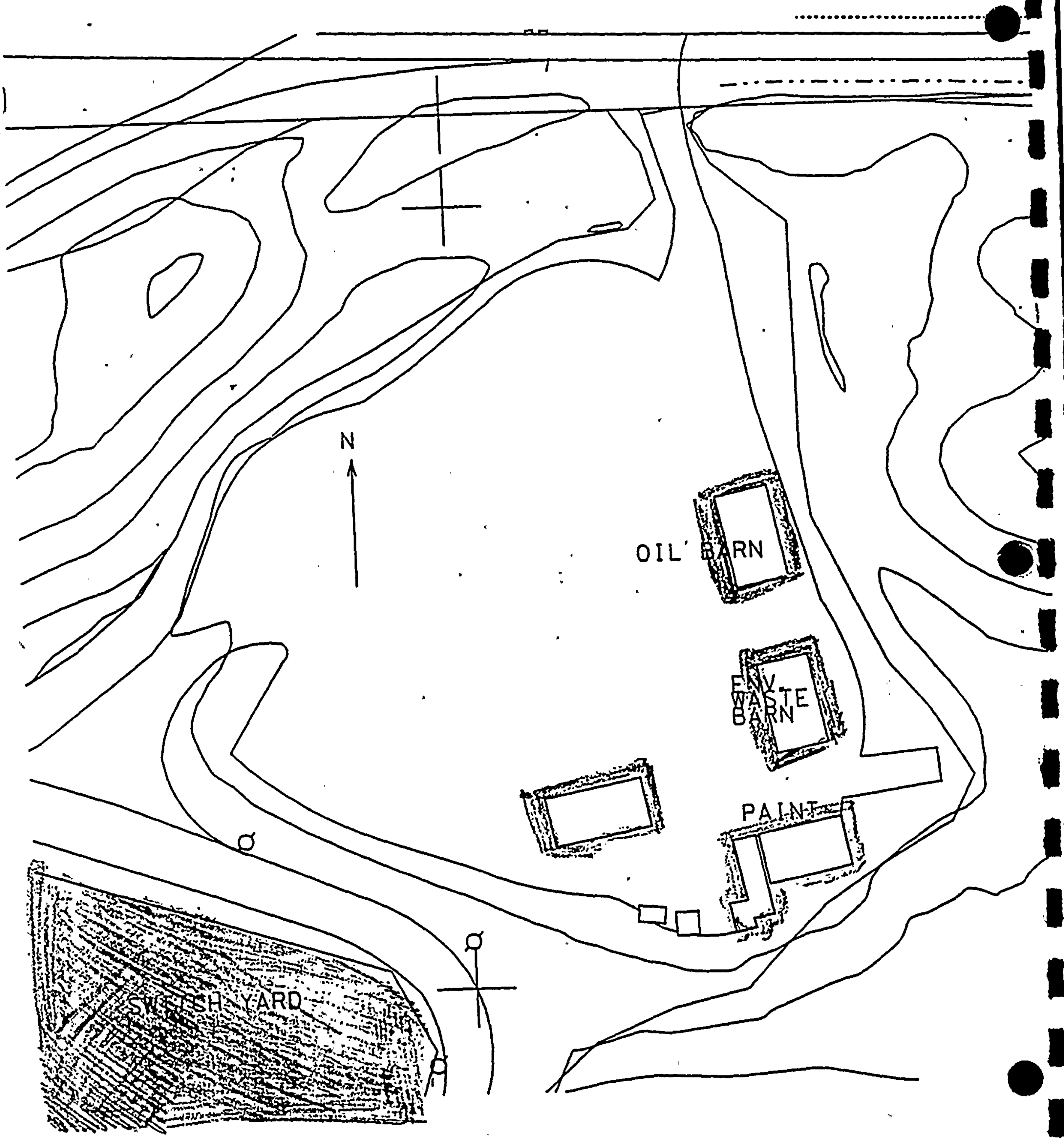
see drawing 12-3041S

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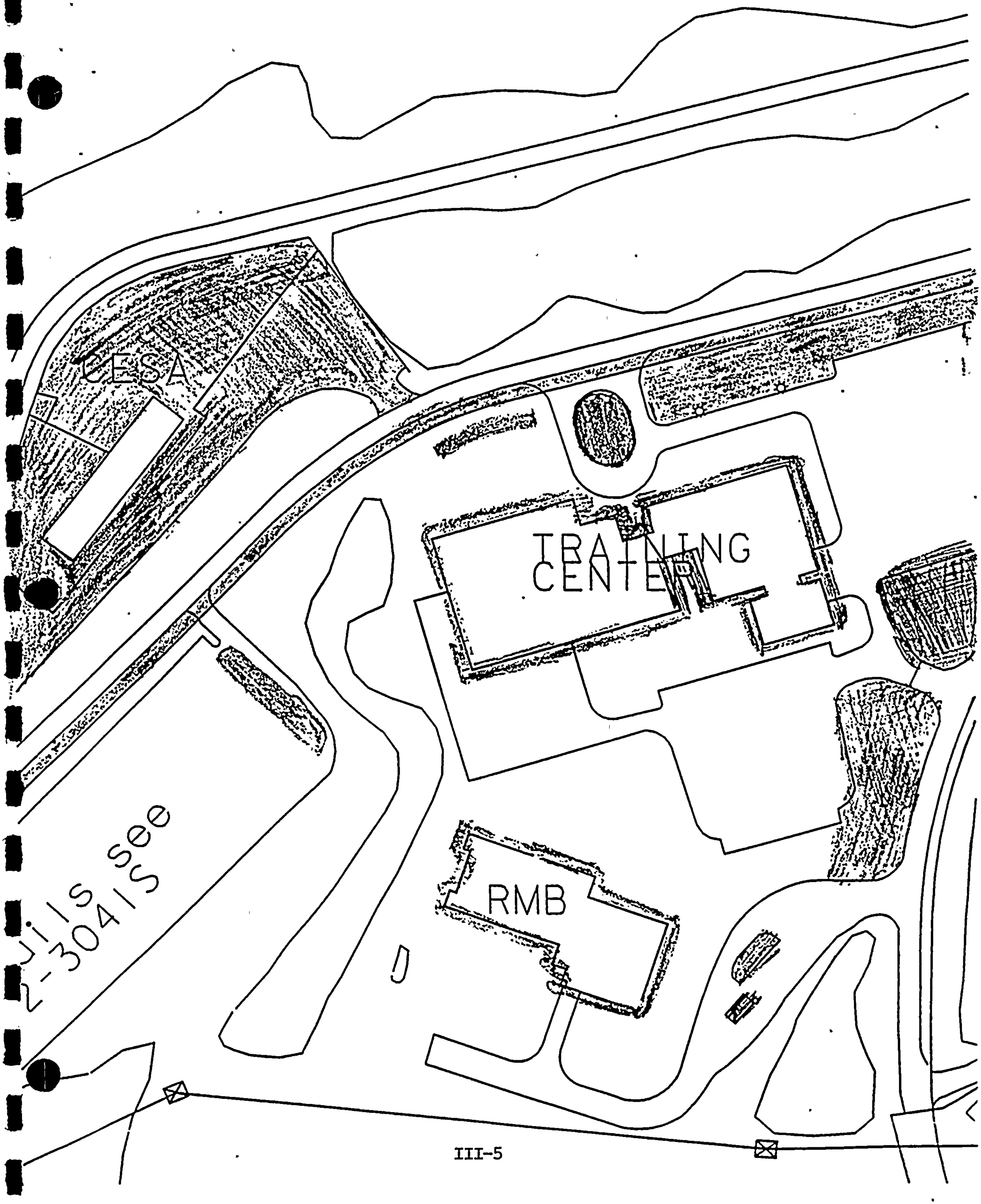
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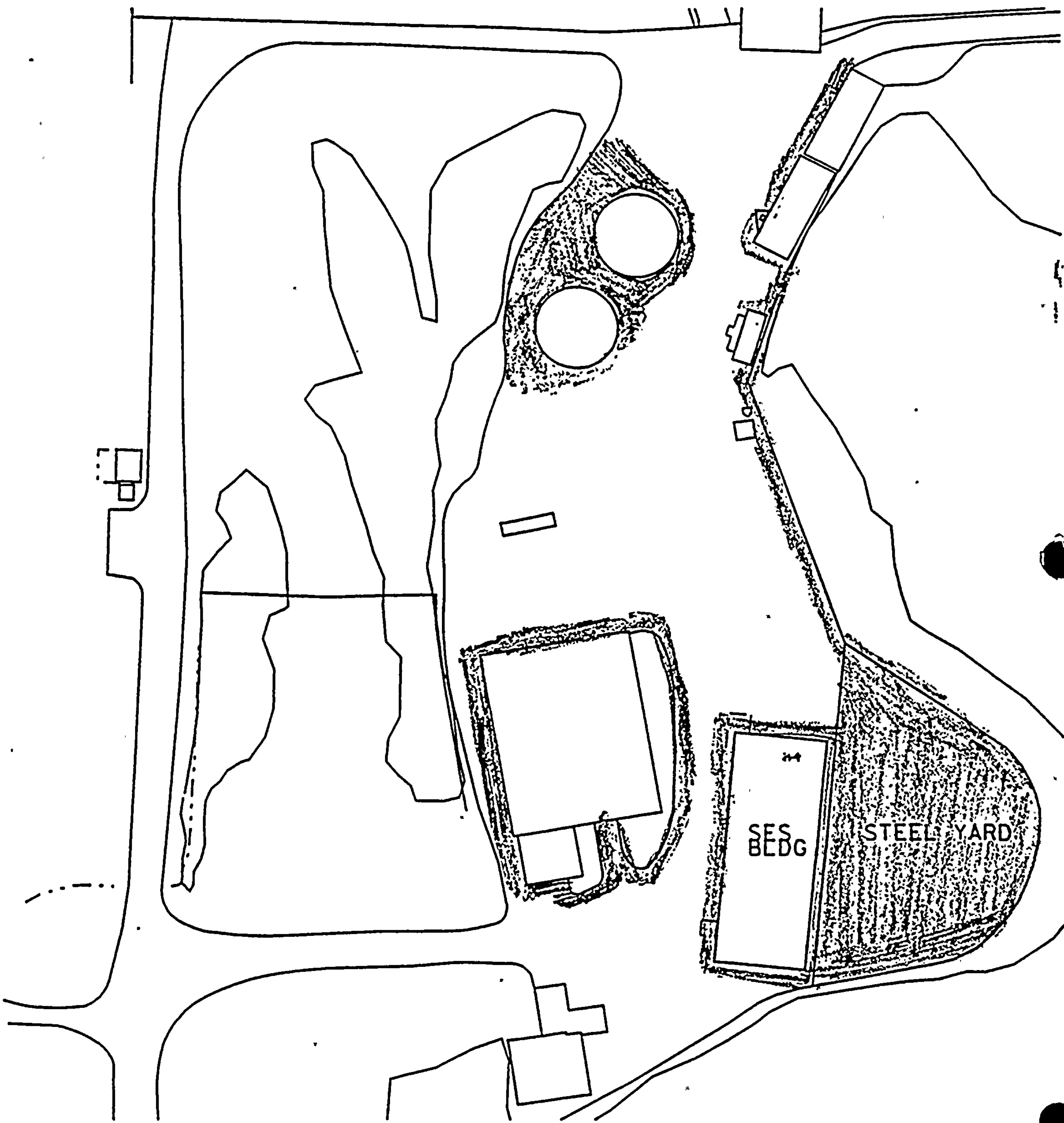
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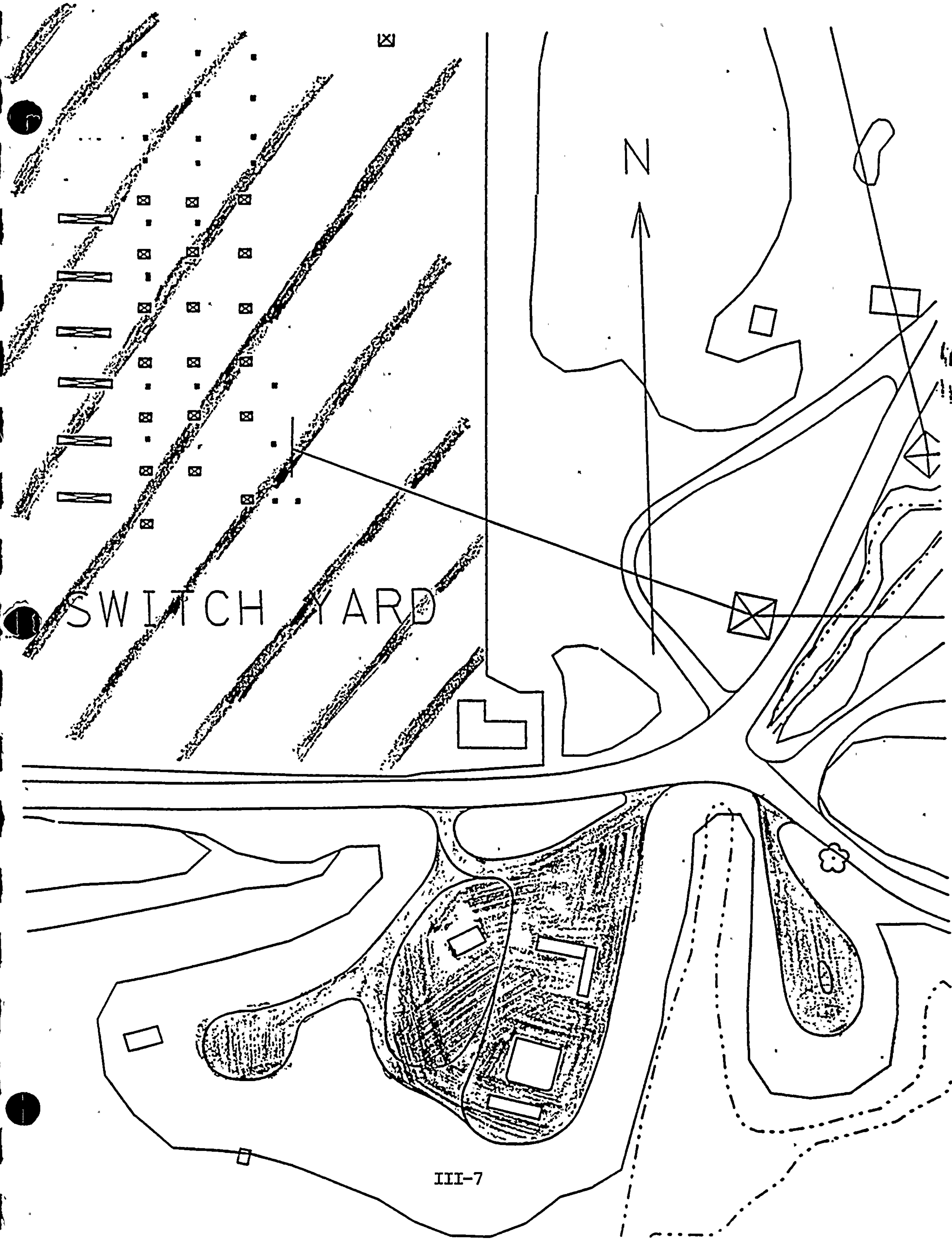
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APPENDIX IV

MACROFOULER MONITORING CONTROL PROGRAM, AND WHOLE EFFLUENT TOXICITY TESTING

1995

Cook Nuclear Plant
1995 Zebra Mussel Monitoring
and Control Report

INTRODUCTION

The Plant's Zebra Mussel Monitoring and Control Program is presented in the reports that follow. Chlorine, molluscicides, and mechanical cleaning, 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.

ERADICATION AND CONTROL MEASURES

The 1995 control strategy consisted of the use of proprietary molluscicides, (Betz Clam-trol CT-2 and Nalco Macro-trol 9380) continuous and intermittent chlorination of the service water, Miscellaneous Sealing and Cooling Water, and Circulating Water systems, and mechanical cleaning.

MECHANICAL CLEANING

Mechanical cleaning of the Unit 1 Intake Forebay and Unit 1 Essential Service Water pump bays was performed by divers during the Unit 1 Refueling Outage in 1995. The Unit 1 Main Condenser Inlet Tunnel was inspected and cleaned during the Unit 1 Refueling Outage. Cleaning and flushing of small bore piping and strainers in the service water systems and low volume water systems was continued in 1995.

All three intake cribs were cleaned in the fall of 1995 to minimize the impact of the intakes on wild ducks. Contrary to 1994's intake structure cleaning which resulted in the entrainment of thirty-three (33) wild ducks in February of 1995, 1995's cleaning was more effective as only two ducks were reported being entrained into the plant in the winter of 1996.

MOLLUSCICIDE TREATMENT RESULTS

A small targeted treatment using Betz Clam-trol CT-2 was performed on the Miscellaneous Sealing and Cooling Water System before it was cross-connected with the Non-Essential Service Water System. Mortality results were 100%. A large scale treatment of the Circulating Water System using Nalco Macro-trol 9380 applied at the North and South Intake cribs on September 16, 1995 was unsuccessful.

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 0.3 to 0.6 ppm was effective in controlling the settlement of zebra mussels in these systems. Intermittent chlorination of the Circulating Water System at 0.2 ppm for 155 minutes per day 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 was still plagued by silt and shell fragments which pass through the Miscellaneous Sealing and Cooling Water Pump Strainers and plug small bore piping downstream.

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.

Modifications of the traveling screen spraywash system in 1995 from a single to a dual spray header with improved nozzle design effectively removed the debris from the screen mesh when the spray headers and spray nozzles did not plug with shell debris. The installation of spray header blowdown piping to facilitate flushing of the spray header is in progress.

CONCLUSION

Weather, plant conditions, water temperature, and other constraints, can confound efforts to remediate juvenile and adult zebra mussels using a proprietary molluscicide in the Circulating Water System. Mechanical cleaning can supplement chemical control methods in the Circulating Water System. Continuous chlorination has proven to be effective in controlling zebra mussels in the service water and the Miscellaneous Sealing & Cooling Water systems. 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.

A ZEBRA MUSSEL (*Dreissena*) MONITORING SURVEY FOR THE DONALD C. COOK PLANT

April - December 1995

Prepared for:

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EXECUTIVE SUMMARY

American Electric Power (AEP) has been monitoring for zebra mussels in the circulating water, essential service water (ESW) and nonessential service water (NESW) at the D.C. Cook Nuclear Plant near Bridgman, Michigan since 1991. The objective of the zebra mussel monitoring program is to monitor incoming lake water zebra mussel veliger and post-veliger settlement concentrations and determine the effectiveness of zebra mussel control via mechanical and chemical means. The scope of work for this study was developed by AEP, as a continuation of AEP zebra mussel control strategies and monitoring programs. This zebra mussel monitoring survey for the D.C. Cook Plant was conducted to supplement ongoing studies and surveys by AEP.

Great Lakes Environmental Center (GLEC) continued the work in 1995 by monitoring the density of veligers in the forebay and the settlement of post-veligers in the three cooling water systems from April through December. Veliger larvae were first observed in the whole-water samples on June 1, and continued to be observed until October 26. Size data for veligers in the whole-water samples suggests that spawning was initiated in the first part of June. Overall, veliger densities were significantly less than previous years and were first noted in the samples at later dates. However, similar trends in the timing and abundance of veligers were observed. Peak spawning activity occurred during mid-August through mid-September which was similar to that observed in 1994. The peak density in the forebay circulating water was on September 28 (5130 / m^3).

Settlement in the forebay began on June 15 and peak settlement densities were observed on three consecutive sampling events; July 27 (338,133 / m^2), August 10 (177,200 / m^2, and August 24 (226,667 / m^2). Peak densities for all of the service water systems (NESW-2, MS&C, ESW-1, and ESW-2) were observed on September 7, however the average size of settled post-veligers was considerably less than those observed in the forebay samples during this same period.

Cumulative settlement in the service water systems reached peak density in all systems on August 24. Cumulative densities in the NESW-2, MS&C, ESW-1, and ESW-2 systems during this period were 92,800 / m^2, 92,800 / m^2, 68,800 / m^2, and 79,467 / m^2,

respectively. Molluscicide treatment on September 16 was apparently effective in removing settled veligers, because veliger densities reduced 75.9, 76.5, and 68.9 percent in the NESW-2, ESW-1, and ESW-2 systems cumulative samples, respectively, when densities were compared to the August 24 samples (pre-treatment) and the September 21 samples (post-treatment). Densities in the MS&C remained high in cumulative samples collected on September 21, however, these were likely entrained, planktonic veligers because their average size was 125 μm.

Chlorine treatment (when in operation) was effective in deterring or preventing settlement in the service water systems. Post-veliger settlement rates in the periodic settlement samples was typically less than 1500 / m^2 / day when the chlorination system was in operation. Peak settlement (based on density and size) in the service water systems occurred between the period of August 24 and September 21, which directly corresponds to chlorine being nearly absent from the service water systems during this entire period. Therefore, it is important to limit chlorination system outages during periods of high post-veliger settlement. References made in the report to chlorine concentrations were based on data collected at the Cook Plant final discharge after mixing with the circulatory water.

The target for AEP's system chlorination is 0.2 - 0.6 mg/L TRC in the service water systems. The chlorine concentration values reported here are less than the target values because the circulating water had mixed with the service water and thereby diluting the total chlorine prior to discharge.

A ZEBRA MUSSEL (*Dreissena*) MONITORING SURVEY FOR THE DONALD C. COOK PLANT

April - December 1995

INTRODUCTION

American Electric Power (AEP) has had an active zebra mussel monitoring program at the D.C. Cook Nuclear Plant (Cook Plant) near Bridgman, Michigan since 1991. The abundance of zebra mussels is monitored in the circulating water, essential service water (ESW) and nonessential service water (NESW) systems. The objective of the zebra mussel monitoring program is to monitor incoming lake water zebra mussel veliger and the post-veliger settlement density to help determine the effectiveness of zebra mussel control via mechanical and chemical means. The scope of work for this study was developed by AEP, as a continuation of AEP zebra mussel control strategies and monitoring programs. This zebra mussel monitoring survey for the Cook Plant was conducted to supplement ongoing studies and surveys by AEP.

The Zebra Mussel Monitoring Program in 1995 involved determining the density of zebra mussels in the circulating water and in the service water systems of the Cook Plant, and subsequently determining the effectiveness of AEP's efforts to control zebra mussels. Whole-water collected from the circulating water system at the forebay were analyzed to determine zebra mussel veliger density, and artificial substrates were placed in the intake and in four of the service water systems to detect and monitor the settlement of post-veligers.

METHODS

The specific methods for each task are described below and are based upon the procedures outlined by AEP for this work (dated January 31, 1995). Where applicable, GLEC standard operating procedures (GLEC II-50-00), which are based on procedures published by the Illinois Natural History Survey (Marsden, 1992), were also used for analysis and enumeration of the samples.

Whole-water Veliger Sampling

The whole-water sampling of the circulating water system was conducted from April 28, 1995 to December 14, 1995, according to the schedule presented in Table 1. The samples were collected from mid-depth in the forebay at a location determined by Cook Plant personnel and consistent with previous studies. Two replicate, 2000-liter samples were collected from the intake forebay immediately upstream of the trashracks by pumping lake water with a submersible pump (Myers, "The Predator", Model# 2JF-51-8; approximate pump rate of 45.4 liters per minute) through an in-line flowmeter (Signet Model# P58640) and into a plankton net (Wildco®, approximately 100 μm mesh size) for approximately 45 minutes. The flow was directed into the plankton net that was suspended in a partially filled 208-liter plastic barrel. This technique had been used in previous surveys at Cook Plant to prevent the net from overflowing when heavy sediment loads or plankton concentrations were present (Lawler Matusky & Skelly Engineers (LMS), 1994). The sample was gently washed into a one-liter nalgene® collection bottle using filtered, circulating water and the volume adjusted to one liter. The first replicate was analyzed within two hours of collection at a nearby off-site location for the presence or absence of veligers, and the second replicate was refrigerated and analyzed immediately following the first sample.

Whole-water samples were pumped from the original location in the forebay from April 28 through June 29, 1995. After the first pump was damaged, whole-water samples were collected from a different position, centrally located in the forebay, using an AEP diving contractors pump which was the same model and had the same pump rate. This pump

was used for samples collected from July 6 through September 7, 1995. On September 14, 1995, samples were collected using a new pump placed in the original location. On September 28, 1995, the new pump was again moved to the central location (this was due to too much current). The pumping rate dropped to 30 liters per minute (due to damage to the pump), therefore, the sampling time was increased to approximately 62 minutes to compensate for this new rate. This pump was used at the central location for the remainder of the study.

To insure that each sample was completely mixed prior to analysis, each one-liter whole-water sample was mixed using a commercial, magnetic stir plate (VWR, Model 200). After three minutes of mixing, ten, one-milliliter sub-samples were removed from the center of the sample with a calibrated pipette. Each one-milliliter sample was transferred to a Sedgewick-Rafter® cell for counting. The veligers in the cell were counted at 50-100X using a low-power binocular microscope (Wild®) equipped with cross-polarizing light filters. This technique has been successfully used by other researchers to accurately and quickly identify veligers with good success (Johnson, in press and personal communication).

A preliminary scan of the entire counting cell was conducted to determine if dilution was necessary prior to counting the veligers in the sample. If less than 60 veligers were present in the sample, no dilution was necessary and all of the veligers on the entire slide were counted. If greater than 60 but less than 100 veligers were present, five, one-milliliter subsamples were counted. If greater than 100 veligers were present, the sample was diluted 1:10 and the entire cell was counted. The number of organisms counted in each subsample, the dilution factor (if any), sample location, sample date, the average number of veligers per milliliter, and the veliger density were recorded on the data sheet. The density was calculated as follows:

Density (#/m^3) = (Average# * DF) / .001L * 1L / 2000L * 1000 L/m^3

where,

DF = dilution factor; Average# = average # per ml.

The duplicate sample was analyzed using the same technique described above. In 1995, the whole-water samples were not diluted on any sampling event.

Size measurements were recorded for each sample from no more than 50 organisms. Veliger length (μm) was measured using an ocular micrometer that was previously calibrated to a stage micrometer according to GLEC standard operating procedure GLEC II-009-00.

Periodic and Cumulative Artificial Substrate Samples

Settlement of post-veliger zebra mussels in the circulating water forebay, two Essential Service Water systems (ESW-1 and ESW-2), the Miscellaneous Sealing and Cooling (MS&C) system, and a Non-Essential Service Water (NESW-2) system was evaluated using artificial substrate sampling. Periodic and cumulative sampling were performed according to the schedule outlined in Table 1.

Circulating Water Forebay Sampling

Settlement in the forebay was determined at a mid-forebay location by monitoring the periodic and cumulative settlement of zebra mussels. Periodic substrate monitors in the forebay consisted of ten microscope slides held within a test tube rack inside a concrete block. The block was suspended directly in front of the trash racks at mid-depth using a rope. On each collection date, the block was retrieved and the microscope slides were removed for analysis and replaced with a clean set of microscope slides. Sample enumeration of each slide was conducted by scraping one side of each slide with a razor blade to remove all of the attached zebra mussels and debris to provide an unobstructed view for the other side of the slide. The scraped side of the slide was placed down on the dissecting microscope stage. Each slide was initially scanned to locate and identify settled juvenile mussels. If juvenile densities were low, all settled mussels on the slide were counted and the number was recorded. If densities were high, the slides would be either quartered or halved, depending on the observed densities, and the remaining mussels were

counted. The length (μm) of the juvenile zebra mussels (up to a total of 50) was also recorded. The density of the mussels was calculated by proportionately extrapolating the number of mussels counted on the slide to one square meter (m^2). The density for each sample was calculated as follows:

Density (#/m^2) = Average # per slide * (10,000/18.75)

where:

18.75 is the number of square centimeters (cm^2) on one side of a slide and 10,000 is the number of cm^2 in a square meter (m^2).

Cumulative samples in the forebay were also analyzed to provide information on the accumulated infestation during the season. Cumulative substrate samples in the forebay consisted of two, 15.24 centimeter long PVC pipes with a 6.35 centimeter ID, cut in half lengthwise and held together with a hose clamp. These sample devices were set on April 28 and removed on December 14, 1995 except that one sampler was temporarily removed on September 16 during the time the systems were receiving molluscicide treatment, and submersed in a untreated sidestream monitor. After seven days, that sampler was placed back in the forebay on September 23 after the molluscicide treatment had ended. Cumulative settlement in the forebay was determined by scraping two discrete 6.45 cm^2 (one square inch) sections in the central region of one half section of the pipe sampler. The middle section of each pipe sampler was selected for analysis to maintain consistency with historical sampling at the plant. The average density for the two areas was then calculated and the number of veligers per square meter was extrapolated from the average number of zebra mussels per 6.45 cm^2 (one square inch) on the sampler.

Service Water Sampling

Settlement in the service water systems was monitored in sidestream monitors at four locations; NESW-2, MS&C, ESW-1, and ESW-2 systems. The placement of the monitors was identical to the placement in previous studies. The monitors were covered as in

previous studies with a fabric to limit light exposure. Plant personnel checked the monitors on a regular basis to ensure proper water flow was present. Periodic sampling devices were deployed on April 28, 1995 in each side stream monitor. Periodic sampling of the service water systems was accomplished by placing 10 slides held in a sampler supplied by AEP in each flow-through sidestream monitor. These slides were retrieved for periodic sampling on each of the scheduled dates (Table 1). On each sampling date, ten slides were removed for analysis and replaced with ten, clean slides.

For the cumulative samples, two test tube racks holding a total of 80 microscope slides were placed inside the same flow-through sidestream monitors used for the periodic monitoring. Each month throughout the study, a group of ten slides were randomly removed from each rack for analysis and were not replaced.

On each sampling event, all of the collected microscope slides (a total of 40) were placed in a cooler immediately after collection in labelled slide racks and analyzed that same day at a nearby off-site location for attached post-veligers, using a low-power binocular microscope equipped with cross-polarizing filters. The attached post-veligers were counted in both the periodic and cumulative samples by averaging the number of post-veligers found on the 20 slides (10 periodic and 10 cumulative) from each sampling site. The average number of attached post-veligers per slide was extrapolated to determine density per square meter. The density for each sample was calculated as follows:

Density ($\#/m^2$) = Average # per slide * (10,000/18.75)

where:

18.75 is the number of square centimeters (cm^2) on one side of a slide and 10,000 is the number of cm^2 in a square meter (m^2).

Shell size was measured to the nearest micrometer using an ocular micrometer calibrated to a stage micrometer. On September 28 and again on November 14, the four sidestream monitors (bioboxes) that held the periodic and cumulative slides for each service water system accumulated approximately 7 and 12 centimeters of sediment due to rough lake conditions and were cleaned of dirt and debris.

Quality Assurance/Quality Control

A total of four samples were reanalyzed by a different staff member to determine the precision and accuracy of our counting procedures. These samples were collected on April 28, June 1, August 24, and October 5, 1995. These samples were shipped to an off-site laboratory and analyzed using the same procedures as the original analyses.

RESULTS AND DISCUSSION

Whole-Water Samples

Whole-water sampling was initiated in the forebay on April 28, 1995 and continued until December 14, 1995. A total of 56 samples (two from each sampling period) were collected (Table 1). Veliger larvae were first observed in the whole-water samples on June 1, 1995 and continued to be observed until November 16, 1995. On November 2 and December 14 no veliger larvae were observed, however, veligers were present in the November 16 sample.

Peak spawning activity occurred during mid-August through late-September. Figure 1 and Table 2 summarize the results of the whole-water sampling. Peak densities were observed on August 17 (3,050 / m^3), August 31 (3,325 / m^3) and September 28 (5,150 / m^3). Veliger densities in the forebay were noticeably lower than in previous sampling years. The average whole-water veliger density over the nine month period was 766 / m^3, ranging from a low of zero to a high of 5,150 / m^3. In contrast, the average density over the same nine month period in 1994 was 45,794 / m^3, with densities ranging from zero to 513,500 / m^3. The increase in veliger density in the September 28 sample corresponds directly with the sampling pump location change. At that time the observed pump rate during sample collection was reduced (45.4 lpm to 30.3 lpm), and the location of the pump in the forebay was moved (from the original location to the center of the forebay). These differences in sample collection and the peak density in the whole-water sample may be only coincidental since we are unable to determine if the increase is a reflection of a natural veliger population

peak, residual veligers remaining in the sample collection hose from a previous sample, or a possible spatial variable (such as currents) occurring in the forebay that is reflected by the position of the pump in the forebay. However, a second peak density period is typical for the lower Great Lakes, which normally experience two peak densities during September and October (Garter and Haag, 1990 and LMS, 1995) and it also corresponds with the time lapse between our first observation of settled post-veligers and the time of reported spawning frequency of sexually mature zebra mussels.

Size data for the whole-water sampling indicates that spawning began in the early part of June. Translocators (veliger larvae greater than 600 μm) were found during each sampling month, with the exception of April, May, and December. The average size of the veliger larvae in the forebay whole-water samples ranged from 140 to 903 μm. Of the 28 sampling dates, only 21 percent (6 of 28) of the days had average veliger sizes that ranged between 180 to 250 μm, which is the reported size range in which veligers settle (Marsden, 1992). The presence of translocators in the samples may be the result of natural weather conditions (i.e. wind, waves, temperature) which have been reported to influence veliger distribution and abundance, such as which was reported during the 1993 survey (LMS, 1994).

The data also show a typical population density curve for the growing season, with the noted exception of two peak densities. Previous research on Lake Erie has noted two spawning peaks, in late July and late August (Garton and Haag, 1990). Our data shows two peaks were present in mid and late August, and a third peak occurred in late September (Figure 1).

Periodic Artificial Substrate Samples

A total of 70 periodic samples were collected from the five sample locations during 14 sample events from May 11 to December 14, 1995 (Table 3). Each sample contained 10 replicate slides. Post-veligers of settleable size were first observed in the forebay on June 15 and continued to be observed through the December 14 samples (Table 3). A single, adult translocator (2376 micrometers) was found in the June 1 sample. Settled post-veligers were

first observed in the ESW-2 and NESW-2 systems on June 29 and were observed throughout the remaining sampling period. The first settled post-veligers in the ESW-1 and MS&C systems were observed on July 13 and continued to be observed through the November 16 sample.

The average size of the settled post-veliger larvae in the forebay samples ranged from 243 to 3,754 μm, with 92 percent of the observed post-veligers averaging greater than 250 μm. In contrast, the average number of samples with post-veligers greater than 250 μm for the NESW-2, MS&C, ESW-1, and the ESW-2 systems was 36, 0, 20, and 30 percent respectively. This data suggests that either the growth rate was slower in the service water systems than in the forebay, that translocators were often absent in the service system samples, or that the post-veligers settle and then move on.

The highest density of settled post-veligers in the forebay was observed in three consecutive samples on July 27 (338,133 / m^2), August 10 (177,200 / m^2), and August 24 (226,667 / m^2) (Figure 2). The size of the veliger larvae during those same periods ranged from 120 to 540 μm. In the MS&C, ESW and NESW service water systems, the greatest density of settled post-veligers was observed on September 7 (Figure 3). The density of settled post-veligers on September 7 in the NESW-2, MS&C, ESW-1, and ESW-2 service water systems was 52,800 / m^2, 64,533 / m^2, 19,733 m/ ^{2}, and 35,733 / m^2, respectively (Table 3). The average size of settled post-veligers for all of the service water systems for the September 7 sampling period ranged from 143 μm in the MS&C system to 192 μm in the ESW-2 system. The corresponding average size in the forebay was 254 μm in the September 7 sample. The smaller size of veligers in the service water systems, which is near the reported settlement range, suggests that active settlement was starting to occur in the service water systems with young veligers, whereas in the forebay, settled post-veligers were actively growing and the samples may have contained more translocators.

Typically, veliger larvae attach to a substrate within 8 to 15 days post-hatch. With the exception of the October 5 periodic sample, this general trend was present, with the greatest settlement rates following increased densities in the forebay whole-water samples (Figure 4). However, the variable chlorine concentrations and interrupted chlorine service

confounded the results and made it difficult to correlate periodic settlement with whole-water veliger density (Figure 5).

Cumulative Artificial Substrate Samples

A total of 34 cumulative samples were collected during 8 sampling events from May 11 to December 14, 1995 (Table 4). Settled post-veligers were first observed in the MS&C system on June 15, and in the NESW-2, ESW-1, and ESW-2 systems in the July 13 sample. Settled post-veligers were observed in the MS&C and ESW-1 systems through the November 16 sample and in the ESW-2 and NESW-2 systems through the December 14 samples (Figure 6).

The size range of post-veligers in the cumulative samples indicates that chlorination was effective in reducing veliger settlement in the service water systems. Initial settlement in the MS&C on June 15 was not unexpected, since chlorination for that system was not initiated until June 15 (Table 5). Average size data ranged from 120-130 μm in the July samples, which is less than the typical settlement range of 180-250 μm. These data suggest that the planktonic veligers had only recently attached to the slides and that older veligers were not present. Previous reports have suggested that the planktonic veligers had been entrained on the slide upon its removal from the biobox (LMS, 1994 and 1995). However, that would suggest that the veligers can readily attach during chlorination and that they would be evenly distributed throughout the sample. Otherwise, it is likely that the relatively small size of the veligers is an indication that the chlorine is effective at reducing settlement and as a result the veligers that are present are transient in the service water systems.

The August samples had the highest densities and the average size of post-veligers (166 - 201 μm) was somewhat larger than the size noted in July, suggesting active settlement was occurring during this time period Table 4. However, veligers in the size range observed in the August cumulative samples were still smaller than the typical settlement size (180 - 250 μm). Again suggesting that they had only recently attached themselves to the cumulative substrate sample slides. Two trends are readily apparent from this data; the increase in post-veliger settlement in August corresponds with some of the greatest numbers of veligers in the

whole-water samples and the increase in post-veliger settlement also corresponds with the interruption of chlorination in the service water systems. Settled post-veliger density in the August 24 samples in all the service water systems (NESW-2, MS&C, ESW-1, and ESW-2 samples) was 92,800 / m^2, 92,800 / m^2, 68,800 / m^2, and 79,467 / m^2, respectively (Table 4).

The post-veliger size range in the September samples was very similar to that of the August sample, with the exception of the MS&C system, which averaged 125 μm. However, the density of settled post-veligers decreased, suggesting that significant mortality had occurred following the molluscicide treatment early in September, and that the settlement afterwards may be due to transient planktonic veligers settling on the slides. It is important to note that Cook Plant conducted a molluscicide treatment on September 16 and that there was a dramatic decrease in settled post-veligers in the September 21 cumulative samples and that decrease continued the rest of the season. Notably, chlorination of the service water systems was reinitiated on September 14. Collectively, the two treatment strategies appear to be responsible for the decreased settlement of post-veligers in the service water systems.

Following treatment of the service water systems on September 16, a 75.9, 12.9, 76.5, and 68.9 percent reduction in veliger density was observed in the NESW-2, MS&C, ESW-1, and ESW-2 systems, respectively, when the August 24 sample was compared to the September 21 samples (Table 6). The 12.9 percent reduction in the MS&C system is misleading, because most of these veligers were not of a settleable size, and were probably just beginning to settle on the slide surface. In subsequent samples the post-veliger density in the service water systems was reduced by at least 97 percent when those samples were compared to the August 24 samples (Figure 7).

In October, post-veliger densities decreased from the September sample density, although the average size was similar and the size range increased, suggesting that possible translocators were present or that some mussels survived previous treatments and were maturing on the sample slides. However, post-veliger growth (as a function of size) in the MS&C and NESW-2 systems during this time period may also be directly correlated to the NESW system being out of service and only the ESW system receiving chlorine for a majority of the time between September 23 and October 3.

In November, the density continued to decrease in the cumulative samples; in fact settled post-veligers were completely absent in the ESW-2 samples. In the service water systems where settled post-veligers were still present, the average size and size range was less than that in the October samples, except for the MS&C service water system where the average size increased to 394 μm and the size range indicated there was larger organisms on the sample slides.

Likewise, the density decreased in the December samples and settled post-veligers and larger organisms were absent in the MS&C and ESW-1 systems samples. Interestingly, settled organisms reappeared in the ESW-2 system samples even though they were absent in the November samples. The density in the December cumulative sample was 160 organisms / m^2. That number is equivalent to an average of less than one organism per slide (0.3). In fact, any of the density values less than 534 / m^2 translates to less than one organism per slide. Therefore, it is reasonable to believe that there were organisms on only a few of the slides, which suggests that the mussels were not evenly distributed among the sample slides. Because the average size and size range was largest in the December samples, and because it appears that the organisms were scattered among the sample slides, we suspect that the organisms in the December cumulative samples, and possibly to some extent in the November samples, were older organisms that survived the molluscicide treatment and the earlier chlorination or translocators from turbulent lake conditions. Its conceivable that these organisms were stragglers in the service water systems. The forebay cumulative samples that were collected on December 14 had settled post-veliger densities of 256,526 / m^2 and 220,100 / m^2 in the untreated and treated samples, respectively. The average size of the treated and untreated samples were 3264 and 3820 μm respectively. Although the average density and size is lower for the treated sample, we expected that if the control procedures were effective there would be a much greater difference in the two samples based on the cumulative sample data from the service water systems. In fact, a zebra mussel mortality assessment conducted by diver inspections determined that the treatment was ineffective in controlling zebra mussels in the intake pipeline and forebay.

Chlorination

As part of their zebra mussel control program, Cook Plant conducts intermittent and continuous dosing of chlorine in the service water systems as an effort to control and minimize zebra mussel settlement. Cook Plant's target chlorine concentration ranges between 0.2 and 0.6 mg/L Total Residual Chlorine (TRC) in the ESW, NESW, and MS&C water systems. Chlorination at the plant was initiated on May 15 and continued until November 21 in the ESW and NESW systems. Chlorination was initiated on June 15 in the MS&C system. A summary of the daily average chlorine concentrations for circulating water discharges Unit 1 and Unit 2 are presented in Table 5. The chlorine concentration values reported in Table 5 are less than the target concentrations of 0.2 - 0.6 because of the mixing of the mixing of the non-chlorinated circulating water with water from the ESW and NESW systems. Between May 15 and July 09, 1995, Cook Nuclear Plant staff also monitored the total residual chlorine (TRC mg/L) in the nonessential service water and essential service water systems for Units 1 and 2 (Table 5a). Continuous chlorination was interrupted in these service water systems between June 23 and July 02, 1995 due to biofouling of the sampling lines for the chlorine analyzers. In that study, TRC in the Unit 1 NESW ranged between 0.200 and 0.989 mg/L, and between 0.287 and 0.877 mg/L in the ESW. The 40-day average for the NESW and ESW systems for Unit 1 was 0.483 and 0.558, respectively. The corresponding TRC concentration in Outfall 001 during the same time period ranged from less than 0.001 to 0.004, and averaged 0.002. In Unit 2, TRC ranged from 0.153 to 0.805 in the NESW system and 0.146 mg/L to 0.793 mg/L in the ESW system. The 40-day average for the Unit 2 NESW and ESW systems was 0.437 and 0.501 mg/L TRC, respectively. The corresponding TRC concentration in Outfall 002 during the same time period ranged from less than 0.001 to 0.002, and averaged less than 0.001 mg/L TRC. Post-veliger settlement in the periodic monitoring did not occur in the NESW or ESW systems until June 29 for Unit 2, and July 13 for Unit 1 in the ESW (Table 3). Post-veliger settlement in the cumulative samples was not evident until July 13, 1995 (Table 4).

Between May 15 and November 21, chlorine was not present in the service water systems for 34 of 190 treatment days (18% of the time). A total of 94 percent (32 out of 34)

of these treatment days when chlorination was interrupted occurred from August 19 through September 21, which directly corresponded to the time of peak settlement in the service water systems (Figure 5). During this period, there was no significant difference (P = 0.142) between the median density values in the forebay and the service water systems which excludes the possibility that the difference was just due to random sampling variability. In addition, there was no significant difference ($P \geq 0.05$) in the average veliger size between the forebay and the NESW-2, MS&C, ESW-1, and ESW-2 service water systems. Conversely, during periods of active chlorination, there was a significant difference ($P \leq 0.05$) between the settled veliger size in the forebay and the average size in the MS&C, ESW-1, and ESW-2 service water systems. There was no significant difference ($P \geq 0.05$) in veliger size between the forebay and NESW-2. This suggests that chlorination at the concentrations used in 1995 was effective (when present) in prohibiting post-veliger settlement and growth in the service water systems. This is visually demonstrated by plotting the average chlorine concentration in the final discharge and periodic settlement rates for the service water systems at each sampling period (Figure 5). Further demonstration of the effectiveness of chlorination in the NESW and ESW systems at controlling post-veliger settlement is the absence of settled post veligers in those systems during the chlorination study between May and July.

Quality Assurance/Quality Control Samples

The results of the QA/QC samples collected from Cook plant are summarized in Table 7. Zebra mussel density calculated from duplicate QA/QC samples for the four sampling events were not significantly different than the original samples. It should be noted that zebra mussel post-veligers were observed in the overlying water that was used during the shipment of the August 24 QA/QC sample, which may explain the apparent differences in numbers between the original sample and the recounted QA/QC sample. Based on these results, similar data trends from previous years and other Great Lakes research, we are confident that our data collecting procedures were precise and accurate and that the data is acceptable.

SUMMARY AND RECOMMENDATIONS

The 1995 zebra mussel sampling at Cook Plant was initiated on April 28 and continued through until December 14, 1995. Peak spawning occurred during August-September as determined from whole-water samples taken from the forebay. In 1995, veliger densities in the forebay whole-water samples were significantly lower than that of previous sampling years. Settlement in the forebay was first observed in the forebay on June 15, and peak density in the forebay occurred on three consecutive sampling periods from a high on July 27 (338,133 / m^2) through August 24. In 1994, veliger density was greatest on June 30 with 533,500 / m^2.

We observed the greatest peak settlement in all of the service water systems on September 7, with densities of 52,800, 64,533, 19,733, and 35,733 / m^2 for NESW-2, MS&C, ESW-1, and ESW-2 systems, respectively. Peak density was observed in the cumulative samples on August 24, with densities of 92,800, 92,800, 68,800, and 79,467 / m^2 for the NESW-2, MS&C, ESW-1, and ESW-2 systems, respectively. The density of settled organisms in the cumulative samples diminished beginning in September.

We correlated the chlorine treatment at Cook Plant (as measured at the final discharge) with the periodic settlement rates in the service water systems and we examined the reduction in post-veliger density in the cumulative samples after a molluscicide treatment to evaluate the effectiveness of Cook Plant's zebra mussel control strategies. Interruption in the continuous and intermittent chlorination from August 19 through September 21 seemed to correlate with increased settlement in the service water systems. When total residual chlorine concentrations in the final discharge were less than 0.03 mg/L, settlement in the service water systems markedly increased. Because of the variable dosage of chlorine to the service water systems and because the amount of circulating water mixing with the service water also varies, it is too problematic to back calculate the chlorine concentration in the service water systems. However, it is reasonable to believe that in this instance, chlorine is responsible for maintaining the lower density of post-veligers in the samples because the density in the whole-water samples during these same time periods were the greatest of the season. Without chlorination, we would expect corresponding increases in settlement 8 to 15

days after the greatest veliger density was recorded. We suspect that the increase in post-veliger settlement during late August and early September was due to the increase in whole-water veliger density in early and mid-August, and the diminishing chlorine concentrations in late August and early September.

We evaluated the molluscicide treatment at Cook Plant by calculating the percent reduction in settled post-veligers in the cumulative settlement samples. Subsequent counts made with the cumulative samples on August 24, September 21, October 19, and November 16 demonstrated significant reductions in post-veliger densities after Cook Plant treated the service water systems between August 24 and September 21.

Previous research has shown that intermittent chlorination has been effective in control of zebra mussel settlement (Barton, 1993). Cook Plant uses intermittent and continuous chlorination, however, interruptions in chlorination appeared to correspond with increased settlement. A reduction in chlorine costs may be realized by utilizing an intermittent or semi-continuous chlorination program as opposed to both continuous and intermittent treatment. However, future monitoring should include a monitoring design that can effectively compare these two treatment methods both individually and collectively. Last year, LMS reported that settlement in the service water systems depended more on mode of chlorination and its frequency than on the availability of post-veligers. In this study, periods of heaviest settlement corresponded to periods of interrupted and intermittent chlorination and with increases in whole-water veligers. The Massena, New York water plant uses chlorine at their intake at a dose of 2.0 mg/L. They subsequently measure 0.4-0.6 mg/L in their service water systems and report a 100 percent mortality rate at the plant. These data correspond well with the 1995 Cook Plant data.

The reinitiation of chlorination at approximately the same time as the molluscicide treatment appears to have effectively controlled the accumulation of settled organisms in the service water systems. Likewise, chlorination also appeared to limit the accumulation and growth of mussels in the service water systems. Consequently, the combination of chlorination throughout the season and a well planned treatment with a molluscicide that aggressively attacks juvenile settled organisms is an effective strategy for zebra mussel control at Cook Plant.

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FIGURES AND TABLES

Table 1. Sampling schedule for zebra mussel monitoring at Cook Plant, 1995.

DATE		WHOLEWATER	ARTIFICIAL SUBSTRATE	
			PERIODIC	CUMULATIVE
April	28	X		
May	11	X	X*	X
	25	X		
June	1	X	X	
	8	X		
	15	X	X	X
	22	X		
	29	X	X	
July	6	X		
	13	X	X	X
	20	X		
	27	X	X	
August	3	X		
	10	X	X	
	17	X		
	24	X	X	X
	31	X		
September	7	X	X	
	14	X		
	21	X	X	X
	28	X		
October	5	X	X	
	12	X		
	19	X	X	X
	26	X		
November	2	X		
	16	X	X	X
December	14	X	X	X

* Initial set in April.

Table 2. Zebra mussel veliger density, average size, and size range from the forebay whole-water sampling at Cook Plant, 1995.

WHOLEWATER SAMPLES			
	Forebay		
Sample Date	Density	Avg. Size	Range
28-Apr-95	0		
11-May-95	0		
25-May-95	0		
01-Jun-95	25	140	140
08-Jun-95	75	396	200-520
15-Jun-95	200	248	80-440
22-Jun-95	75	553	180-800
29-Jun-95	175	903	720-1120
06-Jul-95	200	253	120-800
13-Jul-95	500	150	110-220
20-Jul-95	700	192	140-240
27-Jul-95	1075	205	120-240
03-Aug-95	1275	263	100-380
10-Aug-95	925	345	140-720
17-Aug-95	3050	318	100-840
24-Aug-95	450	518	120-820
31-Aug-95	3325	156	80-660
07-Sep-95	1925	204	90-600
14-Sep-95	750	167	90-740
21-Sep-95	675	167	120-400
28-Sep-95	5150	209	100-440
05-Oct-95	475	227	120-540
12-Oct-95	200	625	420-840
19-Oct-95	100	495	400-620
26-Oct-95	25	640	640-640
02-Nov-95	0		
16-Nov-95	125	644	520-880
14-Dec-95	0		

Density = number of organisms per cubic meter; Avg. Size = micrometers

Table 3. Zebra mussel density, average size, and size range of settled post-veligers from periodic sampling at Cook Plant, 1995

	PERIODIC SAMPLES														
	Forebay			NESW-2			MS&C			ESW-1			ESW-2		
Sample Date	Density	Avg. Size	Range	Density	Avg. Size	Range	Density	Avg. Size	Range	Density	Avg. Size	Range	Density	Avg. Size	Range
28-Apr-95															
11-May-95	0			0			0			0			0		
25-May-95															
01-Jun-95	53	2376	2376	0			0			0			0		
08-Jun-95															
15-Jun-95	320	943	220-4520	0			0			0			0		
22-Jun-95															
29-Jun-95	2027	3754	620-10500	427	149	120-210	0			0			320	150	120-240
06-Jul-95															
13-Jul-95	693	843	500-1200	4747	124	100-900	1707	118	100-800	11307	115	100-160	2027	113	100-500
20-Jul-95															
27-Jul-95	338133	263	200-400	30933	184	100-420	10133	174	100-260	4800	200	100-300	3733	206	100-320
03-Aug-95															
10-Aug-95	177200	302	220-440	3680	196	100-360	5440	232	140-380	13760	272	120-240	7893	263	120-420
17-Aug-95															
24-Aug-95	226667	314	120-520	18666	317	120-640	44267	185	80-360	19200	243	90-480	12267	172	90-520
31-Aug-95															
07-Sep-95	77200	254	120-620	52800	176	80-300	64533	143	80-260	19733	167	100-280	35733	192	100-520
14-Sep-95															
21-Sep-95	39093	243	180-420	6080	209	100-360	19413	143	100-320	12320	191	100-320	15680	148	90-320
28-Sep-95															
05-Oct-95	2933	313	120-960	8053	251	120-720	4853	168	100-300	2560	189	100-300	2080	180	120-320
12-Oct-95															
19-Oct-95	11307	274	120-600	1173	247	120-600	853	200	120-420	1440	195	120-520	1547	198	100-400
26-Oct-95															
02-Nov-95															
16-Nov-95	2453	1619	240-15000	267	448	220-1000	320	243	180-380	480	192	160-240	480	497	180-1030
14-Dec-95	107	1900	1000-2800	160	600	380-780	0			53	520	520-520	640	628	320-1120

Density = number of organisms per square meter; Avg. Size = micrometers

Table 4. Zebra mussel density, average size, and size range of settled post-veligers from cumulative sampling at Cook Plant, 1995

CUMULATIVE SAMPLES													
	Forebay	NESW-2			MS&C			ESW-1			ESW-2		
Sample Date	Density	Density	Avg. Size	Range	Density	Avg. Size	Range	Density	Avg. Size	Range	Density	Avg. Size	Range
28-Apr-95													
11-May-95		0			0			0			0		
25-May-95													
01-Jun-95													
08-Jun-95													
15-Jun-95		0			427	173	100-240	0			0		
22-Jun-95													
29-Jun-95													
06-Jul-95													
13-Jul-95		4000	126	100-160	15947	123	100-160	267	130	120-140	213	120	100-140
20-Jul-95													
27-Jul-95													
03-Aug-95													
10-Aug-95													
17-Aug-95													
24-Aug-95		92800	201	100-360	92800	178	100-340	68800	194	90-180	79467	166	100-380
31-Aug-95													
07-Sep-95													
14-Sep-95													
21-Sep-95		22400	226	100-480	80853	125	90-240	16160	192	90-620	24693	173	90-440
28-Sep-95													
05-Oct-95													
12-Oct-95													
19-Oct-95		1013	306	100-860	1280	197	120-380	1867	186	100-600	1813	196	120-600
26-Oct-95													
02-Nov-95													
16-Nov-95		427	288	140-520	533	394	120-720	106	130	120-140	0		
14-Dec-95		373	797	320-1640	0			0			160	867	600-1240
	Treated 220,100												
	Untreated 256,526												

Density = number of organisms per square meter; Avg. Size = micrometers.
a - Density of settled post-veliger zebra mussels on the foreay "pipe" sampler.

Table 5. Chlorination data for the service systems at Cook Plant (April - December 1995)

DATE	Unit 1 (mg/l)	Unit 2 (mg/l)	Unit 1 Average*	Unit 2 Average*	COMMENTS
28-Apr-95	0.000	0.000	0.000	0.000	No chlorination
29-Apr-95	0.000	0.000			No chlorination
30-Apr-95	0.000	0.000			No chlorination
01-May-95	0.000	0.000			No chlorination
02-May-95	0.000	0.000			No chlorination
03-May-95	0.000	0.000			No chlorination
04-May-95	0.000	0.000			No chlorination
05-May-95	0.000	0.000			No chlorination
06-May-95	0.000	0.000			No chlorination
07-May-95	0.000	0.000			No chlorination
08-May-95	0.000	0.000			No chlorination
09-May-95	0.000	0.000			No chlorination
10-May-95	0.000	0.000			No chlorination
11-May-95	0.000	0.000	0.000	0.000	No chlorination
12-May-95	0.000	0.000			No chlorination
13-May-95	0.000	0.000			No chlorination
14-May-95	0.000	0.000			No chlorination
15-May-95	0.001	0.001			Chlorination Initiated (all boxes except MS&C)
16-May-95	0.001	0.001			All boxes except MS&C
17-May-95	0.001	0.001			All boxes except MS&C
18-May-95	0.003	0.001			All boxes except MS&C
19-May-95	0.003	0.001			All boxes except MS&C
20-May-25	0.003	0.001			All boxes except MS&C
21-May-95	0.003	0.001			All boxes except MS&C
22-May-95	0.000	0.000			No data
24-May-95	0.002	0.001			All boxes except MS&C
25-May-95	0.002	0.001	0.001	0.001	All boxes except MS&C
26-May-95	0.003	0.001			All boxes except MS&C
27-May-95	0.002	0.000			All boxes except MS&C
28-May-95	0.001	0.001			All boxes except MS&C
29-May-95	0.002	0.001			All boxes except MS&C
30-May-95	0.028	0.008			All boxes except MS&C
31-May-95	0.025	0.012			All boxes except MS&C
01-Jun-95	0.021	0.009	0.012	0.005	All boxes except MS&C
02-Jun-95	0.023	0.006			All boxes except MS&C
03-Jun-95	0.016	0.004			All boxes except MS&C
04-Jun-95	0.014	0.005			All boxes except MS&C
05-Jun-95	0.014	0.005			All boxes except MS&C
06-Jun-95	0.022	0.007			All boxes except MS&C
07-Jun-95	0.056	0.021			All boxes except MS&C
08-Jun-95	0.078	0.026	0.032	0.011	All boxes except MS&C
09-Jun-95	0.086	0.026			All boxes except MS&C
10-Jun-95	0.072	0.026			All boxes except MS&C
11-Jun-95	0.066	0.016			All boxes except MS&C
12-Jun-95	0.081	0.011			All boxes except MS&C
13-Jun-95	0.072	0.033			All boxes except MS&C
14-Jun-95	0.082	0.019			All boxes except MS&C
15-Jun-95	0.071	0.028	0.076	0.023	All boxes chlorinated (MS&C started)
16-Jun-95	0.065	0.034			All boxes chlorinated
17-Jun-95	0.037	0.021			All boxes chlorinated
18-Jun-95	0.030	0.021			All boxes chlorinated
19-Jun-95	0.030	0.017			All boxes chlorinated
20-Jun-95	0.004	0.018			All boxes chlorinated
21-Jun-95	0.036	0.028			All boxes chlorinated
22-Jun-95	0.082	0.093	0.041	0.033	All boxes chlorinated
23-Jun-95	0.113	0.113			All boxes chlorinated, intermittent only
24-Jun-95	0.000	0.000			No data
25-Jun-95	0.000	0.000			No data
26-Jun-95	0.127	0.103			All boxes chlorinated, intermittent only
27-Jun-95	0.123	0.123			All boxes chlorinated, intermittent only
28-Jun-95	0.110	0.113			All boxes chlorinated, intermittent only
29-Jun-95	0.170	0.153	0.092	0.086	All boxes chlorinated, intermittent only
30-Jun-95	0.060	0.010			All boxes chlorinated, intermittent only
01-Jul-95	0.058	0.042			All boxes chlorinated, intermittent only
02-Jul-95	0.051	0.037			All boxes chlorinated, intermittent only

*All sampling events are shaded

Table 5. Chlorination data for the service systems at Cook Plant (April - December 1995)

DATE	Unit 1 (mg/l)	Unit 2 (mg/l)	Unit 1 Average*	Unit 2 Average*	COMMENTS
03-Jul-95	0.033	0.019			All boxes chlorinated;inter and cont chlorine
04-Jul-95	0.031	0.026			All boxes chlorinated;inter and cont chlorine
05-Jul-95	0.043	0.031			All boxes chlorinated;inter and cont chlorine
06-Jul-95	0.084	0.052	0.051	0.031	All boxes chlorinated;inter and cont chlorine
07-Jul-95	0.076	0.071			All boxes chlorinated;inter and cont chlorine
08-Jul-95	0.093	0.086			All boxes chlorinated;inter and cont chlorine
09-Jul-95	0.097	0.079			All boxes chlorinated;inter and cont chlorine
10-Jul-95	0.094	0.062			All boxes chlorinated;inter and cont chlorine
11-Jul-95	0.076	0.062			All boxes chlorinated;inter and cont chlorine
12-Jul-95	0.067	0.071			All boxes chlorinated;inter and cont chlorine
13-Jul-95	0.041	0.031	0.078	0.066	All boxes chlorinated;inter and cont chlorine
14-Jul-95	0.061	0.057			All boxes chlorinated;inter and cont chlorine
15-Jul-95	0.076	0.054			All boxes chlorinated;inter and cont chlorine
16-Jul-95	0.084	0.054			All boxes chlorinated;inter and cont chlorine
17-Jul-95	0.004	0.001			No intermittent; Clam-Trol treatment (MS&C)
18-Jul-95	0.081	0.049			All boxes chlorinated;inter and cont chlorine
19-Jul-95	0.071	0.047			U-2 NESW Not chlorinated
20-Jul-95	0.038	0.026	0.059	0.041	Cont. CL2 off at 1155; U-1: Only 1 circ pump in operation
21-Jul-95	0.070	0.056			All boxes chlorinated;inter and cont chlorine
22-Jul-95	0.050	0.052			All boxes chlorinated;inter and cont chlorine
23-Jul-95	0.049	0.052			All boxes chlorinated;inter and cont chlorine
24-Jul-95	0.118	0.054			All boxes chlorinated;inter and cont chlorine
25-Jul-95	0.046	0.056			All boxes chlorinated;inter and cont chlorine
26-Jul-95	0.065	0.038			All boxes chlorinated;inter and cont chlorine
27-Jul-95	0.076	0.045	0.068	0.050	All boxes chlorinated; cont. off
28-Jul-95	0.000	0.097			All boxes chlorinated; intermittent only
29-Jul-95	0.000	0.042			All boxes chlorinated; intermittent only
30-Jul-95	0.000	0.000			No chlorination
31-Jul-95	0.000	0.000			No chlorination
01-Aug-95	0.001	0.051			Continuous Cl2 and intermittent start again
02-Aug-95	0.022	0.088			All boxes chlorinated;inter and cont chlorine
03-Aug-95	0.003	0.067	0.004	0.049	All boxes chlorinated; intermittent only
04-Aug-95	0.004	0.076			Continuous CL2 Started @ 0915
05-Aug-95	0.004	0.008			All boxes chlorinated;inter and cont chlorine
06-Aug-95	0.002	0.038			All boxes chlorinated;inter and cont chlorine
07-Aug-95	0.001	0.051			No U-1 Intermittent CL2
08-Aug-95	0.002	0.037			All boxes chlorinated;inter and cont chlorine
09-Aug-95	0.001	0.156			All boxes chlorinated;inter and cont chlorine
10-Aug-95	0.003	0.101	0.002	0.067	U-2 pumps are getting U-1 CL2 doses
11-Aug-95	0.002	0.029			All boxes chlorinated;inter and cont chlorine
12-Aug-95	0.001	0.050			All boxes chlorinated;inter and cont chlorine
13-Aug-95	0.047	0.044			All boxes chlorinated;inter and cont chlorine
14-Aug-95	0.007	0.044			All boxes chlorinated;inter and cont chlorine
15-Aug-95	0.001	0.027			All continous CL2 suspended, analyzers OOC.
16-Aug-95	0.010	0.037			All boxes chlorinated; intermittent only
17-Aug-95	0.010	0.070	0.011	0.043	All boxes chlorinated; intermittent only
18-Aug-95	0.006	0.051			All boxes chlorinated
19-Aug-95	0.000	0.000			No chlorination - Repair
20-Aug-95	0.000	0.000			No chlorination - Repair
21-Aug-95	0.000	0.000			No chlorination - Repair
22-Aug-95	0.000	0.000			No chlorination - Repair
23-Aug-95	0.000	0.000			No chlorination - Repair
24-Aug-95	0.000	0.000	0.001	0.007	No chlorination - Repair
25-Aug-95	0.000	0.000			No chlorination - Repair
26-Aug-95	0.000	0.000			No chlorination - Repair
27-Aug-95	0.000	0.000			No chlorination - Repair
28-Aug-95	0.000	0.000			No chlorination - Repair
29-Aug-95	0.000	0.000			No chlorination - Repair
30-Aug-95	0.000	0.000			No chlorination - Repair
31-Aug-95	0.000	0.000	0.000	0.000	No chlorination - Repair
01-Sep-95	0.000	0.000			No chlorination - Repair
02-Sep-95	0.000	0.000			No chlorination - Repair
03-Sep-95	0.000	0.000			No chlorination - Repair
04-Sep-95	0.000	0.000			No chlorination - Repair
05-Sep-95	0.000	0.000			No chlorination - Repair

* All sampling events are shaded

Table 5. Chlorination data for the service systems at Cook Plant (April - December 1995)

DATE	Unit 1 (mg/l)	Unit 2 (mg/l)	Unit 1 Average*	Unit 2 Average*	COMMENTS
06-Sep-95	0.000	0.000			No chlorination - Repair
07-Sep-95	0.000	0.000	0.000	0.000	No chlorination - Repair
08-Sep-95	0.000	0.000			No chlorination - Repair
09-Sep-95	0.000	0.000			No chlorination - Repair
10-Sep-95	0.000	0.000			No chlorination - Repair
11-Sep-95	0.000	0.000			No chlorination - Repair
12-Sep-95	0.000	0.000			No chlorination - Repair
13-Sep-95	0.000	0.000			No chlorination - Repair
14-Sep-95	0.000	0.000	0.000	0.000	No chlorination - Repair
15-Sep-95	0.000	0.000			No chlorination - Repair
16-Sep-95	0.000	0.000			No chlorination - Molluscicide Treatment
17-Sep-95	0.000	0.000			No chlorination - Repair
18-Sep-95	0.030	0.057			All boxes chlorinated; intermittent only
19-Sep-95	0.017	0.040			All boxes chlorinated; intermittent only
20-Sep-95	0.000	0.000			No chlorination - Repair
21-Sep-95	0.000	0.000	0.007	0.014	No chlorination - Repair
22-Sep-95	0.001	0.001			Started continuous CL2 at 1500; no intermittent
23-Sep-95	0.001	0.001			ESW only
24-Sep-95	0.001	0.001			ESW only
25-Sep-95	0.024	0.062			ESW only; intermittent only
26-Sep-95	0.026	0.061			ESW only; intermittent only
27-Sep-95	0.026	0.047			All boxes chlorinated
28-Sep-95	0.021	0.061	0.014	0.033	All boxes chlorinated
29-Sep-95	0.042	0.091			NESW tagged out; inter and cont. chlorine
30-Sep-95	0.011	0.084			NESW tagged out; inter and cont. chlorine
01-Oct-95	0.046	0.082			NESW tagged out; inter and cont. chlorine
02-Oct-95	0.013	0.075			NESW tagged out; inter and cont. chlorine
03-Oct-95	0.016	0.057			All NESW/ESW CL2, but NESW leak, may suspend
04-Oct-95	0.065	0.084			All boxes chlorinated
05-Oct-95	0.029	0.091	0.032	0.081	All boxes chlorinated
06-Oct-95	0.071	0.084			All boxes chlorinated
07-Oct-95	0.067	0.082			All boxes chlorinated
08-Oct-95	0.084	0.066			Started U-2 NESW continuous CL2 at 0930
09-Oct-95	0.081	0.058			All boxes chlorinated
10-Oct-95	0.057	0.052			All boxes chlorinated
11-Oct-95	0.880	0.043			All boxes chlorinated
12-Oct-95	0.002	0.002	0.177	0.055	Intermittent CL2 off due to circ. pump testing
13-Oct-95	0.002	0.003			All boxes chlorinated; continuous only
14-Oct-95	0.002	0.002			All boxes chlorinated; continuous only
15-Oct-95	0.003	0.003			All boxes chlorinated; continuous only
16-Oct-95	0.006	0.001			No intermittent U-2 NESW
17-Oct-95	0.003	0.001			All boxes chlorinated; continuous only
18-Oct-95	0.010	0.001			All boxes chlorinated; continuous only
19-Oct-95	0.003	0.002	0.004	0.002	All boxes chlorinated; continuous only
20-Oct-95	0.003	0.002			All boxes chlorinated; continuous only
21-Oct-95	0.002	0.002			All boxes chlorinated; continuous only
22-Oct-95	0.002	0.001			All boxes chlorinated; continuous only
23-Oct-95	0.002	0.002			All boxes chlorinated; continuous only
24-Oct-95	0.002	0.003			U-2 ESW CL2 suspended, U-1 ESW/NESW suspended
25-Oct-95	0.002	0.001			U-1 U-2 NESW/ESW continuous CL2 started
26-Oct-95	0.001	0.001	0.002	0.002	All boxes chlorinated; continuous only
27-Oct-95	0.001	0.001			All boxes chlorinated; continuous only
28-Oct-95	0.001	0.001			All boxes chlorinated; continuous only
29-Oct-95	0.001	0.002			All boxes chlorinated; continuous only
30-Oct-95	0.003	0.004			All boxes chlorinated; continuous only
31-Oct-95	0.002	0.005			All boxes chlorinated; continuous only
01-Nov-95	0.003	0.004			All boxes chlorinated; continuous only
02-Nov-95	0.003	0.020	0.002	0.005	All boxes chlorinated; continuous only
03-Nov-95	0.002	0.005			All boxes chlorinated; continuous only
04-Nov-95	0.002	0.005			All boxes chlorinated; continuous only
05-Nov-95	0.002	0.002			All boxes chlorinated; continuous only
06-Nov-95	0.002	0.003			All boxes chlorinated; continuous only
07-Nov-95	0.002	0.005			All boxes chlorinated; continuous only
08-Nov-95	0.001	0.010			All boxes chlorinated; continuous only
09-Nov-95	0.002	0.005			All boxes chlorinated; continuous only

All sampling events are shaded

Table 5. Chlorination data for the service systems at Cook Plant (April - December 1995)

DATE	Unit 1 (mg/l)	Unit 2 (mg/l)	Unit 1 Average*	Unit 2 Average*	COMMENTS
10-Nov-95	0.001	0.001			All boxes chlorinated; continuous only
11-Nov-95	0.001	0.001			All boxes chlorinated; continuous only
12-Nov-95	0.001	0.001			All boxes chlorinated; continuous only
13-Nov-95	0.001	0.001			All boxes chlorinated; continuous only
14-Nov-95	0.117	0.080			All boxes chlorinated; continuous only
15-Nov-95	0.130	0.070			All boxes chlorinated; intermittent only
16-Nov-95	0.000	0.000	0.019	0.014	no data
17-Nov-95	0.002	0.005			All boxes chlorinated; continuous only
18-Nov-95	0.002	0.005			All boxes chlorinated
19-Nov-95	0.002	0.006			All boxes chlorinated
20-Nov-95	0.002	0.005			All boxes chlorinated
21-Nov-95	0.052	0.002			ALL CHLORINATION STOPPED FOR THE YEAR
22-Nov-95	0.000	0.000			No chlorination
23-Nov-95	0.000	0.000			No chlorination
24-Nov-95	0.000	0.000			No chlorination
25-Nov-95	0.000	0.000			No chlorination
26-Nov-95	0.000	0.000			No chlorination
27-Nov-95	0.000	0.000			No chlorination
28-Nov-95	0.000	0.000			No chlorination
29-Nov-95	0.000	0.000			No chlorination
30-Nov-95	0.000	0.000			No chlorination
01-Dec-95	0.000	0.000			No chlorination
02-Dec-95	0.000	0.000			No chlorination
03-Dec-95	0.000	0.000			No chlorination
04-Dec-95	0.000	0.000			No chlorination
06-Dec-95	0.000	0.000			No chlorination
07-Dec-95	0.000	0.000			No chlorination
08-Dec-95	0.000	0.000			No chlorination
09-Dec-95	0.000	0.000			No chlorination
10-Dec-95	0.000	0.000			No chlorination
11-Dec-95	0.000	0.000			No chlorination
12-Dec-95	0.000	0.000			No chlorination
13-Dec-95	0.000	0.000			No chlorination
14-Dec-95	0.000	0.000	0.000	0.000	No chlorination

*Chlorine concentration averaged from one sampling event to the next

All sampling events are shaded

Table 5a. **Total Residual Chlorine (TRC) Concentrations in the Service Water Systems of Units #1 and #2 and the Corresponding Residual TRC at Outfalls 001 and 002 (May - July, 1995)**

Date		Unit #1 SWS		Outfall 001	Unit #2 SWS		Outfall 002
		NESW (mg/L)	ESW (mg/L)	(mg/L)	NESW (mg/L)	ESW (mg/L)	(mg/L)
Week One:	05/15/95	0.200	0.693	0.001	0.153	0.683	<0.001
	05/16/95	0.409	0.631	<0.001	0.329	0.697	<0.001
	05/17/95	0.407	0.683	<0.001	0.490	0.787	<0.001
	05/18/95	0.410	0.61	0.003	0.353	0.627	<0.001
	05/19/95	0.413	0.644	0.003	0.385	0.644	<0.001
	05/20/95	0.360	0.53	0.002	0.320	0.493	0.001
	05/21/95	0.257	0.393	0.001	0.233	0.47	0.002
Week Two:	05/22/95	0.319	0.422	0.002	0.330	0.467	0.001
	05/23/95	0.305	0.433	0.002	0.366	0.508	<0.001
	05/24/95	0.340	0.456	0.002	0.400	0.490	<0.001
	05/25/95	0.427	0.494	0.002	0.433	0.530	<0.001
	05/26/95	0.338	0.397	0.003	0.402	0.448	<0.001
	05/27/95	0.372	0.443	0.003	0.358	0.471	<0.001
	05/28/95	0.239	0.512	0.001	0.334	0.146	<0.001
Week Three:	05/29/95	0.412	0.604	0.002	0.218	0.604	<0.001
	05/30/95	0.507	0.739	0.004	0.424	0.687	<0.001
	05/31/95	0.649	0.720	0.004	0.598	0.758	<0.001
	06/01/95	0.483	0.557	0.004	0.443	0.610	<0.001
	06/02/95	0.433	0.439	0.002	0.386	0.453	<0.001
	06/03/95	0.409	0.439	0.004	0.342	0.475	<0.001
	06/04/95	0.375	0.439	0.003	0.417	0.405	<0.001
Week Four:	06/05/95	0.293	0.533	0.002	0.355	0.573	<0.001
	06/06/95	0.573	0.753	0.003	0.455	0.666	<0.001
	06/07/95	0.587	0.790	0.002	0.470	0.617	<0.001
	06/08/95	0.557	0.600	0.002	0.433	0.270	<0.001
	06/09/95	0.570	0.877	0.003	0.503	0.347	<0.001
	06/10/95	0.587	0.767	0.004	0.544	0.421	<0.001
	06/11/95	0.542	0.570	0.002	0.512	0.559	<0.001
Week Five:	06/12/95	0.784	0.438	0.001	0.420	0.473	<0.001
	06/13/95	0.989	0.645	0.002	0.525	0.793	<0.001
	06/14/95	0.791	0.730	0.003	0.429	0.453	<0.001
	06/15/95	0.748	0.686	0.004	0.444	0.416	<0.001
	06/16/95	0.639	0.545	0.003	0.297	0.258	<0.001
	06/17/95	0.609	0.471	0.003	0.382	0.438	<0.001
	06/18/95	0.551	0.402	0.003	0.588	0.338	<0.001
Week Six:	07/03/95	0.644	0.658	0.002	0.805	0.271	<0.001
	07/04/95	0.523	0.580	0.003	0.63	0.447	<0.001
	07/05/95	0.467	0.517	0.002	0.707	0.577	<0.001
	07/06/95	0.370	0.343	0.001	0.433	0.320	<0.001
	07/07/95	0.327	0.287	0.001	0.43	0.307	<0.001
	07/08/95	0.540	0.493	0.003	0.633	0.523	0.001
	07/09/95	0.540	0.487	0.001	0.633	0.513	0.001
	High:	0.989	0.877	0.004	0.805	0.793	0.002
	Low:	0.200	0.287	<0.001	0.153	0.146	<0.001
	Average:	0.483	0.558	0.002	0.437	0.501	<0.001

Table 6. Post-veliger density (# / m^2) before and after molluscicide treatment[1] and continuous chlorination in the service systems at Cook Plant, 1995.

	SERVICE SYSTEM			
Sample Date	NESW-2	MS&C	ESW-1	ESW-2
24-Aug-95	92800	92800	68800	79467
21-Sep-95	22400 (75.9%)	80853 (12.9%)	16160 (76.5%)	24693 (68.9%)
19-Oct-95	1013 (99%)	1280 (99%)	1867 (97%)	1813 (98%)
16-Nov-95	427 (>99%)	533 (>99%)	106 (>99%)	0 (100%)

1 Molluscicide treatment was initiated on September 16, 1995.
2 Percent reduction was calculated from the post-veliger densities observed on August 24 (prior to treatment) and subsequent (post-treatment) sample dates.

Table 7. Results of QA/QC samples collected from Cook Plant (April - December 1995).

Sample Date	Sample Type	Sample Location	Onsite Density	QA/QC Density	Difference[1]
April 28	Wholewater	Forebay	0	0	*Not significant*
June 1	Wholewater	Forebay	25	0	*Not significant ($P > 0.1$)*
	Periodic	Forebay	53	0	
	Periodic	ESW-1	0	0	
	Periodic	ESW-2	0	0	
	Periodic	NESW-2	0	0	
August 24	Wholewater	Forebay	450	350	*Not significant ($P > 0.1$)*
	Periodic[2]	MS&C	44267	0	
	Periodic[2]	ESW-2	12267	0	
	Periodic[2]	NESW-2	18660	0	
	Periodic[2]	ESW-1	19200	2000	
	Periodic[2]	Forebay	226667	18000	
	Cumulative[2]	ESW-2	79467	2000	
	Cumulative[2]	NESW-2	92800	4000	
	Cumulative[2]	ESW-1	68800	4000	
	Cumulative[2]	MS&C	92800	0	
October 5	Wholewater	Forebay	475	650	*Not significant ($P = 0.895$)*
	Periodic	Forebay	2933	4267	
	Periodic	ESW-1	2560	2133	
	Periodic	ESW-2	2080	1066	
	Periodic	NESW-2	8053	11200	
	Periodic	MS&C	4853	3200	

1 Difference between onsite and QA/QC density values were calculated from the median value of all samples from each sampling event using t-test procedures.

2 Suspect veligers fell off slides during transport. Samples were shipped in water.

Figure 1. Whole-water zebra mussel veliger abundance in forebay cooling water samples at the D.C. Cook Nuclear Plant (April -December 1995)

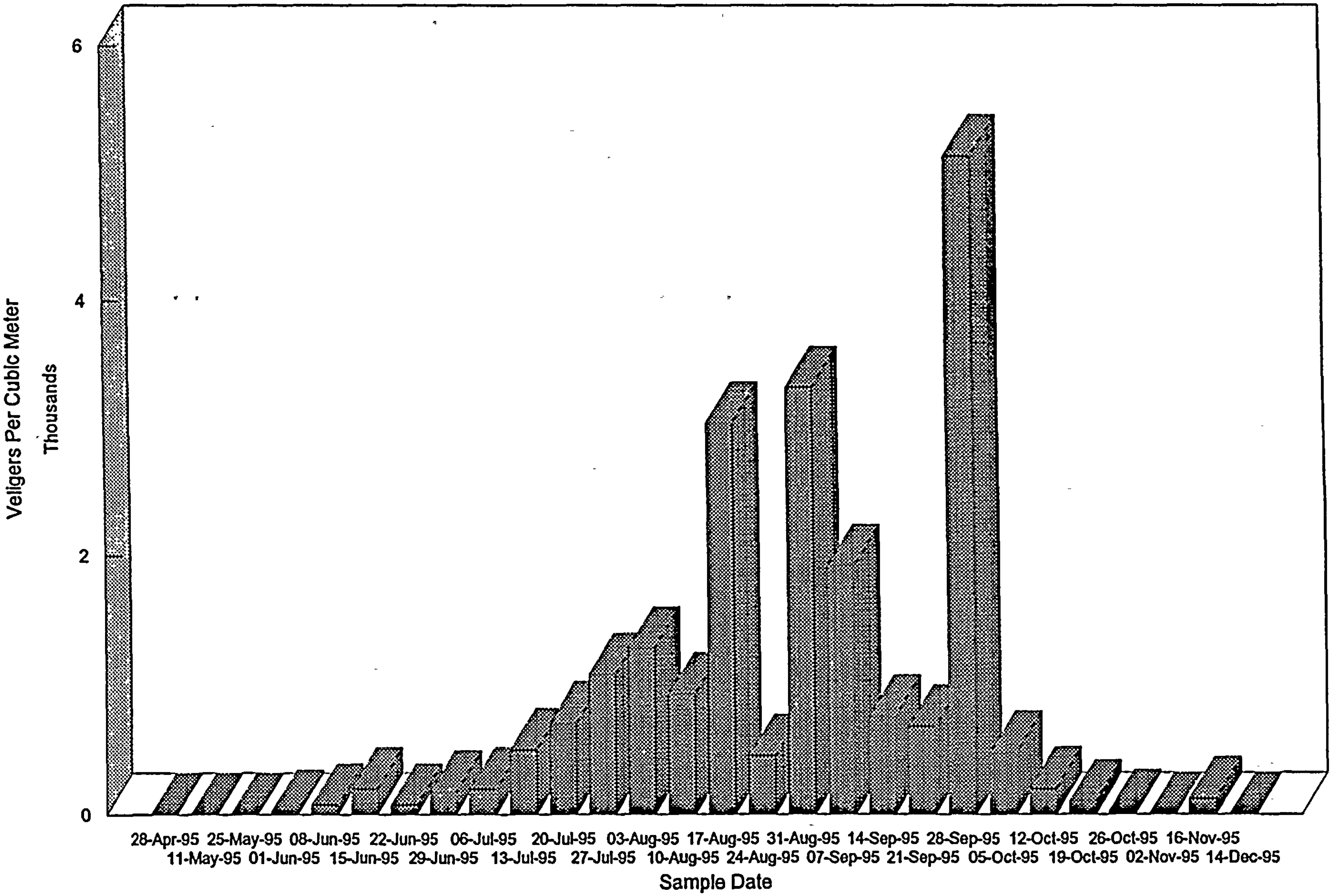


Figure 2. Post-veliger settlement in forebay periodic settlement samples at D.C. Cook Nuclear Plant (May-December 1995)

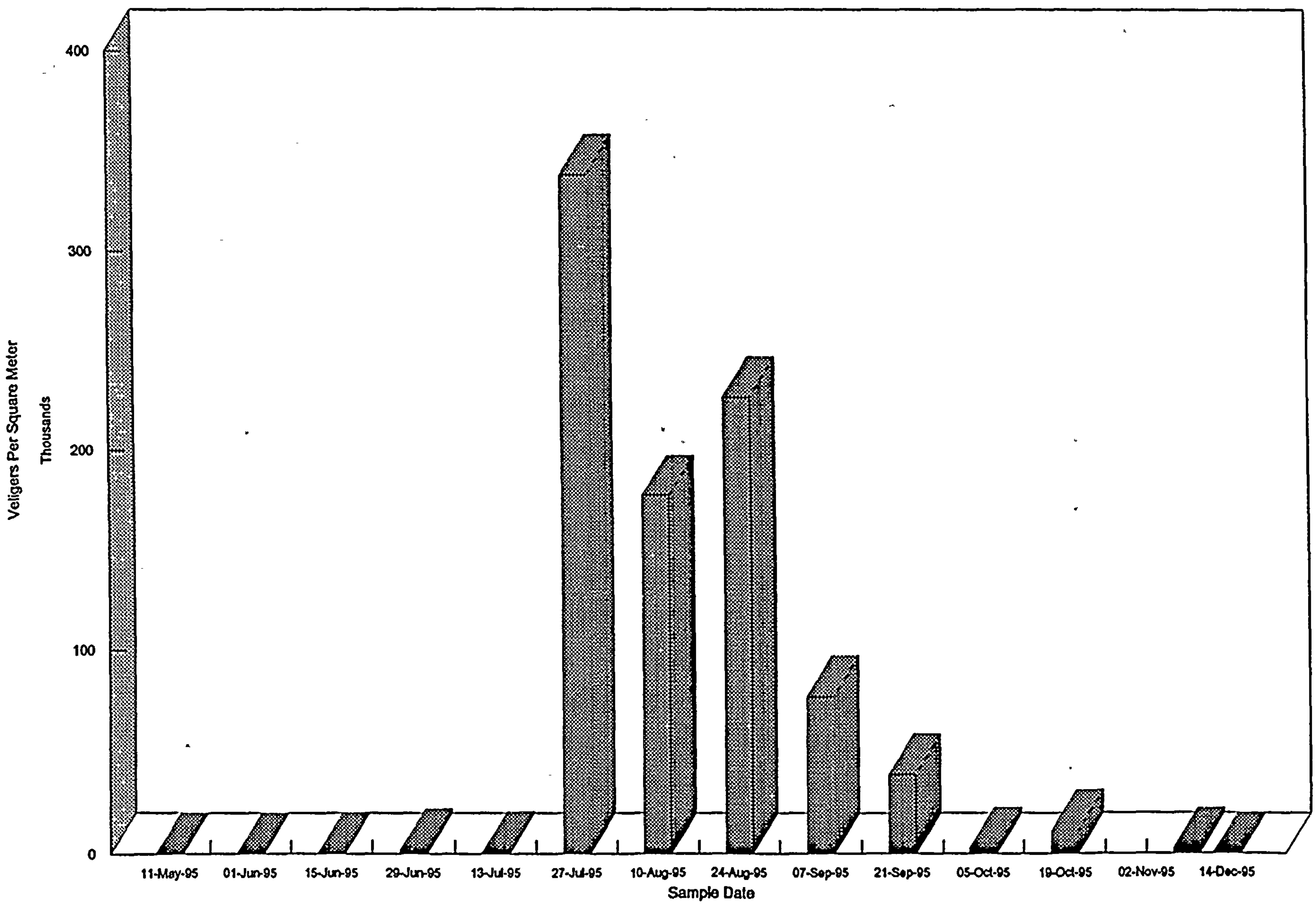


Figure 3. Periodic settlement of post-veligers in the MS&C, NESW and ESW service systems at D.C. Cook Nuclear Plant (May-December 1995)

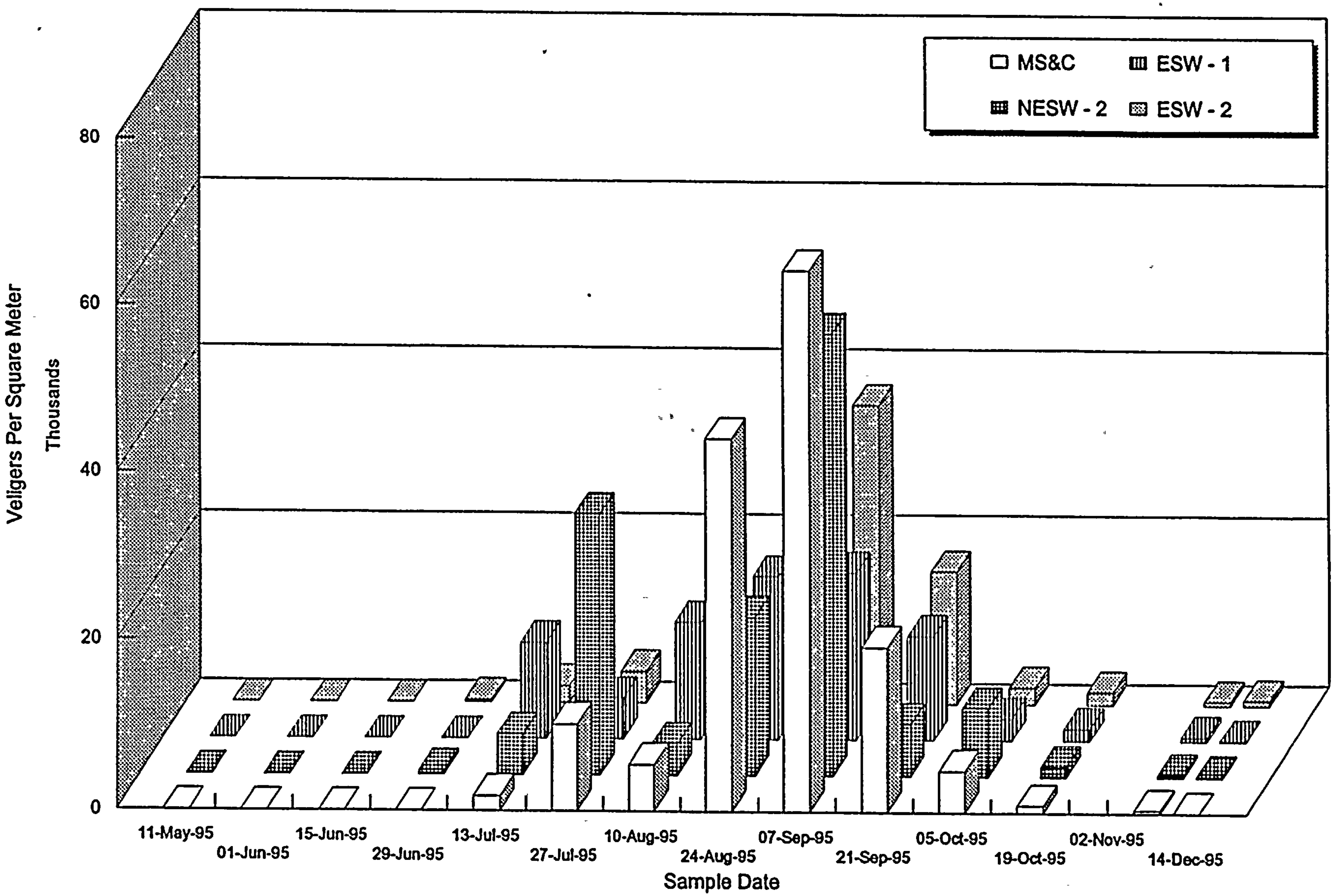


Figure 4. Whole-water veliger density and periodic settlement of post veligers in the service water system at D.C. Cook Plant (April-December 1995)

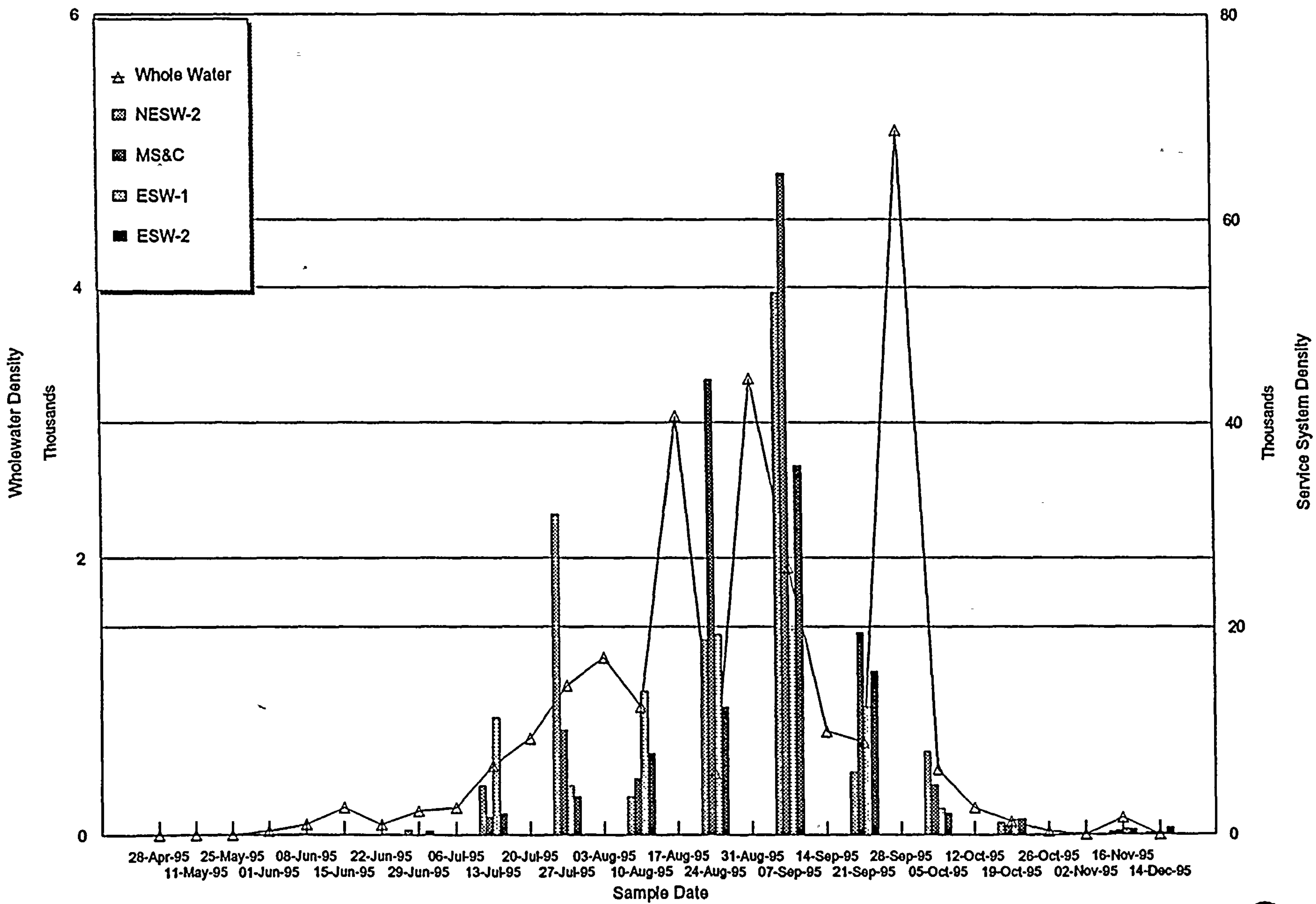


Figure 5. Periodic post-veliger settlement rates and average chlorine concentration in the service water systems at D.C. Cook Plant (May-December 1995)

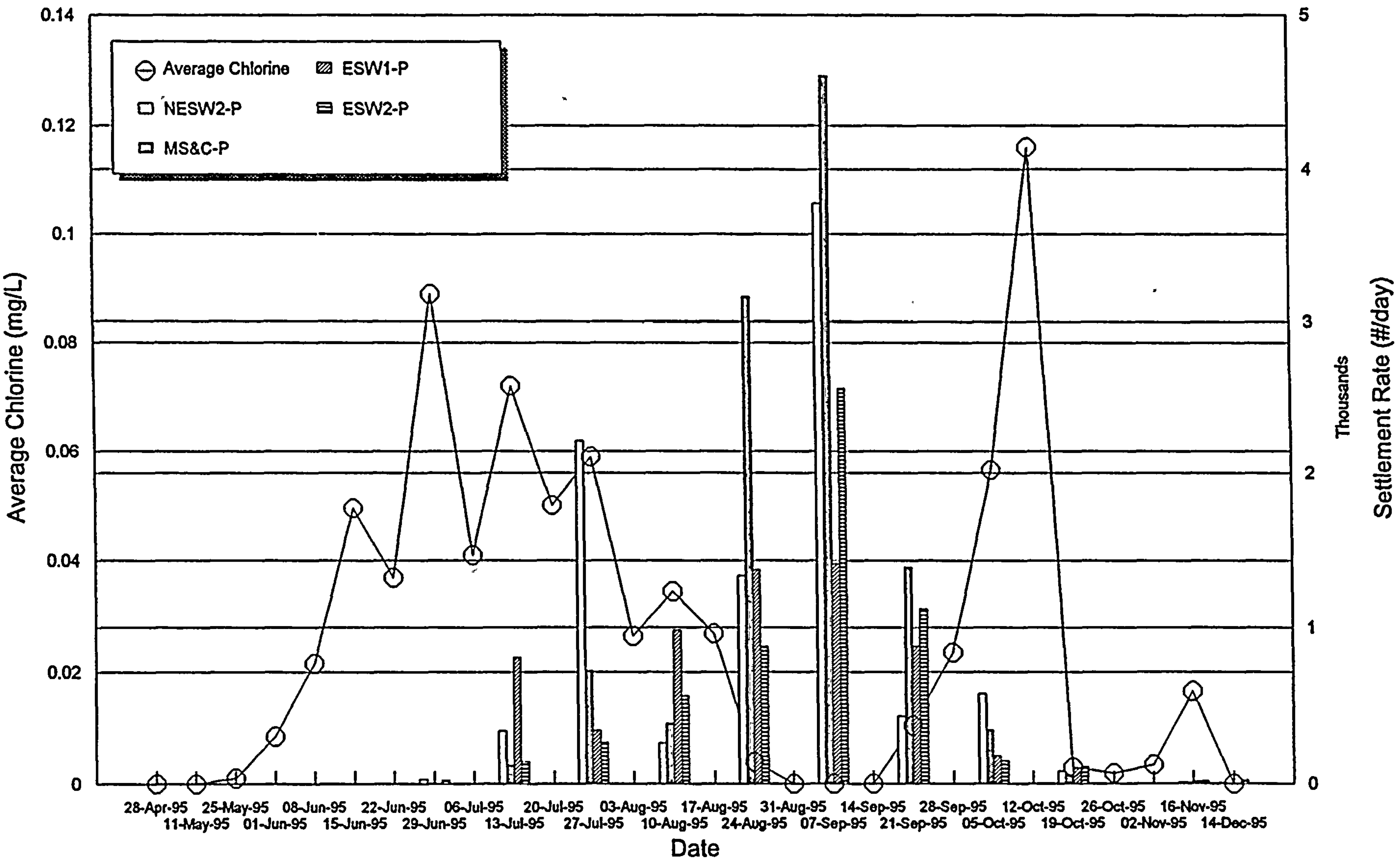


Figure 6. Cumulative settlement of post-veligers in the MS&C, NESW and ESW service systems at D.C. Cook Nuclear Plant (May-December 1995)

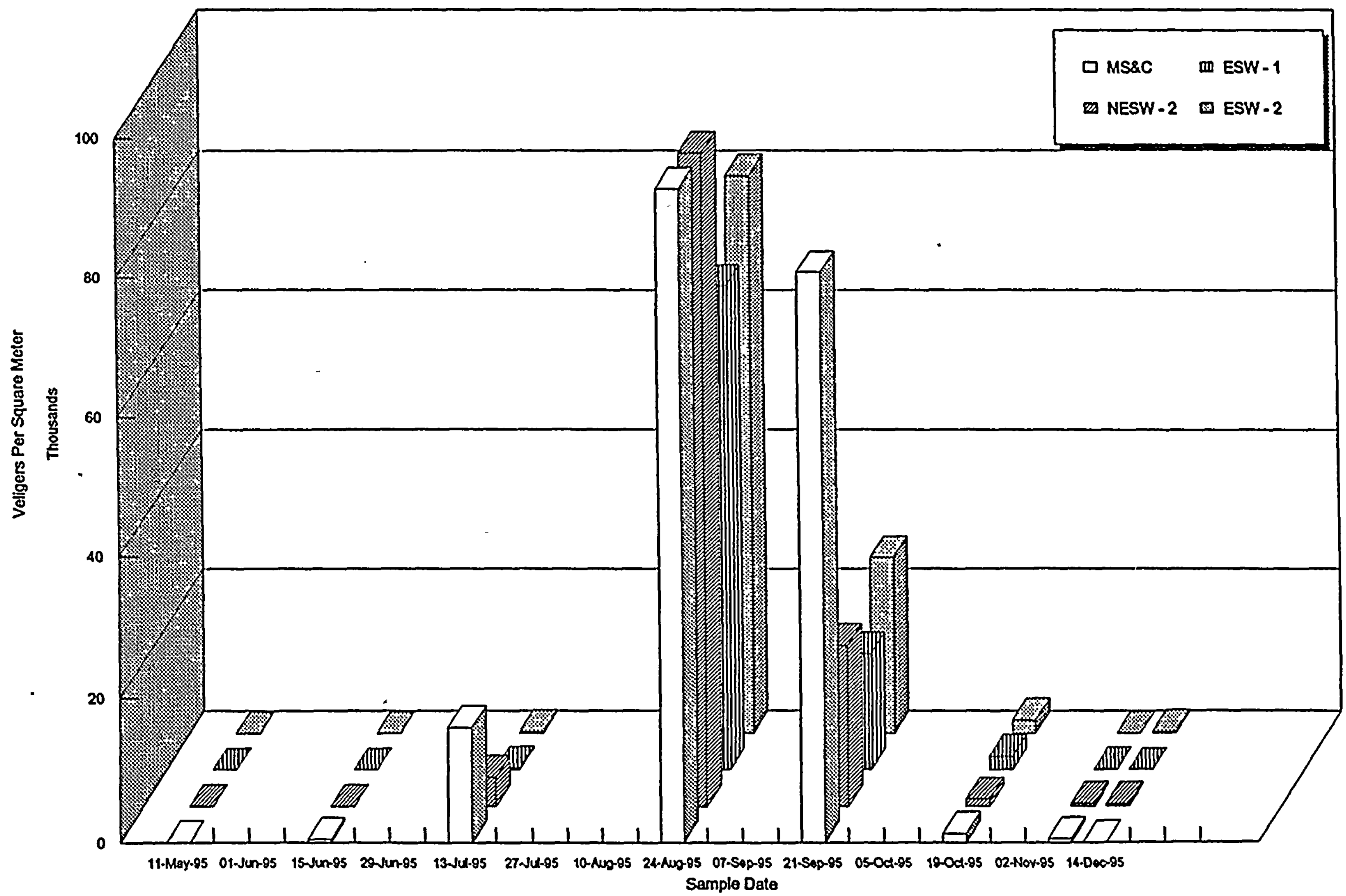
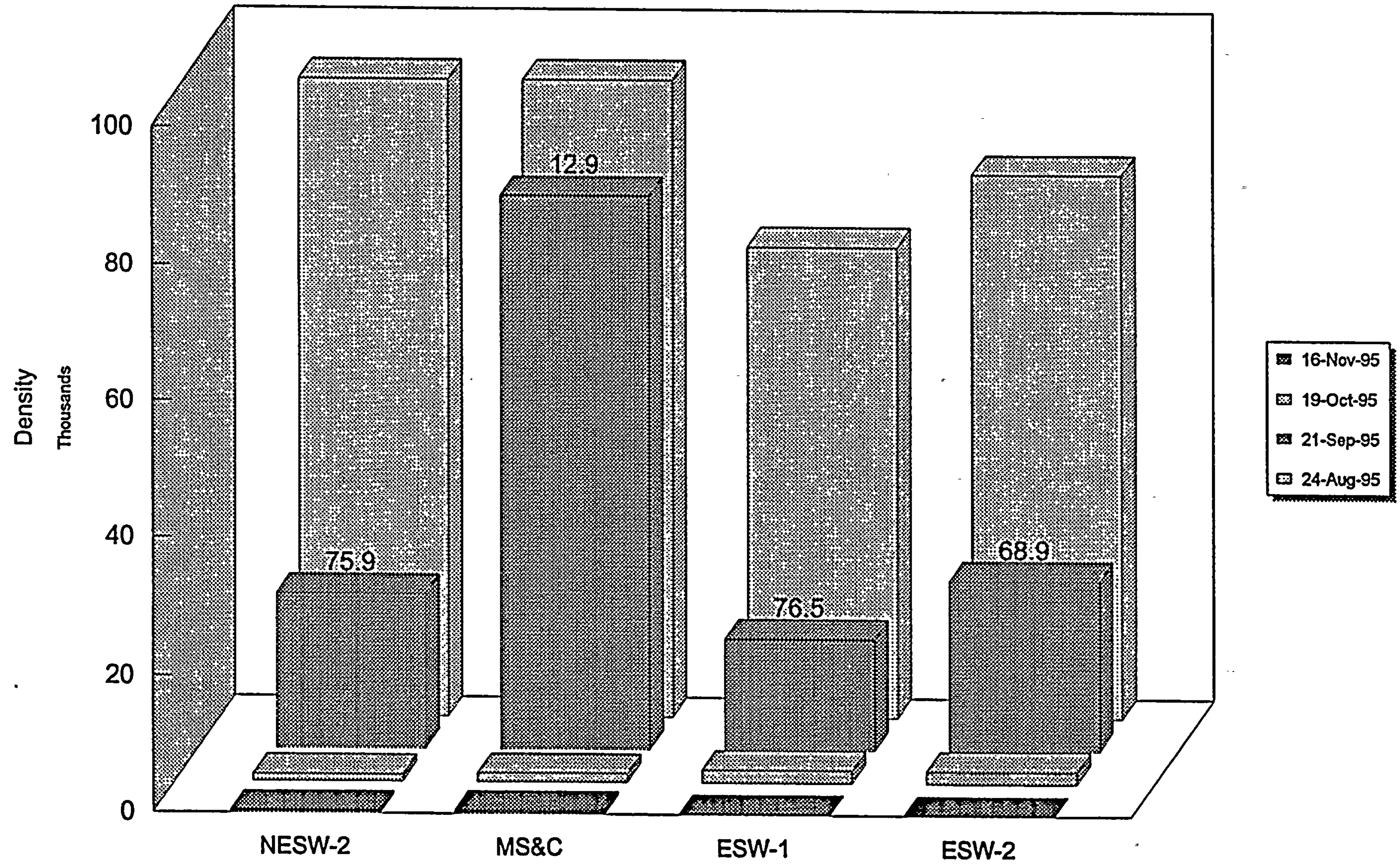


Figure 7. Reduction in post-veliger density in cumulative settlement samples after molluscicide treatment at Cook Plant, 1995



numbers represent percent reduction after initial treatment

APPENDIX 1

Raw Data Sheets

Available upon request

APPENDIX V

SPECIAL REPORTS

APPENDIX V.A

DEMONSTRATION OF ACCEPTABILITY OF INCREASED HEAT ADDITION

Indiana Michigan
Power Company
Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106
616 465 5901

INDIANA
MICHIGAN
POWER

Mr. Asad Quraishi
Permits Section
Surface Water Quality Division
Michigan Dept. of Natural Resources
P.O. Box 30273
Lansing, Michigan 48909

April 11, 1995

Dear Mr. Quraishi:

Re: Cook Nuclear Plant
NPDES Permit MI0005827

The March 24, 1995 draft NPDES Permit MI0005827 contains provisions for increasing the heat rejected to Lake Michigan by the Cook Nuclear Plant. In accordance with your directions, attached is demonstration of the acceptability of the proposed increased heat discharge, in fulfillment of Rule 98 of the Michigan Water Quality Standards.

As the attached information describes, the change in heat rejection will allow the uprating of the Cook Plant Units to provide additional electrical generation. This change is in the best interest of the public, since it promotes low electricity rates, and fosters economic growth in the State of Michigan. This increased generating capacity is also a key element of the Utility Climate Challenge, to reduce, avoid and capture greenhouse gas emissions.

April 11, 1995
Asad Quraishi
Page 2

Should you have any questions on the demonstration, please call me at 616/466-2546.

Sincerely,

Diane Fitzgerald
Environmental, Safety & Health Superintendent

Attachments

I certify under penalty of law that I have personally examined an am familiar with the information submitted on this and all attached documents; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Diane Fitzgerald
Environmental, Safety & Health Superintendent

COOK NUCLEAR PLANT

NPDES PERMIT MI0005827

DEMONSTRATION OF ACCEPTABILITY OF INCREASED HEAT ADDITION

Introduction

With some modifications, the Cook Nuclear Units have the capability to generate about 6% more power above current design limits. Indiana Michigan Power is now making plans to uprate Cook Unit 2 (resulting in 60 MW of increased electrical generation), and is evaluating the potential for a Unit 1 uprate.

The uprate of one or both units will result in a negligible increase in heat rejection to Lake Michigan. The NPDES Permit thermal discharge limit will be raised from 15.5×10^9 BTU/hr to 16.8×10^9 BTU/hr. Modeling studies indicate that this change will result in the calculated mixing zone area to expand from about 593 to 700 acres, an increase of about 18%.

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. There are no prudent alternatives that would achieve the same results in such an environmentally benign manner; in fact, the proposed modification will have an overall environmental benefit when considered against the alternatives.

Considerable evidence exists in support of our belief that the impact of this change will have a negligible effect on the environment. Indiana Michigan Power conducted 10 years of environmental studies at a cost of $12 million dollars to determine the impact of the Plant on Lake Michigan. The aquatic ecological studies conducted as part of the environmental effects studies were summarized in Publication 22[1] from the University of Michigan. (This publication was previously provided to the MDNR.) The authors of Publication 22 concluded that while there were measurable effects on phytoplankton and zooplankton directly in contact with the warmest portions of the thermal plume, there was no measurable change to the abundance, diversity, or productivity of biological communities in Lake Michigan near the Plant.

[1] Great Lakes Research Division/Publication 22, 1986. Southeastern Nearshore Lake Michigan: Impact of the Donald C. Cook Nuclear Plant. Ronald Rossmann (ed.) The University of Michigan, Ann Arbor. 432pp Publication 22 is a compendium of a ten-year study of the impacts of operation of the Donald C. Cook Nuclear Plant on water and sediment chemistry, shoreline erosion, ice formation, periphyton, phytoplankton, benthic invertebrates and fish.

The benefits of uprating the Units are sizeable. They include the avoidance of generation of greenhouse gas emissions, and supporting important social and economic development. These benefits are described in more detail in the following demonstration.

COOK NUCLEAR PLANT

NPDES PERMIT MI0005827

DEMONSTRATION OF ACCEPTABILITY OF INCREASED HEAT ADDITION

Part 4 of the general rules of the Michigan Water Resources Commission (Water Quality Standards) contain in Rule 98 provisions for the Commission to determine that the requested increase in heat addition is acceptable.

The following discussion of the applicable sections of Rule 98 demonstrates the acceptability of the requested heat addition with no prudent alternative. This discussion pertains to the combined discharge of non-contact cooling water and miscellaneous low volume waste streams from the Donald C. Cook Nuclear Plant near Bridgman, Michigan. The discharges in question are identified as outfalls 001 and 002 in NPDES Permit No. MI0005827.

Rule 98(2)(a) Public health, safety, or welfare.

The proposed heat increases to Lake Michigan will not be injurious to the public health, safety or welfare. The nearest drinking water intake, owned by Lake Township, is located approximately 4500 feet to the south of the Cook Plant outfalls. With the prevailing current normally north, the impact of the additional heat discharged will be very minimal on this municipal water supply intake.

Rule 98(2)(b) Uses of water.

The proposed heat increase will not become injurious to domestic, commercial, industrial, agricultural, recreational, or other uses that are or may be made of the waters in the vicinity of the Plant outfalls. With regard to domestic, commercial, industrial, or agricultural uses, this section of Rule 98 is not applicable, as Lake Michigan water is not a source for these uses in the vicinity of the outfalls to the Lake. The proposed heat increase will have no adverse impact on recreational activities such as boating, swimming or fishing; in fact, the area near the Plant outfalls is a favored site for sport fishing. As indicated in Publication 22, the current discharge has actually increased the populations of some sport fish species due to moderate temperatures year round and the beneficial aquatic habitat for food sources in the area of the Plant discharges. As stated in Rule 98(2)(a) above, the effluent from the Cook Plant will not affect the Lake Township municipal water intake.

Rule 98(2)(c) Value or utility of riparian lands.

The modification will not have any significant effect on the adjacent near-shore waters resulting from the requested heat increase to Lake Michigan, nor will it be injurious to the value or utility of riparian lands. The studies performed for the 1973 Final Environmental Statement published by the Nuclear Regulatory Commission, and follow-up studies reported in Publication 22, indicate the plume remains offshore and there is no impact to the surrounding shorelines.

Rule 98(2)(d) Injurious to land or aquatic animals or plants.

Lake Michigan in the vicinity of the Cook Plant is not used as a livestock watering source. The shoreline for many miles north and south of the plant are in non-agricultural land uses and are likely to remain in non-agricultural land use in the future. Land values of Lake Michigan shoreline property are high enough to preclude using Lake Michigan shoreline for the low value cattle grazing and watering land use.

Terrestrial wildlife uses the Lake as a drinking water supply. The thermal discharge is located about 1,100 ft. from shore. In the unlikely event the plume would reach the shoreline, it would be greatly diluted and nearly ambient temperature. Animals would not avoid consuming water that is slightly warmer than ambient temperature.

Several species of ducks and a number of other bird species use Lake Michigan near Cook Plant for resting and foraging. Increasing the size of the plume by 18% will not affect the behavior of the birds currently using the area.

The ten-year study completed in 1982 (Publication 22) documented the magnitude and scope of the impacts of the thermal plume on Lake Michigan fish, benthos, zooplankton, phytoplankton, and periphyton. Measurable ecological impacts attributed to the thermal discharge on benthos, zooplankton, phytoplankton, and periphyton were not detected. Minor changes in the distribution of several fish species were attributed to the thermal discharge. Brown trout, common carp, and gizzard shad were attracted to the thermal plume and the warmer water. Brown trout, however, may have been attracted by the crayfish population living among the rip-rap. Lake white fish and sand shiners were less abundant near the plant than in the reference area. This difference was attributed to these species avoiding the thermal plume. The ecological effect of these changes in local fish distribution is minor. The impacts resulting from increasing the thermal loading

of Cook Plant by 8% will not change observations made during the ten-year study.

Plants, more correctly called rooted aquatic macrophytes, are rare to absent in the vicinity of the Cook Plant. The loose sandy substrate is virtually lacking organic material, and the wave energy prevents aquatic plants from becoming established. Therefore, there is no aquatic macrophyte community near the Cook Plant to be impacted by the thermal plume.

Rule 98(2)(e) Impair or destroy the value of game, fish or wildlife.

The increase in the Cook Plant thermal plume will have no impact on game and wildlife, as referenced in the discussion under Rule 98(2)(d). Fish populations in the vicinity of the Cook Plant were only slightly altered by the addition of the thermal effluent. The small increase in thermal addition will not measurably alter the value of the sport fishery in the Cook Plant vicinity.

Rule 98(2)(f) Against public interest.

The proposed heat increase to Lake Michigan is reasonable and in the public interest, as explained below.

Deregulation

In the imminent era of electric utility deregulation, the fundamental change that the industry faces is that consumers will, perhaps for the first time, have choices. They will decide who supplies them electricity that they use. Electric utility deregulation will begin as an economic development issue, by which the State of Michigan will identify the need to maintain, retain, and recruit new businesses -- to fuel growth in needed jobs. Low-cost electricity will serve as an impetus for businesses to relocate because of opportunities to save money.

I&M recognizes that it must be prepared to compete for customers. Its corporate goal is to satisfy customers by affording the best price, value, and service in the marketplace, while operating to protect the environment and health and safety of our customers and employees.

I&M is also obligated to pursue least-cost methods of supplying electricity to meet demand. This is accomplished through an Integrated Resource Plan. Michigan regulators and consumer groups have the opportunity to review this plan to ensure that it is cost-effective and provides adequate customer service.

Lastly, I&M is obligated to consider the cost of alternate types of generating plants. The Integrated Resource Plan results in a combined schedule of generating plant additions, power purchases from independent power producers or on the wholesale market, and a set of demand side measures for business and residential customers.

The proposed change is in the interest of the public. It enables I&M to continue to provide low-cost electricity, while operating to protect the environment and health and safety of customers and employees.

Rule 98(4) Accommodate important social and economic development, and no prudent alternatives.

CO_2 Issue

On February 3, 1995, American Electric Power (parent company of Indiana Michigan Power), signed Participation Accords for the Utility Climate Challenge. The Climate Challenge is a voluntary effort by electric utilities to reduce, avoid and sequester greenhouse gas emissions. One of the key elements of agreement is increasing the generating capacity of the Company's nuclear-powered units, resulting in CO_2 emissions savings.

The CO_2 emissions savings that will result from the proposed capacity modifications are based on the assumption that the generation would instead come from coal-fired units on the AEP System. The potential emissions savings are projected to be approximately 1 ton of CO_2 for each megawatt-hour (MWH) of generation. The annual (1998) estimated MWHs obtained from the 60 MW of increased capability is 465,600 MWH. Therefore, approximately 465,600 tons of CO_2 emissions will be saved annually from the new capacity.

Cooling Tower Costs: Side Stream Cooling

The estimated capital costs of 60 MW of capacity at the Cook Nuclear Plant with side stream cooling are $13,800,000 (1992$). In addition, a closed cycle cooling system will result in an estimated loss in generation capability of about 2% for auxiliary power requirements. The environmental impacts associated with cooling towers include the necessity to use and store various chemicals to operate and maintain the units, icing, condensed fog, consumption of a critical dune area, and potential environmental damage to a critical dune area.

Economic Development Potential

The proposed heat increase to Lake Michigan is in the public interest as it is necessary to accommodate important social and economic development. Also, there are no prudent and feasible alternatives to the minor effects that will also allow the benefits of the proposal to be realized.

The proposed capacity modifications at the Cook Plant will result in a net electric capacity increase of about 6%. Based on energy projections for 1998, after the unit capacity modifications are completed, approximately 465 million kilowatt hours extra could be generated annually. (This assumes continuous plant operation.)

In order to demonstrate the inherent economic advantages of capacity modifications at the Cook Plant, an analysis was conducted of the electric energy production expenses of I&M's large power plants and those of neighboring companies in Michigan, Illinois, Ohio, and Indiana. The Cook Plant produces electricity more economically than 90% of all power plants in the immediate geographic region. Low cost power is one of the principal factors that new companies will decide whether to locate in Michigan, as demonstrated in the recent North Star Industry site exploration.

As discussed above in Rule 98 Section (2)(f), a correlation exists between the cost of supplying electricity and the potential for economic development. The proposed capacity modifications at Cook Plant will result in an expansion of low-cost electricity production from I&M for the State of Michigan, thereby fostering economic development.

In summary, the proposed heat increase to Lake Michigan is necessary for the capacity modifications at the Cook Plant, which in turn will provide low-cost energy to support future economic development in Michigan.

Rule 98(7) Mixing zones

Heat is not a substance and is not by definition toxic, therefore, this portion of the anti-degradation policy does not apply. EPA does not regulate heat as a toxin.

APPENDIX V.B

TOXICITY TESTING DURING MOLLUSCICIDE TREATMENT

Indiana Michigan
Power Company
Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106
616 465 5901

INDIANA MICHIGAN POWER

Mr. Greg Danneffel
Michigan Department of Environmental Quality
621 North Tenth Street
P.O. Box 355
Plainwell, MI 49080

October 16, 1995

Re: Cook Nuclear Plant
NPDES Permit MI 0005827

Dear Mr. Danneffel:

This letter is provided in response to Ms. Sylvia Heaton's Special Condition letter of August 7, 1995, regarding Cook Plant molluscicide use and toxicity testing. This also satisfies the requirements contained in NPDES Permit No. MI0005827, Part I.A.1**, Mass Balance Calculations and Part I.A.7, Toxicity Testing during the Molluscicide Treatment utilizing Nalco's Macro-trol 9380 in place of Betz's Clam-Trol products.

Compliance With Effluent Limits

On September 8, 1995, the Plainwell District Supervisor was notified of a planned molluscicide treatment. Subsequently a Nalco Macro-trol 9380 application was performed on September 16, 1995, on the Cook Plant's circulating water system. Macro-trol 9380 was applied from a barge at the Plant's north and center intake cribs.

Macro-trol 9380 was fed at a target concentration of 2 ppm for a 12 hr. period. Bentonite clay was fed and adjusted as necessary to maintain a ratio of at least 12:1 clay/Macro-trol for detoxification of the active Macro-trol. Macro-trol concentrations measured at the north and center intake manways were used to provide feedback for the proper Macro-trol feedrate. The Methyl Orange Analytical Method was used as required by the MDEQ.

One thousand ten gallons (1,010 gal.) or 7,878 lbs. (7.8 lbs./gal.) of Macro-trol 9380 detoxified by 145,000 lbs. of bentonite clay were used for the circulating water system treatment. All samples taken from Outfalls 001 (Unit 1 Discharge) and 002 (Unit 2 Discharge) were less than detectable (0.1 mg/l.) The maximum discharge limit for Nalco Macro-trol 9380 is 0.01 mg/l. Mass balance results stated above show that a better than 12:1 clay/Macro-trol ratio for detoxification of the active Macro-trol was maintained during the treatment. The results of the lab analyses are presented in Attachment 1.

Whole Effluent Toxicity (WET) Testing Results

The WET testing was conducted using EPA/600/4-90/027F, "Methods for Measuring the Acute Toxicity of Effluent and Receiving Waters to Freshwater and Marine Organisms." Test results are presented in detail in Attachment 2. Acute 48-hr. toxicity tests were conducted with Daphnia magna on 100%, 50%, 25%, 12.5%, 6.25%, and 0% (control) effluents. The plant discharges consisting of Macro-trol/lake water detoxified by bentonite clay, as well as a 24 ppm clay/lake water sample were determined to be nontoxic. The Daphnia magna 48-hour acute toxic units (TUa) was <1.0 for all samples.

Other Significant Events

A Unit 2 Outfall sample taken at 1900 hrs. on 9/16/95 indicated 0.14 mg/l. The sample was rerun at 2325 hrs. and was found to be less than the detectable concentration of 0.1 mg/l. The detectable concentration determined from the initial analysis was attributed to analytical error. The laboratory technician inadvertently drew off a small amount of clay concentrate at the water/organic interface in the separatory funnel which when placed in the spectrophotometer, caused a visible light interference yielding a false positive reading.

As reported in my memo of September 21, 1995 to F. Morley, on September 16, 1995 at 0930 hrs., unnatural turbidity was observed at Cook Plant Outfalls 001 and 002 (condenser cooling water and miscellaneous low volume waste.) The observed turbidity was caused by bentonite clay being fed into the discharge vaults for Units 1 and 2 outfalls.

Conclusion

The special conditions stated in Ms. Heaton's memo of August 7, 1995 for the application of Nalco Macro-trol 9380 were met. Macro-trol was detected in one outfall sample, but this was determined to be due to analytical error. The results of the whole effluent studies demonstrated that the plant discharges were nontoxic.

If you have any questions on the information provided, please contact Eric Mallen at 616/465-5901, ext. 1540.

Sincerely,

Diane M. Fitzgerald
Environmental, Safety & Health Superintendent

I certify under penalty of law that I have personally examined and am familiar with the information submitted on this and all attached documents; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. Alan Blind 10/17/95

A. A. Blind
Site Vice President

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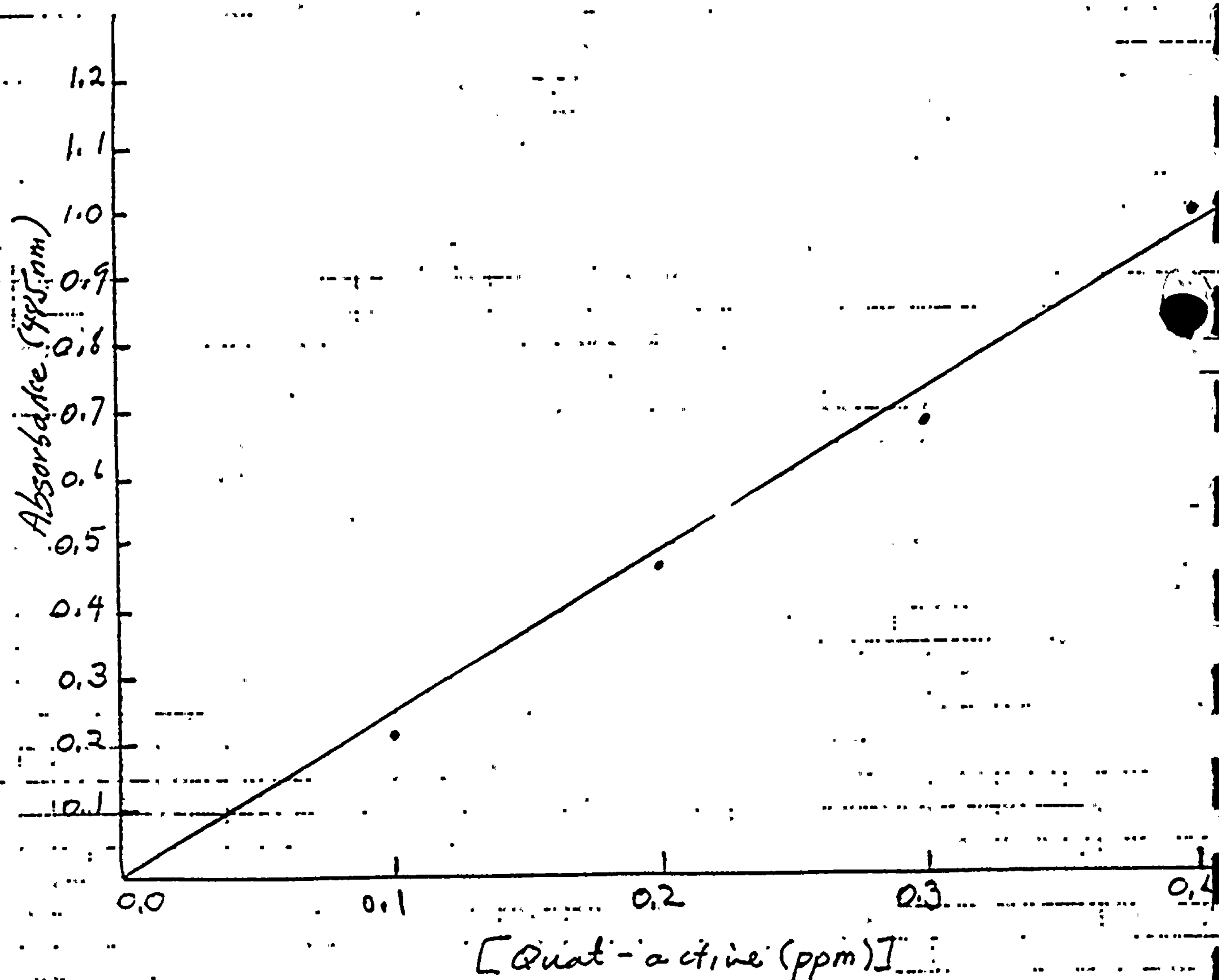
Attachment 1

D.C. Cook Zebra Mussel Kill w MacroTrol ... 3
Sept. 15, 1995

I. Low Calibration curve;

Active Quat (ppm)	A 485
0.1	0.209
0.2	0.459
0.3	0.665
0.4	1.002

r^2 = 0.9

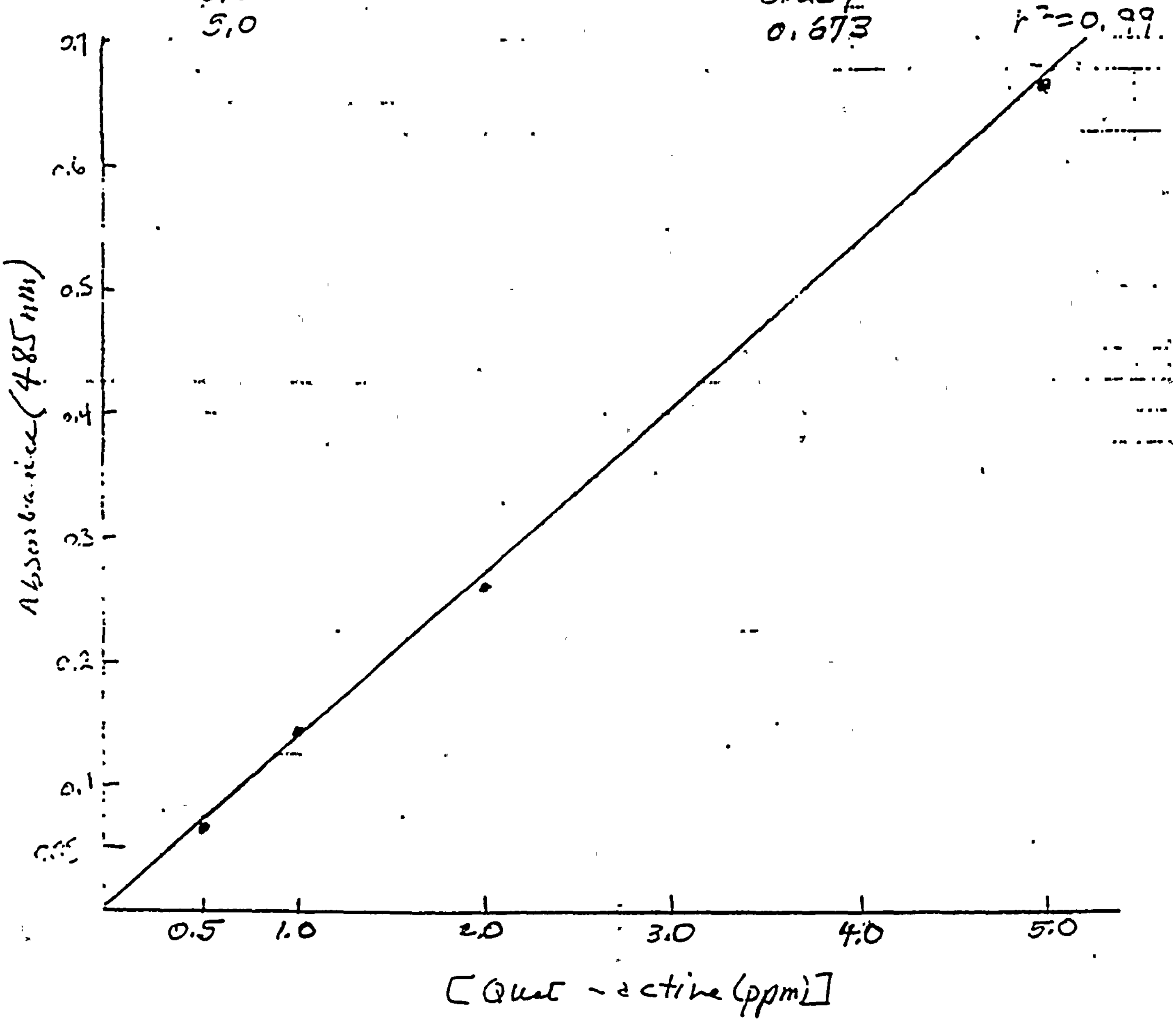


SIGNATURE DATE READ AND UNDERSTOOD BY DATE

D.C. Cook Zebra Mussel Kill c MACROTROL N-9380
Sept 15, 1995

I. High Calibration Curve:

Active Quat (ppm)	A485
0.5	0.065
1.0	0.143
2.0	0.259
5.0	0.673



SIGNATURE: R E McCarthy DATE: 9/15/95

READ AND UNDERSTOOD BY DATE

U1- Outfall
Sample Location

9-16-95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0920	69.6	0.037		<0.1	REM
1108	69.6	0.048		<0.1	REM
1300	67.8	0.170		<0.1	REM
1500	67.8	0.049		<0.1	REM
1700	67.8	0.065		<0.1	REM
1900	67.8	0.123		<0.1	CJF
2100	68.9	.036		<0.1	REM
2305	68.9	0.026		<0.1	DAT

Water Temp Readings taken from
Unit 1 Circ. Water System Environmental Data Sheet
12 THP 6020 ENV 103 Att. 1 for 9/16/95. [initials] 10/13

U2-OUTFALL
Sample Location

9-16-95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0920	76.8	0.017		<0.1	REM
1100	76.8	0.050		<0.1	CJF
1300	85.6	0.099		<0.1	REM
1500	85.6	0.002		<0.1	CJF
1700	85.6	0.195		<0.1	REM
1900	85.6	0.308		0.14	REM.
2100	85.8	0.018		<0.1	DAT
* 1900 ~~[illegible]~~ DAT 9/16/95	85.6	0.123		<0.1	DAT
2305	85.8	0.038		<0.1	CJF

* Second sample ran at 2325.
Water Temp. Readings taken from Unit 2 Circ. Water System Environmental Data Sheet 1,2THP 6020 ENV.103

Middle Intake
Sample Location

9-16-95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0945	66.6	0.086		0.64	REM
1020	66.6	0.105		0.78	REM
1045	66.6	0.070		0.52	REM
1120	66.6	0.147		1.10	REM
1145	66.6	0.113		0.84	REM
1220	67.5	0.140		1.04	REM
1245	67.5	0.096		0.72	REM
1315	67.5	0.128		0.96	CJF
1345	67.5	0.174		1.30	REM
1415	67.5	0.247		1.84	REM
1445	67.5	0.040		<0.5	CJF
1515	67.5	0.311		2.32	REM
1545	67.5	0.375		2.80	CJF
1615	67.5	0.365		2.72	CJF
1645	67.5	0.269		2.01	CJF
1715	67.5	0.216		1.61	CJF
1745	67.5	0.189		1.41	CJF
1845	67.5	0.300		2.24	DAT
2045	68.7	0.225		1.68	REM
* 2235	68.7	0.113		<0.1	CJF

*RUN ON LOW LEVEL PROCEDURE

Water Temp. Readings taken from Unit 1 Circ Water System Environmental Data Sheet 12 THP 6020 ENV.103 Att. 1 for 9/16/95
[initials] 10/13/95

North Intake
Sample Location

9-16-95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0950	66.6	0.014		<0.5	REM
1015	66.6	0.029		<0.5	REM
1050	66.6	0.013		<0.5	REM
1115	66.6	0.023		<0.5	REM
1150	66.6	0.067		0.50	REM
1215	67.5	0.126		0.94	REM
1250	67.5	0.109		0.81	CJF
1315	67.5	0.115		0.86	CJF
1345	67.5	0.200		1.49	CJF
1415	67.5	0.361		2.69	CJF
1445	67.5	0.005		<0.5	CJF
1515	67.5	0.086		0.64	CJF
1545	67.5	0.186		1.39	CJF
1615	67.5	0.182		1.36	REM
1645	67.5	0.261		1.94	REM
1715	67.5	0.296		2.20	REM
1745	67.5	0.302		2.25	CJF
1845	67.5	0.434		3.23	DAT
* 2205	68.7	0.113		<0.1	CJF

* RUN ON LOW LEVEL PROCEDURE

Water Temp. Readings taken from Unit 1 Circ. Water System Environmental Data Sheet 12THP 6020 ENV 103 Att. 1 for 9/16/95

#1 COND A DISCHARGE
Sample Location

9/16/95
Date

[illegible]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1915	67.5	0.331		2.47	CJF

Water Temp Readings taken from Unit 1 Circ. Water System Environmental Data Sheet .2 THP 6020 ENV.103 Att. 1 for 9/16/95
[illegible] 10/13/95

Unit 1 MSCW
Sample Location

9/16/95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1910		0.311		2.32	DAT

Unit 2 MSCW
Sample Location

9/16/95
Date

Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1900		0.276		2.06	DAT

Attachment 2

A Report on the Acute Toxicity of Indiana Michigan Power - Cook Nuclear Plant Whole Effluent Toxicity Tests to *Daphnia magna*

Eric B. Gillespie,
Bioassay Group Manager

Biological Group
Environmental Services, Inc.
6404 MacCorkle Avenue, SW
St. Albans, WV 25177
(304) 768-2233
(304) 768-9988 FAX

ENVIRONMENTAL SERVICES, INC.
6404 MacCorkle Avenue, SW
St. Albans, WV 25177

BIOASSAY REPORT

FOR

INDIANA MICHIGAN POWER
COOK NUCLEAR PLANT

ESI TEST NO. 95-171, 95-172

Daphnia magna

September 17 - 19, 1995, 48 Hour Static Whole Effluent Toxicity Test

INTRODUCTION

Water samples of Indiana Michigan Power - Cook Nuclear Plant, unit 1 and 2 effluent were collected by Indiana Michigan Power, Cook Nuclear Plant for use in a 48 hour acute whole effluent toxicity test. Samples were collected as required by the Michigan Department of Natural Resources to assure no toxic amounts of a molluscicide used for zebra mussel infestation control were released during a treatment. A grab sample from Lake Michigan was collected to be used as the dilution water/control water for the tests.

Effluent samples were collected at the beginning, the fourth, the eighth, and the twelfth hour of the treatment. These eight sample were composite in to one container for testing. Samples were picked-up by Environmental Services on September 16, 1995 at approximately 2130 hours. The sample arrived to the laboratory on September 17, 1995 at 0720 hours. Testing of the samples began at 1520 hours on the 17 of September 1995.

LAKE MICHIGAN DILUTION/CONTROL WATER

Lake Michigan water was used as a control group and the dilution water in the test. The water was collected by Cook Nuclear Plant personnel and filtered to remove the native zooplankton and phytoplankton. Lake Michigan water is described as clear, colorless, no odor, no sediment and no particulate. The temperature of the dilution water was 4°C upon arrival to the laboratory.

EFFLUENT

Effluent collected from unit 1 and 2 on September 16, 1995 is a composite sample collected from each discharge tunnel during the twelve hour treatment. Four equally spaced equal

volume water samples were collected. Samples from each unit were then composite into one sample for testing. Unit 1/2 effluent sample is described as clear, colorless, no odor, no sediment and no particulate present. The temperature of the sample was 3.8°C upon arrival to the laboratory.

TEST METHODS:

48 hour whole effluent toxicity test for AEP - Cook Nuclear Plant, were done according to EPA protocol "Methods for Measuring the Acute Toxicity of Effluent and Receiving Waters to Freshwater and Marine Organisms, EPA/600/4-90/027F". The tests measured the immobilization rather than the death so an EC_{50} rather than an LC_{50} was calculated. Immobilization for this test is defined as, if after gentle prodding or swirling of the test vessel, the organism fails to exhibit normal swimming behavior within the water column for five (5) second, then the organism will be considered immobile/effected.

The effluent was tested at 100%, 50%, 25%, 12.5%, 6.25% and 0% (control) and was diluted with the filtered Lake Michigan water collected on September 16, 1995.

A test series was also included using Lake Michigan water and bentonite clay. The bentonite clay is used to detoxify the molluscicide used in the treatment. This sample was prepared by Cook Nuclear Plant personnel at the same ratio as the clay to water ratio in the detoxified waters in unit 1 and unit 2. This mixture was tested at the same concentrations noted above for the unit 1 and unit 2 sample. Filtered Lake Michigan water was used as the dilution water for this sample also.

RESULTS:

Whole effluent toxicity bioassays are utilized to determine if an effluent is acutely toxic to the test organisms. The testing conducted on unit 1 and unit 2 was to assess the toxicity of the molluscicide used for zebra mussel infestation control.

Indiana Michigan Power - Cook Nuclear Plant unit 1/unit 2 effluent was found not to be acutely toxic, or effective to the mobility of the *Daphnia magna*. No *Daphnia magna* died or displayed any adverse effects during exposure period.

The bentonite clay detoxified sample collected also indicated no acutely toxic effects or inhibition to the mobility of the *Daphnia magna* during the exposure period.

The EC_{50} for the unit 1/unit 2 sample is >100% and the EC_{50} for the detoxified sample is also >100%. The LC50 was also calculated. Unit 1/unit 2 sample the LC50 is >100% and for the detoxified sample the LC50 is >100%.

Chemical and physical analysis of samples are in Appendix A. Copies of laboratory bench sheets are in Appendix B. Chain-of-custody forms are in Appendix C.

ENVIRONMENTAL SERVICES, INC.
BIOMONITORING REPORT FORM
FRESHWATER ACUTE BIOASSAY

Permit No.   DSN: Unit 1/2   ESI #: 95-171

Facility Name: Indiana Michigan Power Cook Nuclear Plant
Facility Location: Bridgeman, Michigan

Contact Person: Eric Mallen
Contact Phone: (616) 465-5901 ext. 1540

Testing Laboratory: Environmental Services, Inc.
6404 MacCorkle Avenue, SW
St. Albans, WV 25177
(304) 786-2233 Fax (304) 768-9988
WV Laboratory Certification No: 022

Bioassay Specifications:
Effluent Type (eg. Final or Prechlorinated): Final
Test Type (Static or Renewal): Static
Test Duration (hours): 48-hrs.

Test Organism: Common Name: Water Flea
Scientific Name: *Daphnia magna*

Test Endpoint: EC50, LC50

Summary of Final Results:
Testing Dates: 9/17-19/95
EC50 (% effluent): >100%
LC50 (% effluent): >100%
Survival in 100% Effluent: 100%
Acute Toxic Unit (TU_a): <1.0

Toxicity Limit: LC50 (% effluent): 100 %
NMAT (no measurable acute toxicity): NA
Test concentration with highest mortality / % mortality: NA
Acute Toxic Unit (TU_a): 1.0

Quality Control Summary:
Control Survival (%): 100%
Test Temperature Maintained ± 2 C? Yes
Dissolved Oxygen Maintained >/= Minimum? Yes
Loading Factor </= Maximum Allowed? Yes
Two or More Trend Deviations? No

Certification

Accuracy of Report Certified by: Eric B. Gillespie 9/21/95
V B-19 Eric B. Gillespie Date
Biological Group Mgr.

Test Organism Data:

Test Organism Source: In-house
Test Organism Age at Start of Test: <24-hrs.
Initial Number of Organisms: 120
Total Acclimation Period (hrs): 0 hrs. Dilution water quality similar to culture water
Exposure to 100% Dilution Water: NA

Mortalities During Acclimation: 0

Test Design:

Number of Effluent Test Concentrations: 5
Test Concentrations (% of effluent): 6.25, 12.5,25.0, 50.0, 100.0
Number of Replicates / Test Concentration: 4
Number of Test Organisms / Replicate: 5
Volume of Test Solution (Liters): .025

Effluent Sampling:

Plant Sampling Location: Unit 1/Unit 2
Starting Date and Time: 9/16/95 0920
Ending Date and Time: 9/16/95 2120
No. Grab Samples in Composite: 4 grabs per unit 8 total
Interval between Grab Samples (min): 240 minutes
Testing Location: St. Albans, WV

Dilution Water

Effluent Receiving Water: Lake Michigan
Dilution Source: Lake Michigan
Substitute Source Approved by MDNR? NA
Preparation/Collection Location: Lake Michigan
Preparation/Collection Dates: 9/16/95

Environmental Services, Inc.

ESI #: 95-171

Effected Data (Number)/Survival Data

Test Conc.		Exposure Time (hrs)		
(% effluent)		0	24	48
CONTROL	1	0/5	0/5	0/5
	2	0/5	0/5	0/5
	3	0/5	0/5	0/5
	4	0/5	0/5	0/5
6.25%	5	0/5	0/5	0/5
	6	0/5	0/5	0/5
	7	0/5	0/5	0/5
	8	0/5	0/5	0/5
12.5%	9	0/5	0/5	0/5
	10	0/5	0/5	0/5
	11	0/5	0/5	0/5
	12	0/5	0/5	0/5
25.0%	13	0/5	0/5	0/5
	14	0/5	0/5	0/5
	15	0/5	0/5	0/5
	16	0/5	0/5	0/5
50.0%	17	0/5	0/5	0/5
	18	0/5	0/5	0/5
	19	0/5	0/5	0/5
	20	0/5	0/5	0/5
100.0%	21	0/5	0/5	0/5
	22	0/5	0/5	0/5
	23	0/5	0/5	0/5
	24	0/5	0/5	0/5

Bioassay Results:

	48 hr.
EC50:	>100%
LC50:	>100%

Calculation Method (48 hr): NA

95% Confidence Interval (48 hr): NA

Acute Toxic Unit (TU_a): <1.0

Note: The data satisfy the Statistical assumptions inherent in the specified method and the EC50 is therefore valid.

ESI #: 95-171

Miscellaneous:

Was organism stress observed during the test? No

Were any exposure chambers aerated during the test? No

Supplementary Information:

Effluent Description	Clarity:	Clear	Sediment:	None
	Color:	Colorless	Particulate:	None
	Odor:	None	Other:	None

Ammonia Analysis: NA

ENVIRONMENTAL SERVICES, INC.
BIOMONITORING REPORT FORM
FRESHWATER ACUTE BIOASSAY

Permit No. DSN: Detox Sample ESI #: 95-172

Facility Name: Indiana Michigan Power Cook Nuclear Plant
Facility Location: Bridgeman, Michigan

Contact Person: Eric Mallen
Contact Phone: (616) 465-5901 ext. 1540

Testing Laboratory: Environmental Services, Inc.
6404 MacCorkle Avenue, SW
St. Albans, WV 25177
(304) 786-2233 Fax (304) 768-9988
WV Laboratory Certification No: 022

Bioassay Specifications:
Effluent Type (eg. Final or Prechlorinated): Final, Detoxified Sample
Test Type (Static or Renewal): Static
Test Duration (hours): 48-hrs.

Test Organism: Common Name: Water Flea
Scientific Name: *Daphnia magna*

Test Endpoint: EC50, LC50

Summary of Final Results:
Testing Dates: 9/17-19/95
EC50 (% effluent): >100%
LC50(% effluent): >100%
Survival in 100% Effluent: 100%
Acute Toxic Unit (TU_a): <1.0

Toxicity Limit: LC50 (% effluent): 100%
NMAT (no measurable acute toxicity): NA
Test concentration with highest mortality / % mortality: NA
Acute Toxic Unit (TU_a): 1.0

Quality Control Summary:
Control Survival (%): 100%
Test Temperature Maintained ± 2 C? Yes
Dissolved Oxygen Maintained >/= Minimum? Yes
Loading Factor </= Maximum Allowed? Yes
Two or More Trend Deviations? No

Certification

Accuracy of Report Certified by: Eric B. Gillespie 9/21/95
Eric B. Gillespie, Biological Group Mgr. — Date

ESI #: 95-172

Test Organism Data:

Test Organism Source: In-house
Test Organism Age at Start of Test: <24-hrs.
Initial Number of Organisms: 120
Total Acclimation Period (hrs): 0 hrs. Dilution water quality similar to culture water
Exposure to 100% Dilution Water: NA

Mortalities During Acclimation: 0

Test Design:

Number of Effluent Test Concentrations: 5
Test Concentrations (% of effluent): 6.25, 12.5,25.0, 50.0, 100.0
Number of Replicates / Test Concentration: 4
Number of Test Organisms / Replicate: 5
Volume of Test Solution (Liters): .025

Effluent Sampling:

Plant Sampling Location: Detoxified sample
Starting Date and Time: 9/16/95 2120
Ending Date and Time: 9/16/95 2120
No. Grab Samples in Composite: NA
Interval between Grab Samples (min):
Testing Location: St. Albans, WV

Dilution Water

Effluent Receiving Water: Lake Michigan
Dilution Source: Lake Michigan
Substitute Source Approved by MDNR? NA
Preparation/Collection Location: Lake Michigan
Preparation/Collection Dates: 9/16/95

Environmental Services, Inc.

ESI #: 95-172

Effected Data (Number)/Survival Data

Test Conc. (% effluent)		Exposure Time (hrs) 0	24	48
CONTROL	1	0/5	0/5	0/5
	2	0/5	0/5	0/5
	3	0/5	0/5	0/5
	4	0/5	0/5	0/5
6.25%	5	0/5	0/5	0/5
	6	0/5	0/5	0/5
	7	0/5	0/5	0/5
	8	0/5	0/5	0/5
12.5%	9	0/5	0/5	0/5
	10	0/5	0/5	0/5
	11	0/5	0/5	0/5
	12	0/5	0/5	0/5
25.0%	13	0/5	0/5	0/5
	14	0/5	0/5	0/5
	15	0/5	0/5	0/5
	16	0/5	0/5	0/5
50.0%	17	0/5	0/5	0/5
	18	0/5	0/5	0/5
	19	0/5	0/5	0/5
	20	0/5	0/5	0/5
100.0%	21	0/5	0/5	0/5
	22	0/5	0/5	0/5
	23	0/5	0/5	0/5
	24	0/5	0/5	0/5

<u>Bioassay Results:</u>

	48 hr.
EC50:	>100%
LC50:	>100%
Calculation Method (48 hr):	NA
95% Confidence Interval (48 hr):	NA
Acute Toxic Unit (TU_a):	<1.0

Note: The data satisfy the Statistical assumptions inherent in the specified method and the EC50 is therefore valid.

Environmental Services, Inc.

ESI #: 95-172

Miscellaneous:

Was organism stress observed during the test? No

Were any exposure chambers aerated during the test? No

Supplementary Information:

Effluent Description	Clarity:	Clear	Sediment:	None
	Color:	Colorless	Particulate:	None
	Odor:	None	Other:	None

Ammonia Analysis: NA

APPENDIX A

SUMMARY OF ENVIRONMENTAL CONDITIONS

ENVIRONMENTAL SERVICES INC.
6404 MACCORKLE AVE.
ST.ALBANS, WEST VIRGINIA

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-171   Organism: Daphnia magna

CONCENTRATION: Control

TIME: (HOURS)		0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.0	24.0
	b	26.0	24.0	24.0
	c	26.0	24.0	24.0
	d	26.0	24.0	24.0
pH	a	7.79	7.62	8.31
	b	7.79	7.62	8.31
	c	7.79	7.62	8.31
	d	7.79	7.62	8.31
DO(mg/l)	a	8.2		8.3
	b	8.2		8.3
	c	8.2		8.3
	d	8.2		8.3
COND.(UMHOS/CM)	a	340		360
	b	340		360
	c	340		360
	d	340		360

CONCENTRATION: CONTROL

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	7.91	0.29	8.31	7.62
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	350	10	360	340

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-171   Organism: Daphnia magna

CONCENTRATION: 6.25%

		TIME: (HOURS) 0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.0	24.0
	b	26.0	24.0	24.0
	c	26.0	24.0	24.0
	d	26.0	24.0	24.0
pH	a	7.83	7.73	8.35
	b	7.83	7.73	8.35
	c	7.83	7.73	8.35
	d	7.83	7.73	8.35
DO(mg/l)	a	8.2		8.3
	b	8.2		8.3
	c	8.2		8.3
	d	8.2		8.3
COND.(UMHOS/CM)	a	260		300
	b	260		300
	c	260		300
	d	260		300

CONCENTRATION: 6.25%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	7.97	0.27	8.35	7.73
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	280	20	300	260

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-171   Organism: Daphnia magna

CONCENTRATION: 12.5%

TIME: (HOURS)		0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.0	24.0
	b	26.0	24.0	24.0
	c	26.0	24.0	24.0
	d	26.0	24.0	24.0
pH	a	7.97	7.79	8.33
	b	7.97	7.79	8.33
	c	7.97	7.79	8.33
	d	7.97	7.79	8.33
DO(mg/l)	a	8.2		8.3
	b	8.2		8.3
	c	8.2		8.3
	d	8.2		8.3

COND.(UMHOS/CM)	a	300	320
	b	300	320
	c	300	320
	d	300	320

CONCENTRATION: 12.5%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	8.03	0.22	8.33	7.79
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	310	10	320	300

APPENDIX V.C

SIX WEEK CHLORINATION STUDY

Indiana Michigan
Power Company
Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106
616 465 5901

INDIANA MICHIGAN POWER

File

Mr. Fred Morley, District Supervisor
Mr. Thomas Leep, District Supervisor
Surface Water Quality Division
Michigan Department of Natural Resources
621 North Tenth Street P. O. Box 355
Plainwell, MI 49080

May 4, 1995

Re: Cook Nuclear Plant
NPDES Permit No. MI 0005827

Dear Messrs. Leep and Morley,

The draft NPDES Permit published March 24, 1995 contains, at Part I, Section A.12 Special Condition, a requirement to submit a "Zebra Mussel Control Plan" which includes a six week chlorination study. The attached draft plan addresses the specific requirements as referenced in this Special Condition of the draft Permit.

The study is scheduled to begin on May 15, 1995. At the completion of the study, we will supply the data to your office within approximately 5 weeks. If the results demonstrate the discharge limits contained in the draft permit are met, we will commence with continuous chlorination of the Service Water Systems, in anticipation of receiving written notification from your office, as stated in the draft permit. It essential for zebra mussel control that Service Water System chlorination not be interupted.

Please contact John Carlson, Environmental Supervisor, at (616) 465-5901 ext. 1153, or me at (616) 466-2546 with any questions or comments you have on the study plan.

Sincerely,

Diane M. Fitzgerald

Diane M. Fitzgerald
Environmental, Safety & Health Superintendent.

Attachments

c: Sylvia Heaton - MDNR Lansing
Tim Unseld - MDNR Plainwell
Greg Danneffel - MDNR Plainwell

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Cook Nuclear Plant

Bridgman, Michigan

Zebra Mussel Control Plan

Chlorination Study

Introduction: In order to safely and efficiently operate the Cook Nuclear Plant, non-contact cooling systems must be maintained in a clean condition. The strategy developed to maintain these systems consists of two key elements:

1. **Control of zebra mussels in the Service Water Systems.**

   The Service Water Systems (SWS), consists of the Essential Service Water (ESW) and Non-Essential Service Water (NESW). Zebra mussel settlement in the SWS can endanger the safe shutdown and safe operation of nuclear related systems.

2. **Slime control in the Main Condensers of the Circulating Water Systems.**

   Formation of slime in the main condensers of the Circulating Water Systems (CWS) results in decreased thermal performance.

We propose to implement a chlorination program, which allows us to effectively control zebra mussel settlement and slime build-up, by continuously chlorinating the service water systems and intermittently chlorinating the circulating water systems. This proposal is based on studies from Canada and at the Cook Plant which show that zebra mussel veligers and translocaters are controlled by the low level continuous dose of chlorine.

This proposal is submitted in fulfillment of Special Condition Part I, Section A. 13, of the draft NPDES permit issued on March 24, 1995. It is also based on previous correspondence from the MDNR (Greg Danneffel and Sylvia Heaton) which require a "Zebra Mussel Control Plan" to be submitted which includes a six week chlorination study. The study must demonstrate that chlorination of the SWS does not result in the discharge of toxic levels of chlorine. The study will demonstrate that total residual chlorine (TRC) is not discharged at levels greater than 0.006 mg/l through Outfalls 001 and 002, other than during periods of intermittent chlorination of the circulating water systems.

Study Site: Cook Nuclear Plant is located on the Lake Michigan shoreline in Berrien County, Michigan (Town 6S, Range 19W, Section 6.) The plant draws in Lake Michigan water via three 16' diameter intake tunnels. Each tunnel is approximately 0.5 miles long. Seven circulating water pumps (three for Unit One and four for Unit Two) move the water at a combined maximum flow rate of 1.6 million gpm. The flow discharges via two discharge tunnels, one 16' in diameter and the other 18' in diameter.

The SWS consists of ESW and NESW. The design flow rates for the NESW is approximately 9000 gpm per unit for a total maximum flow of 18,000 gpm. The ESW flow combined is approximately 15,000 gpm maximum. The ESW and NESW systems are internal discharges to the CWS. The SWS discharge enters the CWS before the water exits the discharge tunnels. Typical ratios of circulating water flow to SWS are found in the

attached Table #2, "Theoretical Circulating Water TRC Values".

Actual ESW and NESW flows are much less than the maximum during normal operations, therefore, the ratios are greater than shown in this study. Our results will document the typical flow as measured during the study. Maximum rated ESW flow is 5000 gpm, (Unit 1), 10000 gpm (Unit 2), and maximum rated NESW flow is 9000 gpm for each unit. Normal flowrates for the NESW and ESW systems will be lower. The study will be used to calculate ratios and predict TRC levels at the outfall.

The chlorination system delivers a sodium hypochlorite solution (NaOCl) to the injection points using individual positive displacement pumps. Each pump delivers ~12% NaOCl solution to the appropriate NESW, ESW or CWS.

Methods: The following Cook Plant sampling procedures will be used to collect samples for the study.

- 12 THP 6020 LAB.037 "Liquid Sampling"
- 12 THP 6020 CHM.304 "Essential Service Water System"

The following Cook Plant procedure will be followed during chlorination of the SWS.

- 12 THP 6020 LAB.200 "Circulating Water Essential Service Water and Non-essential Service Water Chlorination"

TRC analysis will be performed using one or more of the following Cook Plant procedures.

- 12 THP 6020 LAB.213 "Operation and Calibration of the Model 1770 Chlorine Monitor"
- 12 THP 6020 INS.006 "DR/2000 Analyses"
- EPA 330.1 methods

Spiked and replicate samples, as appropriate, will be included with the study. Data generated from the study will be controlled by the following procedures.

- 12 THP 6020 ADM.001 "Quality Control"
- 12 THP 6020 ADM.010 "Analytical Results".

Analysis quality control will be performed via the following procedures.

- 12 THP 6020 ADM.003 "On-line Instrument Quality Control"
- 12 THP 6020 ADM.004 "Control of Volume Devices delivery"
- 12 THP 6020 ADM.005 "Reagent and Standard Control"

All procedures are available for review upon request.

Procedure: SWS TRC discharge will be maintained within a range of approximately 0.3 to 0.6 mg/l during the study. Outfall 001 (Unit 1) and 002 (unit 2) discharge samples will be collected and immediately analyzed for TRC. The CWS and SWS water will again be tested for TRC demand during the study to verify 1994 results. These analyses and demand studies will demonstrate that the limits of 0.006 mg/l TRC have not been exceeded.

Example Calculation for Unit 1: Configuration #1 from Table #2 and #3.

Table #2
Given: Unit One SWS [TRC]=0.3 ppm
Unit One SWS flow=0.14 MG/minute
Unit One circulating water flow=0.69 MG/minute

Calculate Unit One circulating water [TRC] at discharge. Time of reaction: 2 minutes. (Reaction time is based on the time it takes water to flow from the discharge vaults until it reaches the lake.)

$$\text{Unit One circ water [TRC] (mg/l)} = \frac{\text{SWS [TRC] x SWS Flow (MG/min)}}{\text{Unit One circ. flow (MG/min)}}$$

$$\text{Unit One circ. water [TRC] (mg/l)} = \frac{0.3 \text{ mg/l x } 0.014 \text{ MG/minute}}{0.62 \text{ MG/minute}}$$

Unit One circulating water [TRC] (at discharge vault) = 0.006 mg/l with no demand factored in.

Table #3:
Demand factor from previous tests = 40% of original value at the two minute reaction time.

So: 0.006 x 0.40 = 0.002 mg/l

Final calculated TRC for Unit One discharge into the lake: 0.002 mg/l TRC.

Example Calculation for Unit 2: Configuration #1 from Table #2 and #3.

Table #2
Given: Unit Two SWS [TRC]=0.3 ppm
Unit Two SWS flow=0.19 MG/minute
Unit Two circulating water flow=0.92 MG/minute

Calculate Unit Two circulating water [TRC] at discharge. Time of reaction: 2 minutes. (Reaction time is based on the time it takes water to flow from the discharge vaults until it reaches the lake.)

$$\text{Unit Two circ. water [TRC]} = \frac{\text{SWS [TRC] x SWS flow}}{\text{Unit Two circ. flow}}$$

$$\text{Unit Two circ. water [TRC]} = \frac{0.03 \text{ mg/l x } 0.19 \text{ MG/min.}}{0.92 \text{ MG/min.}}$$

Unit Two circulating water [TRC] (at discharge vault) = 0.006 mg/l with no demand factored in.

Table #3:
Demand factor from previous tests = 40% of original value at the two minute reaction time.

So: 0.006 x 0.40 = 0.002 mg/l

Final calculated TRC for Unit Two discharge into the lake: 0.002 mg/l TRC.

Study Report

A report containing data from the study will be submitted to Plainwell MDNR for review. Circulating water TRC discharge data will be included. The TRC results from outfall 001 and 002 samples will show that the SWS can be continuously chlorinated without exceeding the set limit of 0.006 mg/l TRC. The results will reflect the calculated results from Table #3.

The study is scheduled to begin on May 15, 1995. The six-week study will be done during a moderate-to-slight TRC demand period (spring), as compared to the higher TRC demand periods seen later in the year when more biota is found in the water column. The "Task Sheet" included as Attachment 4 describes, in more detail, what will be accomplished during the study.

Continuous chlorination of the SWS will not be interrupted, provided the study results confirm we can meet the 0.006 mg/l discharge limit. The need to continue with chlorination is based on monitoring data which shows that, as a result of interruptions, zebra mussel veliger settlement increases dramatically.

D.C. Cook Plant
Chlorination Plan
February 1995

List and Description of Attachments

1. Table #1 "Chlorine Demand Study" is the result of a demand study on Nov. 11, 1994 using circulating water. The data indicates that additional TRC is utilized by the biota found throughout the circulating water systems and by the existing biotic population in the lake water itself. The demand will lower the final TRC concentration which will allow the Cook Plant to meet the limits of the permit.

2. Table #2 "Theoretical Circulating Water TRC values" shows calculated values of the SWS during normal operations. Table #2 also shows the calculated dilution effects (with no TRC demand) of the circulating water on outfalls 001 and 002 during normal plant operation. This dilution indicates that with SWS concentrations of 0.3 mg/l TRC, the discharge at outfalls 001 and 002 will be 0.006 mg/l or less. At SWS concentrations of 0.6 mg/l TRC, the discharge will be 0.012 mg/l. This represents the theoretical TRC assuming no demand throughout the system.

3. Table #3 "Theoretical TRC values with demand factors included" indicates that when the demand from Table #1 is factored in, the final value will be within the permit limits. For example, the final discharge with the addition of natural TRC demand will be: 0.003 mg/l TRC for an average SWS TRC concentration of 0.3 mg/l, and 0.005 mg/l for an average SWS TRC concentration of 0.6 mg/l.

4. 6 Week Chlorination Study "Tasks" is a one page summary of the important tasks needed to successfully complete the study.

Table # 1
Chlorine Demand Study

Elapsed Time (min)	1			2			3			5			10			20		
Initial [TRC] (ppm)	[TRC] demand	[TRC] (ppm)	% Residual	[TRC] demand	[TRC] (ppm)	% Residual	[TRC] demand	[TRC] (ppm)	% Residual	[TRC] demand	[TRC] (ppm)	% Residual	[TRC] demand	[TRC] (ppm)	% Residual	[TRC] demand	[TRC] (ppm)	% Residual
0.025	0.012	0.013	52	0.015	0.010	40	0.015	0.010	40	0.015	0.010	40	0.020	0.005	20			
0.050	0.025	0.025	50	0.020	0.030	60	0.025	0.026	50	0.028	0.022	44						
0.100	0.038	0.062	62	0.028	0.072	72	0.038	0.062	62	0.042	0.058	58	0.040	0.060	60	0.035	0.065	65
0.200	0.038	0.162	81	0.050	0.150	75	0.060	0.140	70	0.085	0.115	58	0.070	0.130	65	0.085	0.115	58
0.400	0.060	0.340	85	0.100	0.300	75	0.105	0.295	74	0.140	0.260	65	0.120	0.280	70	0.160	0.240	60
0.800	0.100	0.700	88	0.145	0.655	82	0.180	0.620	78	0.190	0.610	76	0.190	0.610	76	0.250	0.550	69
1.500	0.115	1.385	92	0.200	1.300	87	0.220	1.280	85	0.240	1.260	84	0.240	1.260	84	0.320	1.180	79

Chlorine Demand Study

The demand study was conducted on November 11, 1994. Aliquots of Lake Michigan water at 43°F were used to make various concentrations of TRC. The aliquots were analyzed at specific time intervals of 1, 2, 3, 5, 10 and 20 minutes. The above table shows initial [Cl_2] and the corresponding demand at that concentration. The percent demand was calculated by dividing the demand by the initial concentration. The percent demand was converted to a decimal and used to calculate the final concentration at the discharge point to Lake Michigan. The time of two minutes was used for the calculation based on flow rates, diameter and length of the tunnels. For example: an initial TRC of 0.2 ppm at the circ. water discharge vault will be 0.15 ppm two minutes later (the time it takes to reach the lake). The part of the table used for calculations is the 2-minute column and the TRC values of 0.025 and 0.050 since they are closest to the TRC values in the discharge tunnel after dilution of the SWS.

Table # 2

Theoretical Circulating Water TRC Values

(No demand)

No actual chlorination to the circ water.

Configurations	Unit 1 Circ.Water flow (gpm)	Unit 2 Circ. Water flow (gpm)	Ratio in Unit 1 Circ. Water discharge (circ. flow:NESW/ESW flow)	Ratio in Unit 2 Circ. Water discharge	Unit 1 discharge TRC when SWS Cl2 =0.3 ppm	Unit 2 discharge TRC when SWS Cl2 =0.3 ppm	Unit 1 discharge TRC when SWS Cl2 =0.6 ppm	Unit 2 discharge TRC when SWS Cl2 =0.6 ppm
Normal Operating Configurations for Cook Plant.								
#1 both units running	690000	920000	49	48	0.006	0.006	0.012	0.012
(all NESW/ESW disch to Indv. forebay					(0.3/49)	(0.3/48)	(0.6/49)	(0.6/48)
#2 both units running	460000	690000	33	36	0.009	0.008	0.018	0.017
Minimum dilution. (minimum number of pumps) NESW/ESW flows to Indv forebays					(0.3/33)	(0.3/36)	(0.6/33)	(0.6/36)

Maximum NESW and ESW Flows (gpm)		
	Unit 1	Unit 2
NESW	9000	9000
ESW	5000	10000
Total	14000	19000

Table # 3

Theoretical TRC Values With Demand Factors Included

Configurations	Unit 1 Circ. Water flow (gpm)	Unit 2 Circ. Water flow (gpm)	Chlorine demand from table #1 (Time = 2 minutes.)				Final values when adjusted for demand (from test)			
							Unit 1 discharge TRC when SWS Cl2 =0.3 ppm	Unit 2 discharge TRC when SWS Cl2 =0.3 ppm	Unit 1 discharge TRC when SWS Cl2 =0.6 ppm	Unit 2 discharge TRC when SWS Cl2 =0.6 ppm
Normal Operating Configurations for D.C. Cook Plant.			TRC =0.3 ppm	TRC =0.6 ppm	TRC =0.3 ppm	TRC =0.6 ppm				
#1 both units running	690000	920000	0.4	0.4	0.4	0.4	0.002	0.002	0.005	0.005
(all NESW/ESW disch to Indv. forebay							(0.006/0.4)	(0.006/0.4)	(0.012/0.4)	(0.012/0.4)
#2 both units running	460000	690000	0.4	0.4	0.4	0.4	0.004	0.003	0.007	0.007
Minimum dilution. (minimum number of pumps) NESW/ESW flows to Indv forebays							(0.009/0.4)	(0.008/0.4)	(0.018/0.4)	(0.017/0.4)

D.C. Cook Plant
Chlorination Plan
February 1995

Attachment #4

6 Week Chlorination Study

TASKS

1. Continuously chlorinate the service water systems (SWS) for a six week study period. Target dosing at the outlet of the SWS is 0.3 - 0.6 ppm TRC.

2. Collect samples.

   - ESW near Cl_2 injection point three times per day.
   - NESW near Cl_2 injection point three times per day.
   - ESW prior to discharge three times per day.
   - NESW prior to discharge three times per day.
   - Circulating Water three times per day to ensure [TRC] <LLD.

3. Analyze samples for TRC.

   - Use a method approved by the Plainwell District Supervisor.

4. Complete additional demand calculations

   NESW grab (at injection point) - NESW grab (prior to discharge) = demand

   ESW grab (at injection point) - NESW grab (prior to discharge) = demand

5. Submit study results to MDNR upon completion of the six week study.

   - Six week data for Units 1 and 2 circulating water discharge TRC.
   - Six week data for Units 1 and 2 NESW and ESW TRC.
   - Demand study based on the above calculations.
   - Calculations demonstrating discharges at the Cook Plant are below the calculated 0.006 ppm when demand is factored in.

American Electric Power
Cook Nuclear Plant
One Cook Place
Bridgman MI 49106
616 465 5901

AMERICAN ELECTRIC POWER

Mr. Fred Morley, District Supervisor
Mr. Thomas Leep, District Supervisor
Surface Water Quality Division
Michigan Department of Environmental Quality
621 North Tenth Street P. O. Box 355
Plainwell, MI 49080

March 15, 1996

Subject: Cook Nuclear Plant
NPDES Permit No. MI 0005827

Dear Messrs. Morley and Leep:

The NPDES Permit effective June 28, 1995 contains, at Part I, Section A.13 Special Condition, a requirement to submit a "Service Water Systems Chlorination Study." The enclosed study addresses the specific requirements as referenced in this Special Condition of the Permit.

The study began on May 15, 1995, and concluded on July 9, 1995. The results demonstrate the discharge limits contained in the permit are met, and we will commence with continuous chlorination of the Service Water Systems, in anticipation of receiving written notification from your office, as stated in the permit. It is essential for zebra mussel control that Service Water System chlorination not be interrupted.

Please contact John Carlson, Environmental Supervisor, at (616) 465-5901 ext. 1153, or me at (616) 466-2546 with any questions or comments you have on the study.

Sincerely,

Diane M Fitzgerald

Diane M. Fitzgerald
Environmental, Safety & Health Superintendent

Enclosures

c: Sylvia Heaton - MDNR Lansing
Tim Unseld - MDNR Plainwell
Margaret Fields - MDNR Plainwell

bc: J.P. Carlson w/o enclosure
B.K. Zordell w/o enclosure
C.E. Hawk w/o enclosure
D.O. Morey w/o enclosure
R.M. Claes w/o enclosure
MDEQ Files

I certify under penalty of law that I have personally examined and am familiar with the information submitted on this and all attached documents; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. Alan Blind 3/18/96

A.A. Blind
Site Vice President

"SERVICE WATER SYSTEMS CHLORINATION STUDY"

Demonstration of Compliance with Chlorine Effluent Limits for Service Water Systems at the Donald C. Cook Nuclear Plant

Indiana Michigan Power Company
NPDES Permit No. MI0005827
Bridgman, Michigan

March 1996

Table of Contents

Cook Nuclear Plant
Service Water System Chlorination Plan
March 1996

I. Executive Summary

The objective of this study is to demonstrate that continuous chlorination of the Cook Nuclear Plant Service Water Systems for zebra mussel prevention does not result in the discharge of toxic levels of chlorine to Lake Michigan via Outfalls 001 and 002. The study took place over a six week period, using multiple samples taken over each 24 hour period. Total residual chlorine (TRC) was measured using USEPA Approved Methods 330.1 (titration), 330.5 (spectrophotometric), and the Orion electrode model 97-70.

The study results demonstrate that TRC is not discharged to Lake Michigan at levels greater than 0.006 mg/l through Outfalls 001 and 002 other than during periods of intermittent chlorination of the noncontact condenser cooling water. Therefore, as stated in NPDES Permit No. MI0005827, Part I, Section A, Special Condition 13, the intermittent TRC limits will apply for monitoring purposes for Outfall 001 and 002. We will continuously chlorinate the service water systems with a target of 0.5 to 1.0 mg/l TRC.

II. History/Objectives

In order to safely and efficiently operate the Cook Nuclear Plant, non-contact cooling systems must be maintained free from biofouling organisms. The strategy developed to maintain these systems consists of two key elements:

1. **Control of zebra mussels in the Service Water Systems.**

   The Service Water Systems (SWS) consist of Essential Service Water (ESW) and Non-Essential Service Water (NESW). Zebra mussel settlement in the SWS can endanger the safe operation and shutdown of nuclear related systems.

2. **Control of slime forming bacteria in the Circulating Water Systems.**

   Formation of slime in the main condensers of the Circulating Water Systems (CWS) results in decreased thermal performance, resulting in power generation losses.

We have tested a chlorination program that effectively controls zebra mussel settlement and slime build-up by continuously chlorinating the service water systems and intermittently chlorinating the circulating water systems. This program was based on zebra mussel control studies performed in Canada and at the Cook Plant that showed zebra mussel veligers and adult translocaters are controlled by a low level continuous dose of chlorine. Intermittent chlorination of the circulating water systems has been effective in controlling the development of slime forming bacteria.

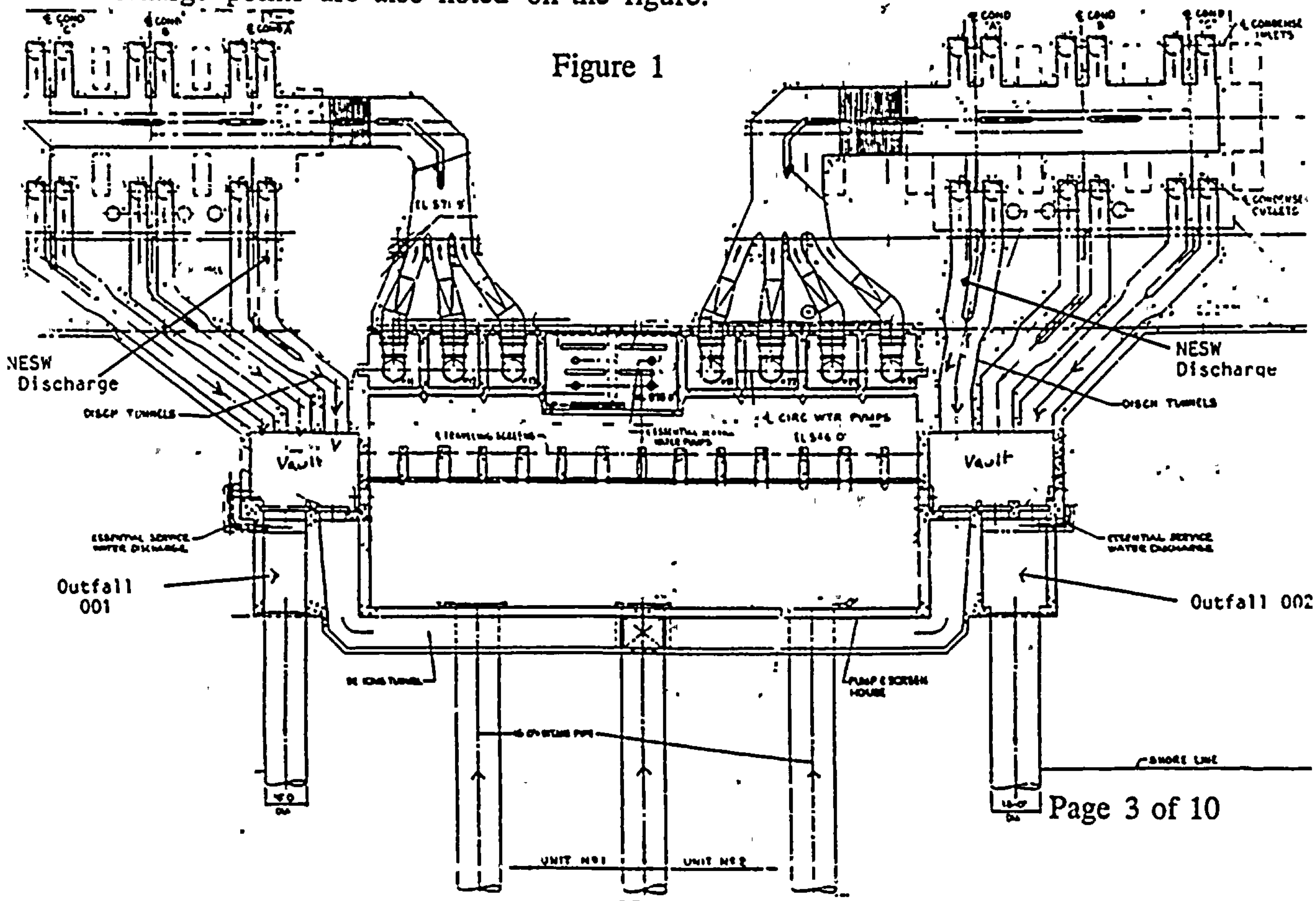
This study is submitted in fulfillment of Part I, Section A, Special Condition 13, of the NPDES permit issued on June 28, 1995. The study was conducted according to the study plan submitted May 4, 1995 to Messrs. Thomas Leep and Fred Morley of the Michigan Department of Natural Resources. This study demonstrates that chlorination of the SWS does not result in the discharge of total residual chlorine (TRC) at levels greater than 0.006 mg/l through Outfalls 001 and 002, other than during periods of intermittent chlorination of the circulating water systems.

III. Study Site

Cook Nuclear Plant is located on the Lake Michigan shoreline in Berrien County, Michigan (Town 6S, Range 19W, Section 6). The plant draws in Lake Michigan water via three, 16 ft diameter intake tunnels. Each tunnel extends into Lake Michigan approximately 0.5 miles. Seven circulating water pumps (three for Unit One and four for Unit Two) move the water at a combined maximum flow rate of 1.645 million gpm. The flow discharges into Lake Michigan 0.25 mile from shore via a 16 ft diameter tunnel for Unit One and an 18 ft diameter tunnel for Unit Two.

The SWS consists of ESW and NESW. The maximum measured flow rates during the test for the NESW was 6000 gpm per unit for a total maximum flow of 12,000 gpm. The Unit One ESW flow was measured at 6500 gpm, Unit Two ESW was measured at 5500 gpm. The ESW and NESW systems are internal discharges to the CWS. The SWS discharge enters the CWS before the water exits through the discharge tunnels. During the testing period, a total flow of SWS to the Unit One CWS was measured to be 12,500 gpm. The total SWS flow rate to the Unit Two discharge vault was measured to be 11,500 gpm. Figure 1 below depicts the three center intake tunnels and the two outer discharge tunnels. The NESW and ESW discharge points are also noted on the figure.

Figure 1



The chlorination system delivers a sodium hypochlorite solution (NaOCl) to the injection points using individual positive displacement pumps. Each pump delivers approximately 12% NaOCl solution to the appropriate location; NESW, ESW or CWS.

IV. Methods Used

The following Cook Plant sampling procedures were used to collect samples for the study.

- 12 THP 6020 CHM.303 "Circulating Water" (Attachment #3)
- 12 THP 6020 CHM.304 "Essential Service Water System" (Attachment #3)

The following Cook Plant procedures were followed during chlorination of the SWS.

- 12 THP 6020 LAB.200 "Circulating Water Essential Service Water and Non-essential Service Water Chlorination" (Attachment #3)

TRC analyses were performed using one or more of the following Cook Plant procedures.

- 12 THP 6020 INS.013 "Chlorine Monitor" (Attachment #3)
- 12 THP 6020 INS.006 "DR/2000 Analyses" (EPA Method 330.5)[1] (Attachment #3)
- Amperometric Titration (EPA Method 330.1)[1] (Attachment #3)

Replicate samples have been included with the study. Data generated from the study was controlled by the following procedures.

- 12 THP 6020 ADM.001 "Quality Control" (Attachment #3)
- 12 THP 6020 ADM.010 "Analytical Results" (Attachment #3)

Analysis quality control was performed via the following procedures.

- 12 THP 6020 ADM.003 "On-line Instrument Quality Control" (Attachment #3)
- 12 THP 6020 ADM.004 "Control of Volume Delivery Devices" (Attachment #3)
- 12 THP 6020 ADM.005 "Reagent and Standard Control" (Attachment #3)

Representative Outfall samples are collected by submersible pumps placed 20 ft into each discharge tunnel (see Figure 1) and routed through 2" stainless steel piping to a pair of Orion Model 1770 chlorine monitors. The chlorine monitors are located in the Northwest corner of the screenhouse building. This location provides shelter from the weather and is located near the sodium hypochlorite dosing controls. The sample delivery piping is checked weekly for chlorine residual demand in sample delivery piping by collecting a sample at the Outfall and analyzing it on the Orion 1770. The results are then compared to the on-line reading. When necessary, the piping is flushed to remove any accumulated debris or macrofouling.

A. **Theoretical circulating water [TRC]** was calculated by inserting known data into the equation below and solving for the unknown quantity.

Calculate Unit One circulating water [TRC] at discharge vaults.

$$\text{Outfall 001 [TRC] mg/l} = \frac{\text{SWS [TRC] mg/l x Average SWS Flow MGM}}{\text{(Unit One CWS flow MGM + Average Unit One SWS Flow MGM)}}$$

The flow rates for the CWS were calculated in million gallons per minute (MGM) using pump curves and heat reject data for the month of June 1995. Flow rates from the SWS were measured by using an ultrasonic testing device that directly attaches to the discharge of each system. This provides the flow rate of the SWS as it flows into the CWS. The SWS flows directly into the CWS at four separate locations (two per unit) and mixes with circulating water prior to exiting via the appropriate discharge tunnel to Lake Michigan. Each system was measured daily for a period of one week and an average flow was calculated. The flow rate is expressed in million gallons per minute (MGM). The SWS [TRC] values were based on average [TRC] for ESW and NESW grab samples during the six week study.

B. **Chlorine Demand Study**

The chlorine demand study was conducted during the same interval by sampling at the chlorine injection point and prior to the SWS discharge point. The results of the study are detailed in Tables 2a, 2b, 2c and 2d. The average demand was then subtracted from the theoretical value. The resulting value is a prediction of the [TRC] as contributed by the various service water systems to Outfall 001 and 002 at the discharge point into Lake Michigan.

V. Data

A. **Study data collection**

The study began on May 15, 1995, and was interrupted from June 19, 1995 to July 2, 1995, due to on-line monitor sample line macrofouling/shell accumulation. Service Water System TRC discharge was maintained within a range of approximately 0.146 to 0.989 mg/l during the study. Table 1 and Table 1a summarize the data collected during the six week study. The individual service water systems and TRC concentrations from each unit outfall were arranged by date in this Table to illustrate the results of the study. Outfall 001 (Unit One) and 002 (Unit Two) discharge samples were collected and immediately analyzed for TRC. Unit One discharge samples ranged from <0.001mg/l to 0.004 mg/l. Unit Two discharge samples ranged from <0.001mg/l to 0.002 mg/l.

Service Water System (SWS) demand tests, results and discussion.

The SWS was tested for demand during the first five weeks of the study. A sample .was taken near the injection point and the exit point of each SWS. Samples were analyzed using EPA Method 330.5[1] and a demand value for each system was calculated. At the measured flow rates, the time between sample points is approximately 1 minute on average for the individual systems. The lake water demand averaged 0.05 mg/l when the outlying values from Table 2b were removed (making the demand average more conservative). Both Units' SWS had similar demand values. The demand values were included to calculate the predicted TRC concentration at the Outfall discharge. Based on these demand studies and additional dilution water from the CWS, expected values will fall below 0.006 mg/l as proven in Table 1 and Table 1a. Supporting data is also found in Reference #2, Vol II (Fig 6.4, Table 6.4, p. 151 - 152, 158 - 159)(Included as Attachment 4).

B. Theoretical calculations

Example Calculation for Unit One:

Conditions from the six week study period:

Unit One SWS [TRC] =	0.52 mg/l
Unit One SWS flow =	0.013 MGM
Unit One circulating water flow =	0.72 MGM

Calculate Unit One circulating water [TRC] at discharge vaults.
No demand factored into the equation.

$$\text{Outfall 001 [TRC] mg/l} = \frac{\text{SWS [TRC] mg/l x SWS Flow MGM}}{\text{(Unit One CWS flow MGM + Unit One SWS Flow MGM)}}$$

$$\text{Outfall 001 [TRC] mg/l} = \frac{0.52\ \text{mg/l} \times 0.013\ \text{MGM}}{(0.72\ \text{MGM} + 0.013\ \text{MGM})}$$

=0.009 mg/l TRC

Unit One circulating water [TRC] (in discharge vault) = 0.009 mg/l with no demand factored in.

Calculate Unit One circulating water [TRC] at discharge vault including demand factor.
Average demand factor from Tables 2a, 2c, 2d = 0.05 mg/l.

So: 0.009 mg/l - 0.05 mg/l = 0 mg/l TRC

The measured demand for the water will consume excess chlorine, and the resulting discharge at the Outfall discharge will be 0 mg/l.

Predicted TRC value at Unit One discharge tunnel:	**0 mg/l**
Average measured TRC value at Unit One discharge tunnel:	**0.002 mg/l**
Estimated TRC value at Unit One Outfall discharge:	**0 mg/l**

Example Calculation for Unit 2:

Conditions from the six week study period:

Unit Two SWS [TRC] =	0.47 mg/l
Unit Two SWS flow =	0.012 MGM
Unit Two circulating water flow =	0.94 MGM

Calculate Unit Two circulating water [TRC] at discharge vaults.
No demand factored into the equation.

$$\text{Outfall OO2 [TRC] mg/l} = \frac{\text{SWS [TRC] mg/l x SWS flow MGM}}{\text{(Unit Two CWS flow MGM + Unit Two SWS flow MGM)}}$$

$$\text{Outfall OO2 [TRC]} = \frac{0.47 \text{ mg/l x } 0.012 \text{ MGM}}{(0.94 \text{ MGM} + 0.012 \text{ MGM})}$$

=0.006 mg/l TRC

Unit Two circulating water [TRC] (at discharge vault) = 0.006 mg/l with no demand factored in.

Calculate Unit Two circulating water [TRC] at discharge vault including demand factor.
Average demand factor from Tables 2a, 2c, 2d = 0.05 mg/l

So: 0.006 mg/l - 0.05 mg/l = 0 mg/l TRC

The measured demand for the water will consume excess chlorine, and the resulting discharge at the Outfall discharge will be 0 mg/l

Predicted TRC value at Unit Two discharge tunnel:	**0 mg/l**
Average measured TRC value at Unit Two discharge tunnel:	**<0.001mg/l**
Estimated TRC value at Unit Two Outfall discharge:	**0 mg/l**

VI. Conclusions

The data presented in Table 1 and Table 1a shows that the SWS TRC concentrations have reached 0.989 mg/l at the discharge point to the circulating water system, while measured [TRC] at Outfalls 001 and 002 have not exceeded 0.006 mg/l. The calculated concentrations of Outfall 001 TRC would be 0 mg/l when SWS TRC = 0.52 mg/l. Average TRC for Outfall 001 was 0.002 mg/l for the monitoring period. The difference was attributed to the relatively short time chlorinated Service Water has to react with unchlorinated Lake Michigan water in the CWS prior to the Outfall sample point. Demand studies performed during the six week study show that the measured values at the Outfalls will be reduced to zero by the time it travels through the discharge tunnel and reenters Lake Michigan. The six-week study was done during a moderate TRC demand period, as compared to the higher TRC demand periods seen later in the year when more biota is found in the water column.
The study results demonstrate that TRC is not discharged to Lake Michigan at levels greater than 0.006 mg/l through outfalls 001 and 002 other than during periods of intermittent chlorination of the noncontact condenser cooling water. Therefore, as stated in NPDES Permit No. MI0005827, Part I, Section A, Special Condition 13, we request that the intermittent TRC limits will apply for monitoring purposes and while the Plant continuously chlorinates the service water systems.

VII. List and Description of Tables

1. Table 1: Service Water System, Outfall 001 and Outfall 002 [TRC] in mg/l.

2. Table 1a: Outfall 001 and 002 6 Week TRC Data

3. Tables #2a, 2b, 2c, 2d, Demand Studies. These four similar tables contain inlet and outlet TRC data for each individual service water system. The data from Table 2b was found to be statistically different from the other data and was not used to calculate demand.

VIII. List of Attachments

1. Attachment 1: Amperometric / Cl_2 analyzer study. A complete log of the redevelopment of EPA Method 330.1 by Cook Plant personnel. The attachment contains low level comparisons of grab samples vs. the Orion model 1770 analyzer.

2. Attachment 2: Instrument Reliability. On-line vs. grab sampling comparisons are included in this attachment. Various other reliability tests are also included in this attachment.

3. Attachment 3: Methods used. Copies of the procedures used to complete the six week chlorination study.

X. List of References

1. "EPA Methods for Chemical Analysis of Water and Wastewater" 1983

2. "Report on Acceptable Levels of Chlorine Discharges at the Donald C. Cook Nuclear Plant" Volumes I and II 1977 Indiana and Michigan Power Company, Donald C. Cook Nuclear Plant Units 1 and 2.

3. "Standard Methods for the Examination of Water and Wastewater" 1992, 18th ed. Edited by A.E. Greenberg, L.S. Clesceri, and A.D. Eaton.

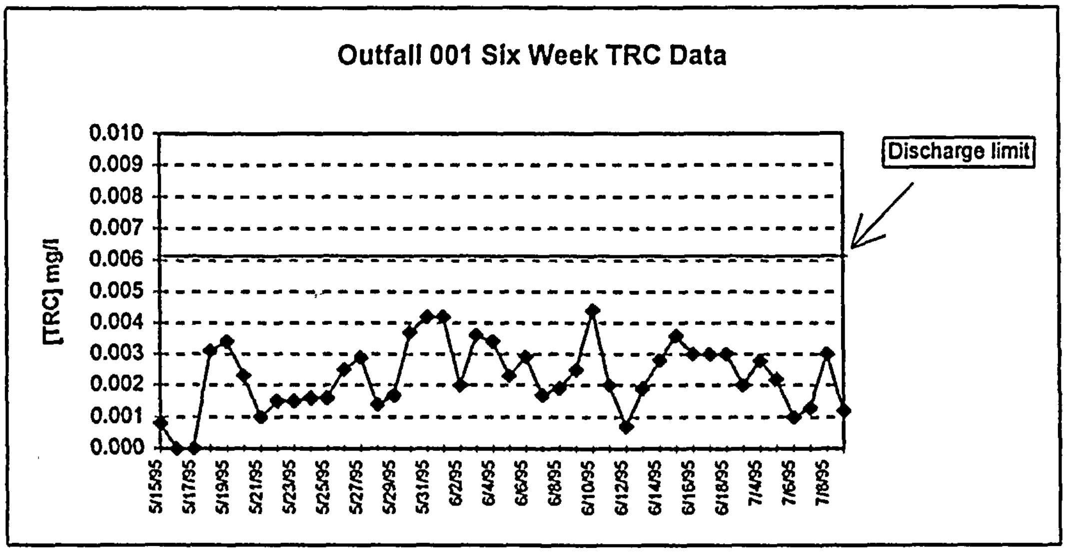
4. "The effects of Intermittent Chlorination on the Biota of Lake Michigan" 1977, A.S. Brooks and G.L. Seegers.

Table 1
Service Water System, Outfall 001 and Outfall 002 [TRC] in mg/l

	U-1 SWS TRC		Outfall 001 TRC	U-2 SWS TRC		Outfall 002 TRC
	NESW	ESW		NESW	ESW	
Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Week One						
5/15/95	0.200	0.693	0.001	0.153	0.683	<0.001
5/16/95	0.409	0.631	<0.001	0.329	0.697	<0.001
5/17/95	0.407	0.683	<0.001	0.490	0.787	<0.001
5/18/95	0.410	0.61	0.003	0.353	0.627	<0.001
5/19/95	0.413	0.644	0.003	0.385	0.644	<0.001
5/20/95	0.360	0.53	0.002	0.320	0.493	0.001
5/21/95	0.257	0.393	0.001	0.233	0.47	0.002
Week Two						
5/22/95	0.319	0.422	0.002	0.330	0.467	0.001
5/23/95	0.305	0.433	0.002	0.366	0.508	<0.001
5/24/95	0.340	0.456	0.002	0.400	0.490	<0.001
5/25/95	0.427	0.494	0.002	0.433	0.530	<0.001
5/26/95	0.338	0.397	0.003	0.402	0.448	<0.001
5/27/95	0.372	0.443	0.003	0.358	0.471	<0.001
5/28/95	0.239	0.512	0.001	0.334	0.146	<0.001
Week Three						
5/29/95	0.412	0.604	0.002	0.218	0.604	<0.001
5/30/95	0.507	0.739	0.004	0.424	0.687	<0.001
5/31/95	0.649	0.720	0.004	0.598	0.758	<0.001
6/1/95	0.483	0.557	0.004	0.443	0.610	<0.001
6/2/95	0.433	0.439	0.002	0.386	0.453	<0.001
6/3/95	0.409	0.439	0.004	0.342	0.475	<0.001
6/4/95	0.375	0.439	0.003	0.417	0.405	<0.001
Week Four						
6/5/95	0.293	0.533	0.002	0.355	0.573	<0.001
6/6/95	0.573	0.753	0.003	0.455	0.666	<0.001
6/7/95	0.587	0.790	0.002	0.470	0.617	<0.001
6/8/95	0.557	0.600	0.002	0.433	0.270	<0.001
6/9/95	0.570	0.877	0.003	0.503	0.347	<0.001
6/10/95	0.587	0.767	0.004	0.544	0.421	<0.001
6/11/95	0.542	0.570	0.002	0.512	0.559	<0.001
Week Five						
6/12/95	0.784	0.438	0.001	0.420	0.473	<0.001
6/13/95	0.989	0.645	0.002	0.525	0.793	<0.001
6/14/95	0.791	0.730	0.003	0.429	0.453	<0.001
6/15/95	0.748	0.686	0.004	0.444	0.416	<0.001
6/16/95	0.639	0.545	0.003	0.297	0.258	<0.001
6/17/95	0.609	0.471	0.003	0.382	0.438	<0.001
6/18/95	0.551	0.402	0.003	0.588	0.338	<0.001
Week Six						
7/3/95	0.644	0.658	0.002	0.805	0.271	<0.001
7/4/95	0.523	0.580	0.003	0.63	0.447	<0.001
7/5/95	0.467	0.517	0.002	0.707	0.577	<0.001
7/6/95	0.370	0.343	0.001	0.433	0.320	<0.001
7/7/95	0.327	0.287	0.001	0.43	0.307	<0.001
7/8/95	0.540	0.493	0.003	0.633	0.523	0.001
7/9/95	0.540	0.487	0.001	0.633	0.513	0.001
High	0.989	0.877	0.004	0.805	0.793	0.002
Low	0.200	0.287	<0.001	0.153	0.146	<0.001
Avg	0.483	0.558	0.002	0.437	0.501	<0.001

The weekly study period from 6/19 to 7/2 chlorination was interrupted due to on-line analyzer malfunction.

Table 1a


Outfall 001 Six Week TRC Data
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
[TRC] mg/l
Discharge limit
5/15/95
5/17/95
5/19/95
5/21/95
5/23/95
5/25/95
5/27/95
5/29/95
5/31/95
6/2/95
6/4/95
6/6/95
6/8/95
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7/4/95
7/6/95
7/8/95

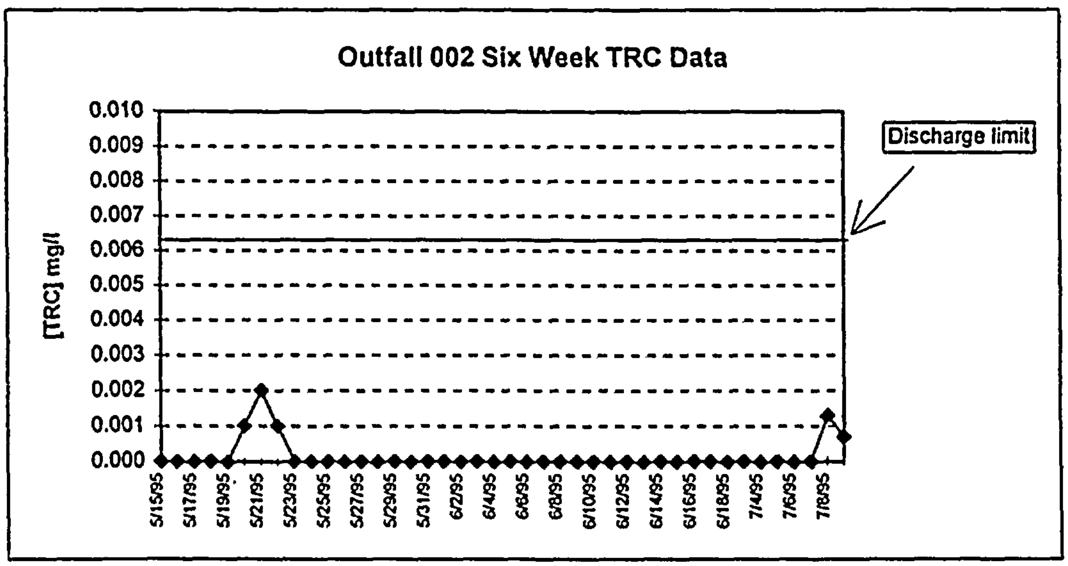
Outfall 002 Six Week TRC Data
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
[TRC] mg/l
Discharge limit
5/15/95
5/17/95
5/19/95
5/21/95
5/23/95
5/25/95
5/27/95
5/29/95
5/31/95
6/2/95
6/4/95
6/6/95
6/8/95
6/10/95
6/12/95
6/14/95
6/16/95
6/18/95
7/4/95
7/6/95
7/8/95

Table 2a
Demand Studies

	U-1 ESW inletTRC (mg/l) Appproximate sample Times				U-1 ESW Outlet TRC (mg/l) Appproximate sample Times				Calculated demand (In - Out)
	3:00	13:00	19:00	AVG	3:00	13:00	19:00	AVG	
Week One									
5/15/95	0.760	1.200	0.740	0.900	0.620	0.920	0.540	0.693	0.207
5/16/95	0.780	0.605	0.552	0.646	0.800	0.469	0.625	0.631	0.014
5/17/95	0.640	0.820	0.790	0.750	0.680	0.770	0.600	0.683	0.067
5/18/95	0.760	0.670	0.440	0.623	0.740	0.570	0.520	0.610	0.013
5/19/95	0.710	0.693	0.620	0.674	0.650	0.641	0.640	0.644	0.031
5/20/95	0.360	0.890	0.760	0.670	0.390	0.570	0.630	0.530	0.140
5/21/95	0.380	0.360	0.400	0.380	0.370	0.470	0.340	0.393	-0.013
Week Two									
5/22/95	0.670	0.350	0.172	0.397	0.520	0.320	0.425	0.422	-0.024
5/23/95	0.433	0.374	0.507	0.438	0.444	0.388	0.466	0.433	0.005
5/24/95	0.545	0.390	0.585	0.507	0.468	0.410	0.490	0.456	0.051
5/25/95	0.502	0.485	0.522	0.503	0.509	0.556	0.418	0.494	0.009
5/26/95	0.472	0.481	0.520	0.491	0.416	0.392	0.382	0.397	0.094
5/27/95	0.609	0.270	0.966	0.615	0.483	0.330	0.515	0.443	0.172
5/28/95	0.636	0.340	0.986	0.654	0.394	0.320	0.821	0.512	0.142
Week Three									
5/29/95	0.637	0.459	0.820	0.639	0.585	0.488	0.740	0.604	0.034
5/30/95	0.940	0.614	1.000	0.851	0.770	0.606	0.840	0.739	0.113
5/31/95	0.920	0.863	0.680	0.821	0.820	0.711	0.630	0.720	0.101
6/1/95	0.570	0.540	0.400	0.503	0.670	0.490	0.510	0.557	-0.053
6/2/95	0.470	0.404	0.521	0.465	0.400	0.393	0.525	0.439	0.026
6/3/95	0.395	0.340	0.601	0.445	0.463	0.478	0.375	0.439	0.007
6/4/95	0.536	0.560	0.335	0.477	0.577	0.429	0.312	0.439	0.038
Week Four									
6/5/95	0.356	0.510	0.830	0.565	0.409	0.400	0.790	0.533	0.032
6/6/95	0.600	0.932	1.000	0.844	0.590	0.860	0.810	0.753	0.091
6/7/95	0.870	0.660	0.880	0.803	0.840	0.720	0.810	0.790	0.013
6/8/95	0.310	0.930	0.760	0.667	0.320	0.670	0.810	0.600	0.067
6/9/95	0.950	0.860	0.890	0.900	0.930	0.770	0.930	0.877	0.023
6/10/95	0.910	0.889	0.740	0.846	0.840	0.821	0.640	0.767	0.079
6/11/95	0.750	0.646	0.560	0.652	0.750	0.580	0.380	0.570	0.082
Week Five									
6/12/95	0.720	0.598	0.699	0.672	0.660	0.376	0.278	0.438	0.234
6/13/95	0.682	0.845	0.666	0.731	0.267	0.915	0.752	0.645	0.086
6/14/95	0.618	0.634	0.674	0.642	0.768	0.705	0.717	0.730	-0.088
6/15/95	0.772	0.489	0.511	0.591	0.738	0.635	0.684	0.686	-0.095
6/16/95	0.563	0.620	0.810	0.664	0.365	0.570	0.700	0.545	0.119
6/17/95	0.603	0.610	0.641	0.618	0.413	0.380	0.621	0.471	0.147
6/18/95	0.404		0.414	0.409	0.377	0.440	0.390	0.402	0.007
High				0.900				0.877	0.234
Low				0.380				0.393	-0.095
Avg				0.630				0.574	0.056

Table 2b
Demand Studies

	U-1 NESW Inlet TRC (mg/l) Appproximate sample Times				U-1 NESW Outlet TRC (mg/l) Appproximate sample Times				Calculated demand (In - Out)
	3:00	13:00	19:00	AVG	3:00	13:00	19:00	AVG	
Week One									
5/15/95	<0.02	0.460	0.360	0.273	<0.02	0.350	0.250	0.200	0.073
5/16/95	0.480	0.337	0.461	0.426	0.430	0.372	0.424	0.409	0.017
5/17/95	0.480	0.460	0.510	0.483	0.430	0.390	0.400	0.407	0.077
5/18/95	0.560	1.620	1.650	1.277	0.500	0.400	0.330	0.410	0.867
5/19/95	1.710	1.369	2.080	1.720	0.410	0.440	0.390	0.413	1.306
5/20/95	2.020	1.970	1.930	1.973	0.260	0.470	0.350	0.360	1.613
5/21/95	1.860	1.540	1.940	1.780	0.250	0.310	0.210	0.257	1.523
Week Two									
5/22/95	1.910	0.220	1.590	1.240	0.380	0.250	0.328	0.319	0.921
5/23/95	0.393	0.365	0.436	0.398	0.286	0.278	0.351	0.305	0.093
5/24/95	0.394	0.380	0.527	0.434	0.330	0.280	0.411	0.340	0.093
5/25/95	0.611	1.520	1.730	1.287	0.396	0.506	0.380	0.427	0.860
5/26/95	0.363	0.457	0.324	0.381	0.306	0.423	0.285	0.338	0.043
5/27/95	0.350	1.710	0.522	0.861	0.305	0.250	0.561	0.372	0.489
5/28/95		1.720	0.426	1.073	0.016	0.290	0.411	0.239	0.834
Week Three									
5/29/95	0.593	1.370	0.610	0.858	0.461	0.286	0.490	0.412	0.445
5/30/95	0.570	0.607	0.770	0.649	0.420	0.562	0.540	0.507	0.142
5/31/95	0.680	1.720	0.580	0.993	0.680	0.716	0.550	0.649	0.345
6/1/95	0.730	0.550	0.510	0.597	0.580	0.480	0.390	0.483	0.113
6/2/95	0.580	1.450	0.492	0.841	0.450	0.432	0.418	0.433	0.407
6/3/95	0.604	0.780	0.410	0.598	0.479	0.425	0.322	0.409	0.189
6/4/95	0.517	0.571	0.564	0.551	0.445	0.366	0.313	0.375	0.176
Week Four									
6/5/95	0.498	0.030	1.380	0.636	0.408	0.020	0.450	0.293	0.343
6/6/95	1.660	0.616	1.700	1.325	0.560	0.618	0.540	0.573	0.753
6/7/95	1.680	0.700	1.710	1.363	0.660	0.550	0.550	0.587	0.777
6/8/95	1.670	0.710	0.570	0.983	0.560	0.610	0.500	0.557	0.427
6/9/95	0.660	0.710	0.620	0.663	0.580	0.530	0.600	0.570	0.093
6/10/95	0.660	0.672	1.660	0.997	0.600	0.611	0.550	0.587	0.410
6/11/95	1.550	1.544	1.380	1.491	0.580	0.485	0.560	0.542	0.950
Week Five									
6/12/95	1.390	1.640	0.910	1.313	0.730	0.825	0.798	0.784	0.529
6/13/95	0.912	0.800	0.841	0.851	0.806	1.770	0.391	0.989	-0.138
6/14/95	0.892	0.167	0.878	0.646	0.824	0.705	0.843	0.791	-0.145
6/15/95	0.938	0.758	0.697	0.798	0.855	0.708	0.682	0.748	0.049
6/16/95	1.700	1.760	1.700	1.720	0.576	0.630	0.710	0.639	1.081
6/17/95	1.470	1.750	1.700	1.640	0.601	0.530	0.696	0.609	1.031
6/18/95	1.730	0.560	1.710	1.333	0.526	0.450	0.676	0.551	0.783
High				1.973				0.989	1.613
Low				0.273				0.200	-0.145
Avg				0.984				0.482	0.502

Table 2c
Demand Studies

	U-2 ESW inletTRC (mg/l) Appproximate sample Times				U-2 ESW Outlet TRC (mg/l) Appproximate sample Times				Calculated demand (In - Out)
	3:00	13:00	19:00	AVG	3:00	13:00	19:00	AVG	
Week One									
5/15/95	0.040	0.370	0.270	0.227	0.440	0.950	0.660	0.683	-0.457
5/16/95	0.520	0.349	0.894	0.588	0.800	0.567	0.724	0.697	-0.109
5/17/95	0.960	0.700	0.910	0.857	0.820	0.830	0.710	0.787	0.070
5/18/95	0.790	0.760	0.500	0.683	0.700	0.680	0.500	0.627	0.057
5/19/95	0.800	0.707	0.660	0.722	0.650	0.632	0.650	0.644	0.078
5/20/95	0.290	0.720	0.410	0.473	0.410	0.410	0.660	0.493	-0.020
5/21/95	0.540	0.620	0.410	0.523	0.460	0.590	0.360	0.470	0.053
Week Two									
5/22/95	0.600	0.260	0.156	0.339	0.530	0.350	0.520	0.467	-0.128
5/23/95	0.659	0.483	0.608	0.583	0.515	0.490	0.520	0.508	0.075
5/24/95	0.537	0.550	0.648	0.578	0.489	0.480	0.502	0.490	0.088
5/25/95	0.536	0.556	0.540	0.544	0.575	0.588	0.428	0.530	0.014
5/26/95	0.576	0.517	0.643	0.579	0.403	0.449	0.491	0.448	0.131
5/27/95	0.484	0.420	0.570	0.491	0.466	0.460	0.486	0.471	0.021
5/28/95	<0.001	0.310	<0.001	0.103	0.081	0.280	0.076	0.146	-0.043
Week Three									
5/29/95	0.014	0.448	0.770	0.411	0.090	0.943	0.780	0.604	-0.194
5/30/95	0.570	0.668	0.700	0.646	0.700	0.580	0.780	0.687	-0.041
5/31/95	0.920	0.957	0.810	0.896	0.840	0.773	0.660	0.758	0.138
6/1/95	0.700	0.860	0.480	0.680	0.680	0.740	0.410	0.610	0.070
6/2/95	0.410	0.394	0.571	0.458	0.400	0.302	0.656	0.453	0.006
6/3/95	0.490	0.307	0.513	0.437	0.525	0.428	0.471	0.475	-0.038
6/4/95	0.412	0.549	0.262	0.408	0.449	0.414	0.353	0.405	0.002
Week Four									
6/5/95	0.326	0.440	0.950	0.572	0.349	0.430	0.940	0.573	-0.001
6/6/95	0.620	0.547	0.900	0.689	0.610	0.517	0.870	0.666	0.023
6/7/95	0.770	0.770	0.350	0.630	0.870	0.760	0.220	0.617	0.013
6/8/95	0.210	0.960	1.110	0.760	0.170	0.380	0.260	0.270	0.490
6/9/95	0.930	0.860	1.050	0.947	0.420	0.330	0.290	0.347	0.600
6/10/95	0.910	0.877	0.640	0.809	0.290	0.313	0.660	0.421	0.388
6/11/95	0.940	0.465	0.410	0.605	0.660	0.508	0.510	0.559	0.046
Week Five									
6/12/95	0.630	0.475	0.450	0.518	0.270	0.612	0.537	0.473	0.045
6/13/95	0.426	0.481	0.239	0.382	1.160	0.451	0.767	0.793	-0.411
6/14/95	0.460	0.352	0.442	0.418	0.410	0.465	0.483	0.453	-0.035
6/15/95	0.460	0.284	0.297	0.347	0.413	0.391	0.444	0.416	-0.069
6/16/95	0.392	0.390	0.410	0.397	0.193	0.270	0.310	0.258	0.140
6/17/95	0.411	0.560	0.311	0.427	0.413	0.400	0.501	0.438	-0.011
6/18/95	0.240	0.730	0.676	0.823	0.273	0.340	0.401	0.338	0.485

High	0.947	0.793	0.600
Low	0.103	0.146	-0.457
Avg	0.559	0.516	0.042

Table 2d
Demand Studies

	U-2 NESW Inlet TRC (mg/l) Appproximate sample Times				U-2 NESW Outlet TRC (mg/l) Appproximate sample Times				Calculated demand (In - Out)
	3:00	13:00	19:00	AVG	3:00	13:00	19:00	AVG	
Week One									
5/15/95	<0.02	0.140	0.220	0.180	<0.02	0.240	0.220	0.153	0.027
5/16/95	0.330	0.257	0.348	0.312	0.370	0.275	0.341	0.329	-0.017
5/17/95	0.400	0.450	0.450	0.433	0.370	0.380	0.720	0.490	-0.057
5/18/95	0.440	0.560	0.330	0.443	0.400	0.390	0.270	0.353	0.090
5/19/95	0.440	0.361	0.400	0.400	0.350	0.455	0.350	0.385	0.015
5/20/95	0.250	0.360	0.380	0.330	0.220	0.390	0.350	0.320	0.010
5/21/95	0.230	0.460	0.270	0.320	0.210	0.250	0.240	0.233	0.087
Week Two									
5/22/95	0.420	0.410	0.677	0.502	0.380	0.240	0.371	0.330	0.172
5/23/95	0.466	0.503	0.597	0.522	0.377	0.326	0.395	0.366	0.156
5/24/95	0.461	0.460	0.492	0.471	0.401	0.350	0.448	0.400	0.071
5/25/95	0.460	0.394	0.359	0.404	0.401	0.507	0.390	0.433	-0.028
5/26/95	0.324	0.593	0.395	0.437	0.340	0.513	0.353	0.402	0.035
5/27/95	0.332	0.350	0.392	0.358	0.367	0.370	0.338	0.358	0.000
5/28/95	0.363	0.360	0.392	0.558	0.340	0.260	0.403	0.334	0.223
Week Three									
5/29/95	0.032	0.142	0.440	0.205	0.035	0.199	0.420	0.218	-0.013
5/30/95	0.420	0.533	0.580	0.511	0.390	0.382	0.500	0.424	0.087
5/31/95	0.580	0.552	0.540	0.557	0.590	0.724	0.480	0.598	-0.041
6/1/95	0.530	0.490	0.380	0.467	0.480	0.440	0.410	0.443	0.023
6/2/95	0.430	0.394	0.405	0.410	0.400	0.353	0.405	0.386	0.024
6/3/95	0.456	0.342	0.341	0.380	0.439	0.310	0.278	0.342	0.037
6/4/95	0.565	0.403	0.389	0.452	0.452	0.495	0.305	0.417	0.035
Week Four									
6/5/95	0.394	0.410	0.410	0.405	0.345	0.290	0.430	0.355	0.050
6/6/95	0.370	0.681	0.500	0.517	0.430	0.464	0.470	0.455	0.062
6/7/95	0.530	0.550	0.390	0.490	0.510	0.510	0.390	0.470	0.020
6/8/95	0.290	0.710	0.790	0.597	0.280	0.570	0.450	0.433	0.163
6/9/95	0.710	0.630	0.850	0.730	0.550	0.540	0.420	0.503	0.227
6/10/95	0.800	0.817	0.730	0.782	0.610	0.602	0.420	0.544	0.238
6/11/95	0.940	0.550	0.670	0.720	0.660	0.445	0.430	0.512	0.208
Week Five									
6/12/95	0.630	0.475	0.450	0.518	0.420	0.458	0.381	0.420	0.099
6/13/95	0.426	0.481	0.239	0.382	0.406	0.734	0.435	0.525	-0.143
6/14/95	0.460	0.352	0.442	0.418	0.424	0.410	0.454	0.429	-0.011
6/15/95	0.460	0.284	0.297	0.347	0.417	0.401	0.514	0.444	-0.097
6/16/95	0.392	0.390	0.410	0.397	0.230	0.340	0.320	0.297	0.101
6/17/95	0.411	0.560	0.311	0.427	0.213	0.530	0.404	0.382	0.045
6/18/95	0.240	0.730	0.676	0.549	0.449	0.670	0.644	0.588	-0.039

High	0.782	0.598	0.238
Low	0.180	0.153	-0.143
Avg	0.455	0.402	0.053

Attachment #1

Amperometric/Cl2 Analyzer Study

Used ASTM D1253-86 and EPA Method 330.1

7-19-95 Standardization of PAO solution

Chemical ID #'s: PAO-6279(Theo. N=0.00564±0.00003)
$KH(IO_3)_2$-6267

Amperometric Titrator #CPC-001 was used

Prep. of 0.1 N $KH(IO_3)_2$: 3.257g diluted to 1002.5g w Locally Deionized Water(LDW)
Prep. of 0.005N $KH(IO_3)_2$: 25.071g 0.1N to 501.4g LDW
Standardized against ~o.00564 PAO:

Trial	$KH(IO_3)_2$	ml. PAO	Obs. PAO N
1	19.997	18.030	.005545
2	22.8060	20.500	.005562
3	21.8152	19.556	.005578

*values were not within 0.25% so test was repeated

Prepared new 0.1N and 0.005N $KH(IO_3)_2$:
1.6245g $KH(IO_3)_2$ to 500.0g w/ LDW then 25.0012g 0.1N to 500.0g w/ LDW

Trial	$KH(IO_3)_2$	ml. PAO	Obs. PAO N
1	20.0000	18.168	.005504
2	20.0000	18.010	.005552
3	20.0000	18.068	.005535

*values are still not within 0.25%. Noted that endpoint is difficult to determine consistently at that concentration. Decided to attempt to standardize with 0.0282N $KH(IO_3)_2$.

7-20-95

Prep. of 0.0282N $KH(IO_3)_2$: 0.9167g $KH(IO_3)_2$ diluted to 1000.4g w/ LDW

Trial	g of 0.0282N $KH(IO_3)_2$	ml. of PAO	Obs. N of PAO
1	6.9871	35.370	.005571
2	8.9691	45.348	.005578
3	6.0795	30.874	.005552
		Avg. =	.005567N

*Trials 1&2 are w/in .25%; #3 was within 0.5% and was used to calculate avg. N

7-20-95 (cont)
PAO calculated N of .005567 is 98.7% of the theo. N of .00564. Since a N of .00564 yields a direct conversion from ml. to ppm TRC (1 ml.PAO=1ppm TRC), all results should be multiplied by .987 to determine actual [TRC].

Initial standard prep and analysis: Used HACH ampoules containing~10 ml of 57.6ppm Cl_2.
17.3623g @57.6ppm diluted to 1000ml = 1.000ppm (This was prep'd 7-18-95)

[Theo]	ml PAO	[Obs]	%O/T	std prep
1.00ppm	.942	.914	91.4	200ml, no dil'n
0.50	.474	.468	93.6	100ml to 200ml
0.25	.242	.239	95.6	50ml to 200ml
0.05	.048	.047	94.0	10ml to 200ml

Prep'd fresh std. to investigate low bias. 9.8629g @ 57.6ppm diluted to 1000ml = 0.559ppm Cl_2

[Theo]	ml PAO	[Obs]	%O/T	std prep
0.559	0.554	0.547	97.8	200ml, no dil'n
0.280	0.280	0.274	98.0	100ml to 200ml
0.028	0.030	0.030	105.8	10ml to 200ml
0.012	0.012	0.012	100.0	4.3ml to 200ml
0.559	0.560	0.553	98.9	200ml, no dil'n

The second set of results compare more favorably than the first-possibly because stock std was prepared fresh.

7-21-95

Prepared another fresh standard in an attempt to duplicate earlier results.

Diluted 9.9336g @ 57.6ppm to 1002ml = 0.571ppm

[Theo]	ml PAO	[Obs]	%O/T	std prep
0.571	0.550	0.543	95.1	200ml, no dil'n
0.286	0.268	0.265	92.5	100ml to 200ml
Reran std prep'd on 7-20-95 (Theo. = 0.559ppm)				
0.559	0.514	0.507	*Amp. titrator was improperly set up	
0.215	0.210	0.207	96.3	77ml to 200ml

Prepared new std- 10.026g @ 57.6ppm diluted to 1000ml w/LDW = 0.577ppm

[Theo]	ml PAO	[Obs]	%O/T	std prep
0.577	0.562	0.555	96.1	200ml, no dil'n

Using a freshly prepared standard did not yield significantly better results a second time.

Although PAO N and Cl_2 standard results are obviously biased low, they are generally within 5% of [Theo] so I chose to proceed with testing of outfall and On-Line Analyzer comparisons.

7-21-95 (cont)
The following samples were taken from designated sample points for Outfalls 001s or 002s(unless otherwise noted-some samples were obtained by dipping a sample bottle into the Circ Water Discharge Forebay sample points-"dip"). Sample analysis was initiated within 2 minutes of sample time(unless otherwise noted).

SAMPLE	TIME	ml of PAO	Obs $[Cl_2]$	On-Line Reading	Comment
Outfall 001	0930	.096	.095	0.17	analyzer unstable after spike up to.55ppm
Outfall 001	1010	.096	.095	.10	
Outfall 001 (dip)	1020	.104	.103	.103	
Outfall 001	1145	.166	.164	.11	suspect electrode poisoned from previous sample (17.5ppm Cl_2)
Outfall 001	1148	.052	.051	.095	Cl_2 injection S/D @ 1135; analyzer response is delayed
Outfall 001	1152	.020	.020	.020	
Outfall 001	1155	.008	.008	.008	
Outfall 001	1206	.002	.002	.002	
Outfall 002	0930	.142	.140	.11	
Outfall 002	1005	.116	.114	.105	
Outfall 002 (dip)	1044	.114	.113	.105	
Outfall 002	1159	<.002	<.002	<.001	
.144ppm std	1050	.162	.160		111% (39.5ml @ .577ppm to 200ml W/LDW
.144ppm std	1055	.142	.140		97.3% (39.5ml @ .577ppm to 200ml W/LDW

8-3-95

Prep'd new std w/ 9.9900 g @ 57.6 ppm   1 ℓ w/ LDW = 0.575 ppm

std/Sample	Time	ml PAO	Obs $[Cl_2]$	On-Line Reading	Comments
200 ml std (.575)		.562	.555		96.5%
40 ml → 200 (.115)		.118	.116		100.9%
18 ml → 200 (.052)		.050	.049		94.2%
TRS (Outfall 00d)	0705	.108	.107		
Outfall 001	0923	.002	.002	.0012	
Outfall 001	0940	.002	.002	.003	
Outfall 001	1110	.004	.004	.0025	
Outfall 002 (Dip)	0930	.142	.140		
Outfall 002 (Dip)	0940	.136	.134		
Outfall 002 (Dip)	1115	.168	.166		
rerun@1120	1115	.158	.156		
rerun@1123	1115	.152	.150		
TRS (outfall 00D)	0956	.028	.028		
200 ml std (.575)	1130	.560	.553		(95.7%)
29 ml → 200 (.083)	1134	.086	.085		102.2%

8-10-95

Prep'd new std w/ 10.068 g @ 57.6 ppm 1 ℓ = 0.580 ppm

td/Sample	Time	ml PAO	Obs [Cl_2]	On-Line Reading	Comments
33 ml std → 200 ml (.096)		.082 .094	.081 .093		1st run (96.9%) rerun (84.4%)
57.5 ml → 200 (.167)		.156	.154		92.2%
Outfall 001	0854	<.002	<.002	<.001	
Outfall 001	0915	.002	.002	<.001	
Outfall 001	0935	.002	.002	.0021	
Outfall 001	1143	<.002	<.002	<.001	
Outfall 002	0857	<.002	<.002	<.001	
Outfall 002	0859	.002	.002	<.001	
Outfall 002	0905	.002	.002	<.001	
Outfall 002	0938	.206	.203	.16	
Outfall 002	0943	.222	.219	.175	
Outfall 002	0948	.202	.199	.185	
utfall 002	0952	.222	.219	.19	
Outfall 002	1138	did not run		.0055	
200 ml std (.580 mg/l)		.558	.551		95.0%

D.C. Cook Nuclear Plant
Service Water System Chlorination Plan
February, 1996

Attachment #2 Instrument Reliability

Sample line QA testing and resolutions: On-line instrumentation Outfall 001 and 002 sample line verifications during the start of the 5th week revealed some problems with macrofouling. The samples collected from the sample pipe did not agree with the samples dipped from the same location. The matter was further complicated by attempting spectrophotometric methods (EPA 330.5)[1] at low TRC levels for further verification. It was finally determined that turbidity in the samples were giving false high TRC levels. The detection limit of 0.006 mg/l could not be met using spectrophotometric methods. Continuous chlorination was temporally halted while the sampling line that draws water from the plant outfall was cleaned of accumulated mussel shells. Intermittent chlorination was continued using grab samples from the outfall sample points and spectrophotometric methods (intermittent TRC levels are usually 0.01 to 0.018 mg/l and are within the method's range). The outfall sample piping was placed on a maintenance schedule that includes weekly hot water flushes to kill any macrofouling that may create a demand for free chlorine from the sample inlet to the analyzer. Grab samples are also taken at the outfall sample point and analyzed with the Orion 1770 on-line meter, readings are then compared with samples taken at the end of the sample delivery pipe. Grab vs on-line comparisons have been satisfactory since weekly hot water flushes have started. Continuous chlorination was restarted on July 3, 1995.

Comparison of on-line instruments to EPA method 330.5 (spectrophotometric method): The additional verification samples were performed during intermittent chlorination when the Outfall TRC concentration is within the limits of detection of EPA method 330.5. Comparison methods at TRC levels <0.01 mg/l are not possible due to turbidity interferences using 100 mm cells with the Perkin Elmer Lambda 12 Spectrophotometer. The Hach Dr-2000 will not detect TRC levels below 0.01 mg/l. During the dates of June 23, 1995 through July 7, 1995, comparisons were made using EPA method 330.5. The comparisons between the Orion 1770 on line analyzer and the Hach Dr-2000 analyzer were satisfactory. EPA method 330.1 (amperometric titration) was used to compare samples below 0.01 mg/l.

Comparison of on-line instruments to EPA method 330.1 (amperometric methods). Low level TRC analysis (<0.01 mg/l) is difficult to do other than by on-line methods. Several methods were researched by the Cook Plant in order to monitor on-line analyzer performance. As discussed earlier, turbidity interferences made low-level comparisons during continuous chlorination an impossibility. Although we were confident that the analyzers worked in the 0.01 to 0.02 mg/l range, we attempted to verify operation by performing comparisons at the levels commonly encountered during continuous chlorination (0.001 to 0.006 mg/l). Amperometric titration (EPA method 330.1)[1] chemicals and

apparatus were ordered in July and we began testing of the method by July 19, 1995. Attachment 1 contains the complete study and the results of the comparisons at low levels of TRC. The results of the study conducted on July 27, August 3, and August 10, 1995 showed that the Orion on-line chlorine analyzers were accurate at TRC levels below 0.01 mg/l.

MDEQ compliance and audit results comparison (May 1995): On May 22, 1995, the MDEQ conducted a compliance sampling inspection. The TRC levels detected by the inspectors matched the TRC levels reported for the day by Cook Plant:

	Sample time (Cook/MDEQ) 08:00/12:15	19:00/19:00
Outfall 001 TRC (mg/l) (Cook/MDEQ)	0.002/<0.01	0.003/<0.01
Outfall 002 TRC (mg/l) (Cook/MDEQ)	< 0.001/<0.01	<0.001/<0.01

Results of NIST traceable standards: On-line analyzers were checked weekly for proper response to traceable standards (0.01 mg/l and 0.03 mg/l). No significant deviations were noted.

Attachment #3. Methods used

These plant procedures are available on request.

D.C. Cook Nuclear Plant
Service Water System Chlorination Plan
February, 1996

Attachment #4.

Selected portions of "Report on Acceptable Levels of Chlorine Discharges at the Donald C. Cook Nuclear Plant" Volumes I and II 1977 Indiana and Michigan Power Company, Donald C. Cook Nuclear Plant Units 1 and 2.

Page 1 of 1

TABLE 6-4. DATA FROM CHLORINATION PLUME SURVEY DONALD C. COOK PLANT - AUGUST 7. [illegible]4

Sample	Mini Ranger Yards A	Mini Ranger Yards B	Time	Temperature °C	Chlorine mg/l
1	479	458	1321	22.0	0.000
2	501	450	1323	23.5	0.000
3	541	478	1325	23.8	0.000
4	467	447	1330	22.4	0.000
5	524	463	1334	22.2	0.017
6	546	489	1336	22.2	0.024
7	511	453	1338	21.7	0.027
8	455	443	1341	21.6	0.117
9	421	422	1342	21.6	0.129
10	487	438	1343	21.6	0.000
11	580	458	1347	21.6	0.063
12	613	508	1348	21.4	0.000
13	581	566	1349	21.4	0.080
14	484	670	1351	21.9	0.000
15	437	583	1352	22.0	0.000
16	517	468	1354	21.9	0.000
17	525	467	1355	21.5	0.126
18	521	475	1356	21.3	0.104
19	666	537	1358	21.3	0.085
20	663	642	1400	21.4	0.027
21	627	714	1401	21.6	0.000
22	741	776	1404	21.9	0.000
23	924	722	1407	21.7	0.029
24	868	664	1408	21.5	0.000
25	715	669	1410	21.5	0.000
26	676	738	1411	21.4	0.062
27	665	807	1412	21.8	0.000
28	658	880	1413	21.9	0.000
29	570	734	1415	21.9	0.000
30	662	612	1417	22.0	0.000
31	748	599	1418	21.9	0.000
32	853	613	1419	21.5	0.011
33	641	682	1420	21.5	0.000
34	998	690	1421	21.5	0.000

TABLE 6-4. Continued

Sample	Mini Ranger Yards A	Mini Ranger Yards B	Time	Temperature °C	Chlorine mg/l
35	776	535	1423	21.6	0.000
36	649	504	1424	21.6	0.000
37	575	548	1425	21.6	0.004
38	527	713	1427	21.6	0.001
39	572	868	1428	22.0	0.000
40	872	1165	1430	22.0	0.000
41	1008	1238	1431	21.9	0.000
42	1045	1225	1432	21.7	0.000
43	1033	1170	1433	21.5	0.000
44	1065	1072	1435	21.5	0.000
45	1198	1061	1437	21.5	0.000
46	1255	1090	1438	21.5	0.005
47	1347	1131	1439	21.6	0.000
48	1336	1103	1440	21.6	0.000
49	1042	810	1442	21.6	0.000
50	897	647	1443	21.7	0.000
51	699	563	1444	21.7	0.000
52	689	706	1447	21.5	0.000
53	809	868	1448	21.9	0.000
54	944	1021	1449	22.0	0.000
55	1097	1230	1451	21.6	0.000
56	1105	1289	1452	21.6	0.000
57	940	1200	1454	21.6	0.000
58	822	1042	1455	21.8	0.000
59	710	833	1456	21.9	0.000
60	593	723	1457	22.0	0.000
61	509	586	1458	22.0	0.000
62	563	367	1501	21.5	0.000
63	408	454	1503	21.7	0.000
64	656	967	1507	21.9	0.000
65	800	1127	1508	22.0	0.000
66	1035	1283	1510	21.9	0.000
67	953	1112	1512	21.8	0.000
68	936	1033	1513	21.9	0.000

TABLE 6-4. Continued

Sample	Mini Ranger Yards A	Mini Ranger Yards B	Time	Temperature °C	Chlorine mg/l
69	942	969	1514	21.7	0.000
70	1037	931	1516	21.8	0.000
71	1100	939	1517	21.6	0.000
72	1421	1091	1520	21.7	0.000

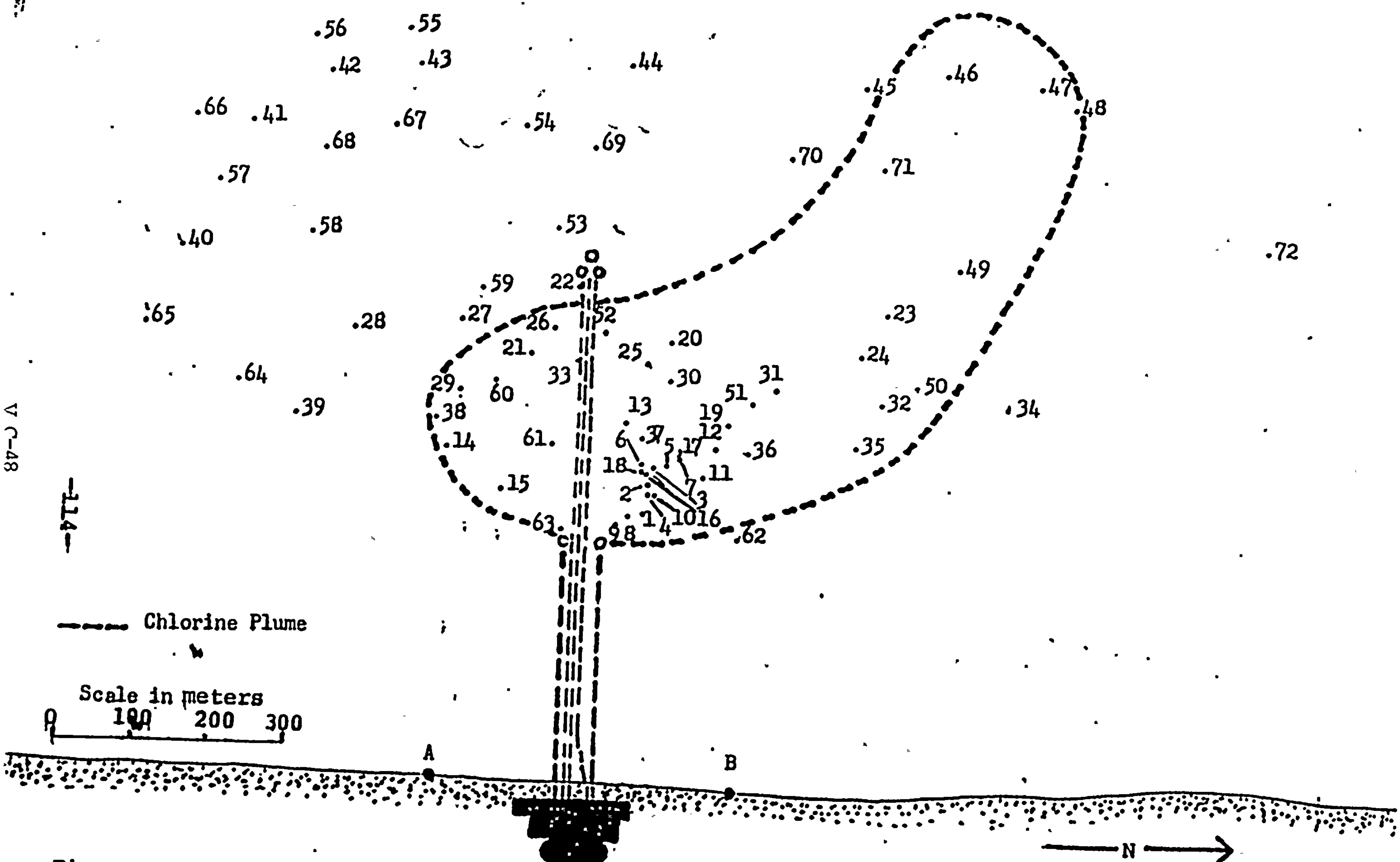

Figure 6-4 Sample station locations in Lake Michigan off the Donald C. Cook plant showing estimated outer bounds of the chorine plume, Aug. 7, 1974. Station numbers correspond to sample numbers in Table 6-4.

8. MATHEMATICAL PLUME MODELING

by Dr. Kwang K. Lee

Introduction

A mathematical model has been developed to predict the distribution of residual chlorine in an effluent plume so that it may be possible to minimize objectional environmental effects and still achieve fouling control. Unlike a thermal effluent which is continuously discharged, chlorine is injected into the cooling water in discrete, interrupted, intervals to provide shock fouling treatment. Since the chlorination is applied intermittently rather than continuously, the residual chlorine plume behaves like a train of transient clouds meandering through the thermal plume.

In addition to advection, dilution, and diffusion within the thermal plume, chlorine also undergoes chemical degradation. The rates of reaction or decay depend on temperature, light intensity, and the chlorine demand of the receiving water (Section 7 this report). Consequently, the effect of thermal plume on the characteristics and distribution of residual chlorine must be coupled with rates of chlorine decay. Without adequate knowledge of thermal plume behavior, and the kinetics of chlorine decay proper assessment of the impact of chlorine residual on receiving waters cannot be determined.

Methods

In view of the interlocking action between a thermal plume and chlorine kinetics, and adequate model of the phenomenon may consist of three steps: namely, the design of a thermal plume model which is capable of including both the dynamic characteristics of thermal plume and the transient behavior of residual chlorine; secondly, a chlorine kinetic model and finally the incorporation of the two interrelated models.

The analysis of chlorine residuals in a thermal effluent discharged by an once-through cooling system must be based on valid mathematical, physical and chemical assumptions in modeling. Most of the available models of thermal discharges are based on the applications of classical theory on steady state turbulent jets. Policastro and Paddock, (1972) provided valid comparison between the available jet models and experimental data. The jet models are generally acceptable for a steady state, initial-momentum dominated jets into an infinitely large receiving water. However, the jet model cannot account for its own influence on the surroundings, and the physical boundary conditions of the receiving water cannot affect the entrainment conditions of the jet. Despite the mathematical simplicity of the jet models, they are not adequate nor compatible with the requirement of valid chlorine residual distribution characteristics. Therefore, a far-field thermal plume model would be the only acceptable alternative

9. SUMMARY

The results of this research indicate that many Lake Michigan organisms can tolerate intermittent chlorination at concentrations comparable to those observed in the lake.

Toxicity tests with six species of important Lake Michigan fish indicate that the fish are more sensitive to chlorine at elevated temperatures. This is exemplified by the results of tests with alewife and yellow perch where both species exhibited a ten-fold increase in sensitivity as test temperatures were increased from 10 to 30 C. The range of 30-minute LC-50 values for all fish tested was 8 mg/l at 10 C for yellow perch to 0.287 mg/l for coho salmon at 20 C. Estimated no mortality levels were approximately one half the LC-50 values ranging from 0.18 mg/l for the alewife to 0.43 mg/l for the yellow perch.

Behavioral observations indicated that most fish are lethargic while exposed to chlorine with the salmonid species somewhat more active than others. Most species came to the surface of the test aquaria to gulp for air during the exposure period. Mortality was delayed following exposure to chlorine in several of the species tested, however, considerable inter- and intra-specific differences were noted. Except for the perch at 10 C fish losing their equilibrium rarely recovered following exposure to chlorine.

The invertebrate species tested were generally less sensitive to intermittent chlorination than were the fish.

The LC-50 values generally decreased with increasing temperature. The range of LC-50 values observed was approximately .15 mg/l at 10 C for *Cyclops bicuspidatus thomasi* to 1.54 mg/l at 10 C for *Limnocalanus macrurus*. Estimated "safe" values (TL-5) ranged from 2.4 to 0.53 mg/l.

Lake Michigan phytoplankton showed a significant loss of active chlorophyll *a* and a permanent reduction of carbon uptake rates following 30 minute exposures to chlorine at levels above 0.5 mg/l. Chlorine concentrations less than 0.1 mg/l produced only slight losses in chlorophyll *a* and, following an initial reduction in carbon uptake rates, nearly complete recovery was observed. Concentrations between 0.5 and 0.1 mg/l generally produced intermediate responses.

Laboratory studies to determine the persistence of chlorine in Lake Michigan water indicated that following chlorine addition there is an initial rapid decrease in chlorine concentrations within 1-2 hours to levels approximately one half of the initial concentrations. Low levels of chlorine were detectable for much longer periods. Degradation rates were more rapid under warm lighted conditions as opposed to cold, dark conditions.

Field surveys at six Lake Michigan power plants indicate that chlorine degrades rapidly within the bounds of the thermal effluent plume. The maximum chlorine concentration observed was 0.376 mg/l. Chlorine was generally not detectable longer than 1-2 hours while the maximum area of the chlorine plume was only a fraction of the observable thermal plume.

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-171   Organism: Daphnia magna

CONCENTRATION: 25.0%

TIME: (HOURS)		0	24	48	
ALIVE	a	5	5	5	
	b	5	5	5	
	c	5	5	5	
	d	5	5	5	
TEMP. C	a	26.0	24.0	24.0	
	b	26.0	24.0	24.0	
	c	26.0	24.0	24.0	
	d	26.0	24.0	24.0	
pH	a	8.00	7.84	8.31	
	b	8.00	7.84	8.31	
	c	8.00	7.84	8.31	
	d	8.00	7.84	8.31	
DO(mg/l)	a	8.2		8.2	
	b	8.2		8.2	
	c	8.2		8.2	
	d	8.2		8.2	
COND.(UMHOS/CM)		a	300		310
		b	300		310
		c	300		310
		d	300		310

CONCENTRATION: 25.0%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	8.05	0.20	8.31	7.84
DO(mg/l):	8.2	0.0	8.2	8.2
COND.(UMHOS/CM):	305	5	310	300

Client: Indiana Michigan Cook Nuclear Plant
ESI Test No.: 95-171

Date: 9/17-19/95
Organism: Daphnia magna

CONCENTRATION: 50.0%

TIME: (HOURS)		0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.0	24.0
	b	26.0	24.0	24.0
	c	26.0	24.0	24.0
	d	26.0	24.0	24.0
pH	a	8.03	7.91	8.31
	b	8.03	7.91	8.31
	c	8.03	7.91	8.31
	d	8.03	7.91	8.31
DO(mg/l)	a	8.2		8.3
	b	8.2		8.3
	c	8.2		8.3
	d	8.2		8.3
COND.(UMHOS/CM)	a	300		320
	b	300		320
	c	300		320
	d	300		320

CONCENTRATION: 50.0%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	8.08	0.17	8.31	7.91
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	310	10	320	300

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-171   Organism: Daphnia magna

CONCENTRATION: 100.0%

TIME: (HOURS)		0	24	48	
ALIVE	a	5	5	5	
	b	5	5	5	
	c	5	5	5	
	d	5	5	5	
TEMP. C	a	26.0	24.1	24.0	
	b	26.0	24.1	24.0	
	c	26.0	24.1	24.0	
	d	26.0	24.1	24.0	
pH	a	8.13	7.95	8.30	
	b	8.13	7.95	8.30	
	c	8.13	7.95	8.30	
	d	8.13	7.95	8.30	
DO(mg/l)	a	8.2		8.3	
	b	8.2		8.3	
	c	8.2		8.3	
	d	8.2		8.3	
COND.(UMHOS/CM)		a	300		320
		b	300		320
		c	300		320
		d	300		320

CONCENTRATION: 100.0%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	8.13	0.14	8.30	7.95
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	310	10	320	300

ENVIRONMENTAL SERVICES INC.
6404 MACCORKLE AVE.
ST.ALBANS, WEST VIRGINIA

Client: Indiana Michigan Cook Nuclear Plant   Date: 9/17-19/95
ESI Test No.: 95-172   Organism: Daphnia magna

CONCENTRATION: Control

TIME: (HOURS)	0	24	48	
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.3	24.0
	b	26.0	24.3	24.0
	c	26.0	24.3	24.0
	d	26.0	24.3	24.0
pH	a	8.12	8.04	8.15
	b	8.12	8.04	8.15
	c	8.12	8.04	8.15
	d	8.12	8.04	8.15
DO(mg/l)	a	8.0		8.2
	b	8.0		8.2
	c	8.0		8.2
	d	8.0		8.2
COND.(UMHOS/CM)	a	300		310
	b	300		310
	c	300		310
	d	300		310

CONCENTRATION: CONTROL

	AVG	STD	MAX	MIN
TEMP C:	24.8	0.9	26.0	24.0
pH:	8.10	0.05	8.15	8.04
DO(mg/l):	8.1	0.1	8.2	8.0
COND.(UMHOS/CM):	305	5	310	300

Client: Indiana Michigan Cook Nuclear Plant
ESI Test No.: 95-172

Date: 9/17-19/95
Organism: Daphnia magna

CONCENTRATION: 6.25%

	TIME: (HOURS)	0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	24.9	24.0	24.0
	b	24.9	24.0	24.0
	c	24.9	24.0	24.0
	d	24.9	24.0	24.0
pH	a	8.26	8.09	8.18
	b	8.26	8.09	8.18
	c	8.26	8.09	8.18
	d	8.26	8.09	8.18
DO(mg/l)	a	8.1		8.3
	b	8.1		8.3
	c	8.1		8.3
	d	8.1		8.3
COND.(UMHOS/CM)	a	300		310
	b	300		310
	c	300		310
	d	300		310

CONCENTRATION: 6.25%

	AVG	STD	MAX	MIN
TEMP C:	24.3	0.4	24.9	24.0
pH:	8.18	0.07	8.26	8.09
DO(mg/l):	8.2	0.1	8.3	8.1
COND.(UMHOS/CM):	305	5	310	300

Client: Indiana Michigan Cook Nuclear Plant
ESI Test No.: 95-172

Date: 9/17-19/95
Organism: Daphnia magna

CONCENTRATION: 12.5%

		0	24	48
TIME: (HOURS)		0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.1	24.0
	b	26.0	24.1	24.0
	c	26.0	24.1	24.0
	d	26.0	24.1	24.0
pH	a	8.22	8.10	8.23
	b	8.22	8.10	8.23
	c	8.22	8.10	8.23
	d	8.22	8.10	8.23
DO(mg/l)	a	8.2		8.3
	b	8.2		8.3
	c	8.2		8.3
	d	8.2		8.3
COND.(UMHOS/CM)	a	290		300
	b	290		300
	c	290		300
	d	290		300

CONCENTRATION: 12.5%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.9	26.0	24.0
pH:	8.18	0.06	8.23	8.10
DO(mg/l):	8.3	0.1	8.3	8.2
COND.(UMHOS/CM):	295	5	300	290

Client: Indiana Michigan Cook Nuclear Plant Date: 9/17-19/95
ESI Test No.: 95-172 Organism: Daphnia magna

CONCENTRATION: 25.0%

	TIME: (HOURS)	0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	25.7	24.4	24.0
	b	25.7	24.4	24.0
	c	25.7	24.4	24.0
	d	25.7	24.4	24.0
pH	a	8.23	8.12	8.24
	b	8.23	8.12	8.24
	c	8.23	8.12	8.24
	d	8.23	8.12	8.24
DO(mg/l)	a	8.1		8.2
	b	8.1		8.2
	c	8.1		8.2
	d	8.1		8.2
COND.(UMHOS/CM)	a	310		320
	b	310		320
	c	310		320
	d	310		320

CONCENTRATION: 25.0%

	AVG	STD	MAX	MIN
TEMP C:	24.7	0.7	25.7	24.0
pH:	8.20	0.05	8.24	8.12
DO(mg/l):	8.2	0.1	8.2	8.1
COND.(UMHOS/CM):	315	5	320	310

Client: Indiana Michigan Cook Nuclear Plant
ESI Test No.: 95-172

Date: 9/17-19/95
Organism: Daphnia magna

CONCENTRATION: 50.0%

TIME: (HOURS)		0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	25.7	24.0	24.0
	b	25.7	24.0	24.0
	c	25.7	24.0	24.0
	d	25.7	24.0	24.0
pH	a	8.26	8.15	8.27
	b	8.26	8.15	8.27
	c	8.26	8.15	8.27
	d	8.26	8.15	8.27
DO(mg/l)	a	8.0		8.2
	b	8.0		8.2
	c	8.0		8.2
	d	8.0		8.2
COND.(UMHOS/CM)	a	300		310
	b	300		310
	c	300		310
	d	300		310

CONCENTRATION: 50.0%

	AVG	STD	MAX	MIN
TEMP C:	24.6	0.8	25.7	24.0
pH:	8.23	0.05	8.27	8.15
DO(mg/l):	8.1	0.1	8.2	8.0
COND.(UMHOS/CM):	305	5	310	300

Client: Indiana Michigan Cook Nuclear Plant
ESI Test No.: 95-172

Date: 9/17-19/95
Organism: Daphnia magna

CONCENTRATION: 100.0%

		TIME: (HOURS) 0	24	48
ALIVE	a	5	5	5
	b	5	5	5
	c	5	5	5
	d	5	5	5
TEMP. C	a	26.0	24.8	24.0
	b	26.0	24.8	24.0
	c	26.0	24.8	24.0
	d	26.0	24.8	24.0
pH	a	8.24	8.17	8.29
	b	8.24	8.17	8.29
	c	8.24	8.17	8.29
	d	8.24	8.17	8.29
DO(mg/l)	a	8.1		8.2
	b	8.1		8.2
	c	8.1		8.2
	d	8.1		8.2
COND.(UMHOS/CM)	a	310		320
	b	310		320
	c	310		320
	d	310		320

CONCENTRATION: 100.0%

	AVG	STD	MAX	MIN
TEMP C:	24.9	0.8	26.0	24.0
pH:	8.23	0.05	8.29	8.17
DO(mg/l):	8.2	0.1	8.2	8.1
COND.(UMHOS/CM):	315	5	320	310

APPENDIX B

COPIES OF ORIGINAL DATA

Environmental Services Inc.
6404 MacCorkle Ave.
St. Albans, West Virginia 25177

Sample/Dilution Water Description sheet

Client Name: Cook Nuclear Plant — Sample ID: Final Effluent

Outfall No.: U1/U2 Outfall — TestNo.: 95-171

Sample Condition Upon Arrival

Chlorine: 0mg/L — Chlorine Adjusted: /
Salinity: 0‰ — Salinity Adjusted: /
pH: 8.13 — pH Adjusted: /

Temperature: 4°C
Alkalinity: 132
Hardness: 146
Conductivity: ~~342~~ 350

D.O. Initial: 8.2mg/L — D.O. Adjiusted: / — Aeration Period: /

Sample Description

Clarity: (clear), cloudy

Color: black, white, brown, red, blue, green yellow, (none), other

Odor: organic, chemical, petroleum, sour, sweet, (none)

Sediments: Organic, flocculent, heavy, fine (none)

Particulates: Organic, flocculent, heavy, fine, (none)

Other: ______

Dilution Water Description

Chlorine: 0mg/L — Chlorine Adjusted: /
Salinity: 0‰ — Salinity Adjusted: /
pH: 7.79 — pH Adjusted: /

Temperature: 4°C
Alkalinity: 94
Hardness: 86
Conductivity: 340

D.O. Initial: 8.2mg/L — D.O. Adjiusted: / — Aeration Period: /

Dilution Water Description

Clarity: (clear), cloudy

Color: black, white, brown, red, blue, green yellow, (none), other

Odor: organic, chemical, petroleum, sour, sweet, (none)

Sediments: Organic, flocculent, heavy, fine (none)

Particulates: Organic, flocculent, heavy, fine, (none)

Other: ______

ENVIRONMENTAL SERVICES BIOASSAY LABORATORY BENCH SHEET

INDUSTRY: Cook Nuclear Plant
ADDRESS: Bridgeman, Michigan
CONTACT: Eric Mallen
ESI TEST NO.: 95–171
TOXICANT: U1/U2 Outfall
DILUTION WATER USED: Recieving Water
TEST TEMPERATURE: 25 +/–1C

PERSON CONDUCTING TEST: EBG/ART
BEGINNING DATE: 9/17/95 TIME: 1520
ENDING DATE: 9/19/95 TIME: 1520

TEST ORGANISM
SPECIES: Daphnia magna
AGE: >24–hrs.

CONC. OR %	TEST VESSEL NUMBER	NUMBER OF ORGANISMS ~~ALIVE~~ Not Effected					D.O. (mg/L)					pH					Temperature (C)					Conductivity (umhos)					Alk.	Hard.
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	0
control	1	5	5	5			8.2	/	8.3			7.79	7.62	8.31			24.0	24.0	24.0			340	/	360			94	86
	2	5	5	5			8.2	/	8.3			7.79	7.62	8.31			24.0	24.0	24.0			340	/	360			94	86
	3	5	5	5			8.2	/	8.3			7.79	7.62	8.31			24.0	24.0	24.0			340	/	360			94	86
	4	5	5	5			8.2	/	8.3			7.79	7.62	8.31			24.0	24.0	24.0			340	/	360			94	86
6.25%	5	5	5	5			8.2	/	8.3			7.83	7.73	8.35			24.0	24.0	24.0			260	/	300				
	6	5	5	5			8.2	/	8.3			7.83	7.73	8.35			24.0	24.0	24.0			260	/	300				
	7	5	5	5			8.2	/	8.3			7.83	7.73	8.35			24.0	24.0	24.0			260	/	300				
	8	5	5	5			8.2	/	8.3			7.83	7.73	8.35			24.0	24.0	24.0			260	/	300				
12.5%	9	5	5	5			8.2	/	8.3			7.97	7.79	8.33			24.0	24.0	24.0			300	/	320				
	10	5	5	5			8.2	/	8.3			7.97	7.79	8.33			24.0	24.0	24.0			300	/	320				
	11	5	5	5			8.2	/	8.3			7.97	7.79	8.33			24.0	24.0	24.0			300	/	320				
	12	5	5	5			8.2	/	8.3			7.97	7.79	8.33			24.0	24.0	24.0			300	/	320				
25.0%	13	5	5	5			8.2	/	8.2			8.04	7.84	8.31			24.0	24.0	24.0			300	/	310				
	14	5	5	5			8.2	/	8.2			8.04	7.84	8.31			24.0	24.0	24.0			300	/	310				
	15	5	5	5			8.2	/	8.2			8.04	7.84	8.31			24.0	24.0	24.0			300	/	310				
	16	5	5	5			8.2	/	8.2			8.04	7.84	8.31			24.0	24.0	24.0			300	/	310				
initials:		EB	EB	AT			EB	AT	AT			EB	AT	AT			EB	AT	AT			EB	AT	AT			AT	AT
QC sign off		EB																										

Comments:

AH&M ENVIRONMENTAL BIOASSAY LABORATORY BENCH SHEET

INDUSTRY: Cook Nuclear Plant
ADDRESS: Bridgeman, Michigan
CONTACT: Eric Mallen
AHM TEST NO.: 95-171
TOXICANT: U1/U2 Outfall
DILUTION WATER USED: Recieving Water
TEST TEMPERATURE: 25 +/-1C

PERSON CONDUCTING TEST: EBG/ART
BEGINNING DATE: 9/17/95 TIME: 1520
ENDING DATE: 9/19/95 TIME: 1520

TEST ORGANISM
SPECIES: Daphnia magna
AGE: >24-hrs.

CONC. OR %	TEST VESSEL NUMBER	NUMBER OF ORGANISMS ~~ALIVE~~ Not Effected					D.O. (mg/L)					pH					Temperature (C)					Conductivity (umhos)					Alk.	Hard.
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	0
50.0%	17	5	5	5			8.2	/	8.3			8.03	7.91	8.31			24.3	24.0	24.0			300	/	320				
	18	5	5	5			8.2	/	8.3			8.03	7.91	8.31			24.3	24.0	24.0			300	/	320				
	19	5	5	5			8.2	/	8.3			8.03	7.91	8.31			24.3	24.0	24.0			300	/	320				
	20	5	5	5			8.2	/	8.3			8.03	7.91	8.31			24.3	24.0	24.0			300	/	320				
100.0%	21	5	5	5			8.2	/	8.3			8.13	7.95	8.30			24.3	24.1	24.0			300	/	320			132	146
	22	5	5	5			8.2	/	8.3			8.13	7.95	8.30			24.3	24.1	24.0			300	/	320			132	146
	23	5	5	5			8.2	/	8.3			8.13	7.95	8.30			24.3	24.1	24.0			300	/	320			132	146
	24	5	5	5			8.2	/	8.3			8.13	7.95	8.30			24.3	24.1	24.0			300	/	320			132	146
initials:		EO	EO	AT			EM	AT	AT			EM	AT	AT			EO	AT	AT			EO	AT	AT			AT	AT
QC sign off		EO																										

Comments:

Environmental Services Inc.
6404 MacCorkle Ave.
St. Albans, West Virginia 25177

Sample/Dilution Water Description sheet

Client Name: Cook Nuclear Plant — Sample ID: Detox sample

Outfall No.: Clay/Lake Michigian Water — TestNo.: 95–172

Sample Condition Upon Arrival

Chlorine: 0 mg/L — Chlorine Adjusted: ✓
Salinity: 0 ‰ — Salinity Adjusted: ✓
pH: 8.93 — pH Adjusted: ✓

Temperature: 4°C
Alkalinity: 112
Hardness: 158
Conductivity: 310

D.O. Initial: 8.2 mg/L — D.O. Adjiusted: — Aeration Period: ✓

Sample Description

Clarity: (clear), cloudy

Color: black, white, brown, red, blue, green yellow, (none), other

Odor: organic, chemical, petroleum, sour, sweet, (none)

Sediments: Organic, flocculent, heavy, fine (none)

Particulates: Organic, flocculent, heavy, fine, (none)

Other:

Dilution Water Description

Chlorine: 0 mg/L — Chlorine Adjusted: ✓
Salinity: 0 ‰ — Salinity Adjusted: ✓
pH: 8.12 — pH Adjusted: ✓

Temperature: 4°C
Alkalinity: 94
Hardness: 86
Conductivity: 300

D.O. Initial: 8.0 mg/L — D.O. Adjiusted: ✓ — Aeration Period: ✓

Dilution Water Description

Clarity: (clear), cloudy

Color: ~~black~~, white, brown, red, blue, green yellow, (none), other

Odor: organic, ~~chemical~~, petroleum, sour, sweet, (none)

Sediments: Organic, flocculent, heavy, fine (none)

Particulates: Organic, flocculent, heavy, fine, (none)

Other:

ENVIRONMENTAL SERVICES BIOASSAY LABORATORY BENCH SHEET

INDUSTRY: Cook Nuclear Plant
ADDRESS: Bridgeman, Michigan
CONTACT: Eric Mallen
ESI TEST NO.: 95-172
TOXICANT: Clay/Lake Michigian Water
DILUTION WATER USED: Recieving Water
TEST TEMPERATURE: 25 +/-1C

PERSON CONDUCTING TEST: EBG/ART
BEGINNING DATE: 9/17/95 TIME: 1520
ENDING DATE: 9/19/95 TIME: 1530

TEST ORGANISM
SPECIES: Daphnia magna
AGE: >24-hrs.

CONC. OR %	TEST VESSEL NUMBER	NUMBER OF ORGANISMS ~~ALIVE~~ not effected					D.O. (mg/L)					pH					Temperature (C)					Conductivity (umhos)					Alk.	Hard.
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	0
control	1 25	5	5	5			8.0	/	8.2			8.12	8.01	8.15			24.0	24.3	24.0			350	/	310			94	86
	2 26	5	5	5			8.0	/	8.2			8.12	8.04	8.15			24.0	24.3	24.0			350	/	310			94	86
	3 27	5	5	5			8.0	/	8.2			8.12	8.01	8.15			24.0	24.3	24.0			350	/	310			94	86
	4 28	5	5	5			8.0	/	8.2			8.12	8.04	8.15			24.0	24.3	24.0			350	/	310			94	86
6.25%	5 29	5	5	5			8.1	/	8.3			8.24	8.09	8.18			24.9	24.0	24.0			300	/	310				
	6 30	5	5	5			8.1	/	8.3			8.24	8.09	8.18			24.9	24.0	24.0			350	/	310				
	7 31	5	5	5			8.1	/	8.3			8.24	8.09	8.18			24.9	24.0	24.0			350	/	310				
	8 32	5	5	5			8.1	/	8.3			8.24	8.09	8.18			24.9	24.0	24.0			350	/	310				
12.5%	9 33	5	5	5			8.2	/	8.5			8.22	8.10	8.23			24.0	24.1	24.0			290	/	300				
	10 34	5	5	5			8.2	/	8.3			8.22	8.10	8.23			24.0	24.1	24.0			240	/	300				
	11 35	5	5	5			8.2	/	8.3			8.22	8.10	8.23			24.0	24.1	24.0			240	/	300				
	12 36	5	5	5			8.2	/	8.3			8.22	8.10	8.23			24.0	24.1	24.0			240	/	300				
25.0%	13 37	5	5	5			8.1	/	8.2			8.23	8.12	8.24			25.7	24.4	24.0			310	/	320				
	14 38	5	5	5			8.1	/	8.2			8.23	8.12	8.24			25.7	24.4	24.0			310	/	320				
	15 39	5	5	5			8.1	/	8.2			8.23	8.12	8.24			25.7	24.4	24.0			310	/	320				
	16 40	5	5	5			8.1	/	8.2			8.27	8.12	8.24			25.7	24.4	24.0			310	/	320				
initials:		EG	EG	AT			EG	AT	AT			EG	AT	AT			EG	AT	AT			EG	AT	AT			AT	AT
QC sign off		EG																										

Comments:

AH&M ENVIRONMENTAL BIOASSAY LABORATORY BENCH SHEET

INDUSTRY: Cook Nuclear Plant
ADDRESS: Bridgeman, Michigan
CONTACT: Eric Mallen
AHM TEST NO.: 95–172
TOXICANT: Clay/Lake Michigian Water
DILUTION WATER USED: Recieving Water
TEST TEMPERATURE: 25 +/–1C

PERSON CONDUCTING TEST: EBG/ART
BEGINNING DATE: 9/17/95 TIME: 1522
ENDING DATE: 9/19/95 TIME: 1530

TEST ORGANISM
SPECIES: Daphnia magna
AGE: >24–hrs.

CONC. OR %	TEST VESSEL NUMBER	NUMBER OF ORGANISMS ~~ALIVE~~ not effected					D.O. (mg/L)					pH					Temperature (C)					Conductivity (umhos)					Alk.	Hard.
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	0
50.0%	~~17~~ 41	5	5	5			8.0	/	8.2			8.24	8.15	8.27			25.7	24.0	24.0			308	/	310				
	~~18~~ 42	5	5	5			8.0	/	8.2			8.24	8.15	8.27			25.7	24.0	24.0			308	/	310				
	~~19~~ 43	5	5	5			8.0	/	8.2			8.16	8.15	8.27			25.7	24.0	24.0			300	/	310				
	~~20~~ 44	5	5	5			8.0	/	8.2			8.24	8.15	8.27			25.7	24.0	24.0			308	/	310				
100.0%	~~21~~ 45	5	5	5			8.1	/	8.2			8.24	8.17	8.29			26.0	24.8	24.0			310	/	320			112	158
	~~22~~ 46	5	5	5			8.1	/	8.2			8.24	8.17	8.29			26.0	24.8	24.0			312	/	320			112	158
	~~23~~ 47	5	5	5			8.1	/	8.2			8.24	8.17	8.29			26.0	24.8	24.0			310	/	320			112	158
	~~24~~ 48	5	5	5			8.1	/	8.2			8.24	8.17	8.29			26.0	24.8	24.0			310	/	320			112	158
initials:		EG	EG	AT			EG	AT	AT			EG	AT	AT			EG	AT	AT			EG	AT	AT			AT	AT
QC sign off		EG																										

Comments:

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APPENDIX C

CHAIN OF CUSTODY FORM

PROJ. NO.	PROJECT NAME	LAB PROJ. NO.
B-029	CLIENT Cook Nuclear Plant	

LABORATORY ANALYSIS

SAMPLERS: *(Signature)*

SAMPLING METHOD

SAMPLE I.D. NO.	DATE	TIME	COMPOSITE	GRAB	WATER	SOIL	REFRIGERATED OR ICED	FILTERED	ACIDIFIED	AIR SAMPLE		NUMBER OF CONTAINERS	LAB I.D. NUMBER	VOLATILE ORGANICS	BTX & E	TOTAL HYDROCARBONS	PCB'S	TOTAL METALS (8)	PLM (ASBESTOS)	PCM (ASBESTOS)	Bioassay	Whole Toxicity Test	SAMPLE LOCATION / REMARKS
Lake Michigan water	9-16-95	0920 pm			X																X	X	
Bentonite clay w/Lake Mich. water	9-16-95	0920 pm			X																X	X	
Composite Detoxified Effluent	9-16-95	0920 pm			X																X	X	

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
V. Stahl / S. Rose	9-16-95 / 0930 pm	Andrew R. Thomas			

Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Project Manager / Phone #:
		Andrew Thomas	9/17/95 / 0720	Eric B. Gillespie (304) 768-2233

AH&M Environmental Inc.
6404 MacCorkle Avenue, S.W. • St. Albans, WV 25177
(304) 768-2233 • (304) 768-9988 FAX

ESI

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APPENDIX VI

ANNUAL REPORT: RADIOLOGICAL ENVIRONMENTAL

MONITORING PROGRAM

1995

DONALD C. COOK NUCLEAR PLANT

UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1995 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1995

Prepared by

Indiana Michigan Power Company

and

Teledyne Brown Engineering

April 15, 1996

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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 1995 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.

The description and conduct of the Radiological Environmental Monitoring Program was moved from Technical Specifications to the Offsite Dose Calculation Manual during 1995. This move was approved on 02/10/95, Amendment No. 189 to Facility Operating License No. DPR-58 and Amendment No. 175 to Facility Operating License No. DPR-74.

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, 1995 through December 31, 1995.

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.

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 1995. 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- 1995

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°		
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°		
ONS-7	(T-07)	2103 ft.		36°		
ONS-8	(T-08)	2208 ft.		82°		
ONS-9	(T-09)	1368 ft.		149°		
ONS-10	(T-10)	1390 ft.		127°		
ONS-11	(T-11)	1969 ft.		11°		
ONS-12	(T-12)	2292 ft.		63°		
New Buffalo	(NBF)	15.6 mi	SSW		Quarterly	Direct Radiation/Quarterly
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- 1995

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°		
ONS-2	(A-2)	2338 ft.		48°		
ONS-3	(A-3)	2407 ft.		90°		
ONS-4	(A-4)	1852 ft.		118°		
ONS-5	(A-5)	1895 ft.		189°		
ONS-6	(A-6)	1917 ft.		210°	Weekly	Gross Beta/Weekly
New Buffalo	(NBF)	15.6 mi	SSW			I-131/Weekly
South Bend	(SBN)	26.2 mi	SE			Gamma Isotopic/
Dowagiac	(DOW)	24.3 mi	ENE			Quarterly Composite
Coloma	(COL)	18.9 mi	NNE			
Groundwater						
Onsite	(W-1)	1969 ft.		11°		
Onsite	(W-2)	2292 ft.		63°		
Onsite	(W-3)	3279 ft.		107°		
Onsite	(W-4)	418 ft.		301°	Quarterly	Gamma Isotopic/Quarterly
Onsite	(W-5)	404 ft.		290°		Tritium/Quarterly
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°		
Steam Generator Storage Facility	(SG-2)	0.7 mi		92°		Gross Beta/Quarterly
Steam Generator Storage Facility	(SG-4)	0.7 mi		93°	Quarterly	Gross Alpha/Quarterly
Steam Generator Storage Facility	(SG-5)	0.7 mi		92°		Gamma Isotopic/Quarterly

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1995

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		L-1	Intake				
Lake Michigan Shoreline		L-2	500 ft.	S		Daily	Gamma Isotopic/Monthly
Lake Michigan Shoreline		L-3	500 ft.	N			Composite
Sediment							
Lake Michigan Shoreline		SL-2	500 ft.	S			
Lake Michigan Shoreline		SL-3	500 ft.	N		Semi-annually	Gamma Isotopic/Semi-
Milk-Indicator							
Schuler Farm	Baroda	Schuler	4.1 mi	SE		14 Days	I-131/Sample
Warmbien Farm	Three Oaks	Warmbien	7.7 mi	S			
Freehling Farm	Buchanan	Freehling	7.0 mi	SE			
Schutze Farm	Buchanan	Schutze (a)	7.0 mi	SE			
Milk-Background							
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

(a) Droppe[illegible] program 04/28/95.

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1995

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 2/year
Lake Michigan	ONS-S	.4 mi	S			
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			Sector A & B		At time of harvest	Gamma Isotopic at time of harvest.
Grapes						
In a land sector containing grapes approximately 20 miles from the Plant and 180° from the sector with the highest D/Q.			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

FIGURE 1

On-site REMP Monitoring Locations

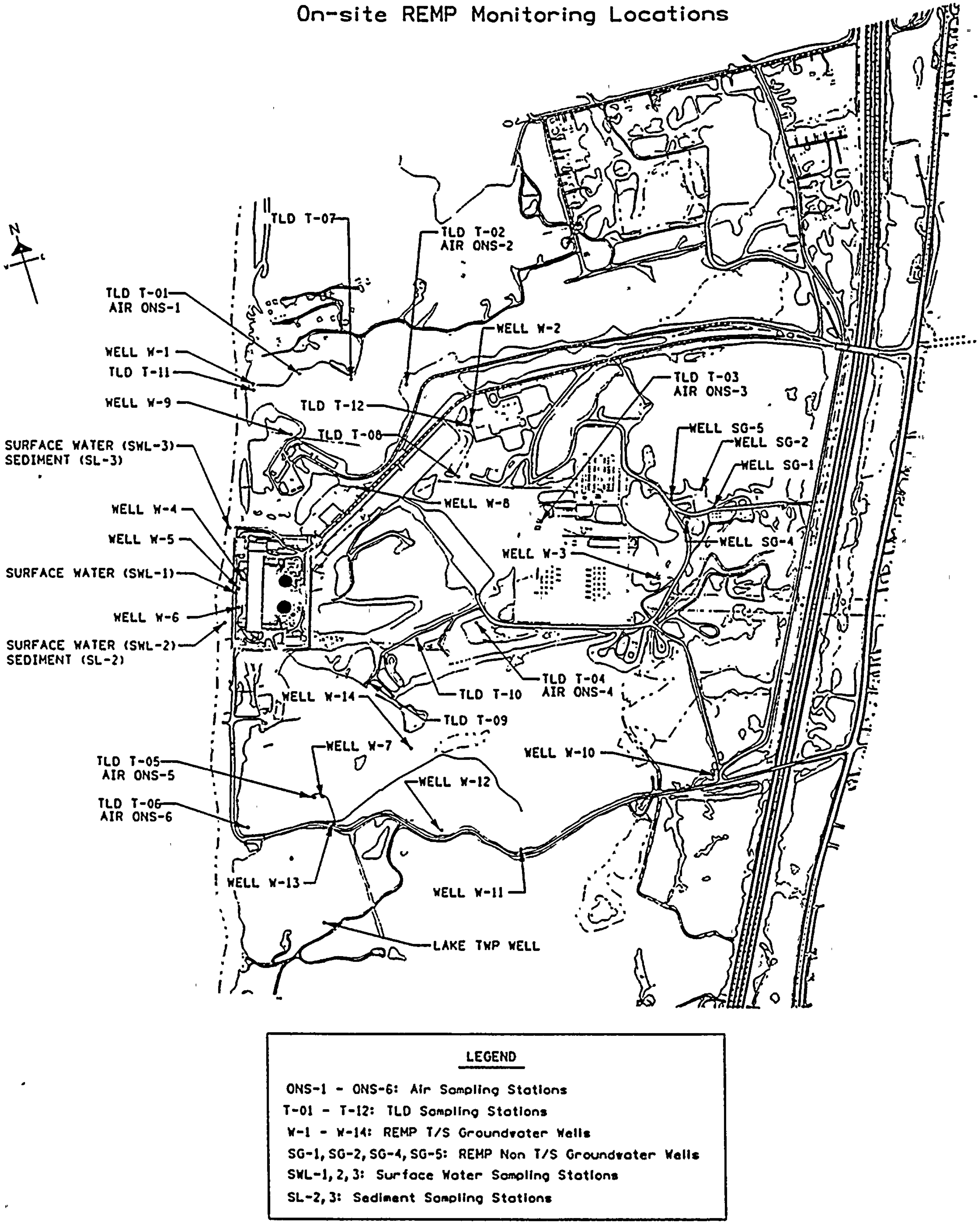
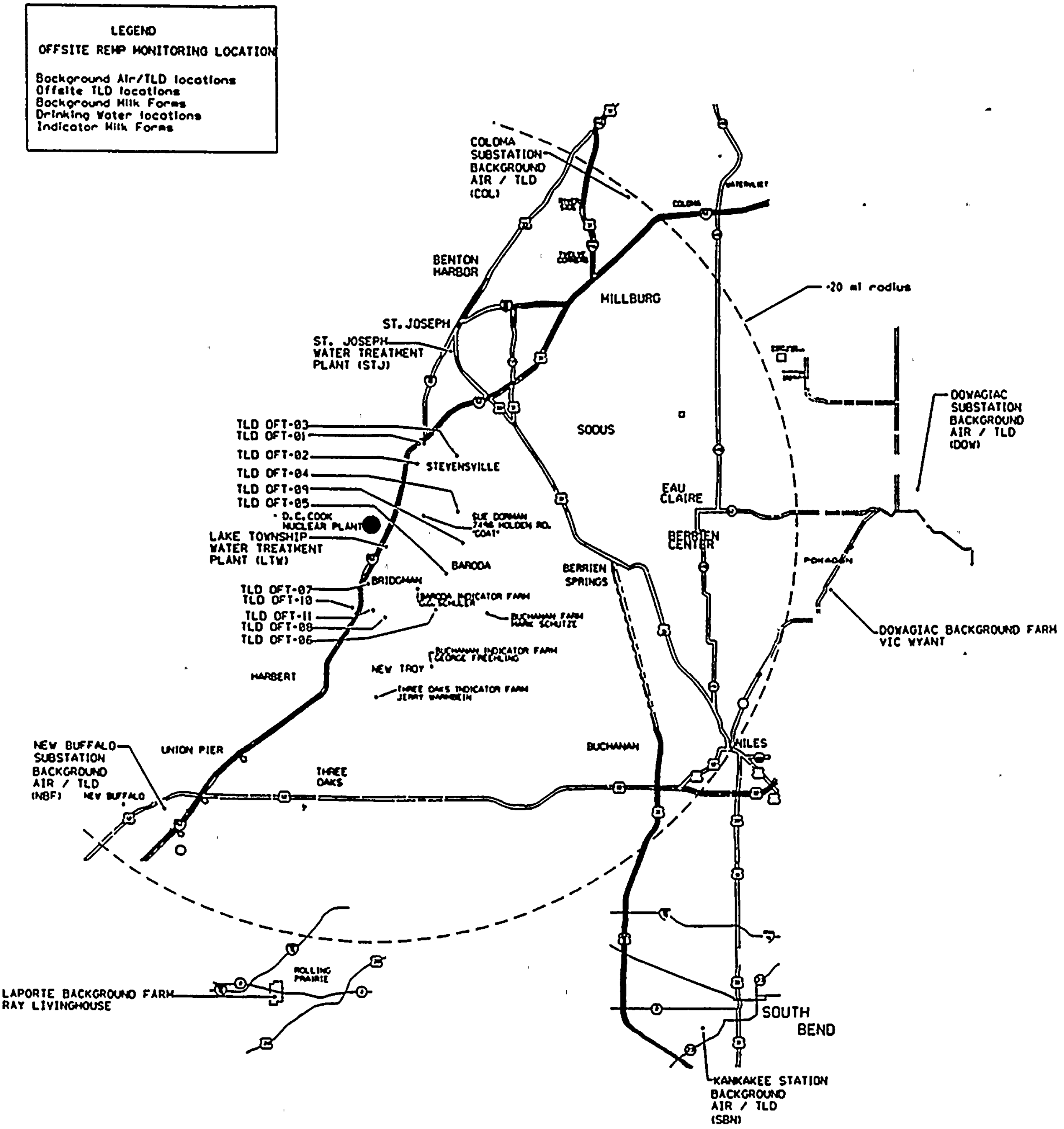


FIGURE 2

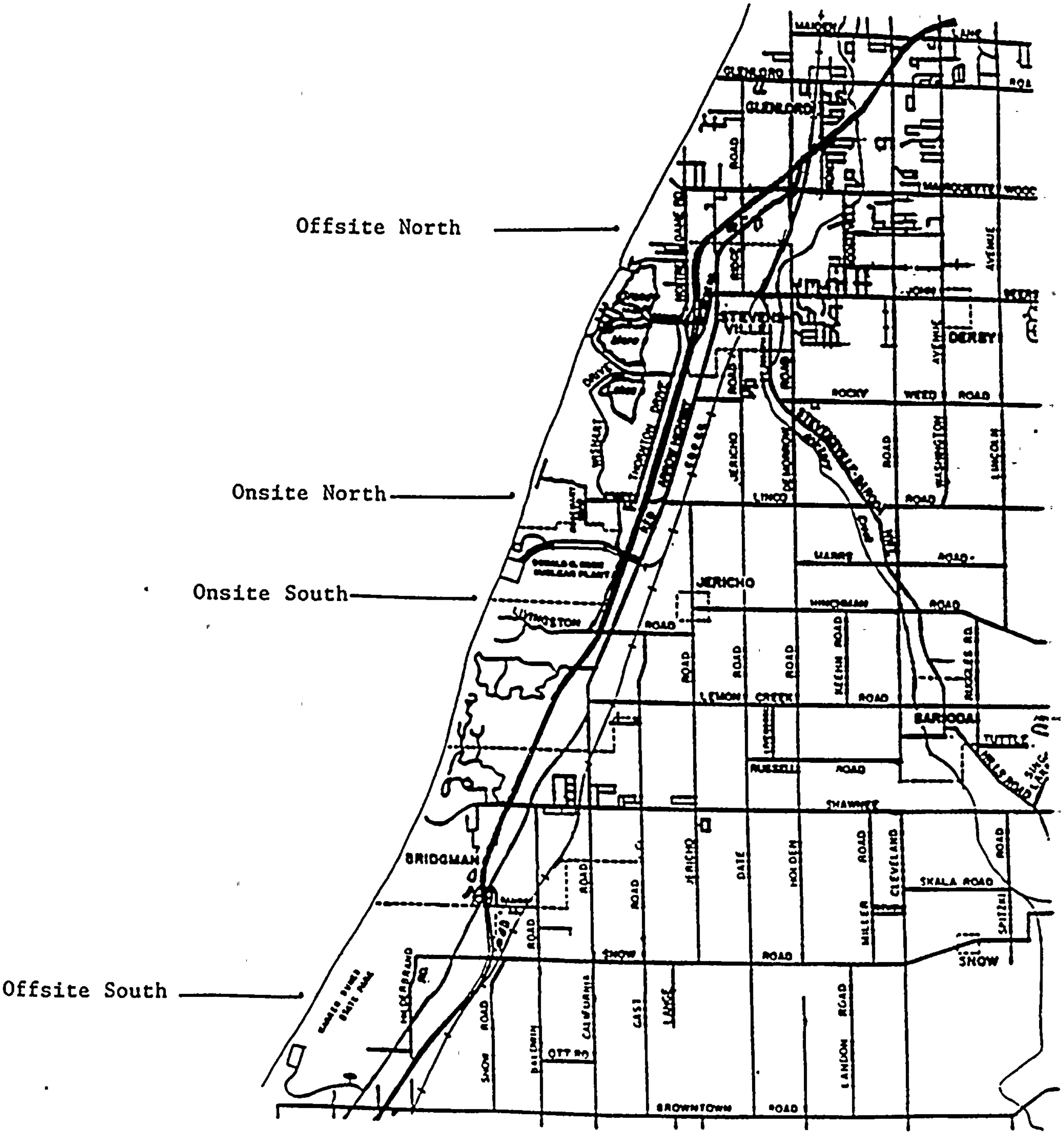


/cook/ul2 sitemaps/watmap.101
1-9-96 dls/rfz
this dwg is superceded by
/cook/ul2.sitemaps/berrien.100

FIGURE 3

SAMPLING LOCATIONS

FISH COLLECTED FOR RADIOLOGICAL ANALYSIS



III. SUMMARY AND DISCUSSION OF 1995 ANALYTICAL RESULTS

III. SUMMARY AND DISCUSSION OF 1995 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 1995 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.

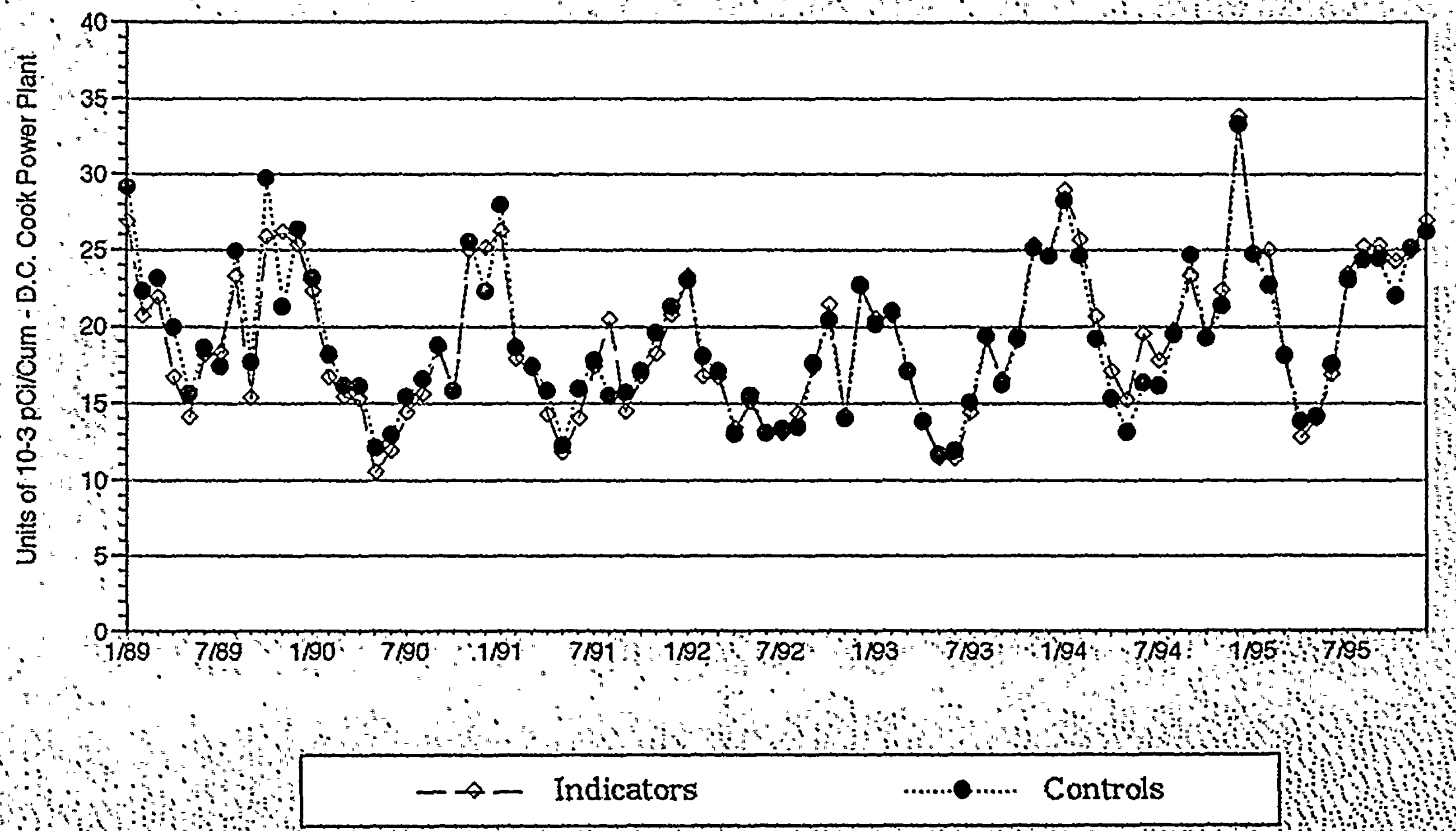
The following is a discussion and summary of the results of the environmental measurements performed during the reporting period. Comparison is made where possible with radioactivity concentrations measured in the preoperational period of August 1971 to the initial criticality of Unit 1 on January 12,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

A. Airborne Particulates

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

Trending Graph - 1

AVERAGE MONTHLY GROSS BETA IN AIR PARTICULATES



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 0.022 pCi/m^3 with a range of individual values between 0.010 and 0.057 pCi/m^3. The average gross beta concentration of the four control locations was 0.021 pCi/m^3 with a range between 0.010 and 0.047 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 1995 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. 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 0.123 pCi/m^3 and the values ranged from 0.086 to 0.163 pCi/m^3. The average concentration for the indicator locations was 0.124 pCi/m^3 with a range of 0.090 to 0.162 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 four of the twenty-four indicator quarterly composites with an average concentration of 0.011 pCi/m^3 and a range of 0.003 to 0.030 pCi/m^3. Potassium-40 was measured in four of the sixteen control quarterly composites with a concentration of 0.006 pCi/m^3 and a range of 0.003 to 0.011 pCi/m^3. No other gamma emitting radioactivity was detected.

B. Airborne Iodine

Airborne particulate samples are collected with a constant flow oil less pump at 56 LPM using a 47 mm particulate filter. 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.

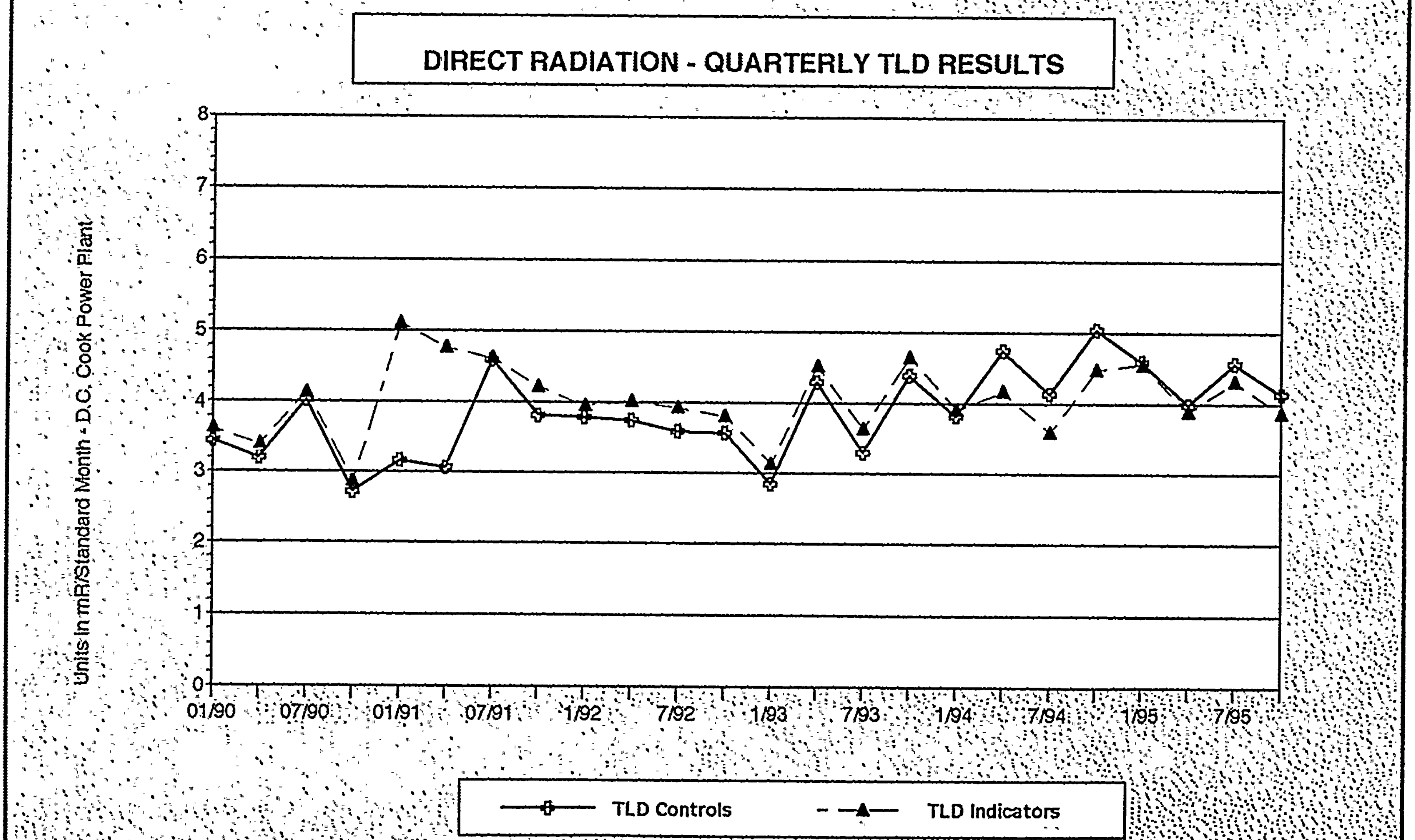
C. Direct Radiation - Thermoluminescent Dosimeters

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 4.33 mR/standard month with a range of 3.4 to 5.2 mR/standard month. The annual accumulation of indicator samples had a measurement of 4.17 mR/standard month with a range of 3.3 to 5.4 mR/standard month. The 1995 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-six samples were analyzed for iodine-131 by the radiochemical technique described on page 71. All results were less than the lower limit of detection of 1 pCi/l. The quarterly composite

Trending Graph - 2



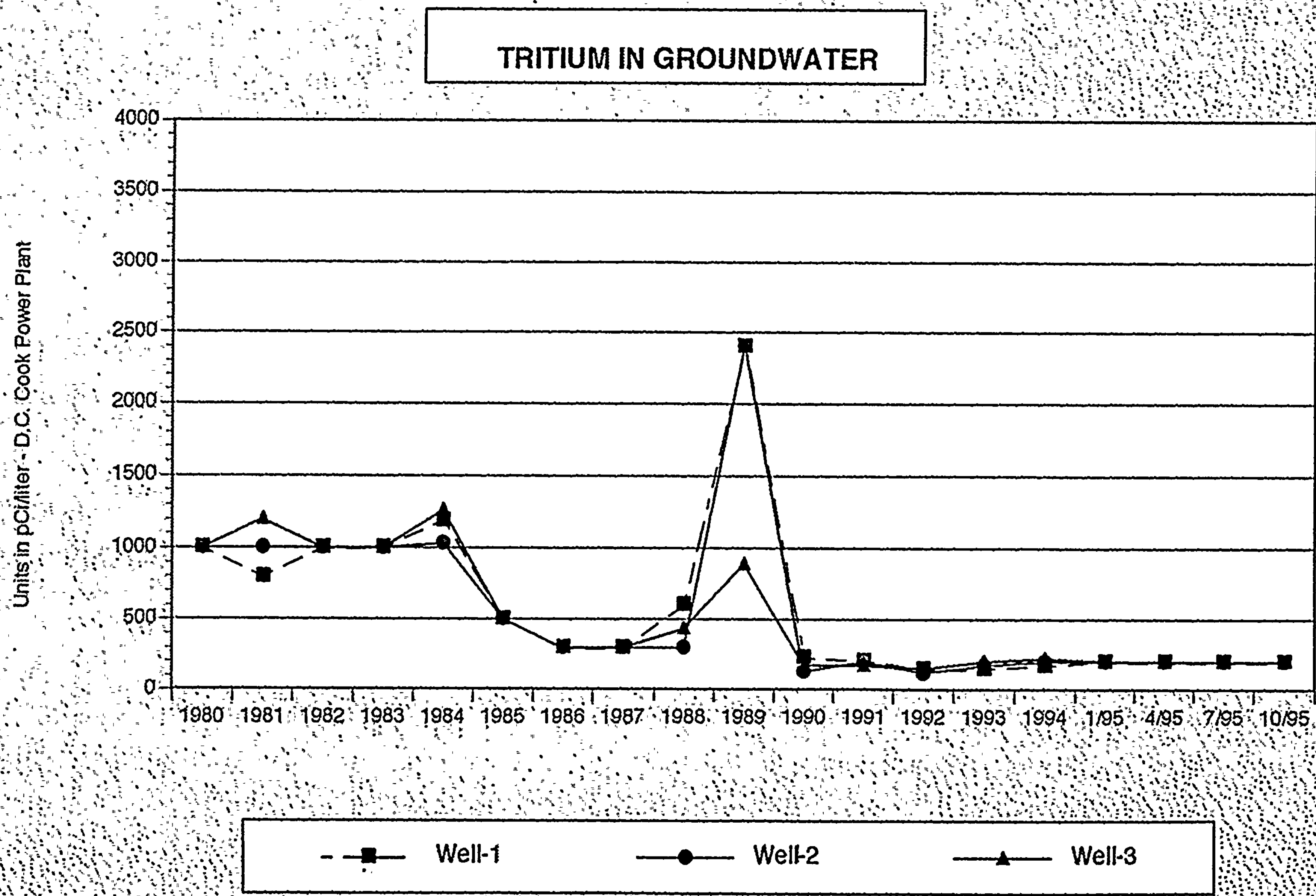
was analyzed for tritium by liquid scintillation method described on page 70. Tritium was detected in 3 of the 36 samples analyzed with an average concentration of 310 pCi/liter and a range of 220 to 370 pCi/liter. This is slightly higher than the 2 measurements in 1994 which had an average concentration of 185 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 1995. Naturally occurring gamma emitting isotopes were detected using gamma ray spectroscopy.

E. Groundwater

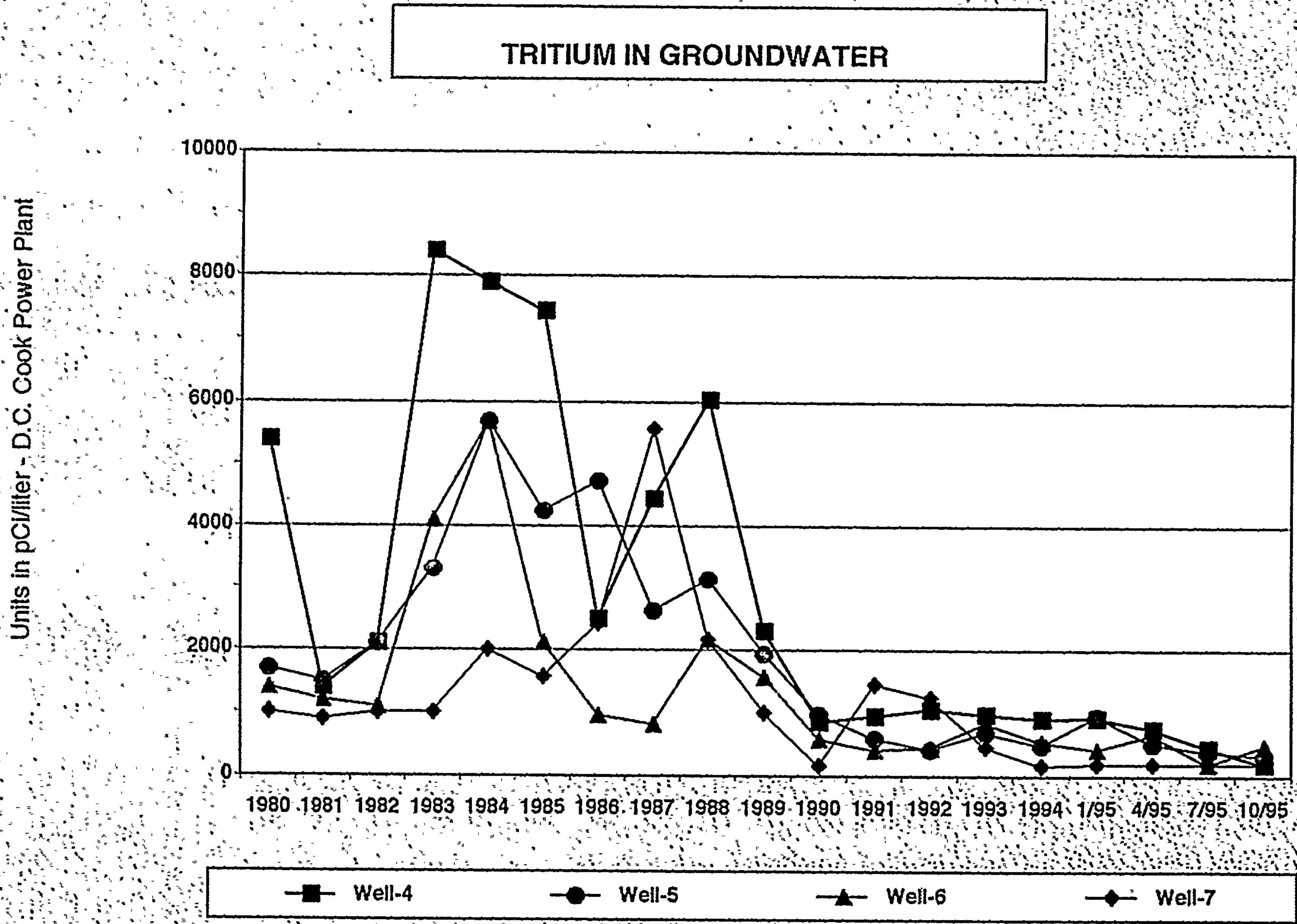
Water samples are collected quarterly from fourteen wells, all within 4300 feet of the reactors. First, a static water elevation is determined and three well bore volumes are purged from the well using a groundwater pump, or equivalent. A two liter sample is then obtained. The samples are analyzed for gamma emitters and tritium. The results are presented in Table B-6. Naturally occurring potassium-40 was measured during 1995 in one sample with an activity of 50.7 pCi/liter. There were no other gamma emitting isotopes measured. The groundwater wells W-4, W-5, W-6, W-11, W-12, W-13 and W-14 had measurable tritium activity throughout 1995. Tritium was measured in 16 of the 56 samples at the locations with an average concentration of 1105 pCi/liter and a range of 200 to 7000 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 1995 in Trending Graph 3.

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

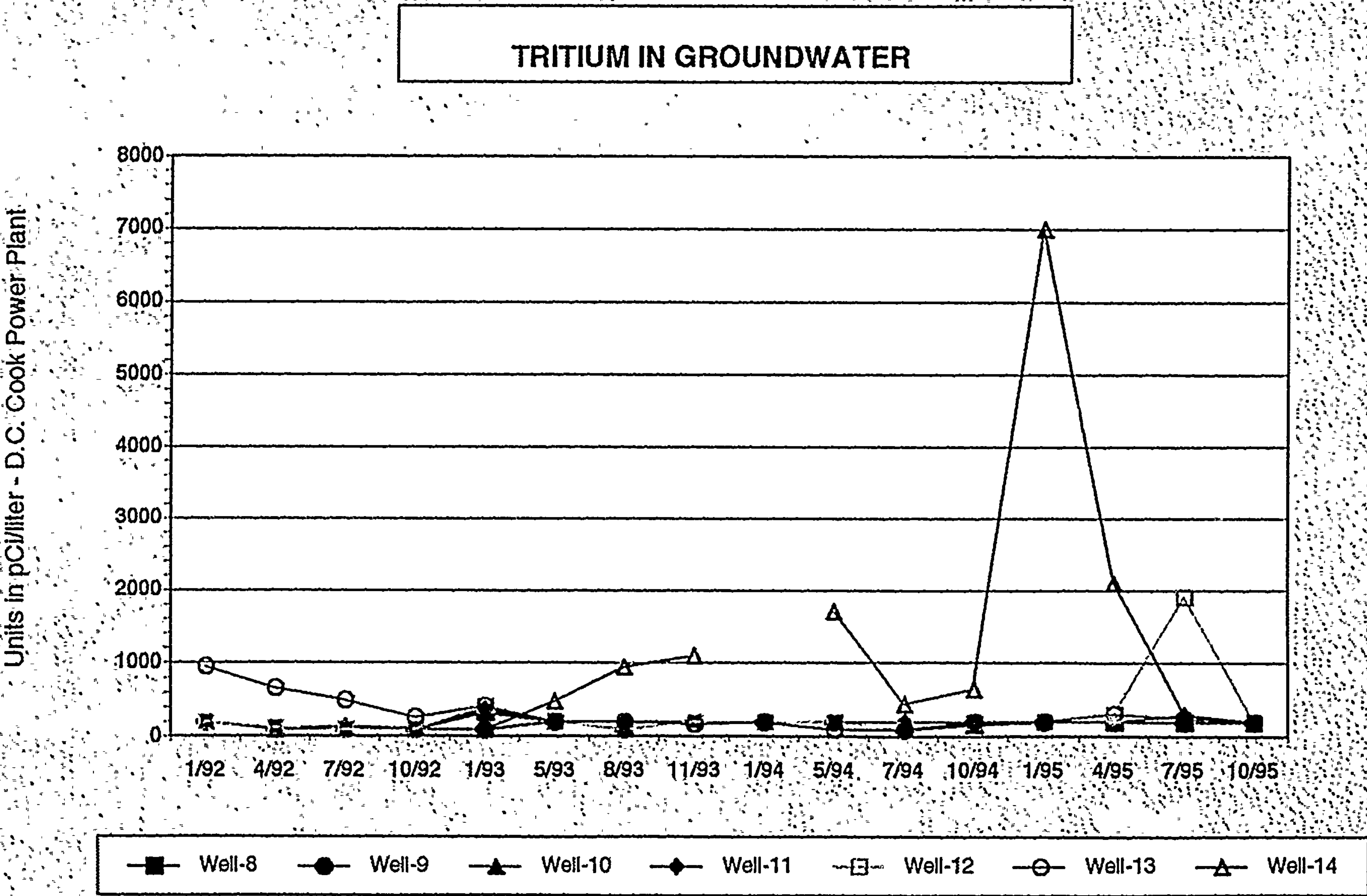
Trending Graph - 3



Trending Graph - 3 (Cont.)



Trending Graph - 3 (Cont.)



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

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.

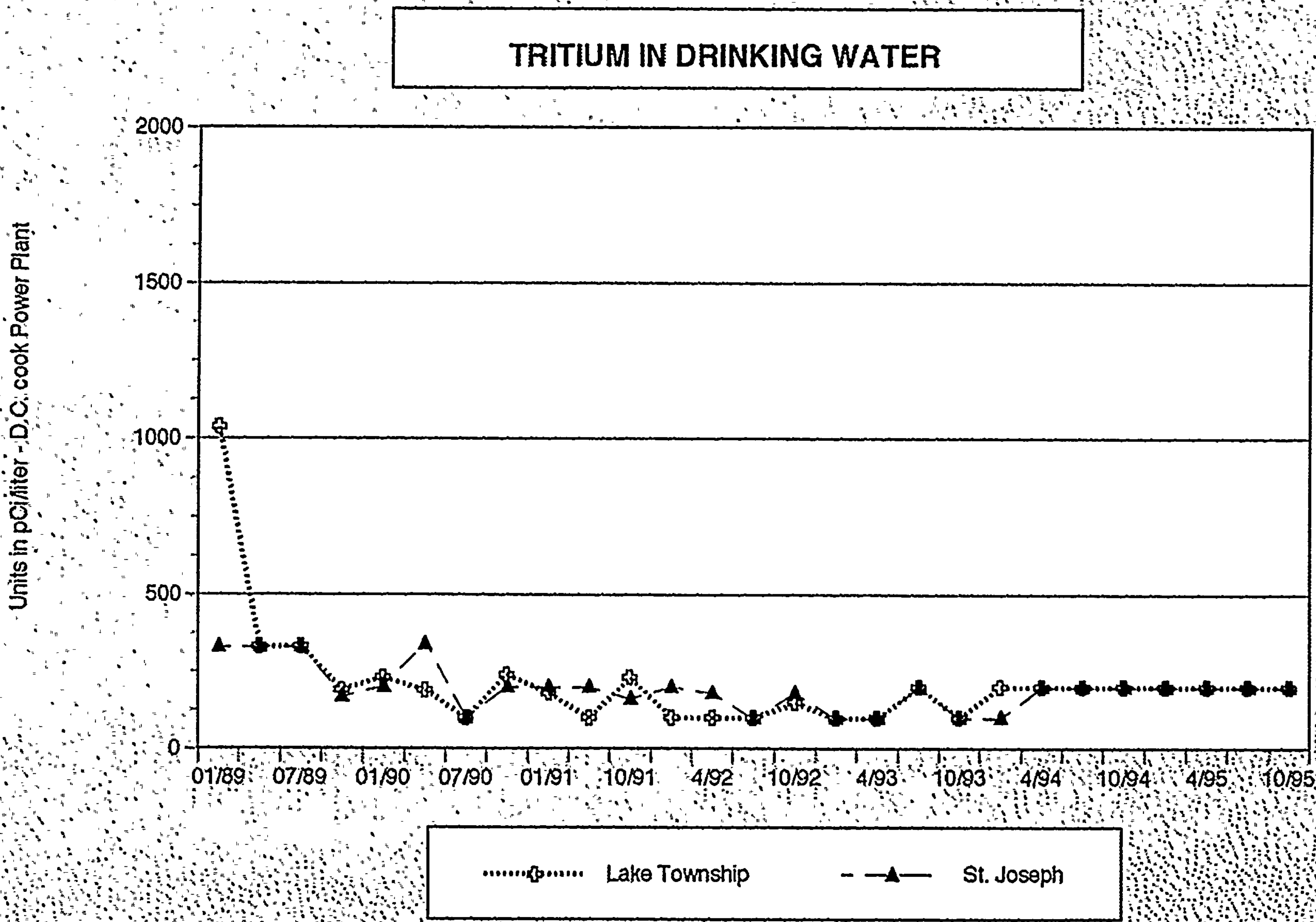
Gross beta activity was measured in all twenty-six samples from the Lake Township intake with an average concentration of 3.52 pCi/liter and a range from 2.1 to 7.6 pCi/liter. Gross beta activity was measured in all twenty-six samples from the St. Joseph intake with an average concentration of 3.48 pCi/liter and a range from 1.8 to 7.0 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, one sample was collected from location SL-2 and SL-3. Gamma ray spectroscopy detected naturally occurring potassium-40 in both samples. The average potassium-40 concentration was 3885 pCi/kg (dry weight) with a range from 3390 to 4380 pCi/kg (dry weight). Thorium-228, also naturally occurring was measured in both samples with an average concentration of 530 pCi/kg (dry weight) with a range from 502 to 557 pCi/kg (dry weight). Radium-226 was also measured in both samples with an average

Trending Graph - 4



activity of 684 pCi/kg and a range of 657 to 711 pCi/kg (dry weight). All other gamma emitters were below the lower limits of detection.

H. Milk

Milk samples of one gallon are collected from a bulk tank (e.g. 500 gallons) every fourteen days from six farms located between 4.1 miles and 20.7 miles from the site. Milk samples are preserved by adding 40 grams per gallon of sodium bisulfite when the samples are collected. The samples are analyzed for iodine-131 and other gamma emitters. The results are shown in Table B-9. Iodine-131 was not measured in any of the 137 samples analyzed.

During the preoperational period potassium-40 was measured in all samples with a range from 520 to 2310 pCi/liter, a range comparable to that in 1993. Iodine-131 was measured in four samples with concentrations between 0.2 and 0.9 pCi/liter. Cesium-137 was measured in numerous samples with concentrations between 7 and 64 pCi/liter.

During 1995 the average potassium-40 concentration for the control locations was 1352 pCi/liter with a range of 1170 to 1580 pCi/liter. The indicator locations had an average concentration of 1392 pCi/liter and a range of 1100 to 1940. There were no detections of iodine-131 during 1995. Cesium-137 was also not detected during 1995.

I. 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. Naturally occurring potassium-40 was measured in all samples with an average concentration of 3519 pCi/kg (wet weight) and a range of 2820 to 4500 pCi/kg (wet weight). Cesium-137 was measured in seven of the eight fish samples with an average

concentration of 30.5 pCi/kg (wet weight) and a range of 14.6 to 58.5 pCi/kg (wet weight).

J. 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. Naturally occurring potassium-40 was measured in all four samples with an average concentration of 2823 pCi/kg (wet weight) and a range of 1720 to 3900 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in two of the four samples with an average concentration of 1960 pCi/kg (wet weight) and a range of 1420 to 2500 pCi/kg (wet weight).

IV. CONCLUSIONS

IV. CONCLUSIONS

The results of the 1995 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 1995 appears 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 1995. No iodine-131 was detected in charcoal filters in 1995.

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 1995. 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 1995 was 7000 pCi/liter while the

highest concentration measured during 1994 was 1700 pCi/liter. The increased tritium concentration occurred during the first and second quarters and was attributed to draining a portion 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. Gamma emitting results were less than LLD and by the third quarter tritium results were less than the LLD of 2000 pCi/liter. Potassium-40, a naturally occurring nuclide was not observed during 1995. 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 1995.

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 collected every fourteen days from six farms up to a distance of 20.7 miles from the site. The samples were measured for iodine-131 and other gamma emitting isotopes. Although I-131 was measured during 1989 there were no measurements of iodine-131 in milk during 1995, 1994, 1993, 1992 or 1991. Potassium-40 was measured in all milk samples at normal background levels. Cesium-137 was not detected in 1995.

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 seven samples.

Food products, consisting of grapes, and broadleaf vegetation were collected and analyzed by gamma ray spectroscopy. No gamma emitting isotopes were measured during 1995.

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, 1995

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Iodine (pCi/m^3)	I-131	530	-(0/318) -			-(0/212) -	0
Airborne Particulates (1E-03 pCi/m^3)	Gross Beta (Weekly)	530	21.8(318/318) (9.9-57)	ONS-2 Onsite 2338 ft.	23.0(53/53) (11-51)	21.4(212/212) (10-47)	0
	Gamma	40					
	Be-7	40	124(24/24) (90-162)	SNB 26.2 mi SE	133(4/4) (96.1-163)	123(16/16) (85.8-163)	0
	K-40	40	10.9(4/24) (2.71-29.7)	ONS-5 Onsite 1895 ft.	29.7(1/4) -	6.06(4/16) (2.58-11.1)	0
Direct Radiation (mR/Standard Month)	Gamma Dose Quarterly	105	4.17(89/89) (3.3-54)	OFT-8 4.0 mi S	5.13(4/4) (4.8-5.4)	4.33(16/16) (3.4-5.2)	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, 1995

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/liter)	Gamma	36	(0/47) -	N/A		(0/0) -	0
	H-3	12	310(3/12) (220-370)	SWL-2 Intake	340(1/4) -	-(0/0) -	0
Groundwater (pCi/liter)	Gamma	56					
	K-40	56	50.7(1/56) -	Well 6 424 ft.	50.7(1/4) -	-(0/0) -	0
	Th-228	56	(0/56) -	N/A		-(0/0) -	0
	H-3	56	1105(16/56) (200-7000)	Well 14 1780 ft.	4550(2/4) (2100-7000)	-(0/0) -	0
Drinking Water (pCi/liter)	Gross Beta	52	3.50(52/52) (1.8-7.6)	LTW 0.4 mi S	3.52(26/26) (2.1-7.6)	-(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, 1995

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Sediment (pCi/kg dry)	Gamma	2					
	K-40	2	3885(2/2) (3390-4380)	SL-2 0.3 mi S	4380(1/1) -	-(0/0) -	0
	Cs-137	2	43.4(1/2) -	SL-3 0.2 mi N	43.4(1/2) -	-(0/0) -	0
	Ra-226	2	684(2/2) (657-711)	SL-2 0.3 mi S	711(1/2) -	-(0/0) -	0
	Th-228	2	530(2/2) (502-557)	SL-2 0.3 mi S	557(1/1) -	-(0/0) -	0
Milk (pCi/liter)	Gamma	137					
	K-40	137	1392(85/85) (1100-1940)	Freehling 7.0 mi SE	1406(26/26) (1270-1540)	1352(52/52) (1170-1580)	0
	I-131	137	-(0/85) -	N/A	N/A	-(0/52) -	0
	Cs-137	137	-(0/85) -	N/A	N/A	-(0/52) -	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, 1995

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	8					
	K-40	8	3519(8/8) (2820-4500)	OFS-South 5.0 mi S	3660(2/2) (2820-4500)	-(0/0) -	0
	Cs-137	8	30.5(7/8) (14.6-58.5)	OFS-South 5.0 mi S	53.5(2/2) (48.4-58.5)	-(0/0) -	0
Food/Vegetation (pCi/kg wet)	Gamma	4					
	Be-7	4	1960(2/4) (1420-2500)	ONS-V Variable	2500(1/1) -	-(0/0) -	0
	K-40	4	2823(4/4) (1720-3900)	ONS-V Variable	3900(1/1) -	-(0/0) -	0
	Cs-137	4	-(0/0) -	N/A	N/A	-(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	Average ± 2 s.d.
JANUARY 95											
01/09/95	29 ± 2	34 ± 3	24 ± 2	30 ± 2	29 ± 2	26 ± 2	27 ± 2	35 ± 2	32 ± 2	30 ± 2	30 ± 7
01/16/95	27 ± 2	35 ± 3	23 ± 2	27 ± 2	30 ± 3	26 ± 2	24 ± 2	26 ± 2	26 ± 2	32 ± 2	28 ± 7
01/23/95	18 ± 2	22 ± 2	13 ± 2	15 ± 2	16 ± 2	15 ± 2	17 ± 2	17 ± 2	15 ± 2	16 ± 2	16 ± 5
01/30/95	19 ± 2	20 ± 2	15 ± 2	17 ± 2	23 ± 2	17 ± 2	18 ± 2	23 ± 2	18 ± 2	22 ± 3	19 ± 6
FEBRUARY											
02/06/95	31 ± 2	36 ± 3	26 ± 2	29 ± 2	38 ± 2	30 ± 2	25 ± 2	31 ± 2	29 ± 2	31 ± 2	31 ± 8
02/13/95	24 ± 2	29 ± 2	17 ± 2	28 ± 2	34 ± 3	25 ± 2	25 ± 2	29 ± 2	27 ± 2	24 ± 2	26 ± 9
02/20/95	30 ± 2	32 ± 3	21 ± 2	28 ± 2	37 ± 3	31 ± 3	26 ± 2	22 ± 2	25 ± 2	31 ± 2	28 ± 10
02/27/95	23 ± 2	23 ± 2	15 ± 2	17 ± 2	26 ± 2	23 ± 2	17 ± 2	17 ± 2	18 ± 2	18 ± 2	20 ± 7
MARCH											
03/06/95	23 ± 2	23 ± 2	19 ± 2	22 ± 2	29 ± 3	20 ± 2	22 ± 2	21 ± 2	19 ± 2	22 ± 2	22 ± 6
03/13/95	20 ± 2	24 ± 2	19 ± 2	22 ± 2	21 ± 2	22 ± 2	23 ± 2	24 ± 2	23 ± 2	21 ± 2	22 ± 3
03/20/95	19 ± 2	21 ± 2	21 ± 2	20 ± 2	21 ± 2	19 ± 2	14 ± 2	19 ± 2	20 ± 2	20 ± 2	19 ± 4
03/27/95	11 ± 2	15 ± 2	12 ± 2	12 ± 2	10 ± 2	13 ± 2	14 ± 2	14 ± 2	10 ± 2	12 ± 2	12 ± 3
04/03/95	18 ± 2	21 ± 2	16 ± 2	21 ± 2	16 ± 2	18 ± 2	18 ± 2	18 ± 2	16 ± 2	17 ± 2	18 ± 4
Quarter Avg.	**22 ± 12**	**26 ± 13**	**19 ± 9**	**22 ± 12**	**25 ± 17**	**22 ± 11**	**21 ± 9**	**23 ± 12**	**21 ± 13**	**23 ± 13**	**22 ± 4**

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	Average ± 2 s.d.
APRIL											
04/10/95	19 ± 2	20 ± 2	20 ± 2	15 ± 2	17 ± 2	18 ± 2	20 ± 2	21 ± 2	19 ± 2	19 ± 2	19 ± 3
04/17/95	14 ± 2	14 ± 2	16 ± 2	13 ± 2	12 ± 2	15 ± 2	16 ± 2	17 ± 2	14 ± 2	14 ± 2	15 ± 3
04/24/95	12 ± 2	14 ± 2	11 ± 2	11 ± 2	9.9 ± 1.7	14 ± 2	16 ± 2	13 ± 2	11 ± 2	13 ± 2	13 ± 4
05/01/95	14 ± 2	13 ± 2	13 ± 2	12 ± 2	14 ± 2	13 ± 2	13 ± 2	14 ± 2	13 ± 2	13 ± 2	13 ± 1
MAY											
05/08/95	12 ± 2	13 ± 2	13 ± 2	11 ± 2	11 ± 2	13 ± 2	14 ± 2	14 ± 2	11 ± 2	15 ± 2	13 ± 4
05/15/95	12 ± 2	17 ± 2	15 ± 2	14 ± 2	12 ± 2	15 ± 2	15 ± 2	17 ± 2	14 ± 2	15 ± 2	15 ± 3
05/22/95	14 ± 2	13 ± 2	12 ± 2	13 ± 2	13 ± 2	12 ± 2	12 ± 2	14 ± 2	12 ± 2	12 ± 2	13 ± 2
05/29/95	13 ± 2	11 ± 2	12 ± 2	11 ± 2	13 ± 2	11 ± 2	11 ± 2	13 ± 2	10 ± 2	12 ± 2	12 ± 2
JUNE											
06/05/95	18 ± 2	19 ± 2	17 ± 2	11 ± 2	19 ± 2	19 ± 2	18 ± 2	17 ± 2	15 ± 2	19 ± 2	17 ± 5
06/12/95	13 ± 2	13 ± 2	11 ± 2	11 ± 2	13 ± 2	10 ± 2	13 ± 2	14 ± 2	12 ± 2	12 ± 2	12 ± 3
06/19/95	23 ± 2	23 ± 2	24 ± 2	22 ± 2	24 ± 2	20 ± 2	16 ± 2	24 ± 2	22 ± 2	25 ± 2	22 ± 5
06/26/95	20 ± 2	25 ± 2	23 ± 2	22 ± 2	24 ± 2	21 ± 2	25 ± 2	28 ± 2	23 ± 2	25 ± 2	24 ± 5
07/03/95	13 ± 2	15 ± 2	11 ± 2	13 ± 2	12 ± 2	11 ± 2	13 ± 2	14 ± 2	12 ± 2	14 ± 2	13 ± 3
Quarterly Avg.	15 ± 7	16 ± 9	15 ± 9	14 ± 8	15 ± 9	15 ± 7	16 ± 8	17 ± 9	14 ± 8	16 ± 9	15 ± 2

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	Average ± 2 s.d.
JULY											
07/10/95	15 ± 2	18 ± 2	15 ± 2	14 ± 2	12 ± 2	15 ± 2	17 ± 2	14 ± 2	13 ± 2	14 ± 2	15 ± 4
07/17/95	37 ± 3	34 ± 2	34 ± 3	31 ± 2	31 ± 2	31 ± 2	32 ± 2	29 ± 2	30 ± 2	32 ± 2	32 ± 5
07/24/95	21 ± 2	20 ± 2	18 ± 2	18 ± 2	19 ± 2	18 ± 2	19 ± 2	24 ± 2	16 ± 2	19 ± 2	19 ± 4
07/31/95	25 ± 2	28 ± 2	22 ± 2	23 ± 2	23 ± 2	22 ± 2	24 ± 2	27 ± 2	25 ± 2	24 ± 2	24 ± 4
AUGUST											
08/07/95	17 ± 2	17 ± 2	17 ± 2	48 ± 6 (a)	17 ± 2	15 ± 2	16 ± 2	19 ± 2	16 ± 2	16 ± 2	17 ± 2
08/14/95	29 ± 2	29 ± 3	28 ± 2	27 ± 2	27 ± 2	24 ± 2	26 ± 2	26 ± 2	24 ± 2	29 ± 2	27 ± 4
08/21/95	20 ± 2	22 ± 2	19 ± 2	21 ± 2	23 ± 8 (b)	16 ± 2	19 ± 2	19 ± 2	18 ± 2	18 ± 2	20 ± 4
08/28/95	22 ± 2	20 ± 2	20 ± 2	22 ± 2	20 ± 2	22 ± 2	24 ± 2	22 ± 2	20 ± 2	19 ± 2	21 ± 3
09/04/95	38 ± 3	31 ± 3	28 ± 2	33 ± 2	29 ± 2	34 ± 3	30 ± 3	32 ± 3	30 ± 3	32 ± 3	32 ± 6
SEPTEMBER											
09/11/95	27 ± 2	27 ± 2	25 ± 2	25 ± 2	27 ± 2	21 ± 2	27 ± 2	25 ± 2	22 ± 2	24 ± 2	25 ± 4
09/18/95	22 ± 2	22 ± 2	20 ± 2	24 ± 2	21 ± 2	18 ± 2	23 ± 2	22 ± 2	20 ± 2	22 ± 2	21 ± 3
09/25/95	13 ± 2	13 ± 2	13 ± 2	13 ± 2	13 ± 2	11 ± 2	13 ± 2	15 ± 2	12 ± 2	11 ± 2	13 ± 2
10/02/95	54 ± 3	51 ± 3	46 ± 3	55 ± 3	49 ± 3	40 ± 3	47 ± 3	43 ± 3	41 ± 3	47 ± 3	47 ± 10
Quarterly Avg.	26 ± 23	26 ± 20	23 ± 18	26 ± 22	24 ± 19	22 ± 17	24 ± 18	24 ± 15	22 ± 16	24 ± 19	24 ± 18

(a) Equipment malfunction; low sample volume and not included in averages.
(b) Power off; low sample volume.

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	Average ± 2 s.d.
OCTOBER											
10/09/95	19 ± 2	18 ± 2	18 ± 2	18 ± 2	19 ± 2	17 ± 2	18 ± 2	18 ± 2	21 ± 2	17 ± 2	18 ± 2
10/16/95	38 ± 3	37 ± 3	34 ± 3	57 ± 4	35 ± 3	32 ± 3	31 ± 2	34 ± 3	31 ± 2	34 ± 3	36 ± 15
10/23/95	20 ± 2	23 ± 2	16 ± 2	17 ± 2	19 ± 2	22 ± 3	19 ± 2	18 ± 2	20 ± 2	17 ± 2	19 ± 5
10/30/95	16 ± 2	22 ± 2	17 ± 2	18 ± 2	20 ± 2	18 ± 2	17 ± 2	18 ± 2	17 ± 2	17 ± 2	18 ± 4
NOVEMBER											
11/06/95	21 ± 2	18 ± 2	20 ± 2	20 ± 2	21 ± 2	20 ± 2	21 ± 2	22 ± 2	17 ± 2	18 ± 2	20 ± 3
11/13/95	26 ± 2	21 ± 2	23 ± 2	20 ± 2	22 ± 2	23 ± 2	23 ± 2	23 ± 2	23 ± 2	25 ± 2	23 ± 3
11/20/95	24 ± 2	23 ± 2	21 ± 2	25 ± 2	24 ± 2	22 ± 2	24 ± 2	26 ± 2	20 ± 2	21 ± 2	23 ± 4
11/27/95	34 ± 2	29 ± 2	29 ± 2	32 ± 2	30 ± 2	29 ± 2	31 ± 2	31 ± 2	28 ± 2	28 ± 2	30 ± 4
12/04/95	25 ± 2	30 ± 3	25 ± 2	25 ± 2	25 ± 2	23 ± 2	25 ± 2	26 ± 2	23 ± 2	24 ± 2	25 ± 4
DECEMBER											
12/11/95	24 ± 2	21 ± 2	20 ± 2	21 ± 2	27 ± 2	24 ± 2	25 ± 2	26 ± 2	25 ± 2	24 ± 2	24 ± 5
12/18/95	48 ± 3	37 ± 3	42 ± 3	38 ± 3	41 ± 3	41 ± 3	43 ± 3	39 ± 3	41 ± 3	47 ± 3	42 ± 7
12/21/95	29 ± 5	24 ± 4	25 ± 5	21 ± 4	29 ± 5	21 ± 4	21 ± 4	29 ± 4	15 ± 3	22 ± 4	24 ± 9
12/27/95	19 ± 2	17 ± 2	17 ± 2	18 ± 2	18 ± 3	16 ± 2	13 ± 2	18 ± 2	12 ± 2	18 ± 2	16 ± 7
01/01/96	27 ± 3	22 ± 3	22 ± 3	25 ± 3	23 ± 3	26 ± 3	20 ± 3	27 ± 3	27 ± 3	26 ± 3	25 ± 5
Quarter Avg.	**26 ± 17**	**24 ± 13**	**24 ± 15**	**25 ± 22**	**25 ± 13**	**24 ± 13**	**24 ± 15**	**25 ± 13**	**23 ± 15**	**24 ± 16**	**24 ± 15**
Annual Avg.	**23 ± 18**	**23 ± 16**	**20 ± 15**	**22 ± 19**	**22 ± 17**	**21 ± 14**	**21 ± 14**	**22 ± 14**	**20 ± 15**	**22 ± 16**	**22 ± 16**

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 01/02/95-04/03/95	Second Quarter 04/03/95-07/03/95	Third Quarter 07/03/95-10/02/95	Fourth Quarter 10/02/95-01/01/96	Average ±2 s.d.
ONS-1	Be-7	125 ± 13	117 ± 12	146 ± 15	108 ± 11	124 ± 32
	K-40	< 5	< 5	< 7	5.10 ± 1.87	5.10 ± 1.87
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-
ONS-2	Be-7	151 ± 15	115 ± 12	149 ± 15	103 ± 10	130 ± 48
	K-40	< 6	6.00 ± 2.02	< 7	< 10	6.00 ± 2.02
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.3	-
ONS-3	Be-7	121 ± 12	92.6 ± 9.3	136 ± 14	96.9 ± 9.7	112 ± 41
	K-40	< 10	< 10	< 7	< 8	-
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
ONS-4	Be-7	150 ± 15	106 ± 11	162 ± 16	107 ± 11	131 ± 58
	K-40	< 4	< 3	< 8	< 6	-
	Cs-134	< 0.2	< 0.2	< 0.4	< 0.3	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.2	-
ONS-5	Be-7	141 ± 14	97.7 ± 9.8	153 ± 15	91.6 ± 9.2	121 ± 61
	K-40	< 4	29.7 ± 3.4	< 7	< 7	29.7 ± 3.4
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 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 01/02/95-04/03/95	Second Quarter 04/03/95-07/03/95	Third Quarter 07/03/95-10/02/95	Fourth Quarter 10/02/95-01/01/96	Average ±2 s.d.
ONS-6	Be-7	162 ± 16	122 ± 12	141 ± 14	90.0 ± 9.0	129 ± 61
	K-40	2.71 ± 1.54	< 5	< 7	< 4	2.71 ± 1.54
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
NBF	Be-7	141 ± 14	108 ± 11	163 ± 16	85.8 ± 8.6	124 ± 69
	K-40	< 5	< 5	< 7	< 4	-
	Cs-134	< 0.2	< 0.3	< 0.2	< 0.2	-
	Cs-137	< 0.2	< 0.2	< 0.2	< 0.2	-
SBN	Be-7	161 ± 16	111 ± 11	163 ± 16	96.1 ± 9.6	133 ± 69
	K-40	5.87 ± 2.82	< 6	< 8	2.58 ± 1.41	4.23 ± 4.65
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.2	-
DOW	Be-7	120 ± 12	95.8 ± 9.6	146 ± 15	92.1 ± 9.2	113 ± 50
	K-40	< 9	< 9	< 6	4.68 ± 2.28	4.68 ± 2.28
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
COL	Be-7	126 ± 13	110 ± 11	146 ± 15	95.4 ± 9.5	119 ± 43
	K-40	< 4	< 5	< 7	11.1 ± 2.6	11.1 ± 2.6
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-

* 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 95										
01/09/95	< 10	< 10	< 10	< 10	< 6	< 10	< 8	< 10	< 10	< 10
01/16/95	< 20	< 20	< 20	< 20	< 10	< 20	< 10	< 20	< 20	< 20
01/23/95	< 20	< 20	< 20	< 20	< 20	< 7	< 10	< 20	< 10	< 10
01/30/95	< 20	< 20	< 20	< 10	< 8	< 20	< 9	< 10	< 10	< 30
FEBRUARY										
02/06/95	< 20	< 20	< 10	< 20	< 8	< 20	< 10	< 20	< 20	< 20
02/13/95	< 20	< 20	< 20	< 20	< 7	< 20	< 9	< 20	< 20	< 20
02/20/95	< 20	< 20	< 20	< 20	< 7	< 10	< 7	< 10	< 10	< 10
02/27/95	< 10	< 10	< 10	< 10	< 9	< 20	< 10	< 20	< 20	< 20
MARCH										
03/06/95	< 10	< 10	< 10	< 10	< 7	< 20	< 10	< 20	< 20	< 20
03/13/95	< 20	< 20	< 20	< 10	< 7	< 10	< 10	< 10	< 10	< 9
03/20/95	< 20	< 20	< 10	< 20	< 7	< 20	< 20	< 20	< 20	< 10
03/27/95	< 20	< 20	< 20	< 20	< 8	< 10	< 10	< 10	< 10	< 8
04/03/95	< 20	< 20	< 20	< 20	< 8	< 10	< 10	< 10	< 10	< 8

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

	STATION CODES									
COLLECTION DATES	ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
APRIL										
04/10/95	< 20	< 20	< 20	< 20	< 7	< 20	< 10	< 10	< 10	< 9
04/17/95	< 10	< 10	< 10	< 10	< 6	< 10	< 10	< 10	< 10	< 9
04/24/95	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10
05/01/95	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10
MAY										
05/08/95	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10
05/15/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 8
05/22/95	< 20	< 20	< 20	< 10	< 9	< 20	< 20	< 20	< 20	< 7
05/29/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 9
JUNE										
06/05/95	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10
06/12/95	< 20	< 20	< 20	< 10	< 9	< 20	< 20	< 20	< 20	< 10
06/19/95	< 10	< 10	< 10	< 10	< 9	< 20	< 20	< 20	< 20	< 10
06/26/95	< 10	< 10	< 10	< 10	< 8	< 10	< 10	< 10	< 10	< 9
07/03/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 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

	STATION CODES									
COLLECTION DATES	**ONS-1**	**ONS-2**	**ONS-3**	**ONS-4**	**ONS-5**	**ONS-6**	**NBF**	**SBN**	**DOW**	**COL**
JULY										
07/10/95	< 20	< 20	< 20	< 10	< 9	< 20	< 20	< 20	< 20	< 10
07/17/95	< 20	< 20	< 20	< 20	< 10	< 20	< 10	< 10	< 10	< 10
07/24/95	< 20	< 20	< 20	< 10	< 7	< 10	< 10	< 10	< 10	< 8
07/31/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 10
AUGUST										
08/07/95	< 10	< 10	< 10	< 50 (a)	< 9	< 20	< 20	< 20	< 20	< 10
08/14/95	< 20	< 20	< 20	< 10	< 10	< 20	< 20	< 20	< 20	< 10
08/21/95	< 10	< 10	< 10	< 20	< 50 (b)	< 9	< 10	< 10	< 10	< 7
08/28/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 9
09/04/95	< 10	< 10	< 10	< 10	< 9	< 20	< 20	< 20	< 20	< 10
SEPTEMBER										
09/11/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 8
09/18/95	< 10	< 10	< 10	< 10	< 9	< 9	< 10	< 10	< 10	< 8
09/25/95	< 20	< 20	< 20	< 20	< 10	< 10	< 20	< 20	< 20	< 7
10/02/95	< 20	< 20	< 20	< 20	< 8	< 10	< 20	< 20	< 20	< 10

(a) Equipment malfunction; low sample volume.
(b) Power off; low sample volume.

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

	STATION CODES									
COLLECTION DATES	ONS-1	ONS-2	ONS-3	ONS-4	ONS-5	ONS-6	NBF	SBN	DOW	COL
OCTOBER										
10/09/95	< 10	< 10	< 10	< 10	< 8	< 10	< 10	< 10	< 10	< 8
10/16/95	< 20	< 20	< 20	< 30	< 10	< 10	< 10	< 10	< 10	< 10
10/23/95	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10
10/30/95	< 20	< 20	< 20	< 20	< 7	< 10	< 20	< 20	< 20	< 10
NOVEMBER										
11/06/95	< 10	< 10	< 10	< 9	< 7	< 10	< 10	< 10	< 10	< 8
11/13/95	< 10	< 9	< 10	< 9	< 7	< 20	< 20	< 20	< 20	< 8
11/20/95	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 8	< 10	< 10
11/27/95	< 20	< 10	< 20	< 10	< 7	< 10	< 10	< 20	< 10	< 9
12/04/95	< 10	< 10	< 10	< 10	< 7	< 10	< 10	< 10	< 10	< 7
DECEMBER										
12/11/95	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 9
12/18/95	< 20	< 20	< 20	< 20	< 7	< 10	< 20	< 20	< 10	< 10
12/21/95	< 30	< 30	< 30	< 30	< 20	< 30	< 20	< 20	< 20	< 20
12/27/95	< 20	< 10	< 20	< 20	< 10	< 20	< 30	< 20	< 20	< 20
01/01/96	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 10

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 01/08/95-04/02/95	SECOND QUARTER 04/02/95-07/02/95	THIRD QUARTER 07/02/95-10/01/95	FOURTH QUARTER 10/01/95-01/01/96	AVERAGE ± 2 s.d.
A-1	4.2 ± 0.2	4.0 ± 0.8	3.9 ± 0.5	3.6 ± 0.4	3.9 ± 0.5
A-2	4.6 ± 0.4	3.9 ± 0.2	4.0 ± 0.3	3.8 ± 0.2	4.1 ± 0.7
A-3	3.8 ± 0.3	3.4 ± 0.1	3.5 ± 0.4	3.4 ± 0.2	3.5 ± 0.4
A-4	4.8 ± 0.3	3.8 ± 0.3	4.1 ± 0.4	3.9 ± 0.4	4.2 ± 0.9
A-5	4.5 ± 0.4	3.7 ± 0.2	4.0 ± 0.4	3.7 ± 0.2	4.0 ± 0.8
A-6	4.2 ± 0.5	3.7 ± 0.1	4.2 ± 0.4	3.6 ± 0.3	3.9 ± 0.6
A-7	4.5 ± 0.2	3.7 ± 0.4	4.1 ± 0.4	3.7 ± 0.3	4.0 ± 0.8
A-8	4.6 ± 0.6	3.8 ± 0.3	4.1 ± 1.4	3.7 ± 0.3	4.1 ± 0.8
A-9	4.4 ± 0.3	4.0 ± 0.2	4.2 ± 0.5	3.8 ± 0.4	4.1 ± 0.5
A-10	4.1 ± 0.2	3.3 ± 0.2	3.6 ± 0.6	3.4 ± 0.1	3.6 ± 0.7
A-11	4.4 ± 0.8	3.8 ± 0.2	4.4 ± 0.3	3.7 ± 0.5	4.1 ± 0.8
A-12	4.8 ± 0.4	4.0 ± 0.3	4.6 ± 0.2	3.8 ± 0.5	4.3 ± 1.0
OFS-1	4.2 ± 0.3	3.6 ± 0.2	4.1 ± 0.1	3.5 ± 0.2	3.9 ± 0.7
OFS-2	4.2 ± 0.6	3.6 ± 0.3	4.2 ± 0.3	3.9 ± 0.4	4.0 ± 0.6
OFS-3	4.4 ± 0.4	3.9 ± 0.1	4.3 ± 0.3	4.2 ± 0.3	4.2 ± 0.4
OFS-4	4.6 ± 0.4	3.9 ± 0.2	(a)	3.8 ± 0.7	4.1 ± 0.9
OFS-5	4.9 ± 0.3	4.0 ± 0.2	4.5 ± 0.9	4.1 ± 0.8	4.4 ± 0.8
OFS-6	5.2 ± 0.4	4.6 ± 0.3	5.3 ± 1.0	5.0 ± 0.7	5.0 ± 0.6
OFS-7	4.5 ± 0.3	3.7 ± 0.2	4.4 ± 0.4	3.5 ± 0.1	4.0 ± 1.0
OFS-8	5.4 ± 0.6	4.8 ± 0.2	5.2 ± 0.9	5.1 ± 0.4	5.1 ± 0.5
OFS-9	4.7 ± 0.5	4.2 ± 0.2	4.9 ± 0.8	4.4 ± 0.4	4.6 ± 0.6
OFS-10	4.5 ± 0.2	(a)	4.3 ± 0.4	3.6 ± 1.0	4.1 ± 0.9
OFS-11	5.3 ± 0.6	4.5 ± 0.5	5.4 ± 0.6	(a)	5.1 ± 1.0
NBF	4.7 ± 0.5	4.2 ± 0.2	4.8 ± 0.2	4.4 ± 0.1	4.5 ± 0.6
SBN	4.8 ± 0.3 (b)	4.9 ± 0.6	5.2 ± 0.8	4.9 ± 0.5	5.0 ± 0.3
DOW	4.6 ± 0.4	3.5 ± 0.2	4.1 ± 0.3	3.7 ± 0.5	4.0 ± 1.0
COL	4.3 ± 0.5	3.4 ± 0.2	4.2 ± 0.3	3.6 ± 0.2	3.9 ± 0.9
Average ± 2 s.d.	**4.6 ± 0.7**	**3.9 ± 0.8**	**4.4 ± 1.0**	**3.9 ± 1.0**	**4.2 ± 1.0**

(a) TLD missing.
(b) Collection dates 02/27/95-04/02/95. Original TLD was missing and replaced 02/27/95.
* Standard month = 30.4 days.

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	01/31/95	< 0.2	< 60	< 200
(Condenser Circ.)	02/28/95	< 0.08	< 50	
	03/31/95	< 0.3	< 50	
	04/30/95	< 0.3	< 60	< 200
	05/31/95	< 0.3	< 50	
	06/30/95	< 1	< 100	
	07/31/95	< 0.2	< 50	370 ± 130
	08/31/95	< 0.3	< 80	
	09/30/95	< 0.7	< 60	
	10/31/95	< 0.2	< 60	220 ± 120
	11/30/95	< 1	< 50	
	12/31/95	< 0.3	< 100	
SWL-2	01/31/95	< 0.2	< 100	< 200
(South Comp)	02/28/95	< 0.3	< 100	
	03/31/95	< 0.6	< 70	
	04/30/95	< 0.3	< 70	< 200
	05/31/95	< 0.2	< 90	
	06/30/95	< 0.9	< 50	
	07/31/95	< 0.1	< 90	340 ± 130
	08/31/95	< 0.4	< 60	
	09/30/95	< 0.8	< 100	
	10/31/95	< 0.2	< 50	< 200
	11/30/95	< 1	< 90	
	12/31/95	< 0.7	< 50	

* 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	01/31/95	< 0.2	< 50	< 200
(North Comp)	02/28/95	< 0.2	< 200	
	03/31/95	< 0.6	< 60	
	04/30/95	< 0.3	< 90	< 200
	05/31/95	< 0.4	< 40	
	06/30/95	< 1	< 50	
	07/31/95	< 0.1	< 80	< 200
	08/31/95	< 0.3	< 60	
	09/30/95	< 0.7	< 50	
	10/31/95	< 0.4	< 70	< 200
	11/01/95	< 1	< 60	
	12/31/95	< 0.8	< 40	

* 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	01/29/95	< 0.2	< 70	< 200
	04/30/95 (b)			
	05/18/95 (d)	(c)	< 100	< 200
	07/30/95	< 0.3	< 50	< 200
	10/29/95	< 0.3	< 50	< 200
Well W-2	01/29/95	< 0.2	< 100	< 200
	04/30/95	< 0.4	< 60	< 200
	07/30/95	< 0.3	< 70	< 200
	10/29/95	< 0.3	< 80	< 200
Well W-3	01/29/95	< 0.2	< 50	< 200
	04/30/95 (b)			
	05/04/95 (d)	< 0.3	< 60	< 200
	08/01/95	< 0.2	< 50	< 200
	10/29/95 (b)			
	11/05/95 (d)	< 0.3	< 60	< 200
Well W-4	01/29/95	< 0.3	< 50	920 ± 150
	04/30/95	< 0.8	< 70	760 ± 250
	07/30/95	< 0.3	< 80	450 ± 160
	10/29/95	< 0.3	< 100	200 ± 130
Well W-5	01/29/95 (a)			
	02/02/95 (d)	< 0.2	< 80	950 ± 160
	04/30/95	< 0.4	< 50	520 ± 190
	07/30/95	< 0.4	< 50	390 ± 240
	10/29/95	< 0.3	< 60	330 ± 150
Well W-6	01/29/95	< 0.2	50.7 ± 26.2	430 ± 120
	04/30/95	< 0.4	< 50	670 ± 170
	07/30/95	< 0.3	< 100	< 200
	10/29/95	< 0.3	< 50	520 ± 130

* 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	01/29/95	< 0.3	< 80	< 200
	04/30/95	< 0.4	< 90	< 200
	07/30/95	< 0.3	< 70	< 200
	10/29/95	< 0.3	< 100	< 200
Well W-8	01/29/95	< 0.4	< 60	< 200
	04/30/95	< 0.4	< 80	< 200
	07/30/95	< 0.3	< 80	< 200
	10/29/95	< 0.3	< 100	< 200
Well W-9	01/29/95	< 0.5	< 50	< 200
	04/30/95	< 0.4	< 90	< 200
	07/30/95	< 0.3	< 60	< 200
	10/29/95 (b)			
	11/13/95 (d)	< 0.3	< 100	< 200
Well W-10	01/29/95	< 0.6	< 50	< 200
	04/30/95	< 0.4	< 80	< 200
	07/30/95	< 0.3	< 50	< 200
	10/29/95	< 0.3	< 70	< 200
Well W-11	01/29/95	< 0.4	< 100	< 200
	04/30/95	< 0.4	< 80	< 200
	07/30/95	< 0.3	< 100	290 ± 160
	10/29/95	< 0.3	< 60	< 200
Well W-12	01/29/95	< 0.5	< 90	< 200
	04/30/95	< 0.4	< 100	< 300
	07/30/95	< 0.3	< 60	1900 ± 200
	10/29/95	< 0.4	< 60	< 200

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	01/29/95	< 0.5	< 100	< 200
	04/30/95	< 0.5	< 60	< 300
	07/30/95	< 0.3	< 90	250 ± 150
	10/29/95	< 0.4	< 100	< 200
Well W-14	01/29/95	< 0.3	< 40	7000 ± 300
	04/30/95	< 0.4	< 70	2100 ± 200
	07/30/95	< 0.3	< 50	< 300
	10/29/95 (e)			
	11/13/95 (d)	< 0.3	< 50	< 200
Average ± 2 s.d.			50.7 ± 26.2	1105 ± 3332

(a) Pump broke; sample not collected.
(b) Power outage; no sample available.
(c) I-131 analysis inadvertently not performed by laboratory.
(d) Replacement sample.
(e) Well not in service.
* 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				
01/19/95	3.6 ± 1.0	< LLD	< 0.2	< 200
02/02/95	4.4 ± 1.0	< LLD	< 0.2	
02/16/95	3.7 ± 0.9	< LLD	< 0.3	
03/02/95	3.5 ± 0.9	< LLD	< 0.3	
03/16/95	3.0 ± 1.0	< LLD	< 0.2	
03/30/95	2.7 ± 1.0	< LLD	< 0.4	
04/13/95	3.6 ± 1.1	< LLD	< 0.2	< 200
04/27/95	4.4 ± 1.1	< LLD	< 0.3	
05/11/95	3.7 ± 1.0	< LLD	< 0.3	
05/25/95	7.6 ± 1.3	< LLD	< 0.4	
06/08/95	4.6 ± 1.2	< LLD	< 0.3	
06/22/95	7.4 ± 1.1	< LLD	< 0.3	
07/06/95	2.5 ± 0.9	< LLD	< 0.2	< 200
07/20/95	2.1 ± 0.9	< LLD	< 0.3	
08/03/95	2.5 ± 0.9	< LLD	< 0.2	
08/17/95	3.3 ± 1.0	< LLD	< 0.6	
08/31/95	3.2 ± 0.9	< LLD	< 0.4	
09/14/95	3.2 ± 1.0	< LLD	< 0.3	
09/28/95	3.1 ± 0.9	< LLD	< 0.2	
10/12/95	2.4 ± 0.9	< LLD	< 0.4	< 200
10/26/95	3.1 ± 0.9	< LLD	< 0.5	
11/09/95	2.5 ± 0.9	< LLD	< 0.4	
11/22/95	2.5 ± 0.9	< LLD	< 0.4	
12/07/95	3.1 ± 1.0	< LLD	< 0.3	
12/21/95	2.8 ± 1.0	< LLD	< 0.4	
01/03/96	2.9 ± 1.0	< LLD	< 0.6	
Average ± 2 s. d.	**3.5 ± 2.7**			

* 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				
01/19/95	3.7 ± 1.0	< LLD	< 0.2	< 200
02/02/95	4.4 ± 1.0	< LLD	< 0.2	
02/16/95	3.6 ± 1.0	< LLD	< 0.3	
03/02/95	3.0 ± 0.9	< LLD	< 0.3	
03/16/95	7.0 ± 1.3	< LLD	< 0.3	
03/30/95	2.9 ± 1.0	< LLD	< 0.2	
04/13/95	3.3 ± 1.1	< LLD	< 0.3	< 200
04/27/95	3.3 ± 1.1	< LLD	< 0.3	
05/11/95	3.5 ± 1.0	< LLD	< 0.4	
05/25/95	2.9 ± 1.0	< LLD	< 0.4	
06/08/95	3.0 ± 1.1	< LLD	< 0.4	
06/22/95	3.0 ± 0.9	< LLD	< 0.3	
07/06/95	3.0 ± 0.9	< LLD	< 0.2	< 200
07/20/95	3.3 ± 1.0	< LLD	< 0.3	
08/03/95	3.4 ± 1.0	< LLD	< 0.3	
08/17/95	6.6 ± 1.2	< LLD	< 0.7	
08/31/95	3.3 ± 0.9	< LLD	< 0.3	
09/14/94	3.2 ± 1.0	< LLD	< 0.3	
09/28/95	3.1 ± 0.9	< LLD	< 0.2	
10/12/95	1.8 ± 0.9	< LLD	< 0.4	< 200
10/26/95	3.2 ± 0.9	< LLD	< 0.5	
11/09/95	3.0 ± 0.9	< LLD	< 0.4	
11/22/95	3.7 ± 1.0	< LLD	< 0.4	
12/07/95	2.8 ± 1.0	< LLD	< 0.6	
12/21/95	3.4 ± 1.1	< LLD	< 0.3	
01/03/96	3.0 ± 1.0	< LLD	< 0.6	
Average ± 2 s. d.	**3.5 ± 2.1**			

* 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	04/27/95	< 200	4380 ± 440	< 20	711 ± 344	557 ± 56
SL-3	04/27/95	< 200	3390 ± 360	43.4 ± 15.4	657 ± 334	502 ± 50
Average ± 2 s.d.			**3885 ± 1400**	**43.4 ± 15.4**	**684 ± 76**	**530 ± 78**

* 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

		STATION CODES					
COLLECTION DATES	**ANALYSIS**	**SHULER**	**WARMBEIN**	**FREEHLING**	**LIVINGHOUSE**	**WYANT**	**SCHUTZE**
01/06/95	K-40	1580 ± 160	1160 ± 120	1330 ± 130	1470 ± 150	1330 ± 130	1370 ± 140
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.3	< 0.4
01/20/95	K-40	1360 ± 140	1270 ± 130	1460 ± 150	1460 ± 150	1290 ± 130	1350 ± 140
	I-131	< 0.2	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2
02/03/95	K-40	1300 ± 130	1240 ± 120	1480 ± 150	1350 ± 130	1260 ± 130	1450 ± 150
	I-131	< 0.2	< 0.1	< 0.2	< 0.2	< 0.3	< 0.2
02/17/95	K-40	1330 ± 130	1290 ± 130	1390 ± 140	1320 ± 130	1190 ± 120	1280 ± 130
	I-131	< 0.2	< 0.3	< 0.3	< 0.3	< 0.2	< 0.4
03/03/95	K-40	1480 ± 150	1280 ± 130	1410 ± 140	1270 ± 130	1300 ± 130	1390 ± 140
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
03/17/95	K-40	1460 ± 150	1340 ± 130	1460 ± 150	1380 ± 140	1400 ± 140	1390 ± 140
	I-131	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2
03/31/95	K-40	1320 ± 130	1230 ± 120	1460 ± 150	1430 ± 140	1300 ± 130	1280 ± 130
	I-131	< 0.3	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
04/14/95	K-40	1250 ± 120	1420 ± 140	1460 ± 150	1480 ± 150	1480 ± 150	1360 ± 140
	I-131	< 0.2	< 0.2	< 0.3	< 0.2	< 0.2	< 0.2
04/28/95	K-40	1340 ± 130	1430 ± 140	1450 ± 150	1390 ± 140	1260 ± 130	(a)
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	
05/12/95	K-40	1390 ± 140	1940 ± 190	1400 ± 140	1320 ± 130	1340 ± 130	
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	

(a) All cows sold; no longer participating in program.

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

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES					
		SHULER	WARMBEIN	FREEHLING	LIVINGHOUSE	WYANT	SCHUTZE
05/26/95	K-40 I-131	1440 ± 140 < 0.2	1220 ± 120 < 0.2	1400 ± 140 < 0.3	1410 ± 140 < 0.2	1370 ± 140 < 0.2	
06/09/95	K-40 I-131	1460 ± 150 < 0.3	1390 ± 140 < 0.4	1270 ± 130 < 0.3	1400 ± 140 < 0.3	1310 ± 130 < 0.2	(a)
06/23/95	K-40 I-131	1170 ± 120 < 0.2	1510 ± 150 < 0.2	1360 ± 140 < 0.2	1230 ± 120 < 0.2	1410 ± 140 < 0.2	
07/07/95	K-40 I-131	1100 ± 110 < 0.2	1490 ± 150 < 0.1	1470 ± 150 < 0.1	1450 ± 150 < 0.2	1250 ± 130 < 0.2	
07/21/95	K-40 I-131	1430 ± 140 < 0.3	1420 ± 140 < 0.3	1400 ± 140 < 0.3	1510 ± 150 < 0.3	1380 ± 140 < 0.4	
08/04/95	K-40 I-131	1440 ± 140 < 0.2	1450 ± 150 < 0.2	1330 ± 130 < 0.2	1230 ± 120 < 0.2	1580 ± 160 < 0.1	
08/18/95	K-40 I-131	1530 ± 150 < 0.4	1320 ± 130 < 0.4	1270 ± 130 < 0.4	1330 ± 130 < 0.3	1240 ± 120 < 0.3	
09/01/95	K-40 I-131	1430 ± 140 < 0.2	1610 ± 160 < 0.2	1340 ± 130 < 0.3	1210 ± 120 < 0.2	1370 ± 140 < 0.2	
09/15/95	K-40 I-131	1390 ± 140 < 0.2	1350 ± 130 < 0.2	1360 ± 140 < 0.2	1580 ± 160 < 0.2	1260 ± 130 < 0.1	
09/29/95	K-40 I-131	1310 ± 130 < 0.2	1290 ± 130 < 0.2	1510 ± 150 < 0.2	1340 ± 130 < 0.1	1170 ± 120 < 0.1	

(a) All cows sold; not participating in program.
* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

		STATION CODES					
COLLECTION DATES	ANALYSIS	SHULER	WARMBEIN	FREEHLING	LIVINGHOUSE	WYANT	SCHUTZE
10/13/95	K-40 I-131	1460 ± 150 < 0.2	1590 ± 160 < 0.2	1380 ± 140 < 0.2	1270 ± 130 < 0.3	1380 ± 140 < 0.3	(a)
10/27/95	K-40 I-131	1490 ± 150 < 0.3	1470 ± 150 < 0.3	1540 ± 150 < 0.3	1450 ± 150 < 0.3	1260 ± 130 < 0.3	
11/10/95	K-40 I-131	1380 ± 140 < 0.2	1350 ± 130 < 0.2	1420 ± 140 < 0.2	1490 ± 150 < 0.2	1230 ± 120 < 0.3	
11/24/95	K-40 I-131	1360 ± 140 < 0.3	1390 ± 140 < 0.2	1370 ± 140 < 0.2	1310 ± 130 < 0.3	1370 ± 140 < 0.3	
12/08/95	K-40 I-131	1480 ± 150 < 0.2	1390 ± 130 < 0.1	1360 ± 140 < 0.1	1330 ± 130 < 0.2	1570 ± 160 < 0.1	
12/22/95	K-40 I-131	1340 ± 130 < 0.2	(b)	1470 ± 150 < 0.2	1400 ± 140 < 0.2	1180 ± 120 < 0.3	

(a) All cows sold; no longer participating in program.
(b) No sample available.
* Typical LLDs are found in table B-12. All other gamma emitters were <LLD.

TABLE B-10

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN FISH

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

Collection Date	Station	Description	Be-7	K-40	Cs-137	Ra-226	Th-228
05/31/95	ONS-N	Sucker	< 50	3820 ± 380	14.6 ± 3.8	< 100	< 10
05/31/95	ONS-S	Sucker	< 50	4180 ± 420	21.7 ± 4.3	< 100	< 10
05/31/95	OFS-N	Sucker/Trout	< 30	3250 ± 330	48.4 ± 4.8	< 70	< 6
05/31/95	OFS-S	Sucker	< 60	4500 ± 450	27.5 ± 5.6	< 100	< 10
10/30/95	ONS-N	Sucker	< 100	3040 ± 300	< 20	< 300	< 30
10/30/95	ONS-S	Sucker	< 90	3030 ± 300	17.8 ± 7.8	< 200	< 20
10/30/95	OFS-N	Lake Trout	< 100	3510 ± 350	58.5 ± 13.1	< 200	< 20
10/30/95	OFS-S	Sucker	< 100	2820 ± 280	24.7 ± 9.9	< 300	< 20
Average ± 2 s.d.				**3519 ± 1200**	**30.5 ± 33.1**		

* 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 FOOD/VEGETATION

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

COLLECTION DATE	Station	Description	Be-7	K-40	I-131	Cs-137
09/25/95	ONS-G	Grapes	< 40	1720 ± 170	< 6	< 5
09/25/95	OFS-G	Grapes	< 50	2610 ± 260	< 8	< 7
09/25/95	ONS-V	Broadleaf	2500 ± 250	3900 ± 390	< 20	< 20
09/25/95	OFS-V	Broadleaf	1420 ± 250	3060 ± 320	< 40	< 30
Average ± 2 s.d.			**1960 ± 1527**	**2823 ± 1818**		

* 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

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
Iodine-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-12 (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 1995 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 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 = $(N/\Delta t\text{-}B)/(2.22\ E\ V\ Y\ DF)$

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

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

where:

- N = total counts from sample (counts)
- Δt = counting time for sample (min)
- B = background rate of counter (cpm)
- 2.22 = dpm/pCi
- V = volume or weight of sample analyzed
- Y = chemical yield of the mount or sample counted
- DF = decay factor from the collection to the counting date
- E = efficiency of the counter for I-131, corrected for self absorption effects by the formula
- E = $E_s(\exp\text{-}0.0085M)/(\exp\text{-}0.0085M_s)$
- E_s = efficiency of the counter determined from an I-131 standard mount
- Ms = mass of $Pd1_2$ 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 $= 2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$

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

$D1 = I_1\ K/R_1 - A$

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

K = the known exposure by the Cs-137 source

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

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

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

APPENDIX D
SUMMARY OF EPA INTERLABORATORY COMPARISONS

EPA INTERLABORATORY COMPARISON PROGRAM

Teledyne Brown Engineering participates in the EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1995 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 1995
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)	
01/13/95	Water	Sr-89	20.0 ±	5.0	19.00 ±	2.65	-0.35	
		Sr-90	15.0 ±	5.0	14.00 ±	0.00	-0.35	
01/27/95	Water	Gr-Alpha	5.0 ±	5.0	5.00 ±	1.00	0.00	
		Gr-Beta	5.0 ±	5.0	6.00 ±	1.00	0.35	
02/03/95	Water	I-131	100.0 ±	10.0	88.33 ±	2.31	-2.02	(d)
02/10/95	Water	Ra-226	19.1 ±	2.9	20.67 ±	0.58	0.94	
		Ra-228	20.0 ±	5.0	18.67 ±	0.58	-0.46	
03/10/95	Water	H-3	7435.0 ±	744.0	7066.67 ±	115.47	-0.86	
04/18/95	Water	Gr-Beta	86.6 ±	10.0	80.33 ±	2.52	-1.09	
		Sr-89	20.0 ±	5.0	20.67 ±	1.15	0.23	
		Sr-90	15.0 ±	5.0	14.67 ±	0.58	-0.12	
		Co-60	29.0 ±	5.0	31.67 ±	2.08	0.92	
		Cs-134	20.0 ±	5.0	19.67 ±	1.73	-0.12	
		Cs-137	11.0 ±	5.0	11.67 ±	1.53	0.23	
		Gr-Alpha	47.5 ±	11.9	39.67 ±	2.52	-1.14	
		Ra-226	14.9 ±	2.2	15.67 ±	0.58	0.60	
		Ra-228	15.8 ±	4.0	13.00 ±	1.73	-1.21	
06/09/95	Water	Co-60	40.0 ±	5.0	42.33 ±	2.52	0.81	
		Zn-65	76.0 ±	8.0	82.33 ±	3.51	1.37	
		Cs-134	50.0 ±	5.0	46.67 ±	2.08	-1.15	
		Cs-137	35.0 ±	5.0	37.67 ±	1.15	0.92	
		Ba-133	79.0 ±	8.0	74.33 ±	2.08	-1.01	
06/16/95	Water	Ra-226	14.8 ±	2.2	15.00 ±	0.00	0.16	
		Ra-228	15.0 ±	3.8	14.00 ±	0.00	-0.46	
07/14/95	Water	Sr-89	20.0 ±	5.0	18.33 ±	1.53	-0.58	
		Sr-90	8.0 ±	5.0	8.0 ±	0.00	0.00	
07/21/95	Water	Gr-Alpha	27.5 ±	6.9	18.33 ±	1.53	-2.30	(e)
		Gr-Beta	19.4 ±	5.0	19.33 ±	1.53	-0.02	
08/04/95	Water	H-3	4872.0 ±	487.0	4866.67 ±	152.75	-0.02	
08/25/95	Air Filters	Gr-Alpha	25.0 ±	6.3	23.67 ±	1.53	-0.37	
		Gr-Beta	86.6 ±	10.0	84.67 ±	1.53	-0.33	
		Sr-90	30.0 ±	5.0	25.33 ±	0.58	-1.62	
		Cs-137	25.0 ±	5.0	27.00 ±	1.00	0.69	
09/15/95	Water	Ra-226	24.8 ±	3.7	27.33 ±	1.15	1.19	
		Ra-228	20.0 ±	5.0	14.67 ±	0.58	-1.85	

Note: Footnotes are located at end of table.

EPA INTERLABORATORY COMPARISON PROGRAM 1995
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)
09/29/95	Milk	Sr-89	20.0 ±	5.0	23.33 ±	3.06	1.15
		Sr-90	15.0 ±	5.0	16.33 ±	0.58	0.46
		I-131	99.0 ±	10.0	103.33 ±	5.77	0.75
		Cs-137	50.0 ±	5.0	54.67 ±	2.52	1.62
		Total K	1654.0 ±	83.0	1683.33 ±	136.50	0.61
10/06/95	Water	I-131	148.0 ±	15.0	150.0 ±	0.00	0.23
10/27/95	Water	Gr-Alpha	51.2 ±	12.8	37.00 ±	3.00	-1.92
		Gr-Beta	24.8 ±	5.0	25.33 ±	1.53	0.18

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.

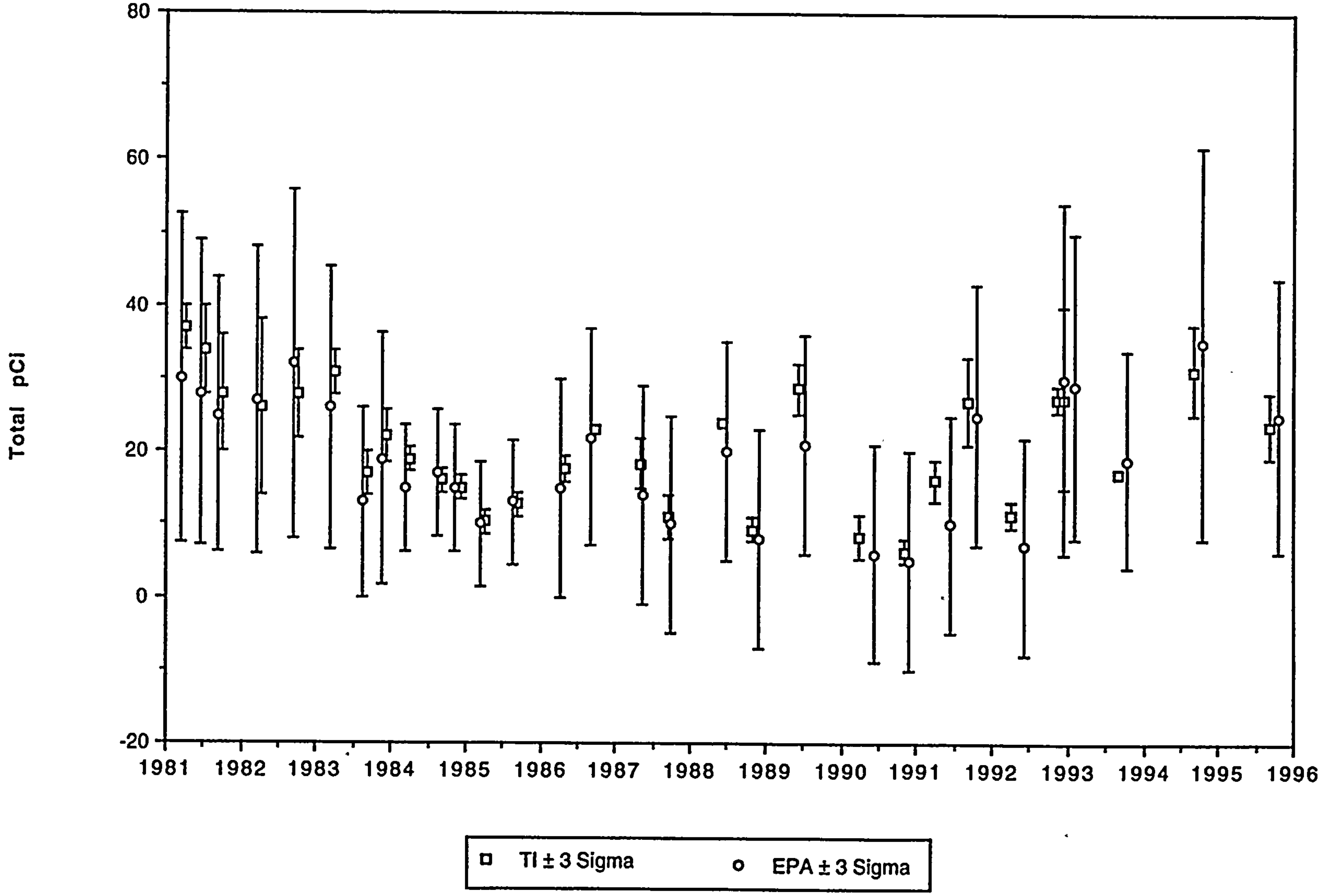
(c) Normalized deviation from the known.

(d) The normalized deviation marginally exceeded the warning level and an apparent trend in the results appeared. The cause was a probable high bias in the beta counting efficiency. Check source control charts did not indicate any changes in the counting equipment, so the I-131 calibration was suspected. New I-131 calibrations were performed July 3 through 6, 1995 after receiving a new standard from the EPA. The intercomparison sample data sheets were recalculated with the new efficiencies and the average result was in excellent agreement with the EPA (96 pCi/l versus the EPA value of 100 pCi/l). The discrepancy in the I-131 efficiency between the current calibration and the previous one (aside from the uncertainty in the standard) appears to be an abnormally low yield in the preparation of the standard for the older calibration which created a high bias in the counter efficiencies. The bias was less than ten percent, therefore further corrective action or revision of previously reported data is deemed not necessary.

(e) The mineral salt content of the water used by the EPA to prepare the samples has been shown to vary substantially throughout the year. Absorption curves to account for mount weight may vary from the true absorption characteristics of a specific sample. Previous results do not indicate a trend toward "out of control" for gross alpha/beta analysis and the normalized deviation from the grand average is only -0.36. The normalized deviation from the known for TBE-ES does not exceed three standard deviations and internal spikes have been in control. No corrective action is planned at this time.

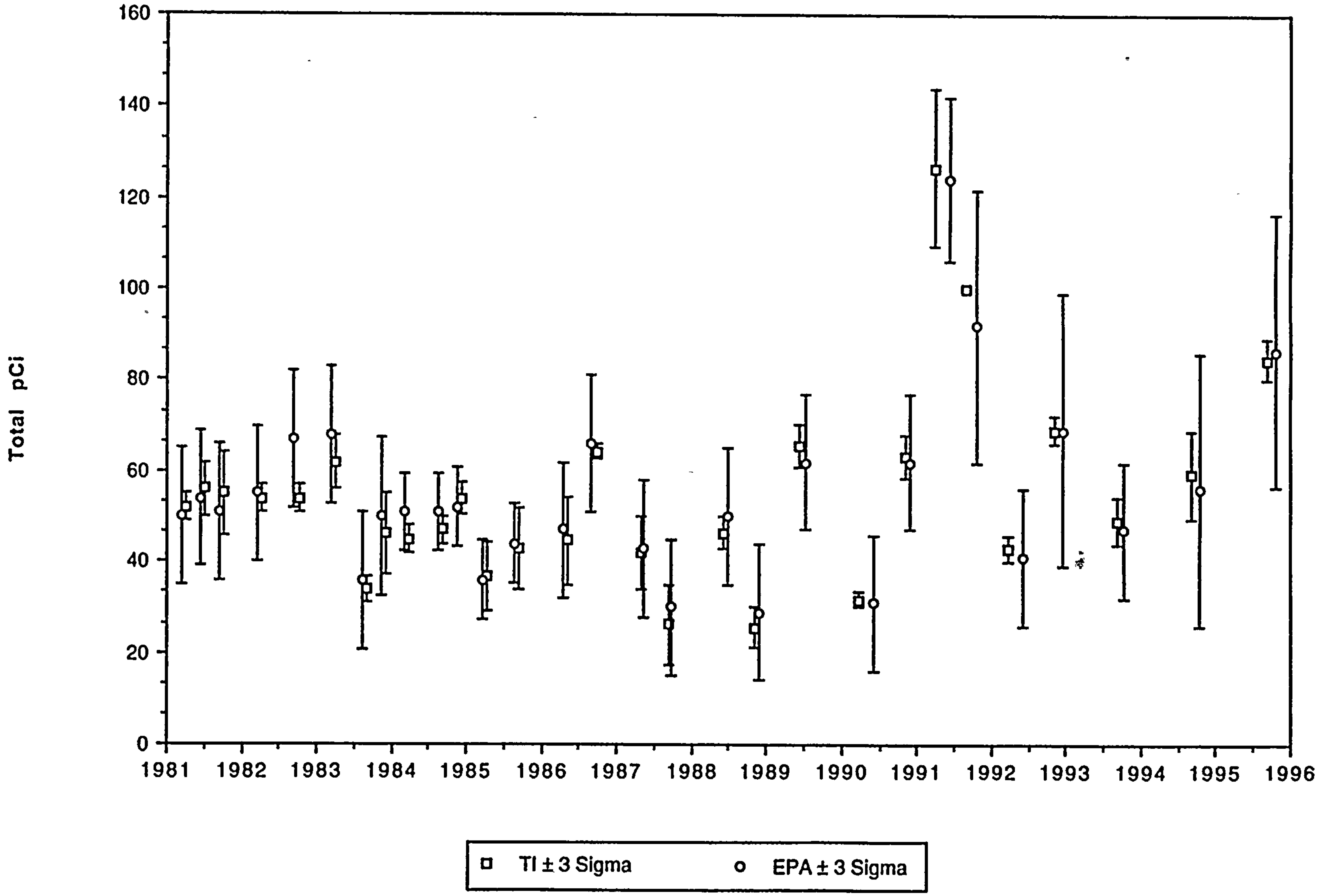
EPA CROSS CHECK PROGRAM

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



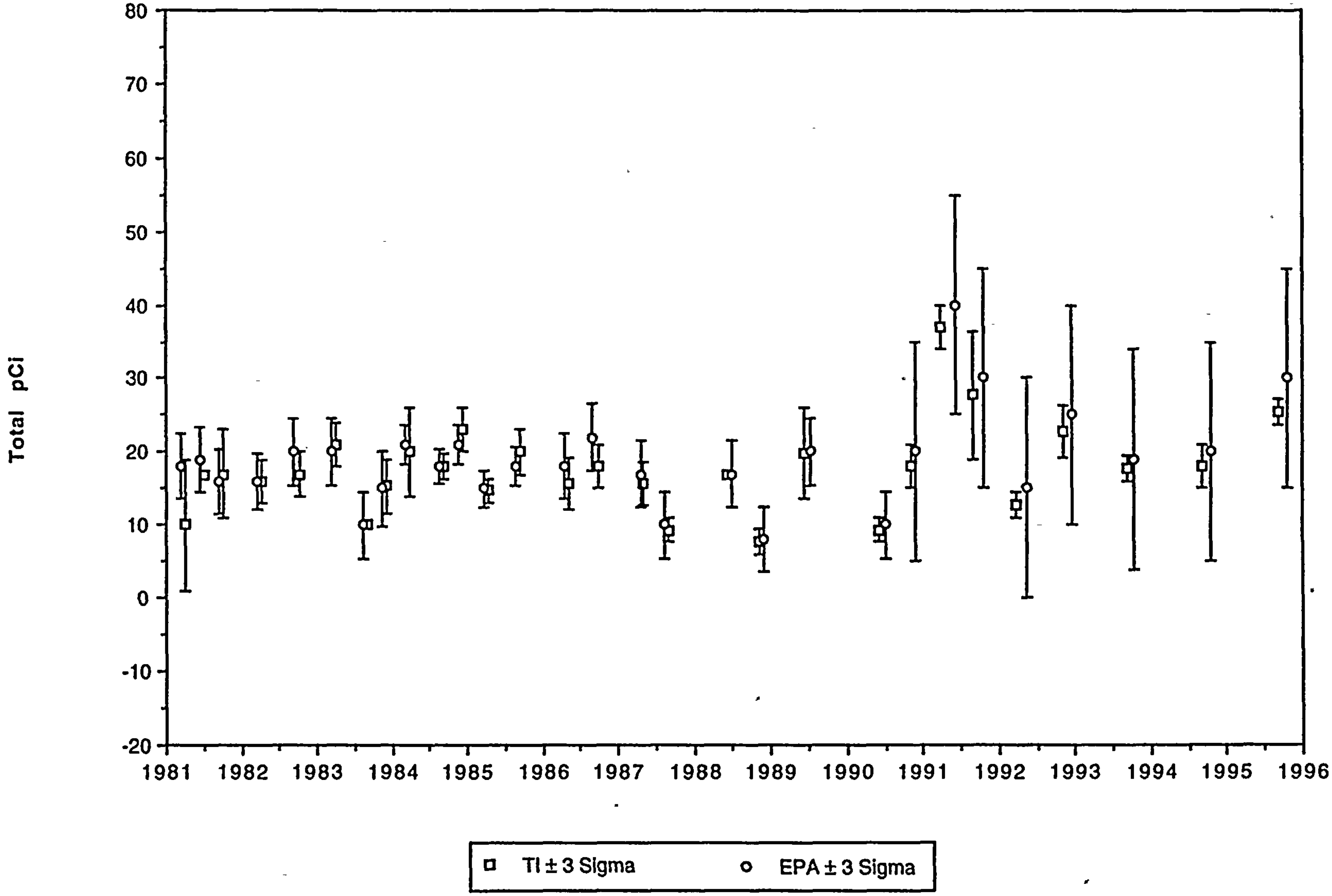
EPA CROSS CHECK PROGRAM

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



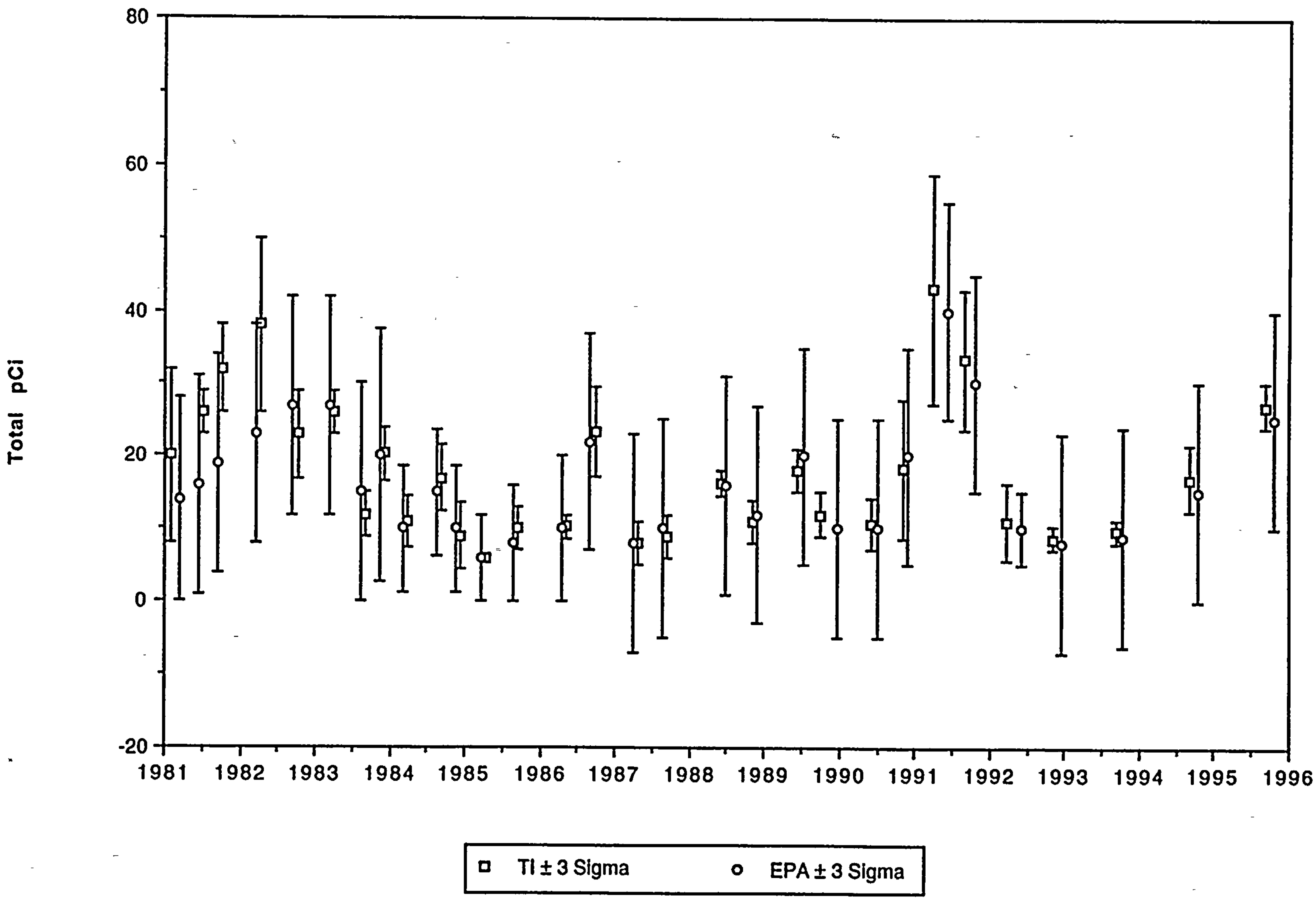
EPA CROSS CHECK PROGRAM

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



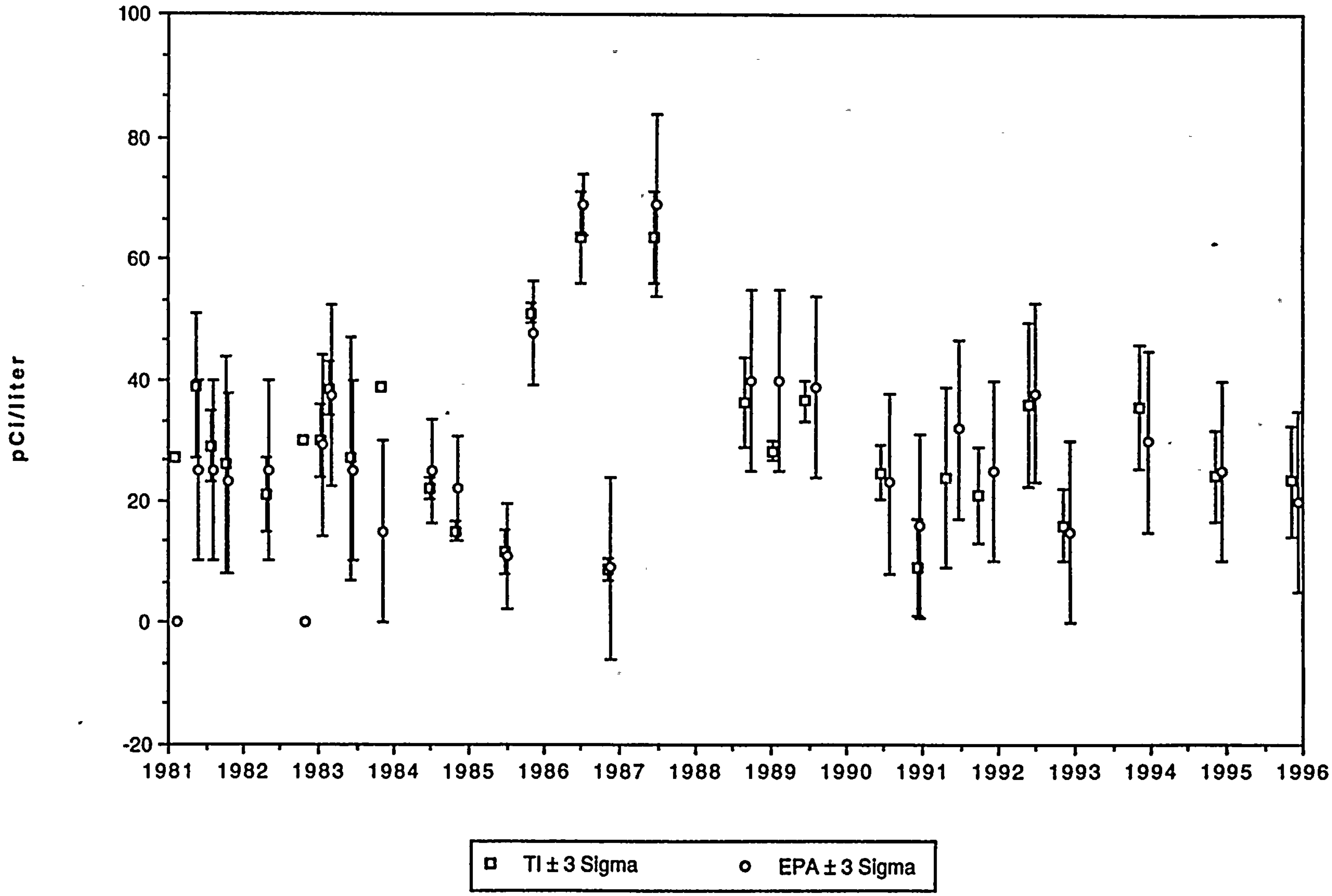
EPA CROSS CHECK PROGRAM

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



EPA CROSS CHECK PROGRAM

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



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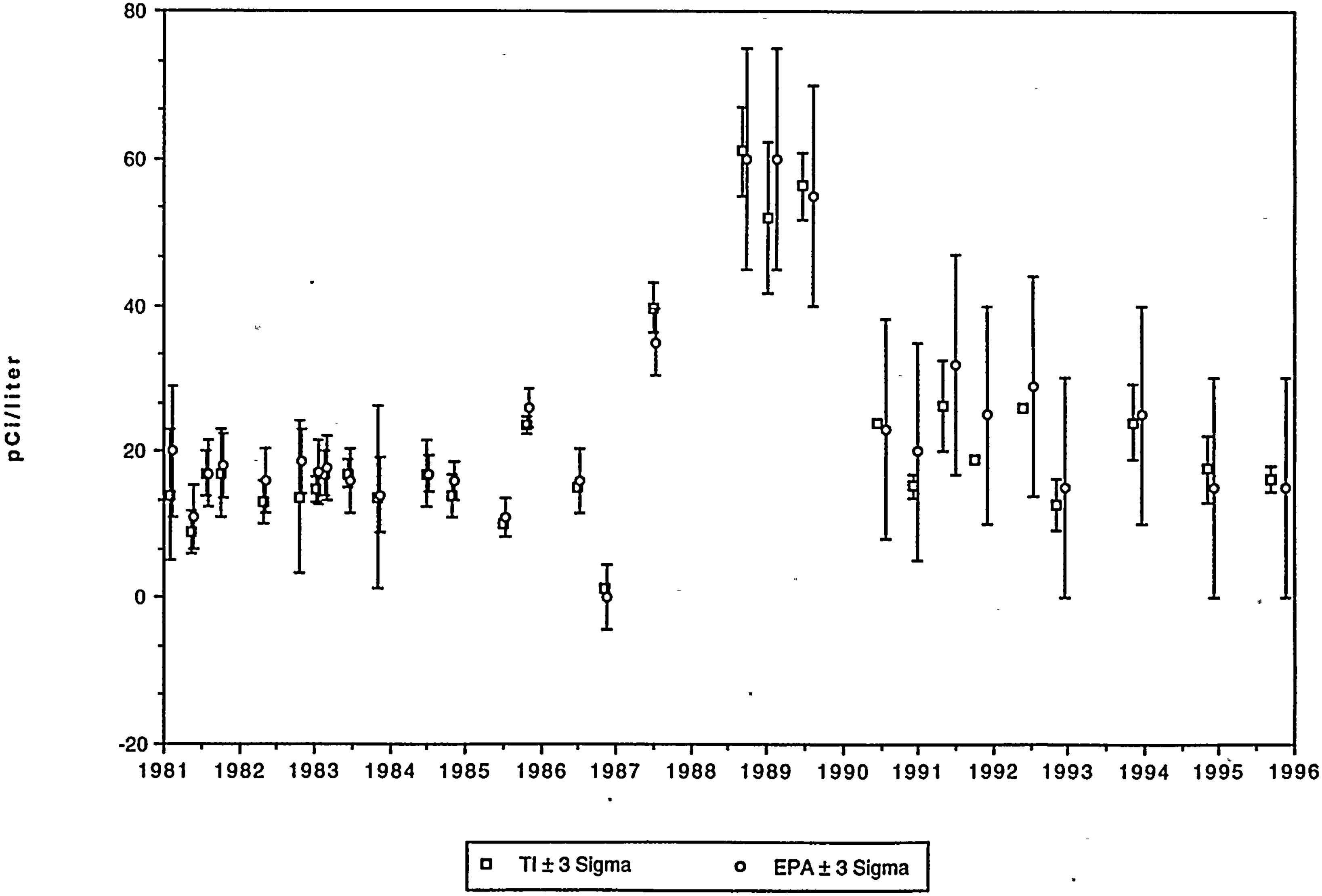
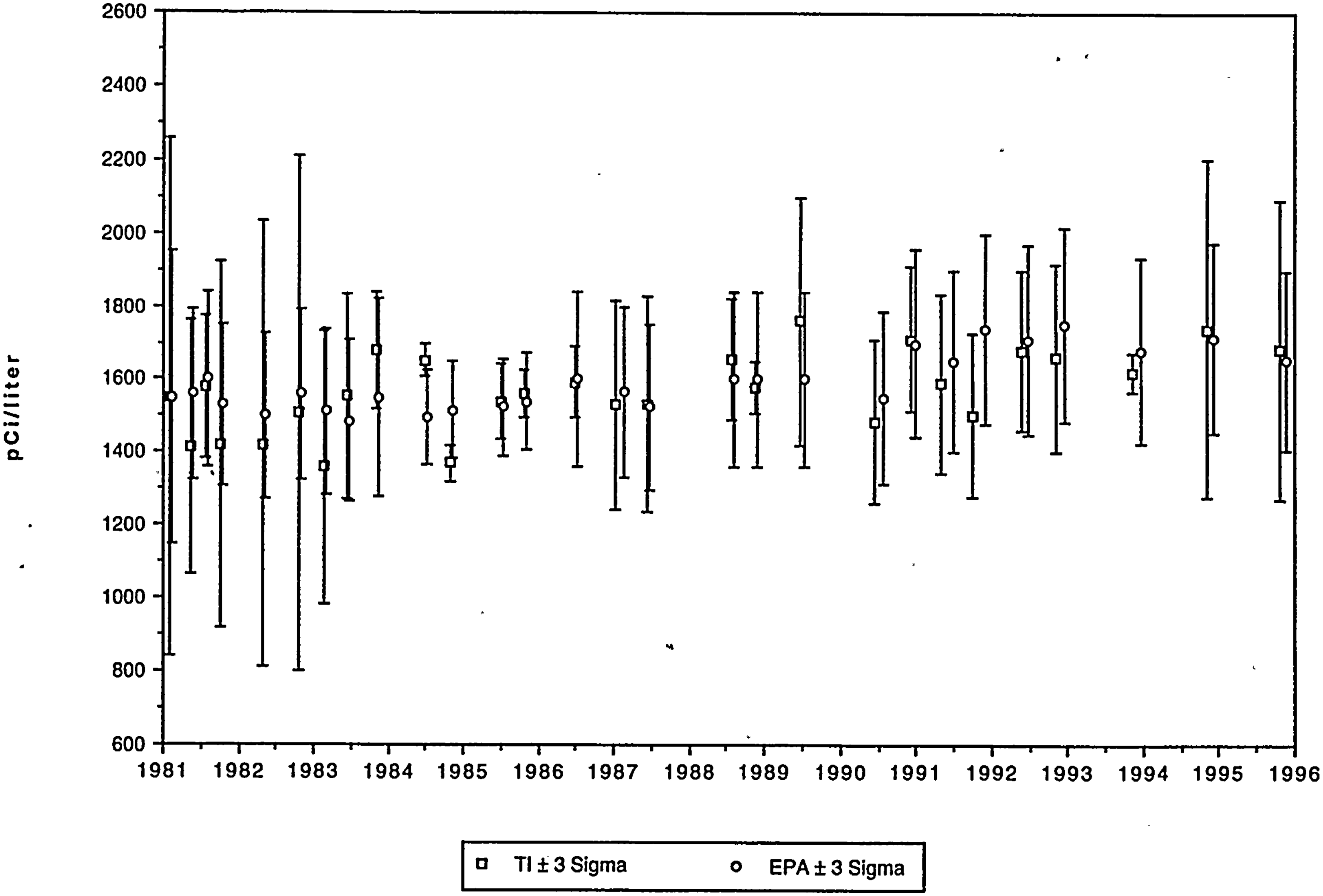
STRONTIUM-90 IN MILK (pg. 1 of 1)



EPA CROSS CHECK PROGRAM

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



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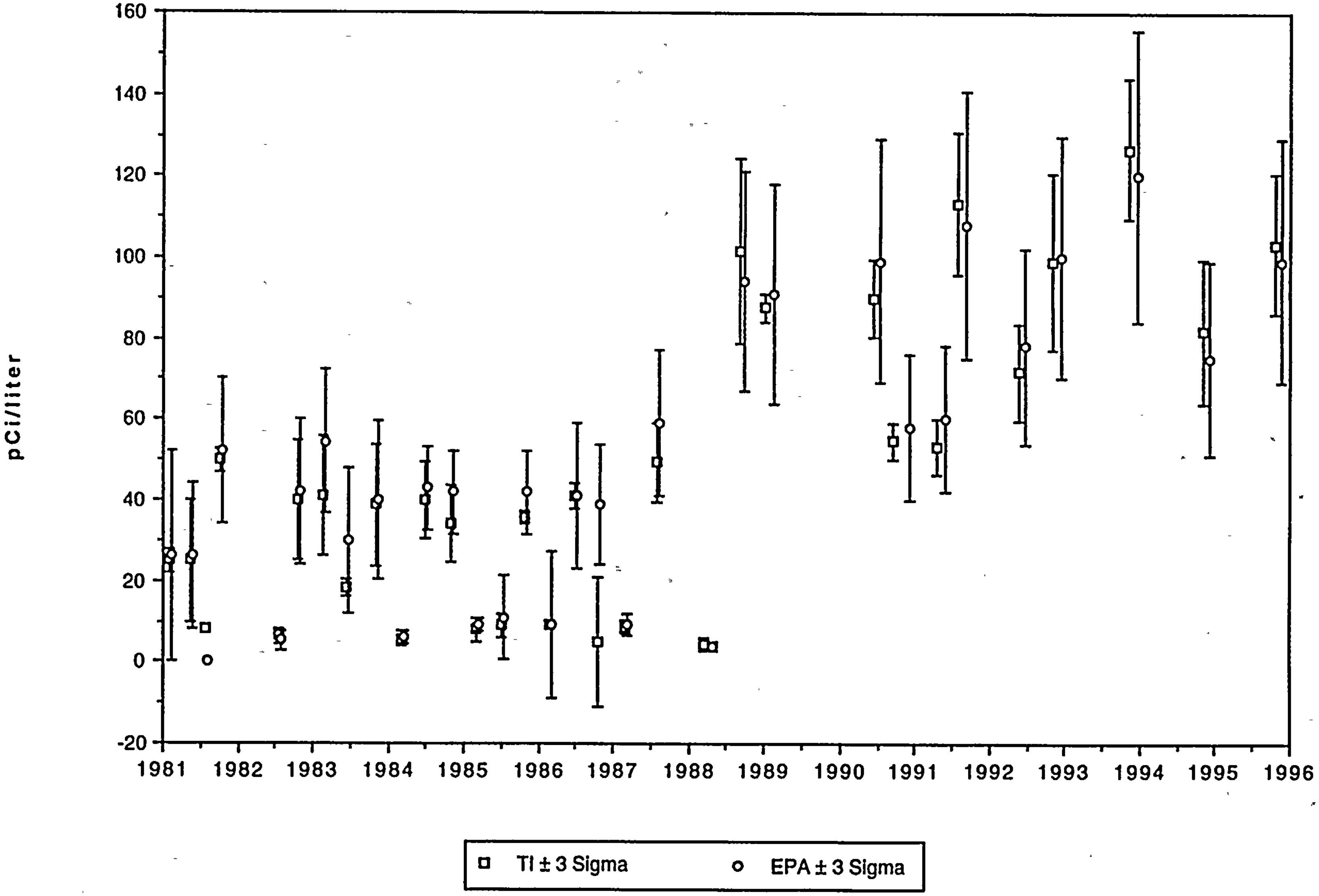
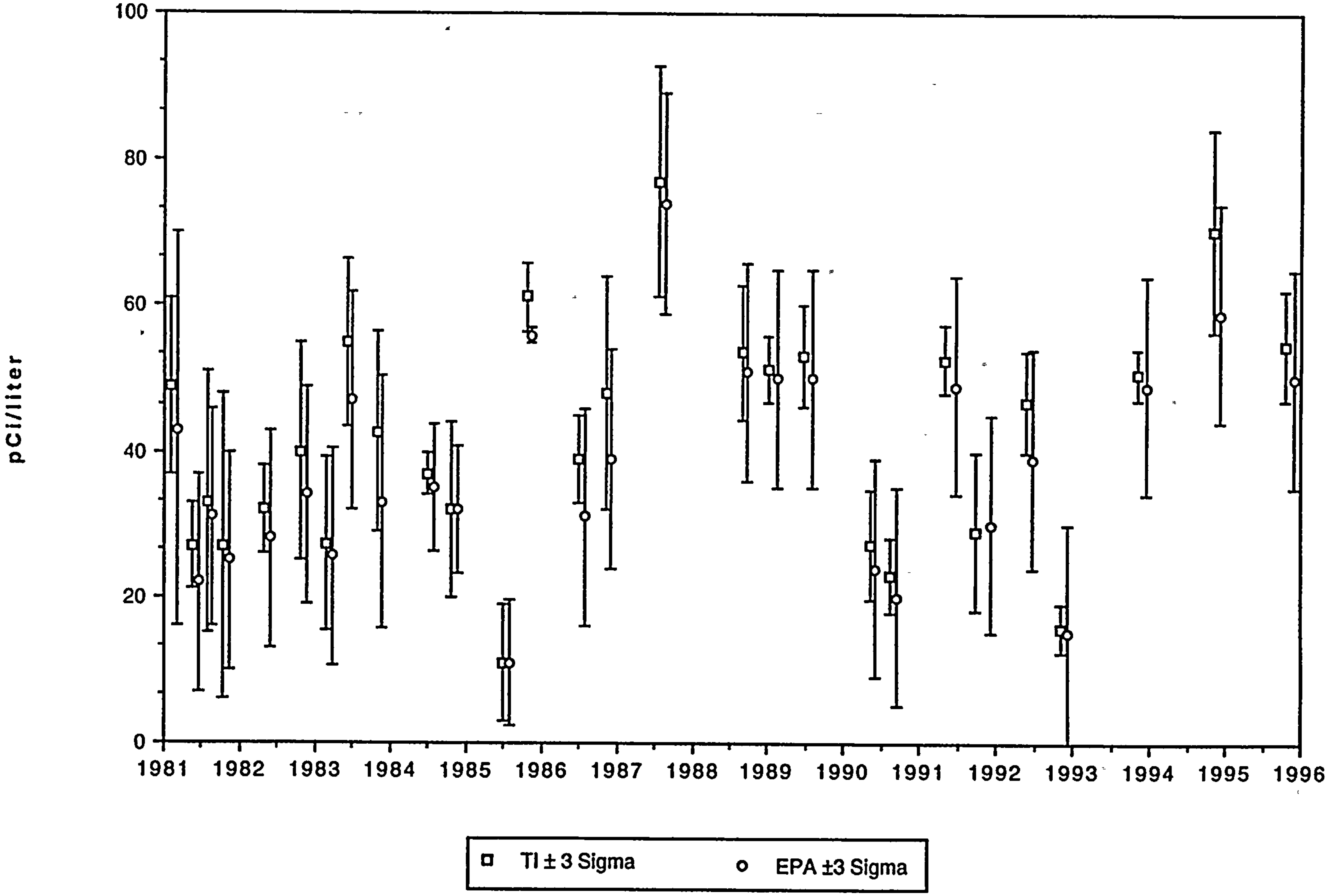
IODINE-131 IN MILK (pg. 1 of 1)



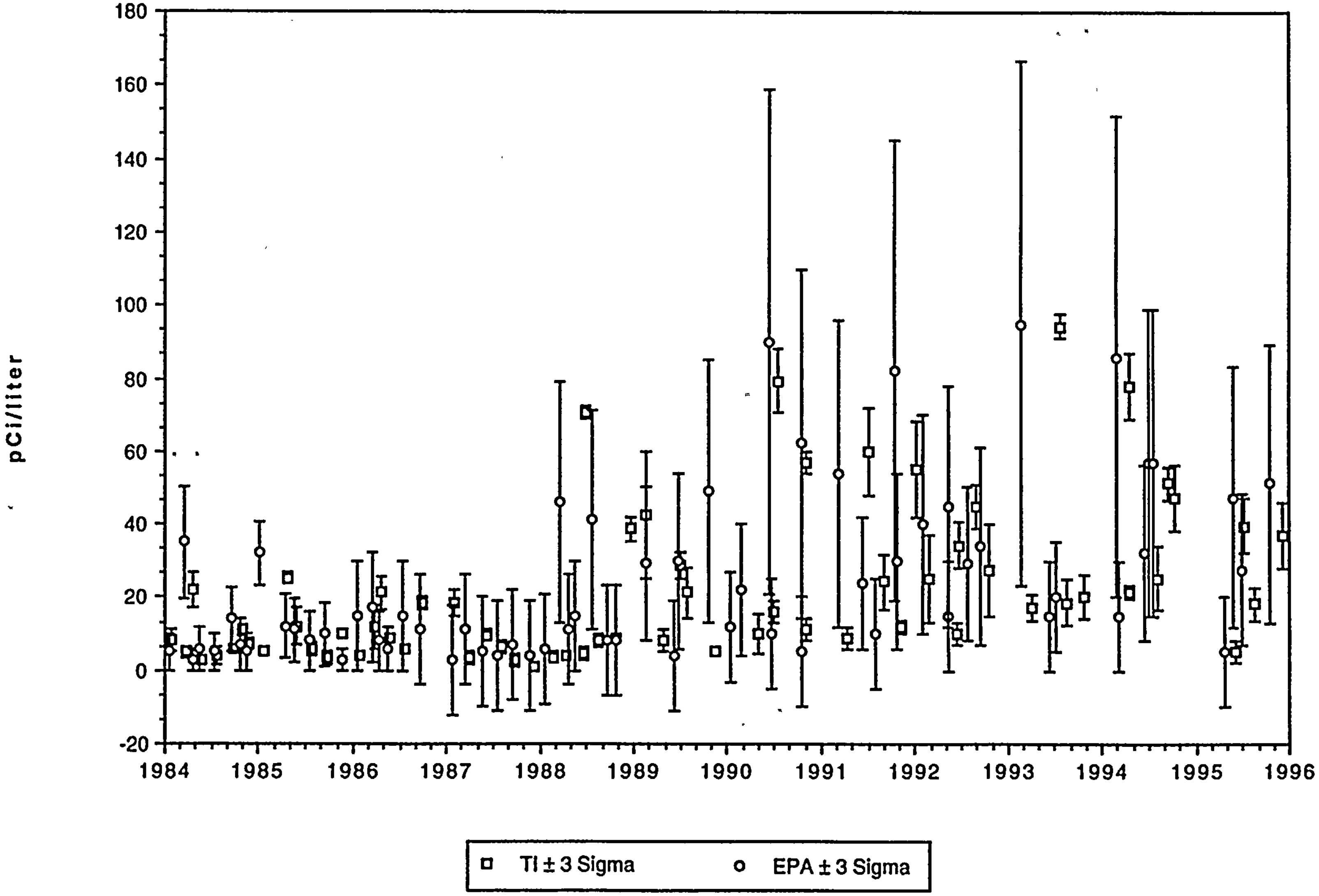
EPA CROSS CHECK PROGRAM

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



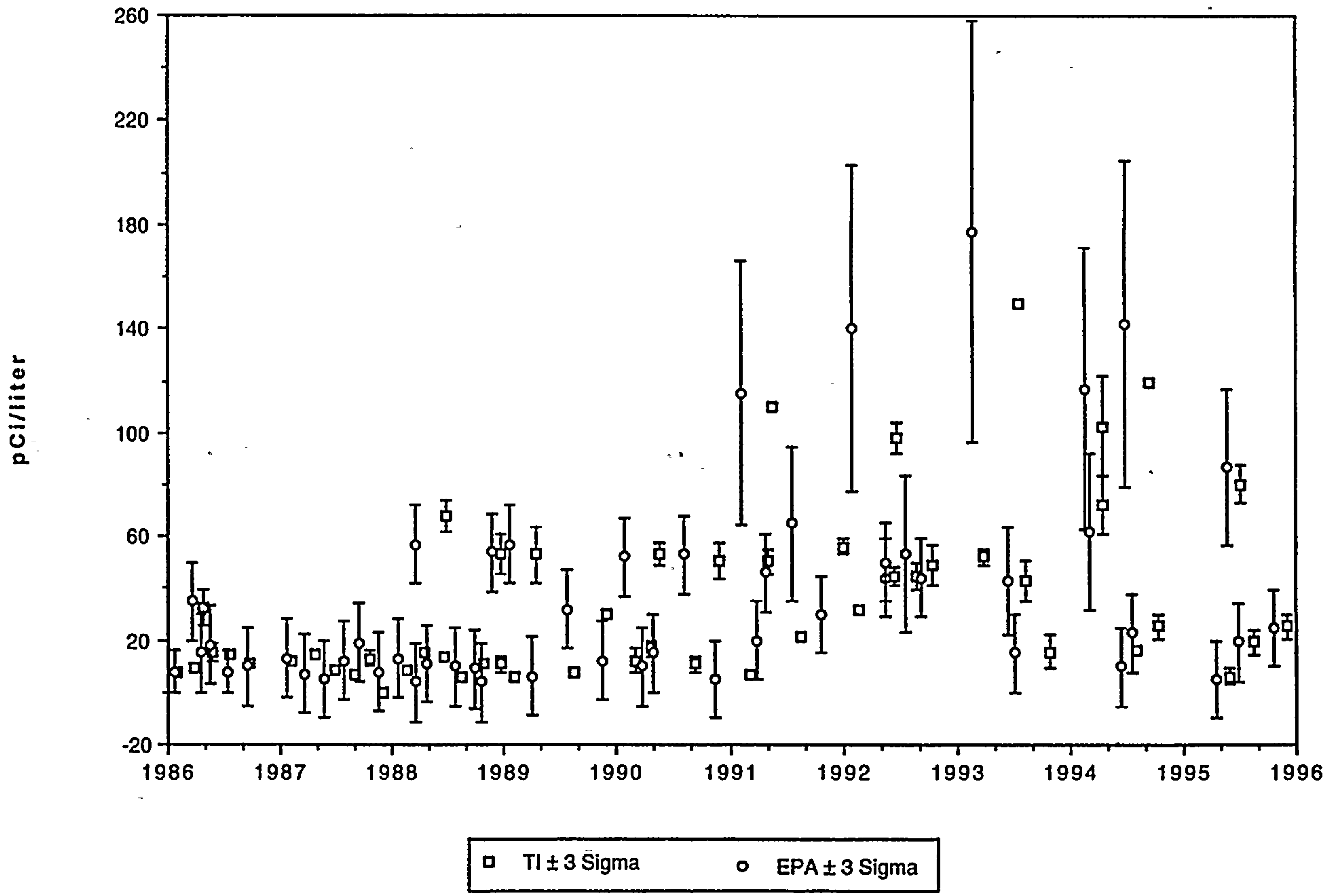
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)



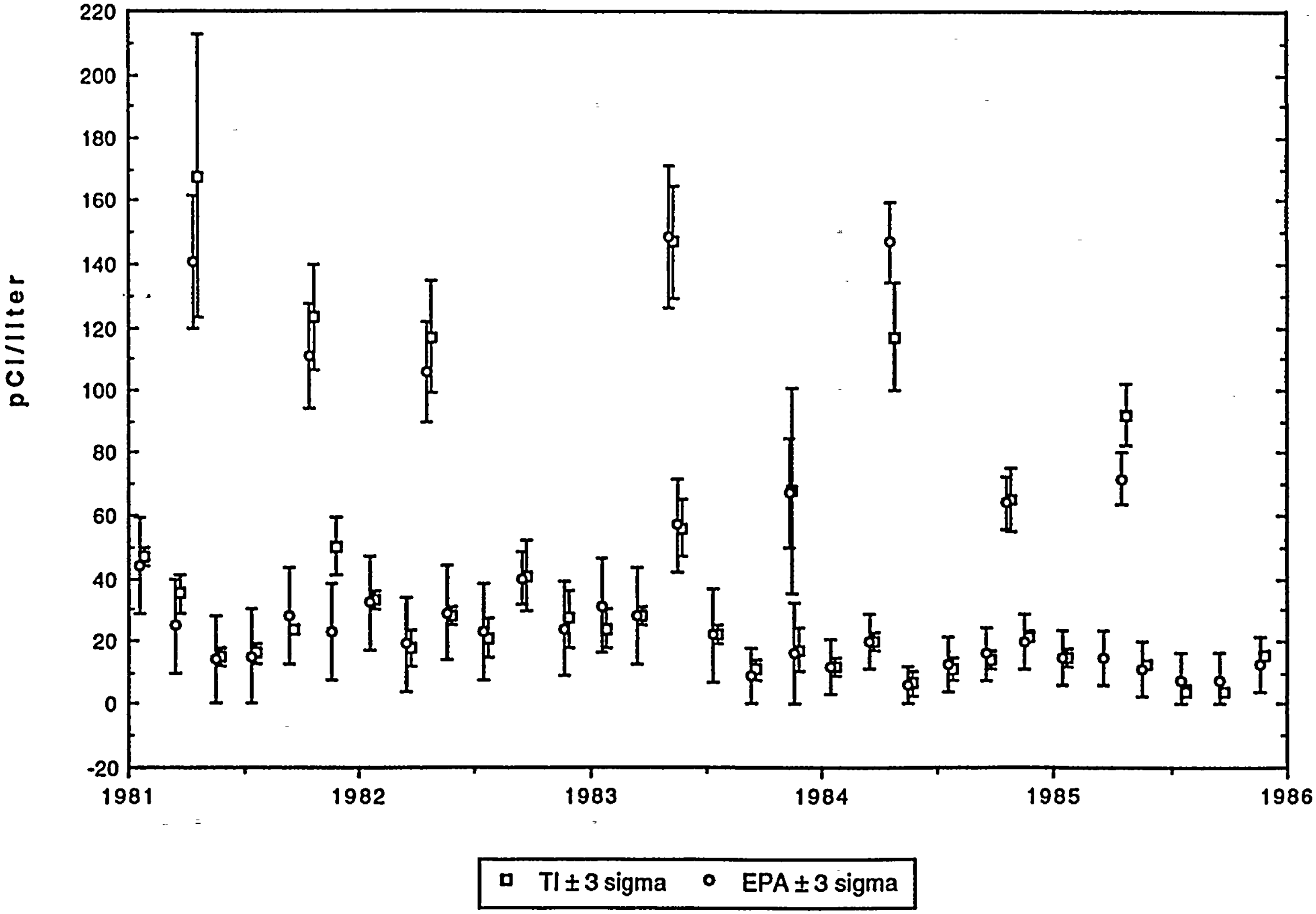
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 2 of 2)



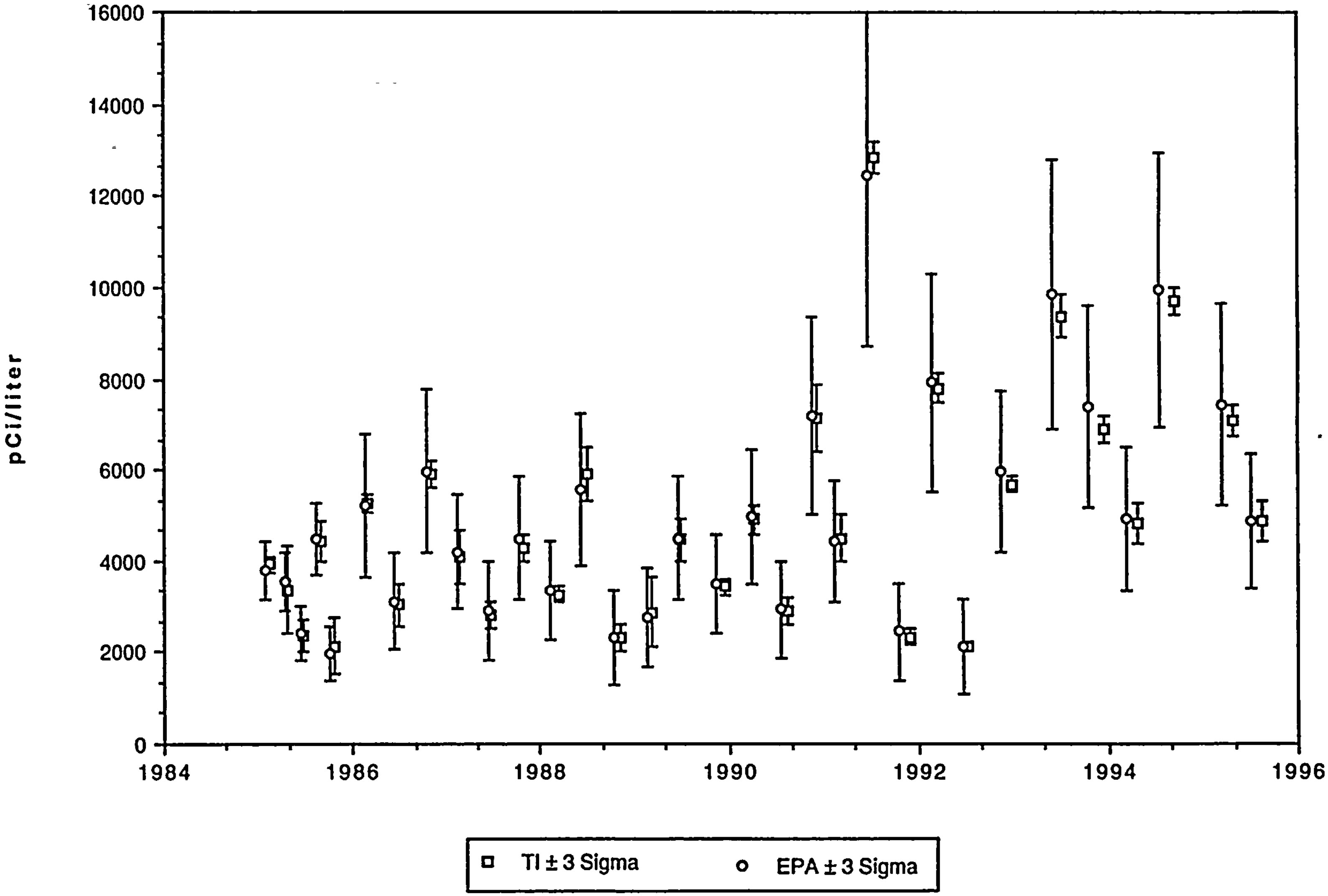
EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)



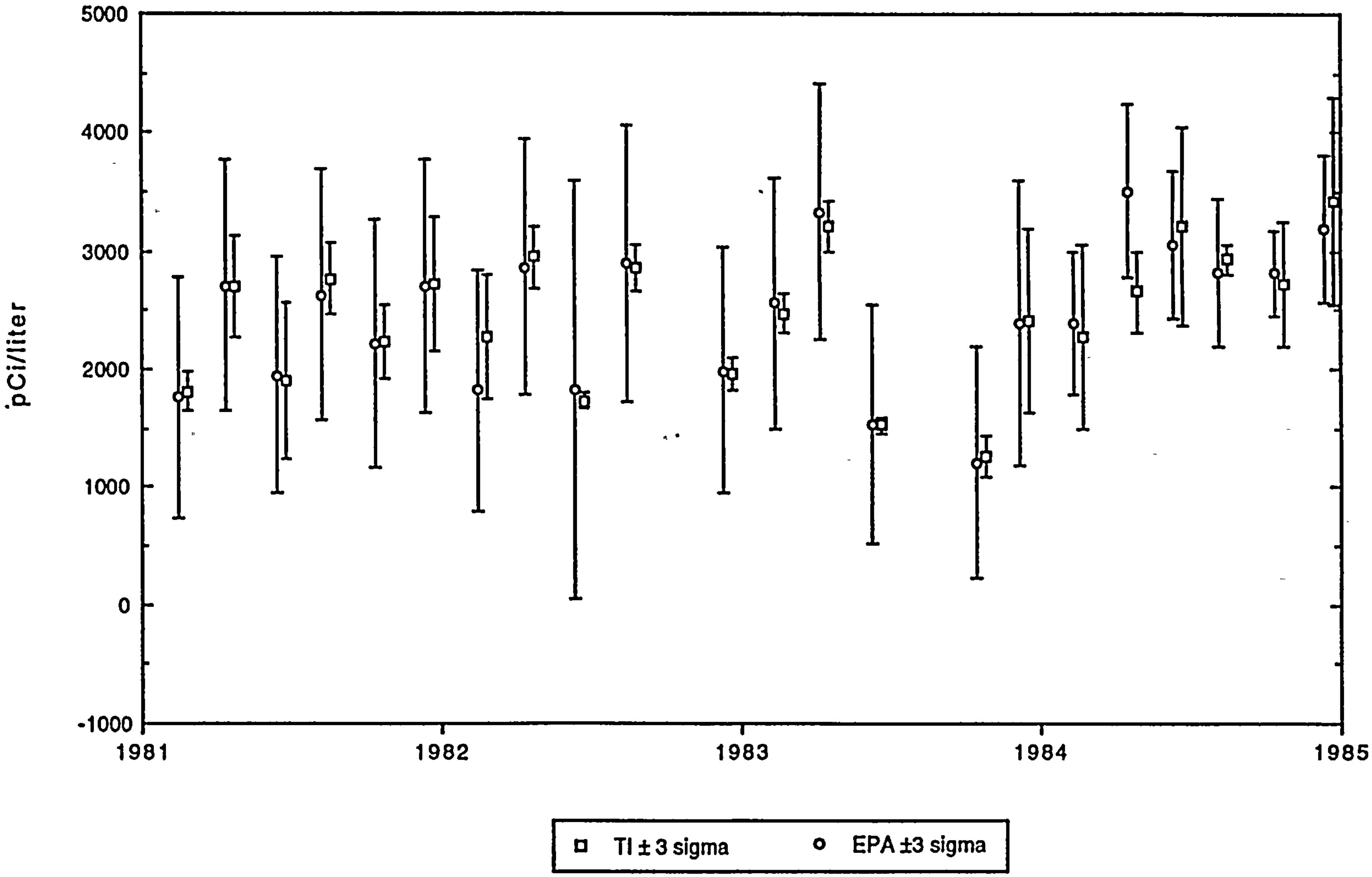
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 2 of 2)



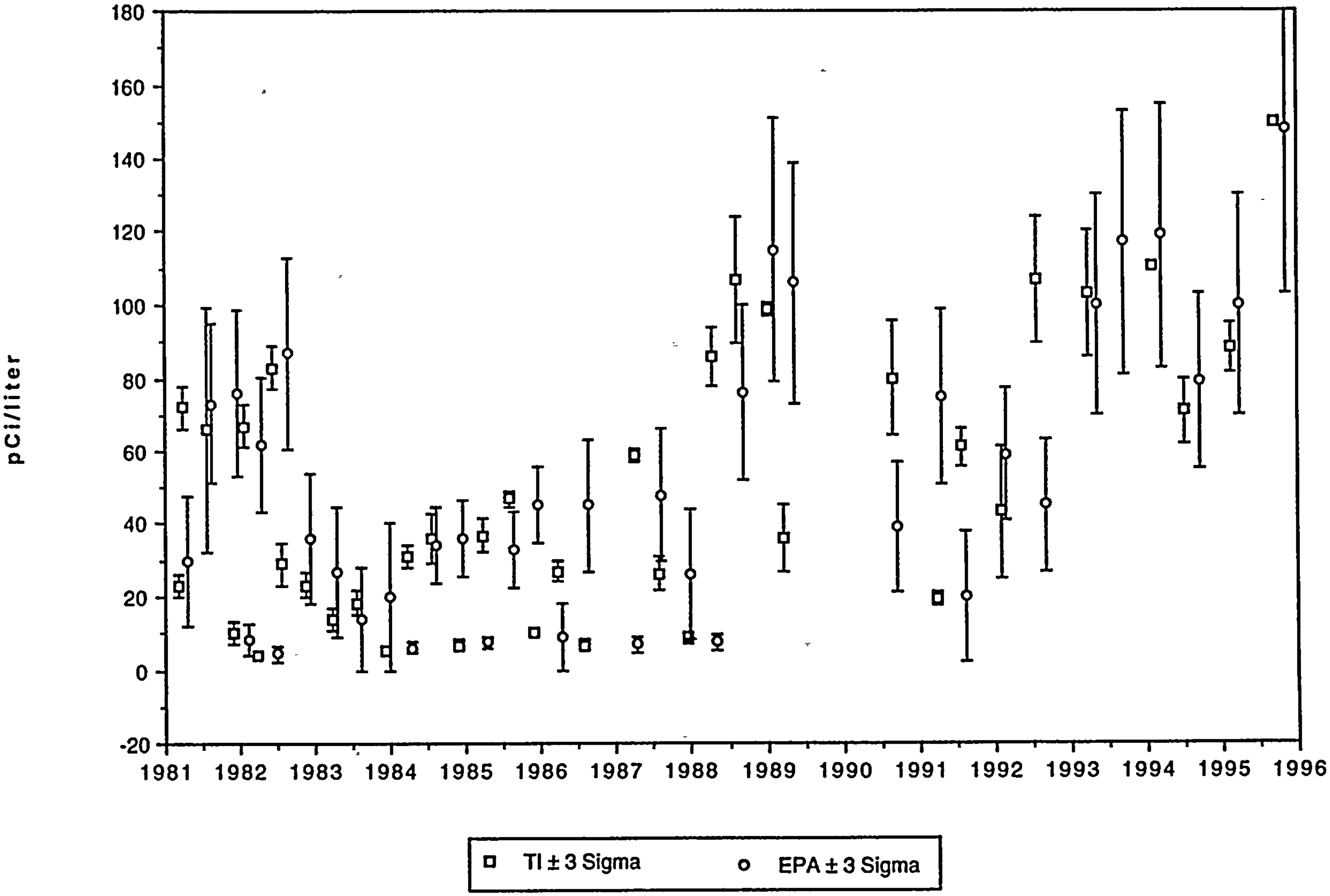
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



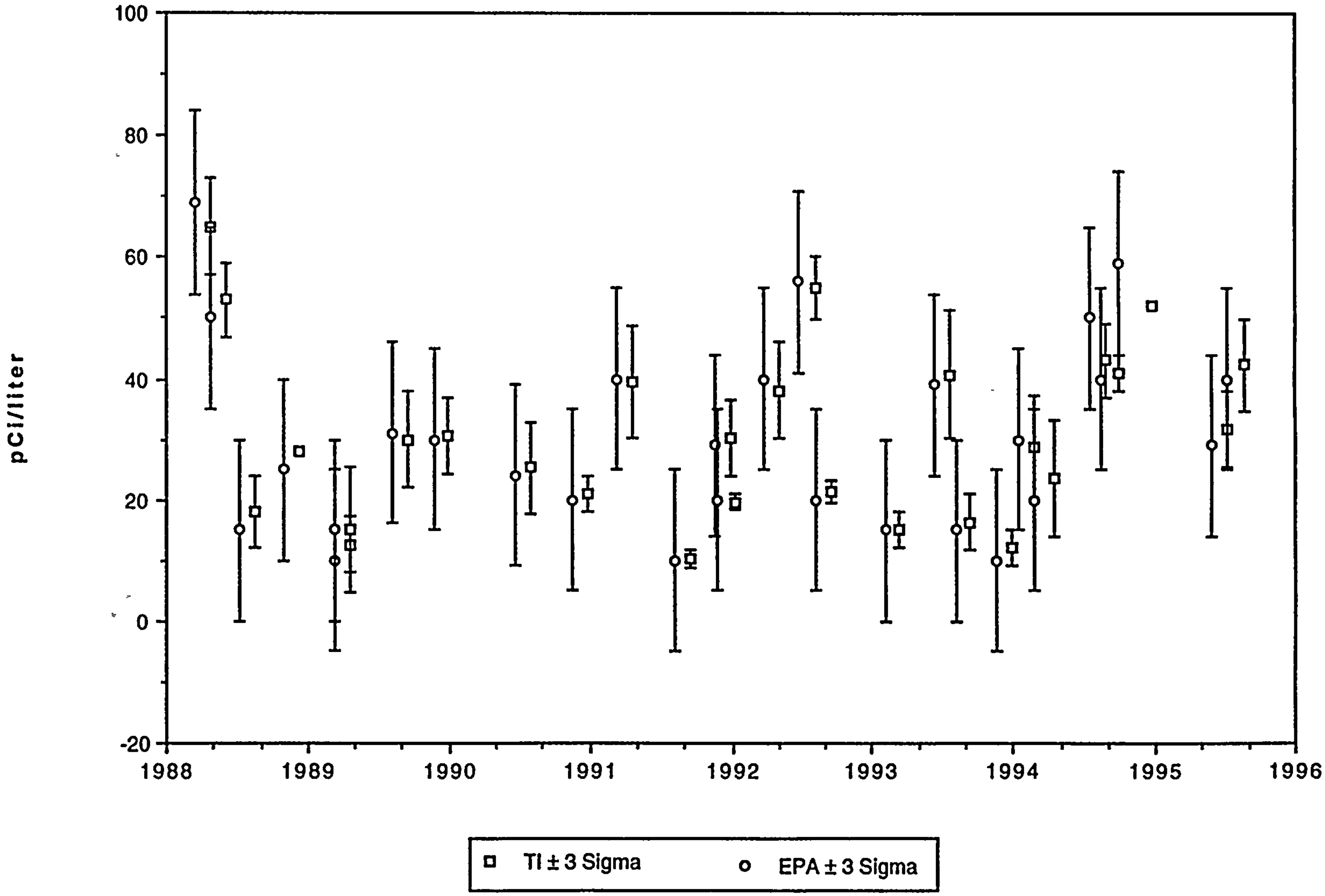
EPA CROSS CHECK PROGRAM

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



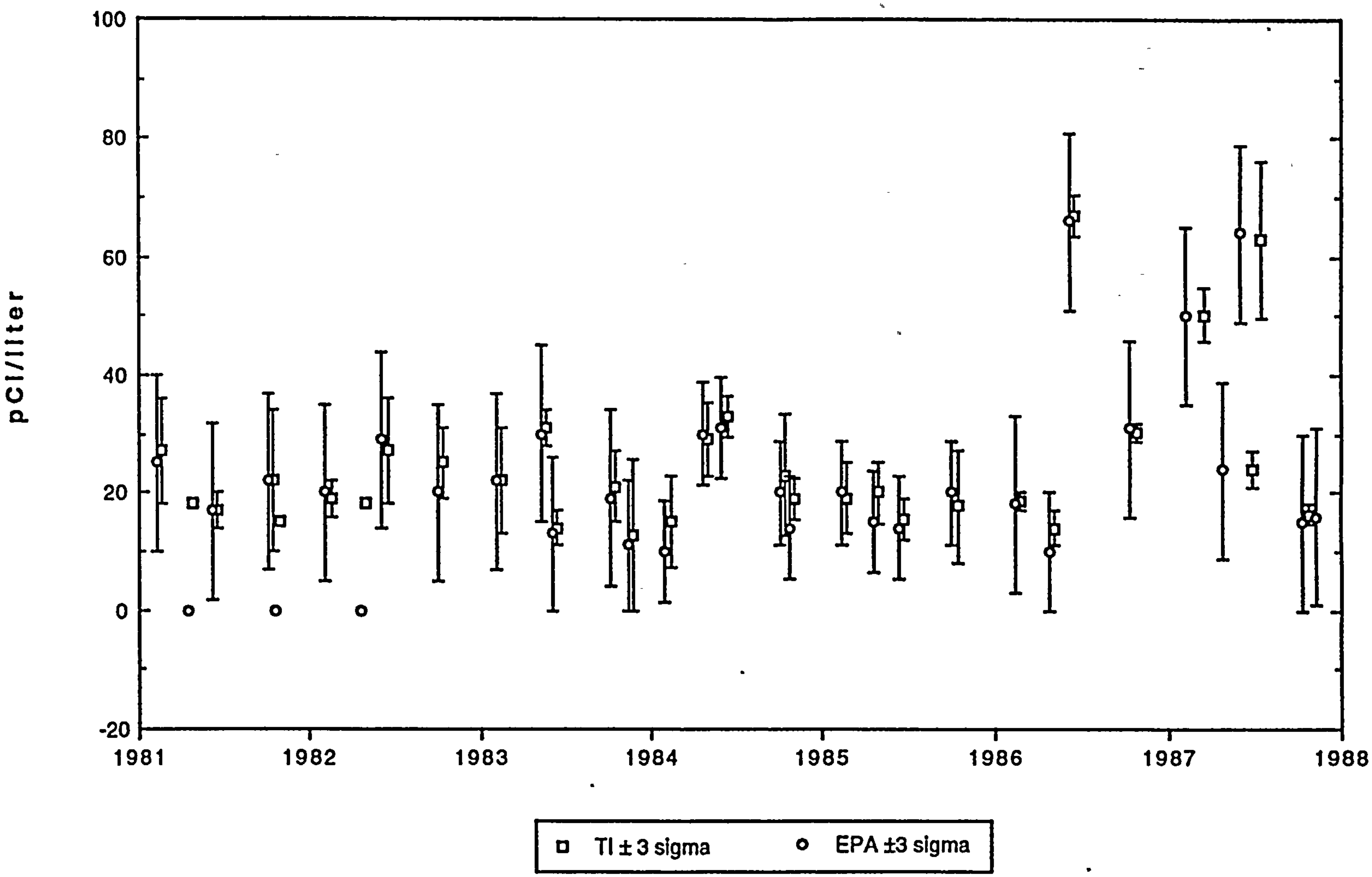
EPA CROSS CHECK PROGRAM

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



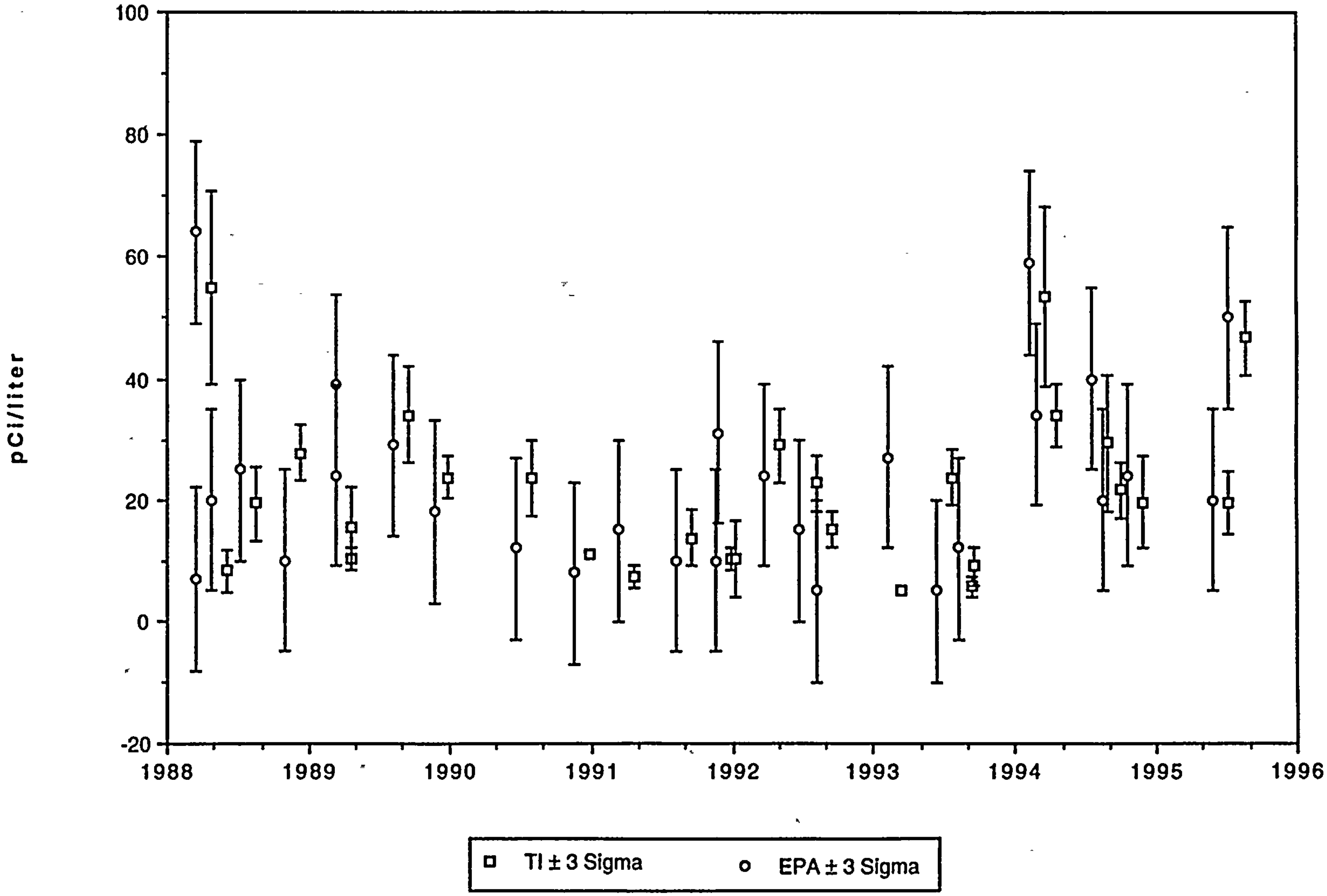
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



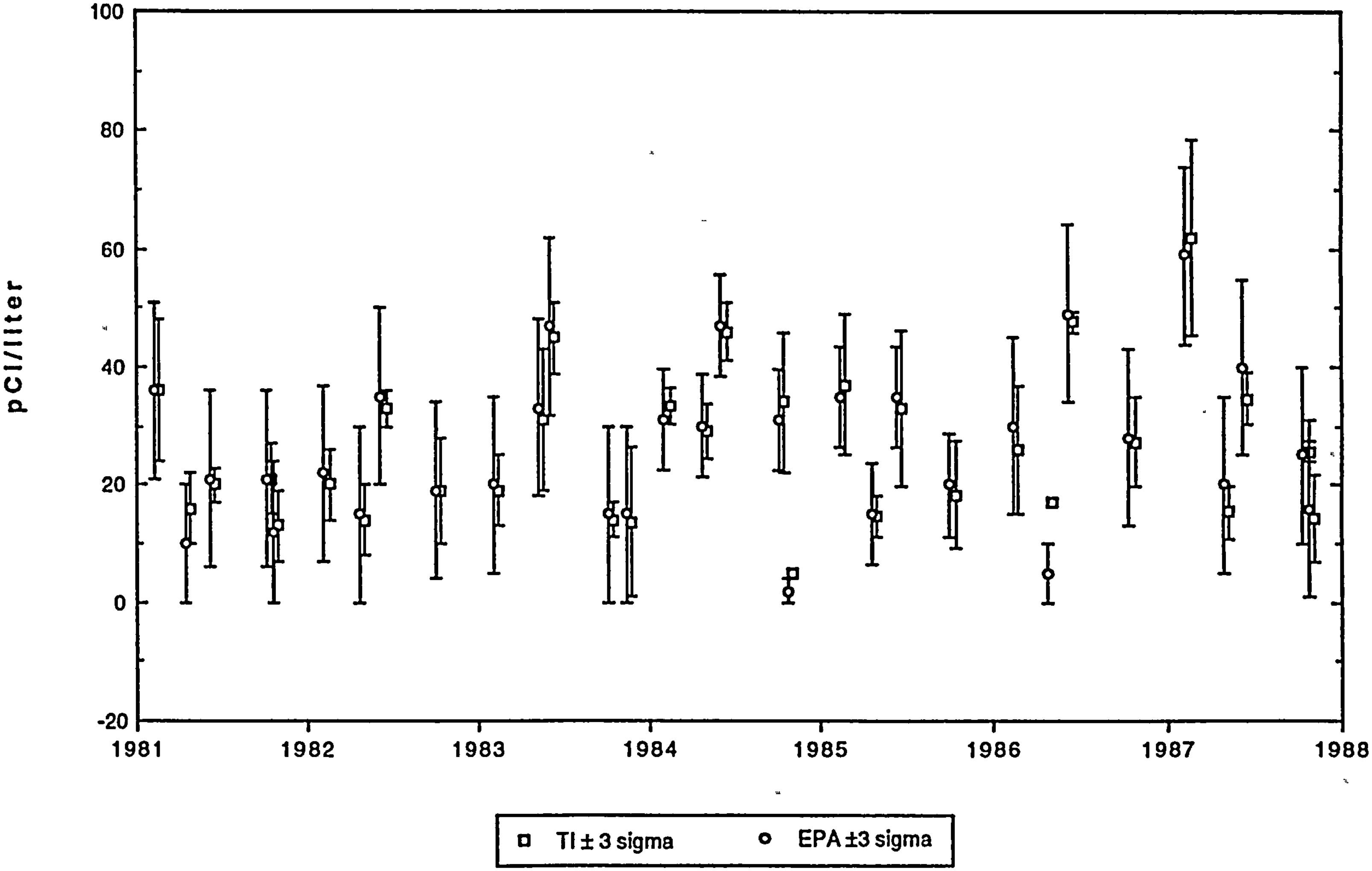
EPA CROSS CHECK PROGRAM

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



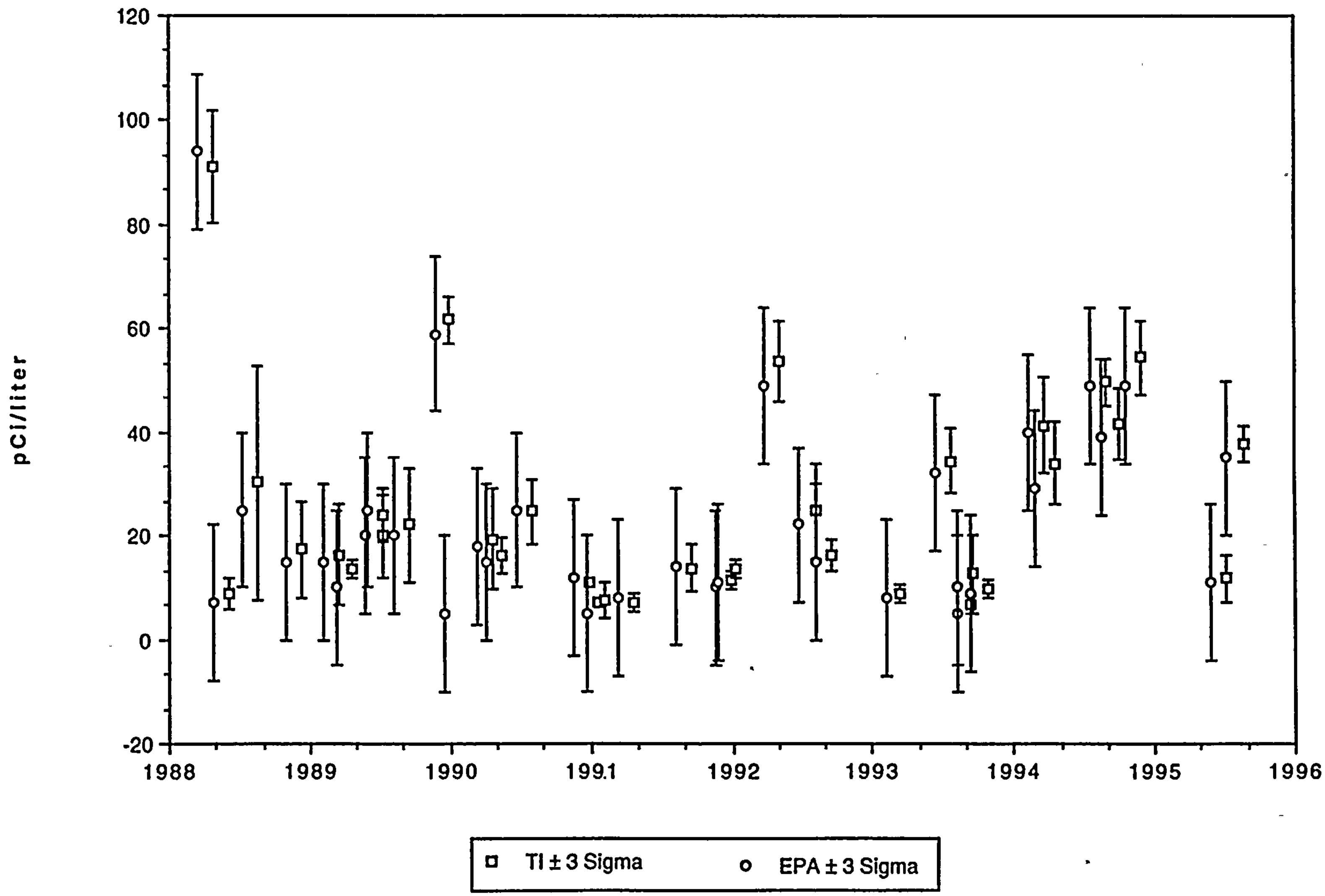
EPA CROSS CHECK PROGRAM

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



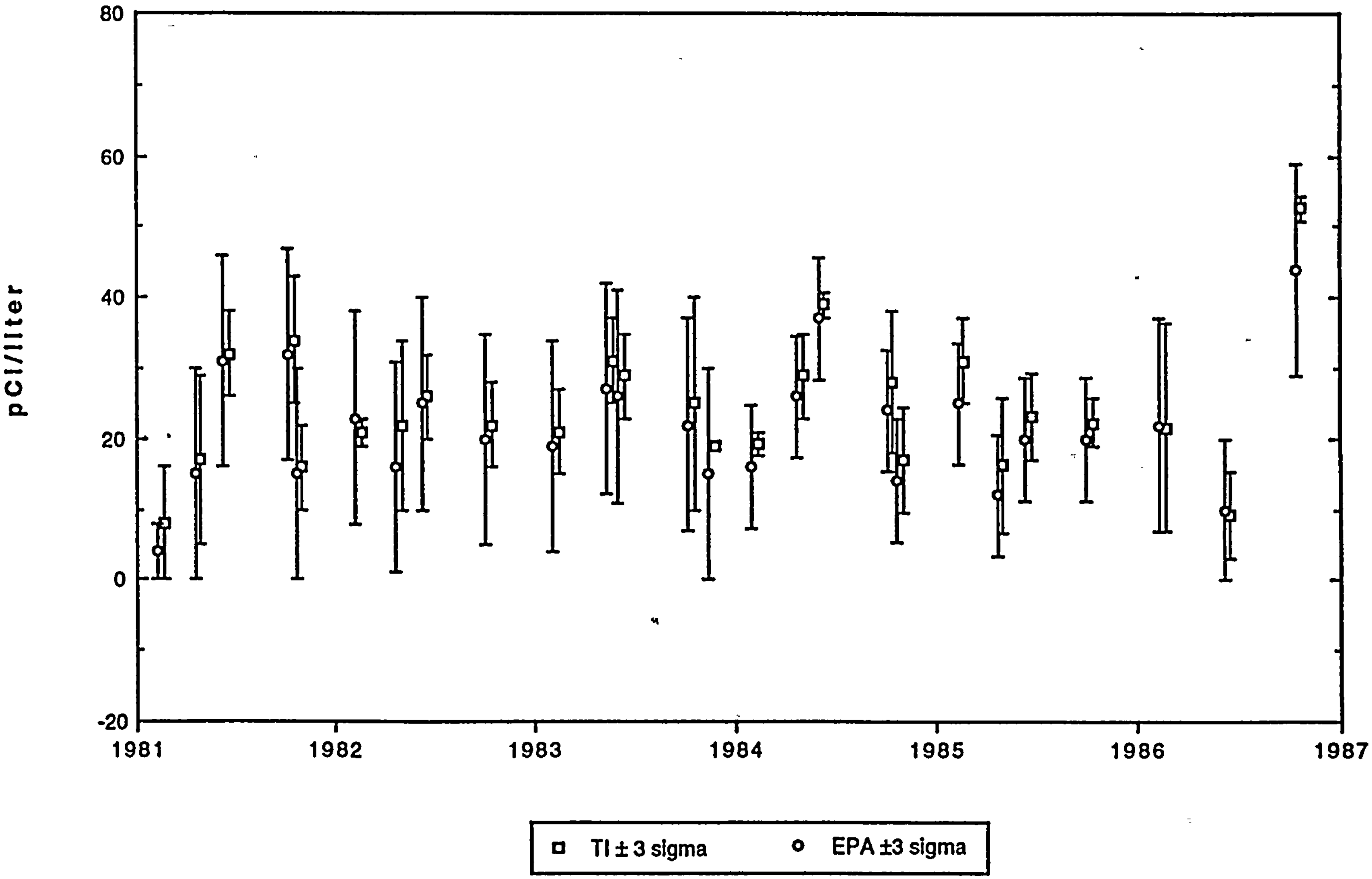
EPA CROSS CHECK PROGRAM

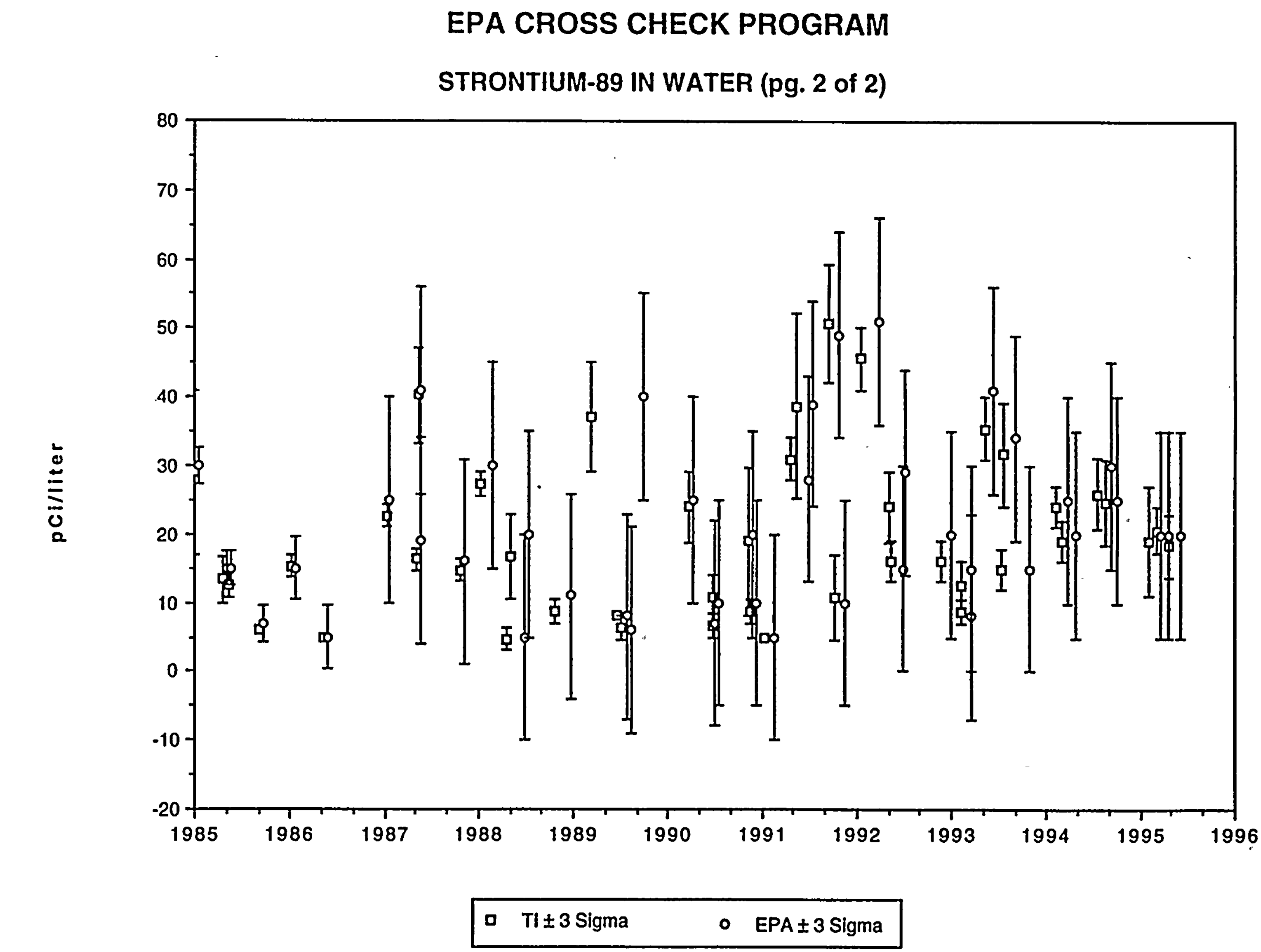
CESIUM-137 IN WATER (pg. 2 of 2)



EPA CROSS CHECK PROGRAM

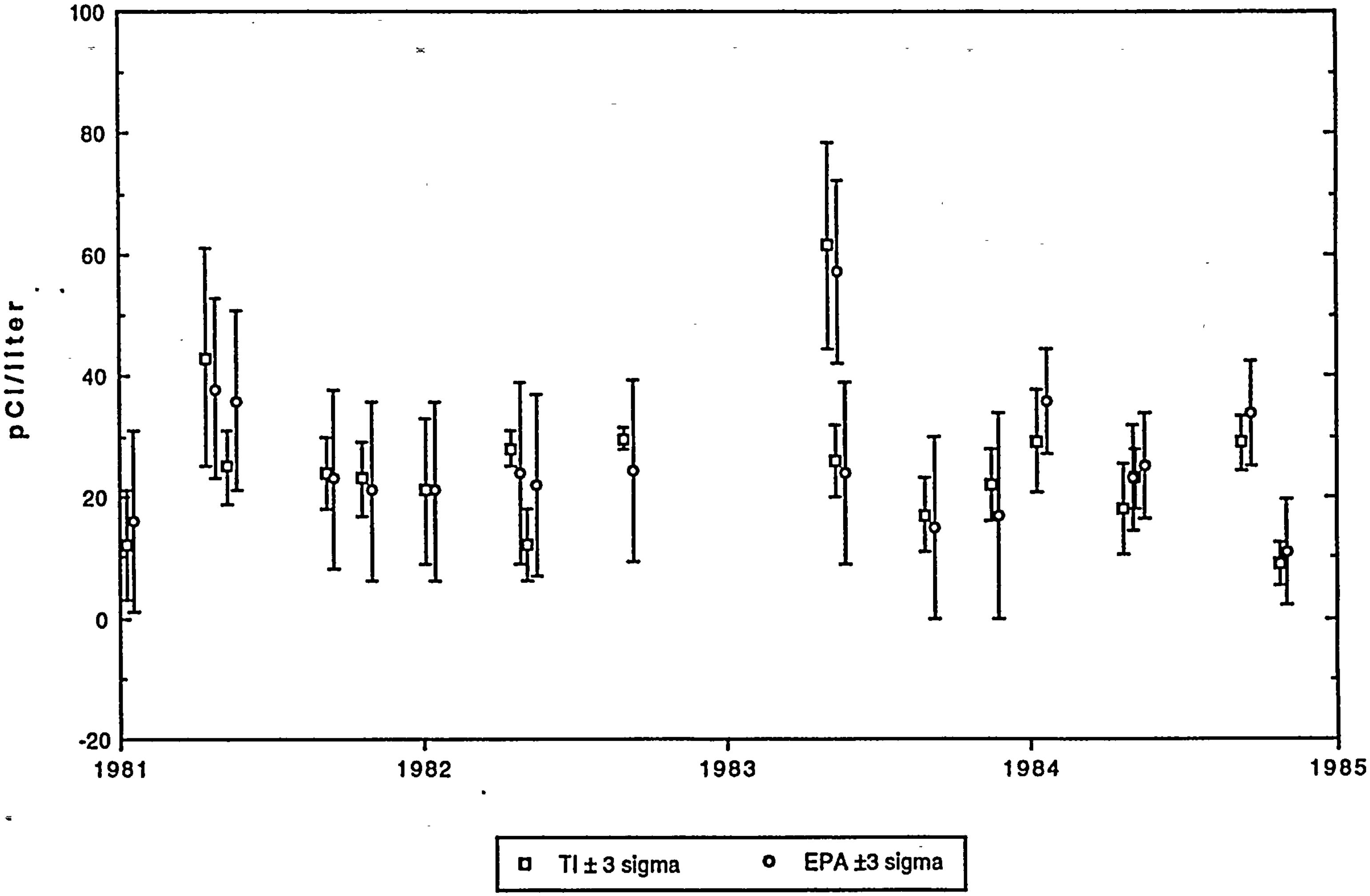
CESIUM-137 IN WATER (pg. 1 of 2)




EPA CROSS CHECK PROGRAM
STRONTIUM-89 IN WATER (pg. 2 of 2)
pCi/liter
80
70
60
50
40
30
20
10
0
-10
-20
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
TI ± 3 Sigma
EPA ± 3 Sigma

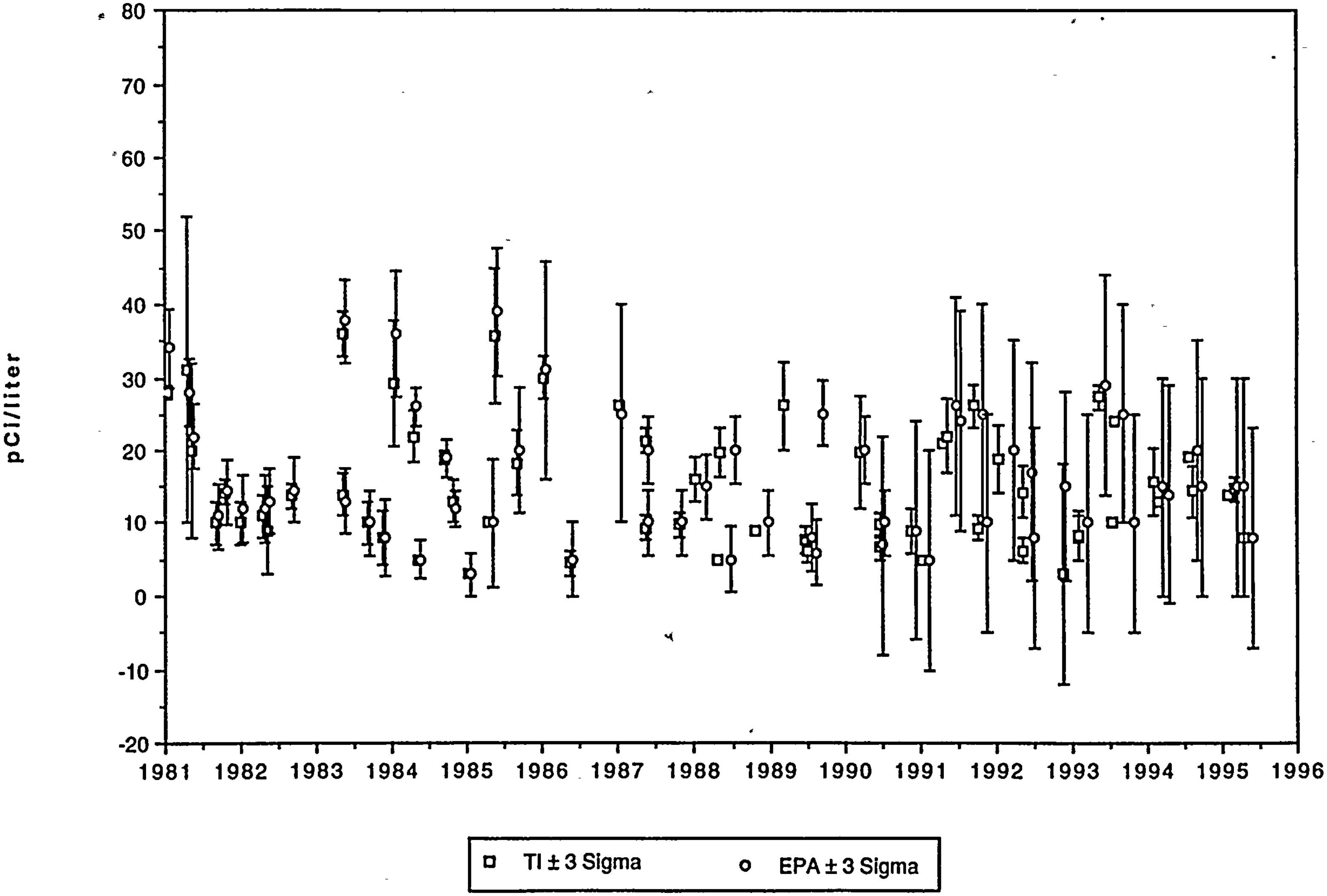
EPA CROSS CHECK PROGRAM

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

REMP deviations for 1995 are listed at the end of this appendix. Where possible, the causes of the deviations have been corrected to prevent recurrence.

Only one deviation involved air samplers during 1995 and it concerned a tripped electrical breaker at station ONS-5 on 08/21/95. The breaker was reset and sampling recommenced. The breaker tripped was determined to be a result of a powerline transient. This was the only occurrence of this type in 1995.

From 01/01/95 through 03/20/95 collection of surface water samples from locations L-2 and L-3 was intermittent due to hazardous conditions caused by shoreline ice. Icy conditions returned to the shoreline on 12/09/95 and samples were not collected the rest of the year.

There were four incidents involving TLDs in 1995. On 02/20/95 the background TLD was discovered to be missing from the South Bend location. The cause appeared to be vandalism (persons unknown reached over the chain-link fence and removed the TLD and its cage) and preventive action included moving this and other like TLDs to an inaccessible section of the fence. A replacement TLD was placed at this location on 03/02/95.

On 07/02/95 TLD OFT-10 was not located on electrical pole #B422-15 or on the ground surrounding the pole. It appeared that the cause was either vandalism or tampering. A replacement TLD was mounted approximately ten feet higher than the previous one had been.

On 10/01/95 TLD OFT-04 was not located on electrical pole #B350-72 or on the ground surrounding the pole. It appeared that the cause was either vandalism or tampering. A replacement TLD was mounted on the pole that same day.

On 01/01/96 TLD OFT-11 was not located on electrical pole #B423-12 or on the ground surrounding the pole. Once again, it appeared that the cause was either vandalism or tampering. A replacement TLD was mounted on the pole that same day. As preventive action all cages holding TLDs on electrical poles, were rehung using stainless steel wire and nails. This was in addition to existing velcro on the cages and poles.

There were several incidents involving groundwater samples in 1995 although all samples were collected within the 25% grace period allowed by the Offsite Dose Calculation Manual.

On 01/29/95 the pump used for well W-5 broke before the sample could be obtained. On 02/02/95 a replacement pump was used for sample collection.

On 04/30/95 there was no power to wells W-1 and W-3. Power was restored and W-3 was sampled on 05/04/95 and W-1 was sampled on 05/18/95.

The well sample obtained from well W-01 on 05/18/95 failed to meet the I-131 LLD. Teledyne Brown neglected to perform the analysis in a timely manner to meet the required detection limit. This was brought to their attention by plant personnel on 06/30/95. This type of error had never occurred during the several years that Teledyne had been performing REMP analysis for American Electric Power.

On 07/30/95 there was no power to well W-3. Power was restored the next day and the well was sampled on 08/01/95.

On 10/29/95 wells W-3 and W-9 were without power. Well W-14 had been disconnected as a new well was in the process of being drilled at this location. A sample from well W-3 was subsequently obtained on 11/05/95 and W-9 and W-14 were sampled on 11/13/95.

There were only two incidents involving milk samples during 1995. On 04/28/95 the Schutze farm "sold the herd" thus ending their participation in the REMP milk sampling program. At that time and through the end of 1995 there were three indicator farms and two background farms participating in the program. On 12/22/95 the milk sample from the Warmbein farm (indicator) was not obtained. The farmer had not been milking his herd due to health problems.

Required lake sediment samples were not obtained from locations SL-2 and SL-3 on 10/16/95. This was not discovered until after the 25% grace period. The 1996 sample schedule was checked and sediment sample collection is scheduled for 04/16/96 and 10/16/96.

REMP Exceptions For Scheduled Sampling And Analysis During 1995

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
ONS-5	Air Particulate/ Air Iodine	08/14/95 08/21/95	Power off
L2	Surface Water	01/01/95 - 03/20/95	Lake Shoreline frozen. Sample collection was intermittent.
L3	Surface Water	01/01/95 - 03/20/95	Lake Shoreline frozen. Sample collection was intermittent.
L2	Surface Water	12/09/95 - 12/31/95	Lake Shoreline frozen. Sample collection not performed.
L3	Surface Water	12/09/95 - 12/31/95	Lake Shoreline frozen. Sample collection not performed.
SBN	TLD	First Qtr.	Original TLD missing and replaced on 03/02/95.
OFS-10	TLD	Second Qtr.	TLD missing.
OFS-4	TLD	Third Qtr.	TLD missing.
OFS-11	TLD	Fourth Qtr.	TLD missing.
W-5	Groundwater	01/29/95	Pump was broken, sample collected on 02/02/95.
W-1, W-3	Groundwater	04/30/95	Power outage; samples collected on 05/04/95 and 05/18/95
W-1	"	05/18/95	I-131 analysis by rad chem not performed.
W-3	"	07/30/95	Power outage, sample collected on 08/01/95.
W-3	"	10/29/95	Power outage, samaple collected on 11/05/95.
W-9	"	"	Power outage, sample collected on 11/13/95.
W-14	"	"	Driving new well, sample collected on 11/13/95.
Schutze	Milk	04/28/95	All cows sold; no longer participating in program.
Warmbein	Milk	12/22/95	No sample available.
SL-2	Sediment	10/16/95	Sample not obtained.
SL-3	Sediment	10/16/95	Sample not obtained.

APPENDIX F
1995 LAND USE CENSUS

APPENDIX F
SUMMARY OF THE 1995 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 1995 Land Use Census. The following is a summary of the 1995 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 September 22, 1995.

In 1995 there were four deletions to the Michigan Department of Agriculture's list of dairy farms in Berrien County Michigan. One of the deleted farms participated in the REMP Milk Sampling Program during the first part of 1995.

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 September 22, 1995. There were no new residential building permits issued by Lake Township during 1995. 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 1995 were less than the Technical Specification LLDs.

Figure 4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Milk Farm Survey - 1995

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 - 1995

Sector	Year	House (1)	In Feet	Property #	Street Address
A	a	1	2161	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

1995 MILK FARM SURVEY

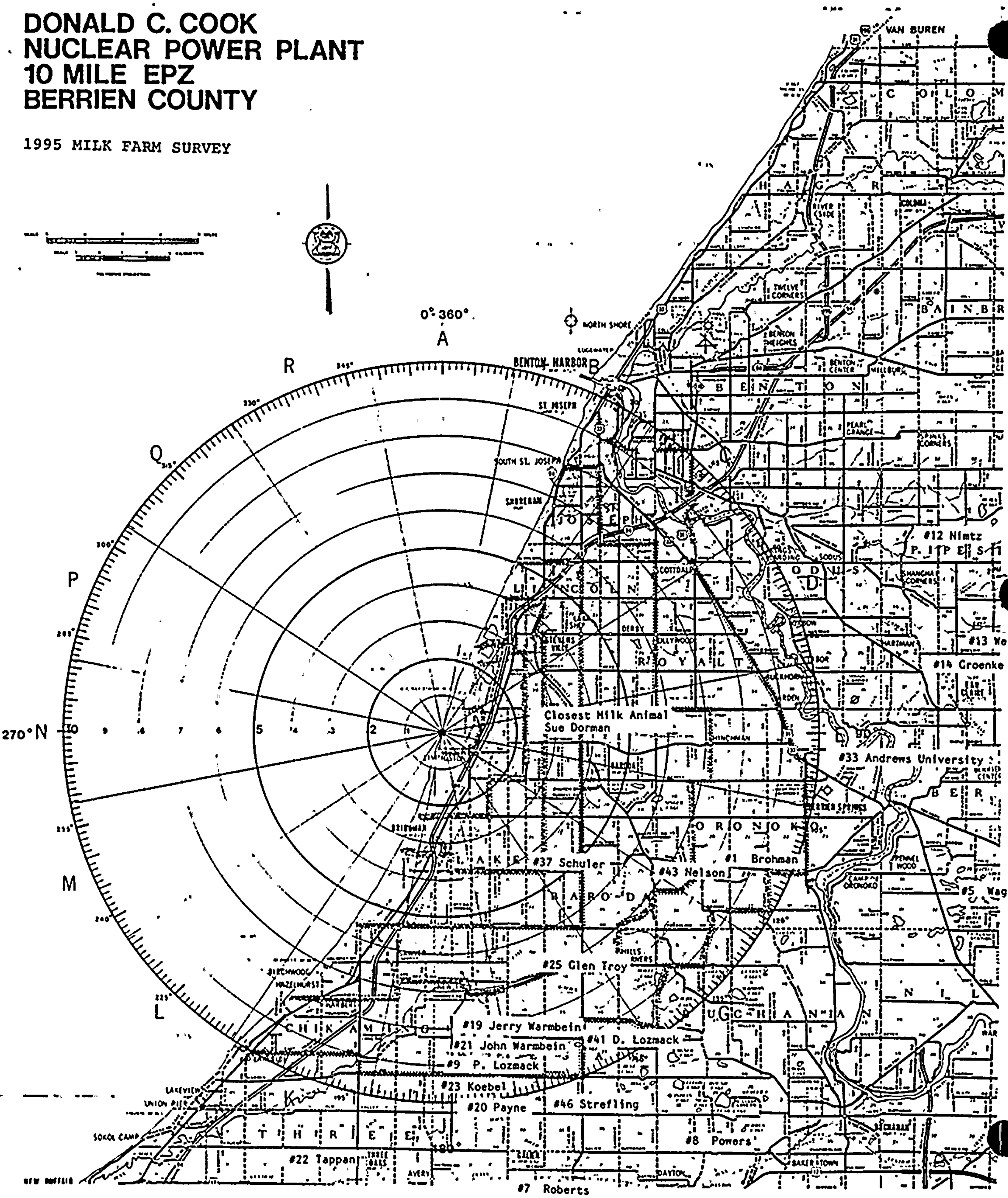
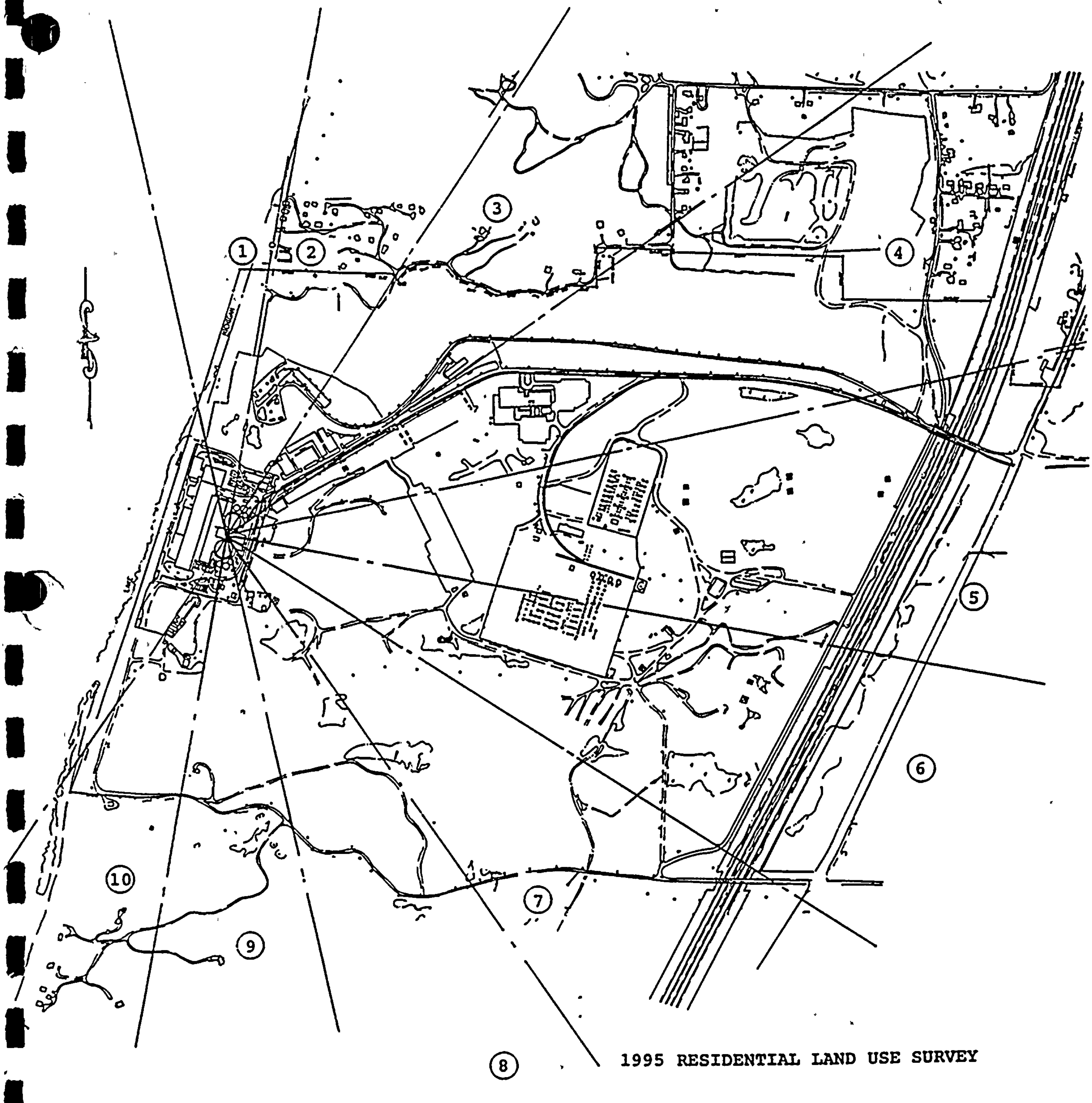


FIGURE 7



1995 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 1995.

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

1995. Analyses performed during the preoperational but not required in 1995, 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, 1995 December 31, 1995 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 Department Manager 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 1995

Results of Duplicate Analyses for 1995

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates	Gr-Beta	2.0 ± 0.2 E-02	2.2 ± 0.2 E-02
Results in Units of	"	1.1 ± 0.2 E-02	1.4 ± 0.2 E-02
10^{-3} pCi/m^3	"	2.0 ± 0.2 E-02	2.2 ± 0.2 E-02
	"	1.6 ± 0.2 E-02	1.3 ± 0.2 E-02
	"	1.4 ± 0.2 E-02	1.4 ± 0.2 E-02
	"	1.3 ± 0.2 E-02	1.4 ± 0.2 E-02
	"	1.3 ± 0.2 E-02	1.4 ± 0.2 E-02
	"	1.4 ± 0.2 E-02	1.4 ± 0.2 E-02
	"	1.2 ± 0.2 E-02	1.2 ± 0.2 E-02
	"	1.2 ± 0.2 E-02	1.1 ± 0.2 E-02
	"	1.1 ± 0.2 E-02	1.1 ± 0.2 E-02
	"	2.4 ± 0.2 E-02	2.4 ± 0.2 E-02
	"	1.4 ± 0.2 E-02	1.2 ± 0.2 E-02
	"	3.0 ± 0.2 E-02	3.0 ± 0.2 E-02
	"	2.4 ± 0.2 E-02	2.7 ± 0.3 E-02
	"	2.9 ± 0.2 E-02	3.0 ± 0.3 E-02
	"	2.0 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	2.5 ± 0.2 E-02	2.6 ± 0.2 E-02
	"	1.3 ± 0.2 E-02	1.5 ± 0.2 E-02
	"	1.7 ± 0.2 E-02	1.7 ± 0.2 E-02
	"	2.2 ± 0.3 E-02	2.3 ± 0.3 E-02
	"	2.1 ± 0.2 E-02	2.2 ± 0.2 E-02
	"	2.6 ± 0.2 E-02	2.4 ± 0.2 E-02
	"	2.3 ± 0.2 E-02	2.3 ± 0.2 E-02
	"	4.7 ± 0.3 E-02	4.7 ± 0.3 E-02
	"	1.9 ± 0.2 E-02	2.0 ± 0.2 E-02
Air Particulates/	Iodine-131	L. T. 1. E-02	L. T. 1. E-02
Charcoal Filters	"	L. T. 2. E-02	L. T. 9. E-03
Results in Units of	"	L. T. 2. E-02	L. T. 1. E-02
10^{-3} pCi/m^3	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 9. E-03	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 8. E-03
	"	L. T. 2. E-02	L. T. 7. E-03

(a) All gamma results less than the detection limit (LLD).

Results of Duplicate Analyses for 1995 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates/ Charcoal Filters	Iodine-131	L. T. 1. E-02	L. T. 1. E-02
Results in Units of	"	L. T. 2. E-02	L. T. 3. E-02
10^{-3} pCi/m^3	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 8. E-03	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
Surface Water	Gamma	(a)	(a)
Results in Units of pCi/liter	H-3	L. T. 2. E 02	L. T. 2. E 02
Ground Water	Gamma	(a)	(a)
Results in Units of	H-3	7.6 ± 2.5 E 02	6.7 ± 1.8 E 02
pCi/liter	Gamma	(a)	(a)
	H-3	L. T. 3. E 02	L. T. 3. E 02
	I-131	L. T. 8. E-01	L. T. 8. E-01
Drinking Water	Gr-Beta	3.5 ± 1.0 E 00	3.1 ± 1.0 E 00
Results in Units of	Gr-Beta	2.8 ± 1.0 E 00	3.0 ± 1.0 E 00
pCi/liter	Gamma	(a)	(a)
	Gamma	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)
Milk	K-40	1.32 ± 0.13 E 03	1.27 ± 0.13 E 03
Results in Units of	K-40	1.25 ± 0.12 E 03	1.43 ± 0.14 E 03
pCi/liter	K-40	1.39 ± 0.14 E 03	1.45 ± 0.15 E 03
	K-40	1.34 ± 0.13 E 03	1.23 ± 0.12 E 03
	K-40	1.31 ± 0.13 E 03	1.54 ± 0.15 E 03
	I-131	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)

(a) All gamma results less than the detection limit (LLD).

Teledyne Brown Engineering In-House Spiked Sample Results - 1995
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	2.1 ± 0.5 E 01	1.6 - 2.6 E 01
Gamma (Cs-137)	2.2 ± 0.3 E 04	1.9 - 2.5 E 04
H-3 (LS)	1.3 ± 0.4 E 03	0.9 - 1.7 E 03 (1/1-6/30/95
H-3 (LS)	1.2 ± 0.4 E 03	0.8 - 1.6 E 03 (7/1-10/24/95)
H-3 (LS)	1.5 ± 0.5 E 03	1.0 - 2.0 E 03 (10/25-12/31/95)

TI #	Analysis Date	Gross Beta Activity (pCi/l)
72885	01/04/95	1.9 ± 0.1 E 01
73599	01/11/95	2.1 ± 0.1 E 01
74376	01/18/95	2.0 ± 0.2 E 01
75039	01/25/95	2.1 ± 0.1 E 01
75543	02/01/95	2.0 ± 0.1 E 01
75941	02/08/95	1.7 ± 0.1 E 01
76667	02/15/95	2.1 ± 0.1 E 01
77216	02/22/95	2.2 ± 0.2 E 01
77620	03/01/95	1.7 ± 0.1 E 01
78069	03/08/95	1.9 ± 0.2 E 01
78912	03/15/95	1.7 ± 0.1 E 01
79261	03/22/95	1.6 ± 0.1 E 01
79645	03/29/95	1.8 ± 0.1 E 01
80185	94/05/95	2.0 ± 0.1 E 01
80856	04/05/95	2.0 ± 0.1 E 01
81808	04/19/95	3.4 ± 0.2 E 01
82167	04/26/95	2.3 ± 0.2 E 01
82919	05/03/95	2.0 ± 0.2 E 01
83676	05/10/95	2.0 ± 0.2 E 01
84371	05/17/95	1.8 ± 0.1 E 01
85196	05/24/95	1.8 ± 0.1 E 01
86172	05/31/95	2.2 ± 0.2 E 01
86722	06/07/95	2.1 ± 0.1 E 01
87824	06/14/95	1.7 ± 0.1 E 01
88456	06/21/95	1.9 ± 0.1 E 01
89162	06/28/95	1.6 ± 0.1 E 01
89683	07/05/95	1.6 ± 0.1 E 01
90252	07/12/95	1.8 ± 0.1 E 01
91420	07/19/95	2.5 ± 0.2 E 01
92015	07/26/95	1.5 ± 0.1 E 01
92679	08/02/95	2.4 ± 0.2 E 01
93092	08/09/95	1.9 ± 0.1 E 01
93998	08/16/95	1.7 ± 0.1 E 01

TI #	Analysis Date	Gross Beta Activity (pCi/l)
94421	08/23/95	2.2 ± 0.1 E 01
95022	08/30/95	1.9 ± 0.1 E 01
95640	09/06/95	2.2 ± 0.2 E 01
96305	09/13/95	2.0 ± 0.1 E 01
97469	09/20/95	1.9 ± 0.1 E 01
98098	09/27/95	2.1 ± 0.1 E 01
98755	10/04/95	2.1 ± 0.2 E 01
99407	10/11/95	1.6 ± 0.1 E 01
00319	10/18/95	1.9 ± 0.1 E 01
01030	10/25/95	2.1 ± 0.2 E 01
01808	11/01/95	1.8 ± 0.1 E 01
02307	11/08/95	1.9 ± 0.1 E 01
03161	11/15/95	2.5 ± 0.2 E 01
03595	11/22/95	2.3 ± 0.2 E 01
04730	12/06/95	2.6 ± 0.2 E 01
05604	12/13/95	2.0 ± 0.1 E 01
05953	12/20/95	2.4 ± 0.2 E 01
06466	12/27/95	2.3 ± 0.2 E 01
06806	01/03/96	2.0 ± 0.2 E 01

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
72890	01/04/95	2.20 ± 0.22 E 04
73604	01/11/95	2.27 ± 0.23 E 04
74381	01/18/95	2.24 ± 0.22 E 04
75044	01/25/95	2.15 ± 0.22 E 04
75548	02/01/95	2.27 ± 0.23 E 04
76672	02/15/95	2.28 ± 0.23 E 04
77221	02/22/95	2.09 ± 0.21 E 04
07625	03/01/95	2.22 ± 0.22 E 04
78074	03/08/95	2.26 ± 0.23 E 04
78917	03/15/95	2.00 ± 0.20 E 04
79266	03/22/95	2.31 ± 0.23 E 04
79650	03/29/95	2.28 ± 0.23 E 04
80190	04/05/95	2.24 ± 0.22 E 04
80861	04/12/95	2.30 ± 0.23 E 04
81817	04/19/95	2.19 ± 0.22 E 04
82172	04/26/95	2.21 ± 0.22 E 04
82924	05/03/95	2.09 ± 0.21 E 04
83681	05/10/95	2.30 ± 0.23 E 04
84376	05/17/95	2.26 ± 0.23 E 04
85201	05/24/95	2.19 ± 0.22 E 04
86177	05/31/95	2.26 ± 0.23 E 04

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
86727	06/07/95	2.20 ± 0.22 E 04
87765	06/14/95	2.22 ± 0.22 E 04
89461	06/21/95	2.25 ± 0.23 E 04
89688	07/05/95	2.21 ± 0.22 E 04
90257	07/12/95	2.32 ± 0.23 E 04
91425	07/19/95	2.26 ± 0.23 E 04
92020	07/26/95	2.27 ± 0.23 E 04
92684	08/02/95	2.16 ± 0.22 E 04
93097	08/09.95	2.09 ± 0.21 E 04
94003	08/16/95	2.16 ± 0.22 E 04
94426	08/23/95	2.26 ± 0.23 E 04
95027	08/30/95	2.26 ± 0.23 E 04
95645	09/06/95	2.27 ± 0.23 E 04
96310	09/13/95	2.23 ± 0.22 E 04
97474	09/20/95	2.26 ± 0.23 E 04
98103	09/27/95	2.32 ± 0.23 E 04
98760	10/04/95	2.34 ± 0.23 E 04
99412	10/11/95	2.36 ± 0.24 E 04
00324	10/18/95	2.22 ± 0.22 E 04
01035	10/25/95	2.34 ± 0.23 E 04
01813	11/01/95	2.30 ± 0.23 E 04
02312	11/08/95	2.21 ± 0.22 E 04
03166	11/15/95	2.21 ± 0.22 E 04
03600	11/22/95	2.29 ± 0.23 E 04
04151	11/29/95	2.23 ± 0.22 E 04
04735	12/06/95	2.14 ± 0.21 E 04
05609	12/13/95	2.19 ± 0.22 E 04
05958	12/20/95	2.54 ± 0.25 E 04
06471	12/27/95	2.47 ± 0.25 E 04
06811	01/03/96	2.23 ± 0.22 E 04

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
72887	01/04/95	1.2 ± 0.1 E 03
73601	01/11/95	1.37 ± 0.15 E 03
74378	01/18/95	1.40 ± 0.15 E 03
75041	01/25/95	1.39 ± 0.15 E 03
75545	02/01/95	1.29 ± 0.15 E 03
75943	02/08/95	1.19 ± 0.15 E 03
76669	02/15/95	1.36 ± 0.15 E 03
77218	02/22/95	1.33 ± 0.15 E 03
77622	03/01/95	1.22 ± 0.14 E 03
78071	03/08/95	1.46 ± 0.15 E 03
78914	03/15/95	1.07 ± 0.15 E 03
79263	03/22/95	1.27 ± 0.16 E 03

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
79647	03/29/95	1.31 ± 0.16 E 03
80187	04/05/95	1.21 ± 0.15 E 03
80858	04/12/95	1.34 ± 0.15 E 03
81814	04/19/95	1.21 ± 0.15 E 03
82169	04/26/95	1.45 ± 0.15 E 03
82921	05/03/95	1.31 ± 0.16 E 03
83678	05/10/95	1.47 ± 0.17 E 03
84373	05/17/95	1.37 ± 0.17 E 03
85198	05/24/95	1.27 ± 0.17 E 03
86174	05/31/95	1.36 ± 0.16 E 03
86724	06/07/95	1.54 ± 0.17 E 03
87762	06/14/95	1.35 ± 0.16 E 03
88458	06/21/95	1.54 ± 0.17 E 03
89164	06/28/95	1.14 ± 0.16 E 03
89685	07/05/95	1.14 ± 0.17 E 03
90254	07/12/95	1.19 ± 0.17 E 03
91422	07/19/95	1.33 ± 0.19 E 03
92017	07/26/95	1.19 ± 0.18 E 03
92681	08/02/95	1.27 ± 0.18 E 03
93094	08/09/95	1.23 ± 0.17 E 03
94000	08/16/95	1.23 ± 0.17 E 03
94423	08/23/95	1.56 ± 0.18 E 03
95024	08/30/95	1.27 ± 0.17 E 03
95642	09/06/95	1.62 ± 0.18 E 03
96307	09/13/95	1.66 ± 0.19 E 03
97471	09/20/95	1.13 ± 0.17 E 03
98100	09/27/95	1.17 ± 0.17 E 03
98757	10/04/95	1.30 ± 0.18 E 03
99409	10/11/95	1.03 ± 0.16 E 03
00321	10/18/95	1.22 ± 0.19 E 03
01032	10/25/95	1.44 ± 0.17 E 03
01810	11/01/95	1.47 ± 0.17 E 03
02309	11/08/95	1.46 ± 0.16 E 03
03163	11/15/95	1.39 ± 0.17 E 03
03597	11/22/95	1.42 ± 0.16 E 03
04148	11/29/95	1.48 ± 0.16 E 03
04732	12/06/95	1.44 ± 0.15 E 03
05606	12/13/95	1.63 ± 0.16 E 03
05955	12/20/95	1.29 ± 0.15 E 03
06468	12/27/95	1.32 ± 0.14 E 03
06808	01/03/96	1.44 ± 0.15 E 03

Teledyne Brown Engineering In-House Blanks Sample Results - 1995
Water

GROSS BETA BLANKS

TI #	Analysis Date	Gross Beta Activity (pCi/l)
72884	01/04/95	L. T. 8. E-01
73598	01/11/95	L. T. 7. E-01
74375	01/18/95	L. T. 1. E 00
75038	01/25/95	L. T. 8. E-01
75542	02/01/95	L. T. 7. E-01
75940	02/08/95	L. T. 7. E-01
76666	02/15/95	L. T. 7. E-01
77215	02/22/95	L. T. 7. E-01
77619	03/01/95	L. T. 7. E-01
78068	03/08/95	L. T. 9. E-01
78911	03/15/95	L. T.. 1. E 00
79260	03/22/95	L. T. 8. E-01
79644	03/29/95	L. T. 8. E-01
80184	04/05/95	L. T. 8. E-01
80855	04/12/95	L. T. 7. E-01
81811	04/19/95	L. T. 1. E 00
82166	04/26/95	L. T. 9. E-01
82918	05/03/95	L. T. 9. E-01
83675	05/10/95	L. T. 1. E 00
84370	05/17/95	L. T. 8. E-01
85195	05/24/95	L. T. 1. E 00
86171	05/31/95	L. T. 9. E-01
86721	06/07/95	L. T. 8. E-01
87760	06/14/95	L. T. 1. E 00
88455	06/21/95	L. T. 6. E-01
89161	06/28/95	L. T. 6. E-01
89682	07/05/95	L. T. 7. E-01
90251	07/12/95	L. T. 6. E-01
91419	07/19/95	L. T. 7. E-01
92014	07/26/95	L. T. 9. E-01
92678	08/02/95	L. T. 9. E-01
93091	08/09/95	L. T. 8. E-01
93997	08/16/95	L. T. 7. E-01
94420	08/23/95	L. T. 8. E-01
95021	08/30/95	L. T. 9. E-01
95639	09/06/95	L. T. 7. E-01
96304	09/13/95	L. T. 6. E-01
97468	09/20/95	L. T. 8. E-01
98097	09/27/95	L. T. 9. E-01
98754	10/04/95	L. T. 8. E-01
99406	10/11/95	L. T. 1. E 00

GROSS BETA - BLANKS (Cont.)

TI #	Analysis Date	Gross Beta Activity (pCi/l)
00318	10/18/95	L. T. 8. E-01
01029	10/25/95	L. T. 8. E-01
01807	11/01/95	L. T. 9. E-01
02306	11/08/95	L. T. 8. E-01
03160	11/15/95	L. T. 1. E 00
03594	11/22/95	L. T. 5. E-01
04145	11/29/95	L. T. 8. E-01
04729	12/06/95	L. T. 8. E-01
05603	12/13/95	L. T. 7. E-01
05952	12/20/95	L. T. 8. E-01
06465	12/27/95	L. T. 8. E-01
06805	01/03/96	L. T. 8. E-01

TRITIUM - (H-3) - BLANKS

TI #	Analysis Date	Activity (pCi/l)
72889	01/04/95	L. T. 2. E 02
73603	01/11/95	L. T. 1.48 E 02
74380	01/18/95	L. T. 1.51 E 02
75043	01/25/95	L. T. 1.61 E 02
75547	02/01/95	L. T. 1.60 E 02
75945	02/08/95	L. T. 1.73 E 02
76671	02/15/95	L. T. 1.53 E 02
77220	02/22/95	L. T. 1.55 E 02
77624	03/01/95	L. T. 1.57 E 02
78073	03/08/95	L. T. 1.49 E 02
78916	03/15/95	L. T. 1.85 E 02
79625	03/22/95	L. T. 1.72 E 02
79649	03/29/95	L. T. 1.68 E 02
80189	04/05/95	L. T. 1.69 E 02
80860	04/12/95	L. T. 1.59 E 02
81816	04/19/95	L. T. 1.61 E 02
82171	04/26/95	L. T. 1.50 E 02
82923	05/03/95	L. T. 1.65 E 02
83680	05/10/95	L. T. 1.75 E 02
84375	05/17/95	L. T. 1.79 E 02
85200	05/24/94	L. T. 1.90 E 02
86176	05/31/95	L. T. 1.70 E 02
86726	06/07/95	L. T. 1.73 E 02
87764	06/14/95	1.77 ± 105E 02
88460	06/21/95	L. T. 1.66 E 02
89166	06/28/95	L. T. 1.76 E 02
89687	07/05/95	L. T. 2.06 E 02

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

TI #	Analysis Date	Activity (pCi/l)
90256	07/12/95	L. T. 1.91 E 02
91424	07/19/95	L. T. 2.41 E 02
92019	07/26/95	L. T. 2.32 E 02
92683	08/02/95	L. T. 2.19 E 02
93096	08/09/95	L. T. 2.34 E 02
94002	08/16/95	L. T. 1.99 E 02
94425	08/23/95	L. T. 1.70 E 02
95026	08/30/95	L. T. 1.81 E 02
95644	09/06/95	L. T. 2.21 E 02
96309	09/13/95	L. T. 1.87 E 02
97473	09/20/95	L. T. 1.87 E 02
98102	09/27/95	L. T. 2.03 E 02
98759	10/04/95	L. T. 2.31 E 02
99411	10/11/95	L. T. 1.77 E 02
00323	10/18/95	L. T. 2.45 E 02
01034	10/25/95	L. T. 2.02 E 02
01812	11/01/95	L. T. 1.75 E 02
02311	11/08/95	L. T. 1.61 E 02
03165	11/15/95	L. T. 2.08 E 02
03569	11/22/95	L. T. 1.70 E 02
04150	11/29/95	L. T. 1.77 E 02
04734	12/06/95	L. T. 1.58 E 02
05608	12/13/95	L. T. 1.51 E 02
05957	12/20/95	L. T. 1.55 E 02
06470	12/27/95	L. T. 1.41 E 02
06810	01/03/96	L. T. 1.43 E 02

APPENDIX I
TLD QUALITY CONTROL PROGRAM

TLD QUALITY CONTROL PROGRAM

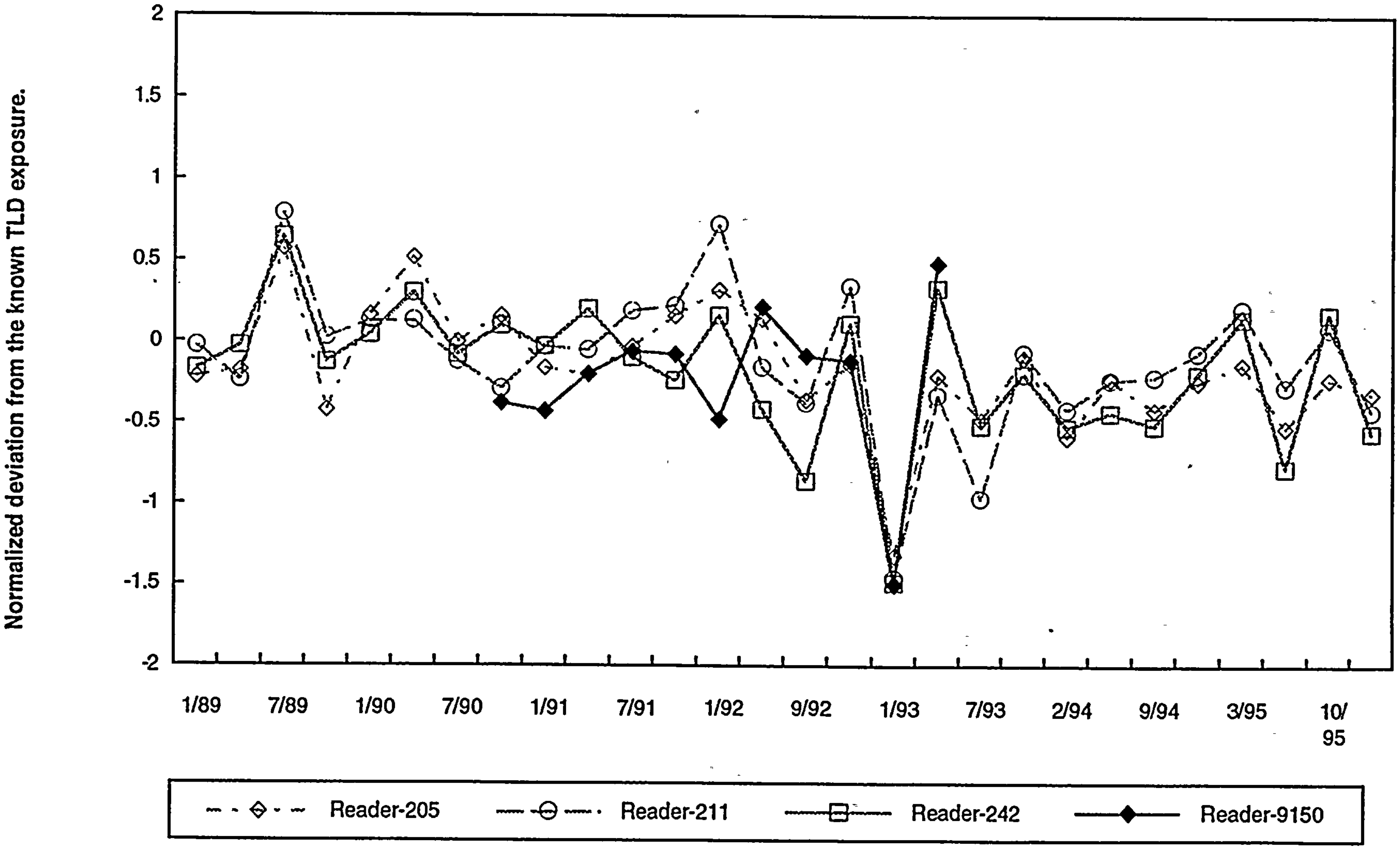
Teledyne Brown Engineering performs an in-house quality assurance testing program for the environmental TLD laboratory. On a quarterly basis the QA manager or a qualified designate exposes groups of TLDs to three different doses using a known exposure rate from a cesium-137 source.

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 1995 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

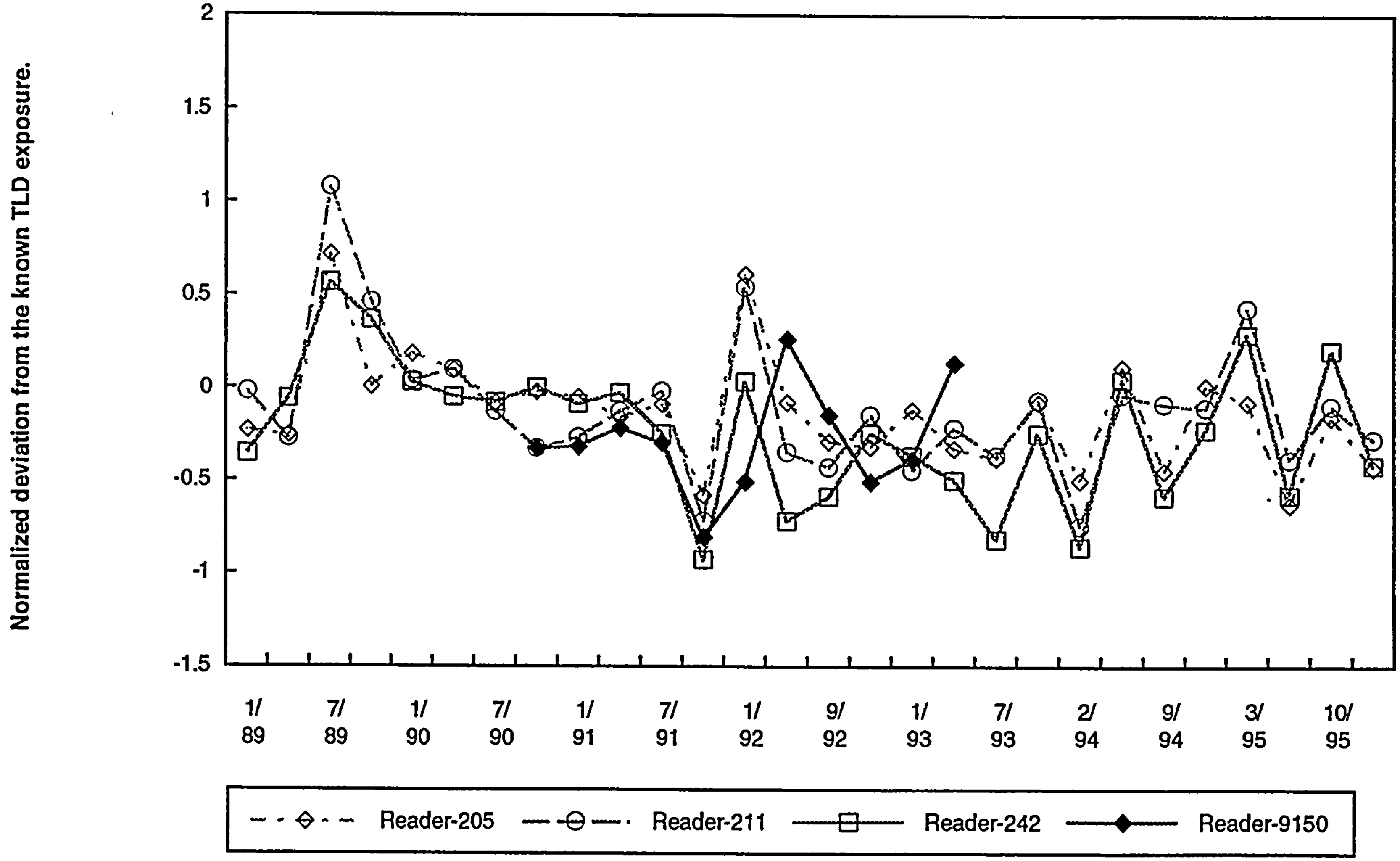
LOW DOSE



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

QUALITY CONTROL - TLDs

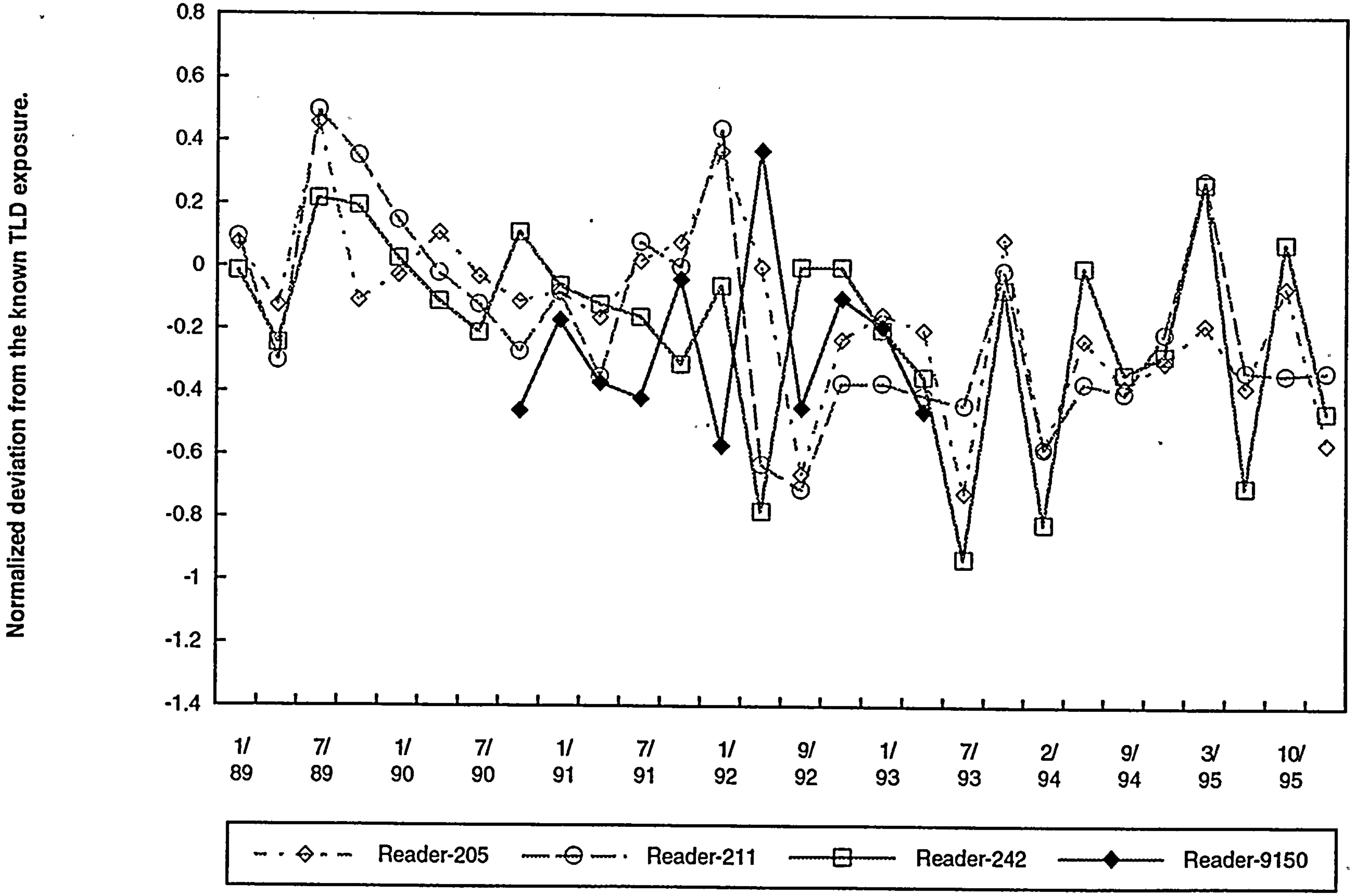
MIDDLE DOSE



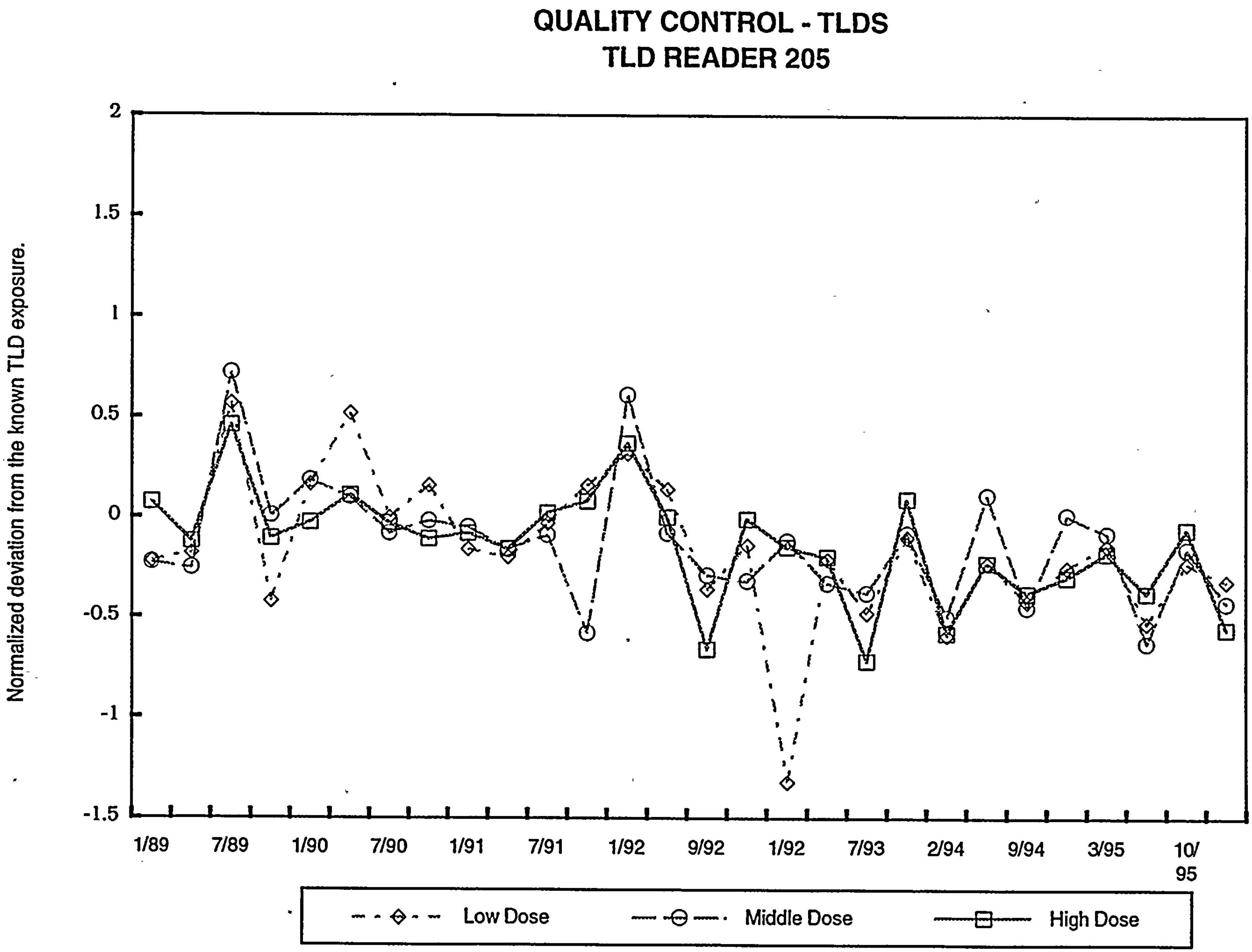
Reader-9150 was permanently removed from service during the first quarter 1993.

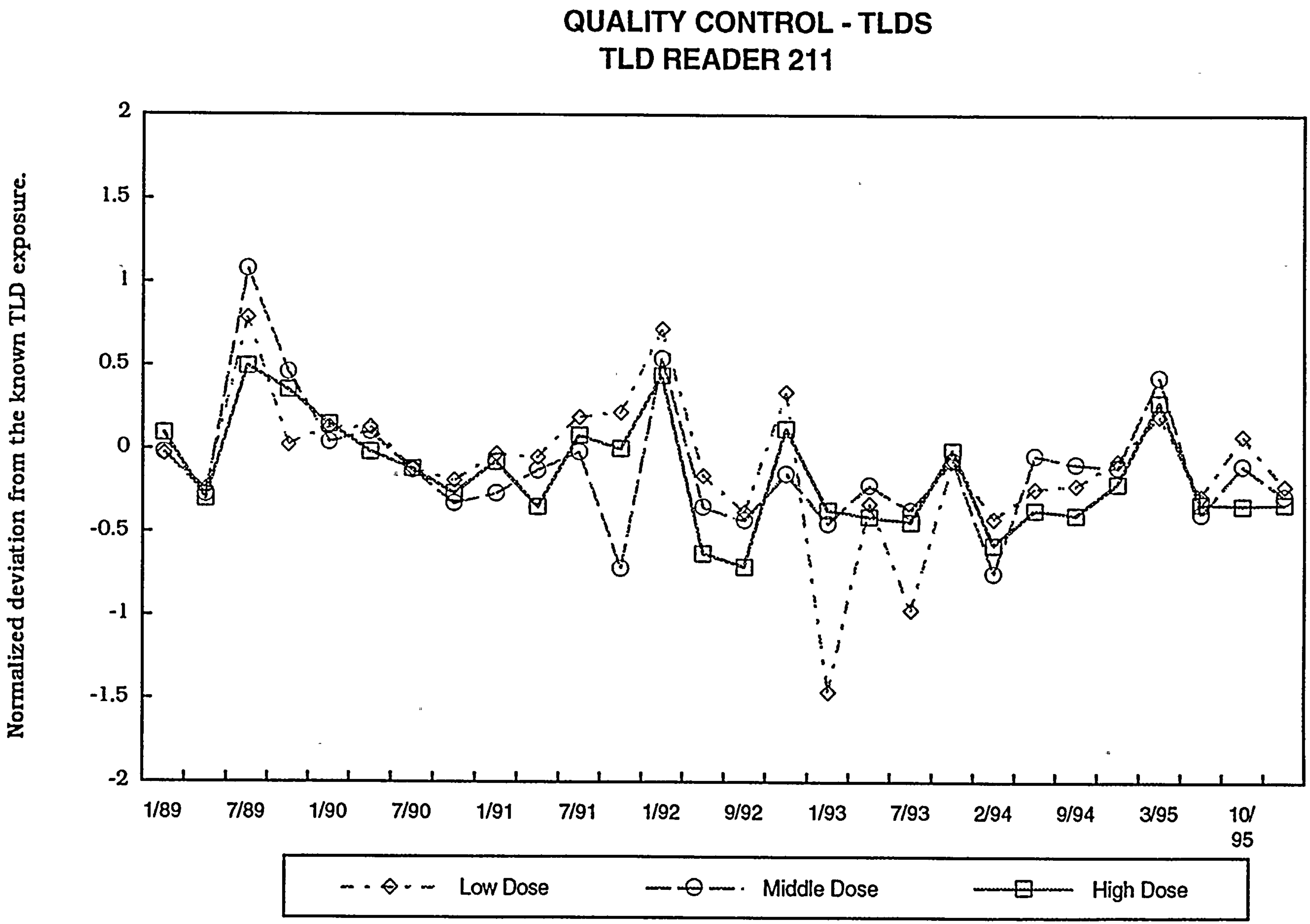
QUALITY CONTROL - TLDs

HIGH DOSE



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


QUALITY CONTROL - TLDS
TLD READER 205
Normalized deviation from the known TLD exposure.
2
1.5
1
0.5
0
-0.5
-1
-1.5
1/89
7/89
1/90
7/90
1/91
7/91
1/92
9/92
1/92
7/93
2/94
9/94
3/95
10/95
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
1/89
7/89
1/90
7/90
1/91
7/91
1/92
9/92
1/93
7/93
2/94
9/94
3/95
10/95
Low Dose
Middle Dose
High Dose

QUALITY CONTROL - TLDs
TLD READER 242