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Donald C. Cook Nuclear Plant Units 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74
ANNUAL ENVIRONMENTAL OPERATING REPORT - 1993

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

Attn: W. T. Russell

April 19, 1994

Dear Mr. Russell:

Enclosed is the Donald C. Cook Nuclear Plant Annual Environmental Operating Report for the year 1993. This report was prepared in accordance with Section 5.4.1 of Appendix B, Part II and Section 6.9.1.6 of Appendix A Technical Specifications of Donald C. Cook Nuclear Plant.

Sincerely,

for E. E. Fitzpatrick
Vice President

blb

Enclosure

c: A. A. Blind - Bridgman (10 encl.)
G. Charnoff
J. B. Martin - Region III Aministrator (2 encl.)
NFEM Section Chief
NRC Resident Inspector - Bridgman
J. R. Padgett

IE25

TABLE OF CONTENTS

LIST OF APPENDICES

I. INTRODUCTION

Technical Specification Section 6.9.1.6 and Appendix B, Part II, 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, 1993.

During 1993, 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)	9,079,300	7,853,870
Unit Service Factor (%)	100.0	96.6
Unit Capacity Factor - MDC* Net (%)	100.0	81.3

* Maximum Dependable Capacity

II. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

There were no environmental Technical Specification changes in 1993.

III. NON-RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

A.1 Plant Design and Operation

During 1993, 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 five environmental evaluations during the reporting period. Copies of these evaluations are located in Appendix II of this report. The evaluations determined that there were no unreviewed environmental questions.

A.2 Non-Routine Reports

A summary of the 1993 non-routine events is located in Appendix I of this report. No long-term, adverse environmental effects were noted.

A.3 Environmental Protection Plan

There were no instances of Environmental Protection Plan noncompliance in 1993.

A.4 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 five environmental evaluations during the reporting period. Copies of these evaluations are located in Appendix II of this report. The evaluations determined that there were no unreviewed environmental questions.

B. Environmental Monitoring - Herbicide Application

Technical Specifications Appendix B, Subsection 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 Subsection 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 Subsection 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 1993 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.

C. Macrofouler Monitoring and Control Program, and Whole Effluent Toxicity Testing

Macrofouler Monitoring and Control Activities, and Whole Effluent Toxicity testing during 1993 are discussed in Appendix IV of this report. Zebra Mussels remained under control in 1993. Whole effluent toxicity testing studies showed no adverse environmental impact.

IV. SOLID, LIQUID, AND GASEOUS RADIOACTIVE WASTE TREATMENT SYSTEMS

There were no changes in the solid, liquid, or gaseous radioactive waste treatment systems during 1993. However, an advanced liquid processing system was installed which added coagulant to the system. This system still uses the same media.

V. RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

The Radiological Environmental Monitoring Program annual report is located in Appendix V 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.1 Changes to the REMP

There was one change to the REMP during 1993. A ground water well (W14) was added. The location of well W14 can be found on page 12 of Appendix V.

A.2 Radiological Impact of Donald C. Cook Nuclear Plant Operations

This report summarizes the collection and analysis of various environmental sample media in 1993 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.

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

B. 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. No such changes were identified during the 1993 Land Use Census. A further discussion of the Land Use Census can be found in Appendix V (F) of this report.

VI. CONCLUSION

Based upon the results of the radiological environmental monitoring program and the radioactive effluent release reports for the 1993 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.

1993 Non-Routine Events

January 4, 1993 - An on-site contractor released approximately 1 1/2 gallons of 50% ethylene glycol solution (six pounds pure compound) to the Plant's wastewater treatment plant.

February 15, 1993 - A thin oil sheen was discovered at stormwater Outfalls 001S and 002S while performing the weekly environmental surveillance tour.

March 4, 1993 - Plant personnel discovered a small oil sheen at stormwater Outfall 001S while collecting storm water samples.

March 22, 1993 - Plant personnel discovered a small oil sheen at stormwater Outfall 001S.

May 21, 1993 - During intermittent chlorination of the plant service water systems, Total Residual Chlorine (TRC) analysis of Outfall 002, indicated a daily maximum value of 0.22 mg/l. Limit is 0.2 mg/l.

July 28, 1993 - Plant personnel discovered sodium hypochlorite leaking to circulating water intake forebay. Approximately 25.4 lbs. were released.

July 30, 1993 - Plant personnel estimated that a 4,800 gallon batch of treated water was released and contained approximately 2,400 ppm glycol (approx. 11 gal.). The calculated concentration at the discharge to Lake Michigan was estimated to be 0.04 ppm glycol.

August 8, 1993 - During intermittent chlorination of the Unit 1 circulating water and the plant nonessential service water systems, a Total Residual Chlorine (TRC) analysis at Outfall 002 (Unit 2) indicated a value of 0.53 mg/l. Limit is 0.2 mg/l.

August 15, 1993 - Two samples were missed at Outfall 00D (turbine room sump) for sulfate and total dissolved solids.

October 3, 1993 - During intermittent chlorination of the plant service water systems, the Total Residual Chlorine (TRC) analysis of the Outfall 002 discharge indicated a daily maximum value of 0.22 mg/l. Limit is 0.2 mg/l.

December 14, 1993 - An estimated 30 gallons of ethylene glycol was released to the soil while changing tires on a front-end loader.

APPENDIX II

ENVIRONMENTAL EVALUATION REPORTS

1993

AMERICAN ELECTRIC POWER

Date October 13, 1993

Subject Environmental Screening
12-PM-858, Modification of Selected Secondary Sample Points

From G. P. Arent

To 12-PM-858 Packet

Introduction

Plant Modification 12-PM-858 proposes to install sample coolers for key secondary chemistry parameters for the purpose of installing corrosion product monitors and monitor sample coolers. The systems affected are located on both Unit One and Two and include: 1) heater drain pump discharge, 2) feed pump discharge, 3) final feedwater and 4) main steam. Non-essential service water (NESW) will be utilize as the cooling medium.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed and determined not to be impacted by the proposed plant modification.

In discussions with the Mike O'Keefe of the Chemical Engineering and Performance Section, it was determined that the return lines from both the corrosion monitors and the sample coolers would be returned to the turbine room sump via floor drains. Mr. O'Keefe stated that the monitor/coolers will not be in continuous operation, however, as a conservative measure, the amount of water being returned to the turbine room sump was calculated assuming all six monitors were in continuous operation. Based on the following calculation, the assumed flow of sample and cooler water to the turbine room sump was determined to be 40,565 gallons per day.

Calculation:

Assumptions: Six (6) monitors/coolers in service, 24 hours per day.
Monitor flow: 2 liters/minute per monitor
Cooler flow: 25 gallons/minute total

Corrosion Monitor Flow

$$\frac{(60\ \text{min})}{(1\ \text{hr})} \times \frac{(24\ \text{hrs})}{(1\ \text{day})} \times \frac{(2\ \text{liters})}{(1\ \text{min})} \times \frac{(.2642\ \text{gals})}{(1\ \text{liter})} \times \frac{(6\ \text{monitors})}{(1)} = \frac{4{,}565\ \text{gals}}{\text{day}}$$

Cooler Flow

$$\frac{25\text{ gallons}}{(1\text{ min})} \times \frac{24\text{ hours}}{(1\text{ day})} \times \frac{60\text{ minutes}}{(1\text{ hr})} = \frac{36,000\text{ gallons}}{\text{day}}$$

Total Flow = 4,565 (Monitor flow) + 36,000 (Cooler flow) = 40,565 gpd*
* gallons per day

While the existing NPDES permit does not place specific limits on the effluent flowrate from the turbine room sump to the absorption pond, the FES states that an average of 516 gallons per minute (or 743,040 gpd) is assumed. This average assumed flowrate was compared to the average plant flowrate to determine if the addition of 40,565 gallons per day would result in exceeding the FES assumed average. Based on discussions with Diane Fitzgerald, General Supervisor-Chemistry Support (Plant), the actual average effluent flowrates for July and August 1993 were 277,000 gallons per day and 345,000 gallons per day respectively. Assuming that these are indicative of the average effluent flowrate to the turbine room sump, the addition of 40,565 gallons per day would not result in exceeding the FES assumed average.

A review of the NPDES Permit was also performed to determine if the additional effluent being discharged to the absorption pond met the limits specified in the permit. The NPDES Permit does not specify chemical limitations for effluent discharged from the turbine room sump to the absorption pond. As part of the NPDES Groundwater Discharge Authorization, sample parameter, frequency and type is specified. These sample requirements are not affected by the proposed PM.

Comments

It is the opinion of this reviewer that measures should be taken during the design change process (whether AEPSC or Plant initiated) to return sample streams and cooling water to the systems which supply them. In the case of 12-PM-858, at a minimum the NESW flow from the monitor cooler could be returned to the system. This would have the potential of reducing the flow to the absorption pond by 36,000 gallons per day or 13,140,000 gallons annually.

Conclusion

Based on this review of 12-PM-858, the Assessment 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) 12-PM-858 Packet

Keywords

turbine room sump
corrosion monitor
12-PM-858

Approved by: Rodney L. Simms
R. L. Simms, Manager
Assessment

c: D. L. Eads
M. J. O'Keefe
D. M. Fitzgerald/J. Carlson
DC-N-6370.1

AMERICAN ELECTRIC POWER

Date October 25, 1993

Subject Environmental Screening
Site Utilization Storage Yard

From G. P. Arent

To W. C. Rigg

Introduction

The Site Utilization Plan has identified the need to clean up certain existing areas on the site property and develop a site utilization storage yard. In support of this need, an activity has been proposed to clean up five identified site areas and to construct a new insulation storage building and a dumpster/satellite scaffold area.

Review Action Taken

The Final Environmental Statement (FES), Appendix B of Technical Specifications and the Site Utilization Master Plan Report were reviewed and determined not to be impacted by the proposed changes.

A review of the proposed cleanup areas (areas currently identified as laydown/storage areas including: steam generator storage facilities, laydown area north east of 345 Kv yard, areas (2) south east of 765 Kv yard and laydown area near service road off Thorton Road) and the proposed locations of the insulation warehouse and the dumpster/satellite scaffold area has determined that these areas have been previously disturbed. Additionally, based on draft site location plans, dunes located in these areas would not be impacted by the proposed changes. Discussions with D. M. Fitzgerald, General Supervisor-Chemistry Support at D. C. Cook, confirmed these observations.

Conclusion

Based on this review of the proposed cleanup of five specific site areas and the construction of a new insulation building and designation of a dumpster/satellite scaffold area, the Assessment 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) Final Environmental Statement, August 1973
3) Site Utilization Master Plan Report, April 1, 1993

Keywords

site utilization plan
insulation building
laydown area

Approved by: Rodney L. Simms
R. L. Simms, Manager
Assessment

c: D. L. Eads
D. M. Fitzgerald/J. Carlson
R. F. Kroeger/T. G. Harshbarger
DC-N-6370.1

AMERICAN ELECTRIC POWER

Date October 25, 1993

Subject Environmental Screening
Change Sheet No. 22, 12-THP 6020 LAB.041
Data Sheet Instructions

From G. P. Arent

To 12-THP 6020 LAB.041, CS-22 Packet

Introduction

Change Sheet No. 22, to procedure 12-THP 6020 LAB.041 "Data Sheet Instructions" proposes to change certain cation conductivity action levels to allow for the use of ethanolamine(ETA) also known as monoethanolamine at D. C. Cook for secondary side pH control for Unit 1 and 2. The purpose of this procedure change is to allow for the initial use of ETA to determine the optimum level to be utilized. A safety evaluation by the Nuclear Safety Section has been completed with no open items.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Dischar[ge] Elimination System (NPDES) Permit and Appendix B of Technica[l] Specifications were reviewed in support of this screening to determine the potential impact of the use of ETA.

In accordance with RS-34, Revision 1 "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 morpholine as a water treatment additive was not identified as a contributor to an adverse environmental impact in the FES. Additionally, a review of the Material Safety Data Sheet states that ETA is not an "Extremely Hazardous Substance (as defined in 40CFR 355)" and is not listed on the "List of Toxic Chemicals (as identified in 40CFR 372).

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

No. While ETA was not originally identified as a water treatment additive in the FES, morpholine (of which ETA is a breakdown product) was identified. Morpholine was added as a corrosion inhibitor, ETA will be utilized in the same manner and has been shown to perform in a superior manner for pH adjustments.

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

No. The FES identified a morpholine concentration of 20 ppm, as being the maximum value expected in the plant steam generator blowdown effluent. Estimates during initial testing of ETA indicate that the highest level expected in the steam generator blowdown is 2.0 to 2.5 ppm.

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

No. Authorized power level will not be changed by utilizing ETA for secondary pH and corrosion control.

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

No. Site grounds will not be disturbed by this change.

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 use of ETA.

Notification of the use of ETA was provided to the Michigan Department of Natural Resources (MDNR) in accordance with Part II.A.2 of our permit. It was stated in this notification (reference 5) that the addition of ETA would comply with the effluent limitations as specified in the NPDES Permit.

Based on the above screening, it has been determined that the use of ETA for pH control at D. C. Cook does not result in a condition inconsistent with the existing environmental assumptions made for D. C. Cook. The findings of the above screening were discussed with Messrs. J. P. Novotny of the Environmental Engineering Section and M. J. O'Keefe of the Chemical Engineering and Performance Section, who concurred with the conclusions.

Open Item(s)

During this review it was determined that a potential existed for ETA to be released via Outfall "C" (Plant Heating Boiler). Based on conversations with Diane Fitzgerald, General Supervisor-Chemistry Support a letter of notification will be initiated and sent to the MDNR.

Conclusion

Based on this review of the use of ETA for secondary system pH and corrosion control, the Assessment 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 E. E. Fitzpatrick, et al, "Field Evaluation of Ethanolamine for Secondary Side pH Control for Unit 1 and 2", August 16, 1993.
5) Memo, D. L. Baker to Mr. Fred Morley and Mr. Thomas Leep, "NPDES Perm No. MI0005827 Cook Nuclear Plant, Bridgman, Michigan", March 15, 199

Keywords

turbine room sump
steam generator blowdown
ETA

Approved by: Rodney L. Simms
R. L. Simms, Manager
Assessment

c: D. L. Eads
M. J. O'Keefe
D. M. Fitzgerald/J. Carlson/B. Zordell
J. P. Novotny
DC-N-6370.1

AMERICAN ELECTRIC POWER

Date December 15, 1993

Subject Environmental Screening
Procedure 12-THP SP.225
Containment Spray Heat Exchanger Chemical Cleaning

From G. P. Arent

To 12-THP SP.225 Packet

Introduction

Procedure 12-THP SP.225, Revision 0, "Containment Spray Heat Exchanger Chemical Cleaning" provides direction for the removal of iron deposits on the tube bundle secondary side tube surfaces of the Unit 1 and Unit 2 Containment Spray Heat Exchangers. The cleaning process will utilize a Citric/Ascorbic acid solvent to dissolve iron deposits within the heat exchangers. A safety evaluation screening checklist performed at the Cook Nuclear Plant identified no further safety review requirements.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential impact of performing the chemical cleaning of the containment spray heat exchangers.

A review of the special procedure was performed to determine how the proposed chemical cleaning process would be conducted. Briefly, the essential service water (ESW) system supply to the containment spray heat exchanger to be cleaned will be isolated. Iron solvent will then be introduced into the heat exchanger and be circulated for a period of approximately twenty four (24) hours. The solvent solution will then be rinsed from the heat exchanger to waste holding tanks for processing and disposal.

Discussions related to this process were held with Mr. Bob Claes, AEPNO Radiation Support and Mr. Jeff Novotny of AEPSC Environmental Engineering. Based on these discussions, and a subsequent telecon on December 15, 1993, it was determined that due to the nature of the isolation valves utilized in the ESW system (butterfly valves), positive closure of the ESW lines would be required to preclude the potential discharge of chemical via the ESW system to the lake. Specifically, on the ESW supply, positive system pressure, greater than the chemical cleaning process pressure, must exist upstream of the ESW supply isolation valve. In the event pressure cannot be assured, a blind flange should be installed. On the outlet side of the heat exchanger, a blind flange must be installed.

Based on this determination, this environmental evaluation is predicated on the positive closure requirements described above. Failure to provide positive closure for the ESW valves voids this review.

Intra-System

In accordance with 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 positive closure requirements ensures that the solution utilized to chemically clean the containment spray heat exchangers will not be inadvertently discharged to Lake Michigan.

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

No. The chemical cleaning solvent and rinse water will be prevented from entering any Cook Nuclear Plant waste stream by the positive closure controls described previously. Additionally, all solvent and rinse water will be directed to tankers which will be removed from site following the cleaning process. As a result, no impact on the Final Environmental Statement will be realized.

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

No. No see Item 2.

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

No. Authorized power level will not be changed as a result of the chemical cleaning process.

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

No. Site grounds will not be disturbed by this activity.

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

No. Based on the positive closure requirements and the removal of all solvent and rinse water from the Cook Nuclear Plant Site, no impact on the NPDES Permit will be realized.

Based on the above screening, it has been determined that the containment spray heat exchanger chemical cleaning process will not result in a condition inconsistent with the existing environmental assumptions made for the Cook Nuclear Plant.

Open Item(s)

Positive closure requirements as described in the Review Action Taken Section, must be in place to perform chemical cleaning of the containment spray heat exchangers. Additionally, sampling of the final rinse water to ensure residual chemicals are not present should be completed prior to the removal of the blind flanges.

Conclusion

Based on this review of the containment spray chemical cleaning process proposed for Cook Nuclear Plant, the Assessment 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, Richard D. Reid, Ph.D. to D. Fitzgerald, "Donald C. Cook Nuclear Plant Containment Spray Heat Exchanger Chemical Cleaning; Process Description", November 9, 1993.
5) Pacific Nuclear Proposal PN93-087, Rev. 1, "Chemical Cleaning Services of the Unit 1 and Unit 2 Containment Spray Heat Exchangers", September 1993.

Keywords

containment spray heat exchanger
chemical cleaning

Approved by: Rodney L. Simms
R. L. Simms, Manager
Assessment

c: D. L. Eads
R. M. Claes
D. M. Fitzgerald/J. Carlson/B. Zordell
J. P. Novotny
DC-N-6370.1

Date December 21, 1993

Subject Environmental Screening
Plant Modification 12-PM-865
Installation of Outage and Special Projects Power Supply

From G. P. Arent

To 12-PM-865 Packet

Introduction

Plant Modification 12-PM-865, Revision 0, proposes to install both a 480 volt, three phase and 120 volt single phase electrical power supply with distribution panels located on either side of the radiation protection access control building (RPAC). The purpose of this proposed modification is to reduce the cost of leasing diesels to provide outage and special projects power needs.

Review Action Taken

The Final Environmental Statement (FES), 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 installing a transformer in the proposed location. Additionally, plant modification 12-PM-1234, which installs transformer spill containments was reviewed for applicability.

Plant modification 12-PM-865 proposes to install a 12kV/480 volt, three phase transformer north west of the existing containment access building (CAB). In discussions with R. J. Roman of NEEP, it was determined that the actual location of the transformer and cable conduit trenches had not been finalized. However, it was indicated that the transformer would be located in the general area northwest of the CAB near the refueling water, primary water and condensate storage tanks. Discussions related to trenching in support of cable and conduit runs indicated that all trenching would occur within the security area.

Based on the above information, it is concluded that the candidate placement locations of the transformer and the proposed cable and conduit trenches are located inside of the security fence. The area within the security fence is pre-disturbed ground and is considered not to negatively impact the existing environment.

A second issue related to the type of transformer to be used was also discussed with Mr. Roman. At this time, the type of transformer is still unknown. It was requested, however, that the option to utilize an oil filled transformer be provided. The use of an oil filled transformer would be allowed provided an oil spill containment be designed and installed prior to the installation of the 12-PM-865 transformer. This requirement will be identified as an action item later in this memo.

In accordance with 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 installation of a transformer and distribution services does not increase the environmental impact previously evaluated in the FES. This determination assumes that, in the event an oil filled transformer is utilized, an appropriately designed oil pill containment is installed.

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

No. Installation of transformers and electrical distribution systems were previously evaluated in the FES.

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

No. This proposed plant modification will not result in a change to the effluent released from the plant. In the event an oil filled transformer is utilized, an oil spill containment will prevent the transmission of the oil to the storm drain system.

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

No. Authorized power level will not be changed as a result of the installation of the outage and special projects power supply.

Will a previously undisturbed area be impacted by this activity ?

No. As discussed previously, the candidate placement locations of the transformer and the proposed cable and conduit trenches are located inside of the security fence. The area within the security fence has been previously disturbed. Therefor, this modification does not negatively impact the existing environment.

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

No. Based on the installation of an oil spill containment, in the event an oil filled transformer is utilized, no impact on the NPDES Permit will be realized.

Based on the above screening, it has been determined that the installation of a 480 volt, three phase transformer and associated distribution system as defined by 12-PM-865 will not result in a condition inconsistent with the existing environmental assumptions made for the Cook Nuclear Plant.

Open Item(s)

In the event an oil filled transform is utilized in this application, the installation of an oil spill containment will be mandatory. Failure to install an oil spill containment, if one is required, voids this environmental evaluation.

A plant modification (12-PM-1234) has been developed for the design and installation of oil spill containments for various transformers located at the site. It is recommended, that this plant modification be used if an oil spill containment is required in support of 12-PM-865.

Conclusion

Based on this review of plant modification 12-PM-865, installation of an outage and special projects power supply, for Cook Nuclear Plant, the Assessment 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) 12-PM-865, Revision 0, Installation of a 12kV/480 volt, three phase transformer and associated distribution system.

Keywords

electrical power supply
480 volt
120 volt
outage

Approved by: Rodney L. Simms
R. L. Simms, Manager
Assessment

c: D. L. Eads
R. M. Claes
D. M. Fitzgerald/J. Carlson
J. P. Novotny
R. J. Roman
DC-N-~~6370.1~~

APPENDIX III

HERBICIDE APPLICATION REPORT

1993

INDIANA MICHIGAN POWER

Date February 8, 1994

Subject **1993 Herbicide Spray Report - Cook Nuclear Plant**

From J.S. Lewis

To J.P. Carlson

From July 26 -30, 1993, Tree Preservation applied Pathway herbicide as a stump treatment on trees cut within the Plant Right-Of-Way, except in highly erodible areas. A total of one gallon of Pathway was used on 400-425 tree stumps. Pathway was applied in accordance with the manufacturer's label. Mr. Frederick H. Meyer, Inspector for Indiana Michigan Power Company, performed the inspection and found that the areas treated with Pathway herbicide were satisfactory and no signs of overspray existed. No adverse environmental effects or concerns were found.

Attachment

Intra-System

APPENDIX IV

MACROFOULER MONITORING CONTROL PROGRAM, AND WHOLE EFFLUENT TOXICITY TESTING

1993

Aquatic Issues - 1993 Zebra Mussel Monitoring and Control Report

The following reports detail the 1993 zebra mussel monitoring and control activities performed at the Cook Nuclear Plant. Specific reports from LMS, our biological monitoring contractor; and Brand Utilities Services, our diving contractor are provided.

Indiana Michigan Power Company

Cook Nuclear Plant
1993 Zebra Mussel Monitoring
and Control Report
March 30, 1994

INTRODUCTION

The Plant's Zebra Mussel Monitoring and Control Program has progressed from a detection based program to a monitoring and control program. Through the Plant's control efforts utilizing plant design changes, preventive maintenance enhancements, mechanical cleaning, chlorination, and proprietary molluscicides, zebra mussel densities were maintained at manageable levels which did not significantly affect plant operation.

Monitoring efforts continue to assess the threat of zebra mussel infestation and determine the effectiveness of plant control techniques. A report on bio-monitoring studies by LMS, a diver report of zebra mussel infestation in the intake forebay, and a diver assessment of zebra mussel mortality in the intake forebay in the aftermath the September 1993 Clam-trol treatment is attached.

Design and mechanical problems of the chlorination system in 1993 made it difficult to assess the effectiveness of intermittent chlorination of the service water systems. Colonization in low or no flow areas remains a concern as experienced in the aftermath of the Sept. 11-12, 1993 Clam-trol treatment where pluggage occurred in components of the service water systems. Cumulative settlement data collected from the sidestream samplers located on the service water systems showed that zebra mussels settled and developed until shell lengths reached 1.5 mm, then either died or translocated elsewhere in the systems. Intermittent chlorination of the circulating water system was ineffective in controlling colonization in those systems which draw water from the circulating water system. Zebra mussels which slough off from the intake pipelines present a challenge to the screenwash and traveling screen system, and service water pump strainers.

ERADICATION AND CONTROL MEASURES

The 1993 control strategy consisted of the use of a proprietary molluscicide (Clam-trol), intermittent chlorination of the service and circulating water systems, and mechanical cleaning.

MECHANICAL CLEANING

Mechanical cleaning of the intake forebays using new scrubber technology was performed to supplement the Sept. 11-12, 1993

Clam-trol treatment. In the aftermath of the Clam-trol treatment, cleaning and flushing of small bore piping and strainers in the miscellaneous seal & cooling water system, screenwash and lawn sprinkler pump strainers, NESW cooling to the Unit 2 air compressor, ESW to the Unit 1 North Control Room Air Conditioning Chiller Condenser, and the Unit 2 Main Turbine Lube Oil Coolers was performed. All three intake cribs were cleaned of zebra mussels to minimize the impact of the intakes on wild ducks. No wild ducks were entrained into the plant's intake structures in 1993.

CLAM-TROL TREATMENT RESULTS

A single treatment of the intake forebay and circulating water system using Betz Clam-trol CT-1 was performed in 1993. Because the service water systems, misc. seal & cooling, and screenwash pump systems draw from this treated water, they also received benefit from the treatment.

On September 11-12, 1993, the entire circulating water system was treated for 12 hours using Clam-trol at a target feed rate of 15 ppm. Bentonite clay was injected into the discharge as a detoxicant at a ratio of at least 3:1 clay:Clam-trol before being discharged to Lake Michigan. Zebra mussel mortalities measured by bio-boxes placed throughout the plant ranged from 4-100%. Subsequent intake forebay inspections by divers two weeks after the application (See attached report), indicated a 5-95% kill on the walls and surfaces of the forebay. The area which experienced a low kill rate represented a small portion (<5%) of the total forebay area. This area was mechanically cleaned by divers. A total of 636 cubic yards of zebra mussel shell relics were removed from the intake forebay in the aftermath of the Clam-trol treatment.

CHLORINATION TREATMENT RESULTS

In 1993, the essential service water (ESW) and non-essential service water (NESW) systems received daily intermittent sodium hypochlorite treatments of 1.5-2.0 ppm total residual chlorine (TRC) for 155 minutes from May until early December. The circulating water system received daily intermittent sodium hypochlorite treatments of 0.2 ppm (TRC). A detailed discussion and availability of the chlorination system is included in the attached report from LMS.

Plant systems are fouled as a result of larval, juvenile, and adult zebra mussels being allowed to infest areas due to lack of, or insufficient physical and chemical control methods. Clam-trol treatments can exacerbate the problem by killing mussels residing in plant systems with the resultant sloughing of shells which can overwhelm traveling screens, plug strainers, heat exchangers, and small bore piping systems.

Systems exposed to high, and especially turbulent flow, which are also routinely chlorinated as in the main condenser water boxes and CCW heat echangers, are virtually mussel free. Sargent & Lundy performed a special study for Commonwealth Edison which showed that systems exposed to flow velocities of >= 5 feet/sec. in the absence of a biocide, displayed no zebra mussel settlement. This can be confirmed at Cook Plant by the plant's trash racks in high flow areas of the intake forebay being clear of zebra mussel settlement. The combination of flow and chlorine in the plant's service and circ. water systems appears to have a positive effect on keeping these piping systems clean.

Attempts were made in 1993 to chlorinate the service water systems continuously at 0.5-1.0 ppm to ensure colonization did not occur in the ESW and NESW systems. Due to certain design deficiencies, continuous operation of the system was unsuccessful. System upgrades have been made over this past winter and continuous chlorination of the service water systems will be attemped again in 1994.

CHANGES IN PLANT DESIGN

Fire Protection System

The Plant's fire protection system was converted to chlorinated municipal drinking water in the Spring of 1993. Zebra mussels no longer pose a threat to this system.

FOULING FROM THE INTAKE PIPELINES

The intake pipelines have been treated in the past with Clam-trol when necessary and plant conditions allow. The North and the Center Intake pipelines were treated with Clam-trol in 1992. Zebra Mussel sloughage still occurs from the intake pipelines and is most apparent when flow velocities are changed by cycling the Center Intake gate valve, WMO-30. 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. A molluscicide treatment to the South Intake pipeline is planned for 1994 and plans to upgrade the traveling screenwash system to more effectively handle zebra mussel sloughage are in progress.

CONCLUSION

Shock treatments of a proprietary molluscicide to remediate juvenile and adult zebra mussels in conjunction with the use of sodium hypochlorite to control veliger settlement, has been an effective method in controlling zebra mussels. Mechanical cleaning can be effective in areas where chemical means are

impossible or uneconomical. Chemical methods for controlling zebra mussels in low or no flow areas of the service water systems can be improved with continuous chlorination. Switching the fire protection system from raw lake water to municipal drinking water in 1993 eliminated the threat of zebra mussel infestation in the fire protection system. A bio-monitoring program utilizing side-stream and artificial substrate monitors along with diver and heat exchanger inspections will continue to be used to evaluate the effectiveness of chemical and physical control measures.

Prepared for

INDIANA MICHIGAN POWER COMPANY
One Cook Place
Bridgman, Michigan

MOLLUSC BIOFOULING MONITORING DURING 1993

Donald C. Cook Nuclear Plant

March 1994

Prepared by
LAWLER, MATUSKY & SKELLY ENGINEERS
Environmental Science & Engineering Consultants
One Pierce Place Suite 500E • Itasca, Illinois

Prepared for

INDIANA MICHIGAN POWER COMPANY
One Cook Place
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LMSE-94/0181&673/001

Prepared by:

LAWLER, MATUSKY & SKELLY ENGINEERS
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Indiana Michigan Power Company has been conducting biofouling studies at the Donald C. Cook Nuclear Plant since 1983. In 1990, monitoring of zebra mussels in the circulating water, essential service water (ESW), and nonessential service water (NESW) systems was added to the program. The objectives of this monitoring are to detect the presence and density of zebra mussel veligers in the circulating water system and post-veliger settlement in the forebay and service water systems.

Veligers were present in the forebay from the first sampling date (27 May 1993) through November sampling. Peak densities occurred on 24 June and 11 October 1993, with the major peak occurring on the October date (108,950/m^3), along with high winds (25+ mph). This disturbance of the water column contributed not only high numbers of veligers, but also high numbers of post-veligers to the whole-water samples. This effect of storms may impact plant water systems adversely.

Settlement of post-veligers first occurred in the forebay on 30 July and continued for the remainder of the sampling season. Settlement peaked between 11 and 21 October, at an average daily settlement rate estimated at 72,197/m^2. Heavy post-veliger settlement extended from 9 September to 18 November 1993. Many of the individuals examined during the latter part of this period were relatively large, suggesting that they were translocators.

Cumulative post-veliger densities in the forebay generally increased during the season, but remained less than 25,000/m^2 until after the ClamTrol treatment. Twelve days after this treatment, densities had increased to approximately 135,500/m^2. After 40 days, densities were about 2 million/m^2. Translocators then moved onto the substrates, making further estimates impractical. This increase in densities was attributed to the absence of predator mussels in the forebay to control veligers, churned-up lake conditions in September, and an abundance of clean substrate upon which the veligers settled following the ClamTrol Treatment.

Settlement first appeared on the artificial substrates located in the service water systems on 1 July. Peak settlement occurred on the supply and return sides of the ESW and NESW systems at different times. Peak settlement dates and densities were as follows:

ESW supply :	9-23 September	($3,040/m^2$)
ESW return :	30 July - 12 August	($6,613/m^2$)
NESW supply:	12-26 August	($1,973/m^2$)
NESW return :	23 September - 11 October	($9,066/m^2$)

These periods of settlement generally followed extended periods when the chlorination system did not deliver chlorine to the service water systems. Availability of the chlorination system ranged from 29 to 70% during peak settlement periods. In addition, on most sampling dates, more settlement took place on the return side of the systems, which indicates that not as much chlorine was reaching this portion of the systems.

Cumulative settlement data collected from the sidestream samplers located on the service water systems produced the following results. Development proceeded until shell lengths reached 1.5 mm. This "size limit" was maintained throughout the season. Larger zebra mussels did not find the conditions in the samplers suitable for continued growth and either died or translocated to avoid perceived stress. The design of the 1993 monitoring program did not permit identification of the causes of the observed phenomenon.

CHAPTER 1

INTRODUCTION

1.1 PAST HISTORY

Indiana Michigan Power Company (I&M), a subsidiary of American Electric Power Company (AEP), has been conducting biofouling studies at the Donald C. Cook Nuclear Plant since 1983. These studies were initially directed toward Asiatic clams. Because of the recent appearance of zebra mussels in Lake Michigan, however, the studies were expanded in 1990 to include zebra mussels. The purpose of the studies was to detect the presence of biofouling molluscs in the circulating water, essential service water (ESW), and nonessential service water (NESW).

The 1993 monitoring program conducted by Lawler, Matusky & Skelly Engineers (LMS) was designed to detect when spawning and settling of zebra mussels occur at the Cook Nuclear Plant and to collect and analyze (1) whole-water samples for planktonic veligers and (2) artificial substrates set within the circulating water, ESW, and NESW systems for periodic and cumulative post-veliger settlement.

1.2 OBJECTIVES

Specific objectives for the 1993 biofouling monitoring program were as follows:

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

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

CHAPTER 2

METHODS

2.1 WHOLE-WATER SAMPLING

Whole-water sampling of the circulating water system was conducted from 27 May to 16 December 1993. Samples were collected from the intake forebay by pumping lake water through an in-line flowmeter into a plankton net. Two replicates (2000 liters each) were collected during each sampling event.

A JABSCO utility pump, rated to deliver 26 gpm, was connected to a flowmeter assembly consisting of a Cole-Parmer ACCUM-U-FLO model digital flowmeter/accumulator, ROTOR-X paddle wheel flow sensor, and a PVC 80 installation fitting. To minimize organism abrasion, measured flow was directed into a No. 20 plankton net that was suspended in a partially filled 55-gal plastic barrel. Valves were adjusted to reduce flow, thus preventing the plankton net from overflowing when heavy sediment loads or plankton concentrations were present.

Samples were washed down gently into the cod-end bucket and then transferred into a 1 liter plastic jar. If needed, filtered water was added to the jar to ensure that a full liter was analyzed. After the second replicate was taken, both samples were packed on ice for transport to the laboratory and refrigerated until analyzed (within 48 hrs of collection).

Samples were initially mixed thoroughly for 5 min. Then, using a calibrated disposable Pasteur pipette, a 1-ml aliquot of mixed sample was placed into a Sedgewick-Rafter cell for counting, using a low-power binocular microscope (10-40X) with cross-polarizing filters. Five replicates were counted, and the average was extrapolated to determine the number of individuals per cubic meter. This process was repeated for the second replicate and the two values were averaged to yield a final value.

2.2 ARTIFICIAL SUBSTRATES

To determine zebra mussel settlement in the circulating water, ESW, and NESW systems, artificial substrates were placed in the intake forebay upstream of the trash racks; sidestream samplers were set on the supply and return sides of both systems. Monitors were equipped with modified test-tube racks designed to hold slides for periodic and cumulative sampling. (*Periodic settlement* is defined as short-term monitoring, either two- or four-week periods, depending on the month. *Cumulative settlement* is long-term monitoring that extends from initial deployment [20 May] to the end of the sampling season.) A sufficient number of substrates were placed in the samplers initially to allow 10 slides to be removed on each sampling date. Cumulative monitoring was designed to provide information on accumulated infestation throughout the growing season.

On each sampling date 10 slides from each location were retrieved and replaced with clean slides. These were labeled as periodic settlement. A second set of 10 slides placed in the monitor on 20 May was retrieved from each location and used for the cumulative monitoring. These slides were not replaced. Slides were placed in labeled racks, covered with a plastic bag, and kept on ice during transport to the laboratory. They were then refrigerated until analysis began.

Artificial substrates placed in the intake forebay consisted of cinderblocks with test-tube racks secured inside the openings. These samplers were deployed by rope in the north, central, and south locations approximately 1 meter from the bottom.

Sidestream monitors were placed on the supply and return sides of the service water systems (ESW and NESW). Each monitor contained two modified test-tube racks that held all slides above the monitor base. This allowed silt and sediment to fall out before they could influence post-veliger settlement. Monitors were covered with an I&M-approved fireproof fabric to limit light exposure. Plant personnel checked the monitors periodically to ensure that adequate flow was available, and flow was adjusted as necessary.

Analysis was conducted with a low-power binocular microscope (10-40X) equipped with cross-polarizing filters. After one side of the slide was cleaned, the slide was placed on the microscope so that the attached post-veligers could be counted. When slides became heavily infested, a subsampling technique was followed:

- The first slide was counted in its entirety.
- The remaining nine slides were subsampled using a splitter that permitted either half or a quarter of the slide to be counted. Counts were then extrapolated and adjusted, depending on the fraction used.

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

Shell diameters were measured on selected and random individuals to obtain maximum, minimum, and average sizes. Diameters were measured using an ocular micrometer calibrated to a stage micrometer.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 WHOLE-WATER SAMPLING

Sampling of planktonic veligers in the circulating water system was initiated on 27 May 1993 and completed on 16 December 1993. Thirty-six samples were taken (two per sampling date) from the station's intake forebay. The monitoring system, which was redesigned for this season, performed up to expectations. The addition of an electronic flowmeter provided data comparable to those of other researchers on the lake. As a result, direct comparisons with 1991 and 1992 data are difficult to make.

Results of sampling are presented in Figure 3-1 and Table 3-1. With the exception of the December sampling date, veligers were present in all samples collected. Two major peaks were observed: the first on 24 June (86,500/m^3), the second on 11 October (108,950/m^3).

Veliger presence throughout the monitoring program (except for December) suggests substantial densities of veligers in the water column for more than six months of the year. Heaviest spawning activity occurred in late fall, when lake temperatures were between 50° and 60°F. During the six weeks from early September to mid-October, veliger densities were consistently over 50,000/m^3, peaking at just over 100,000/m^3.

The effect of wind and wave action on the planktonic occurrence of zebra mussels was observed this season. The highest whole-water density (on October 11) was during 25+ mph westerly winds. Wave activity extended the mud line approximately half a mile offshore, which carried high sediment loads into the intake structure. Whole-water samples contained unusually large quantities of sand, silt, veligers, and post-veligers. Shell length data indicated that over 70% of zebra mussels in the water column were of post-veliger size (>225 μm). This is indicative of the influence that storms can exert on veliger occurrence and the abundance of post-metamorphic zebra mussels. These larger mussels, which were physically detached from their

Figure 3-1
WHOLE-WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER - D.C. COOK 1993

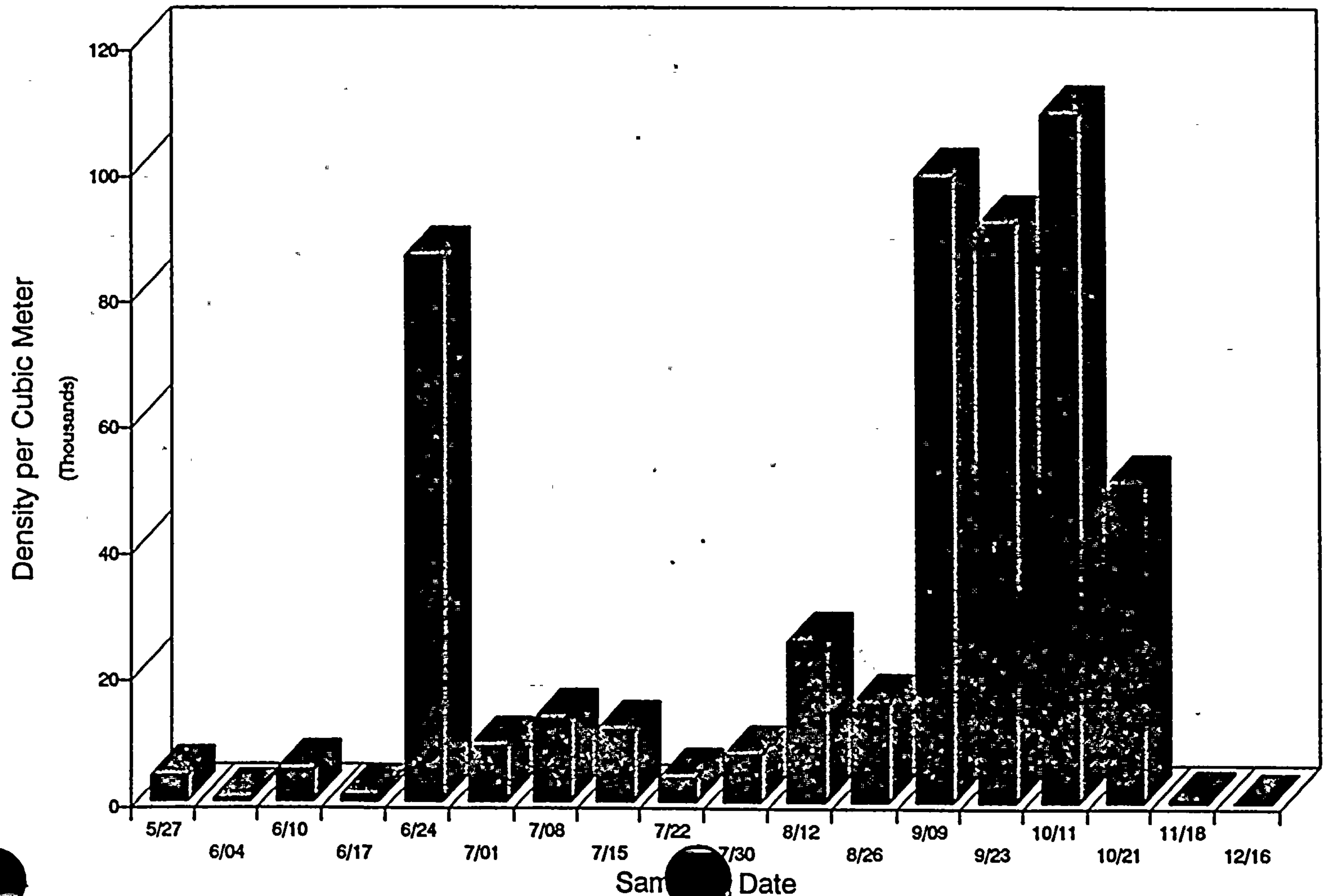


TABLE 3-1

WHOLE-WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER, D.C. COOK, 1993

DATE	DENSITY (No./m^3)
5/27/93	4,000
6/04/93	500
6/10/93	5,000
6/17/93	900
6/24/93	86,350
7/01/93	8550
7/08/93	12,900
7/15/93	11,200
7/22/93	3,700
7/30/93	7,400
8/12/93	25,300
8/26/93	15,500
9/09/93	98,800
9/23/93	91,500
10/11/93	108,950
10/21/93	50,050
11/18/93	400
12/16/93	0

previous location, could impact water systems adversely by quickly resettling following a storm event.

3.2 ARTIFICIAL SUBSTRATE SAMPLING

3.2.1 Circulating Water System

Artificial substrate monitoring was conducted from 20 May to 16 December 1993. Periodic settlement rates for the circulating water system (forebay) are shown in Figure 3-2 and Table 3-2. The north and south locations are not shown because the artificial substrates placed at these locations were damaged or destroyed by heavy water turbulence during two-unit operation. The center location, which is protected by a deflector wall, provided the most reliable location for settlement monitoring in the forebay.

Settlement of post-veligers first appeared in the forebay on 30 July and continued for the remainder of the sampling season. Post-veliger settlement peaked between 11 and 21 October, with an estimated average daily settlement rate of 72,197/m^2 (Figure 3-3). Average settlement rates in excess of 10,000 m^2/day were observed between 23 September and 18 November. There was no evidence of settlement on 15 July in the forebay from the cohort observed in the whole-water samples on 24 June. The heaviest spawning activity was first seen on 9 September and continued to 21 October. Heavy post-veliger settlement of the forebay was first observed on 23 September (sampling period from 9 to 23 September) at 165,274/m^2. This equates to a daily settlement rate of 11,805/m^2/day. These settlement rates continued to increase to a peak of over 72,000/m^2/day between 11 and 21 October. Settlement remained relatively high between 21 October and 18 November at 31,086/m^2/day. The larger size of these individuals suggests that either settlement occurred during the latter part of October or that many had translocated from elsewhere. Whole-water samples from 18 November showed light densities of primarily post-veliger-size mussels (approximately 200 μm) in the water column. Slides retrieved on 16 December were colonized at densities of over 90,000/m^2. Based on size, these individuals were almost exclusively translocators that averaged 600 μm. The smallest

Figure 3-2

ARTIFICIAL SUBSTRATE SETTLEMENT - FOREBAY LOCATION
SETTLEMENT PER SQUARE METER, D.C. COOK 1993

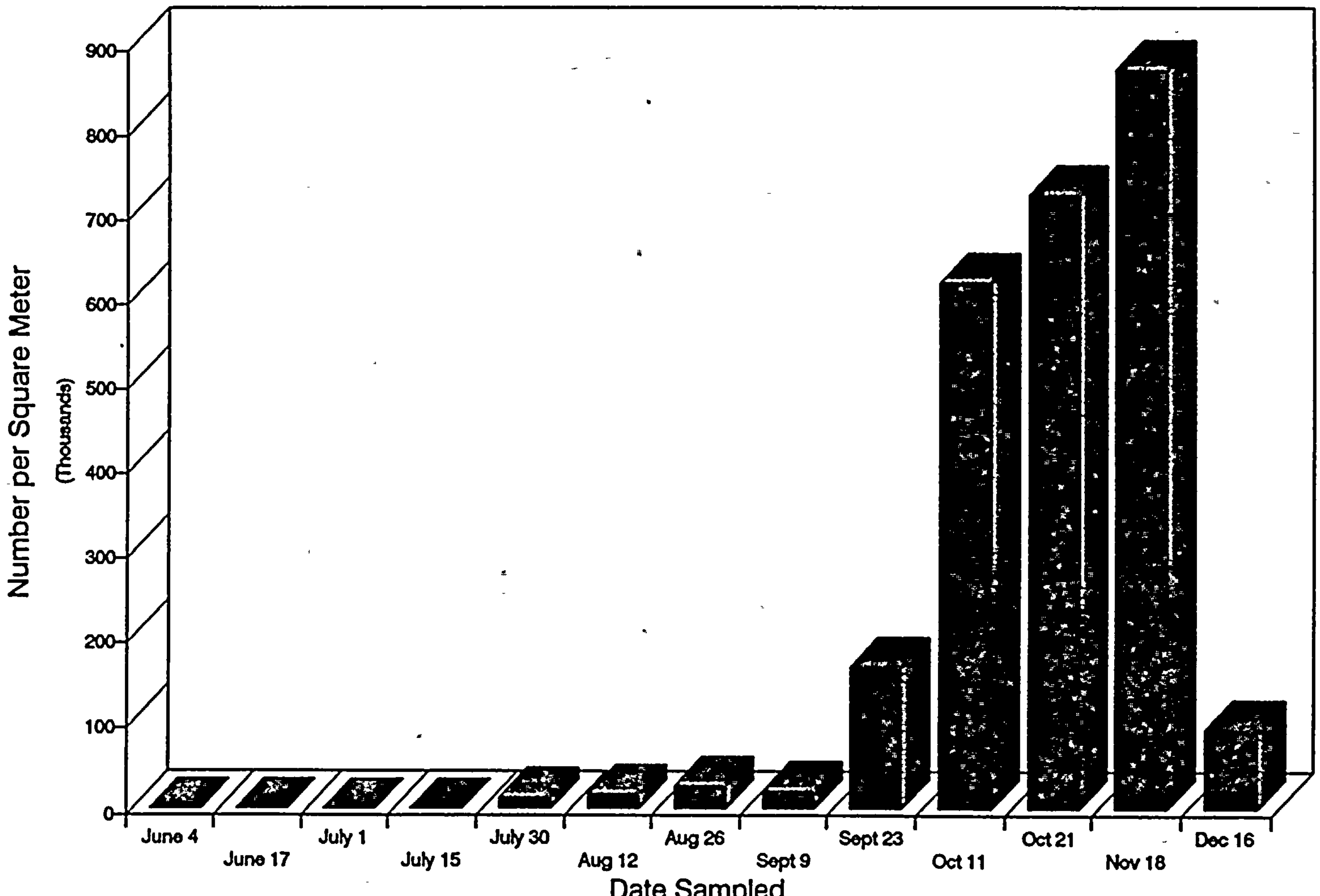


TABLE 3-2

ARTIFICIAL SUBSTRATE SETTLEMENT-*PERIODIC* POST-VELIGER DENSITY PER SQUARE METER, D.C. COOK, 1993

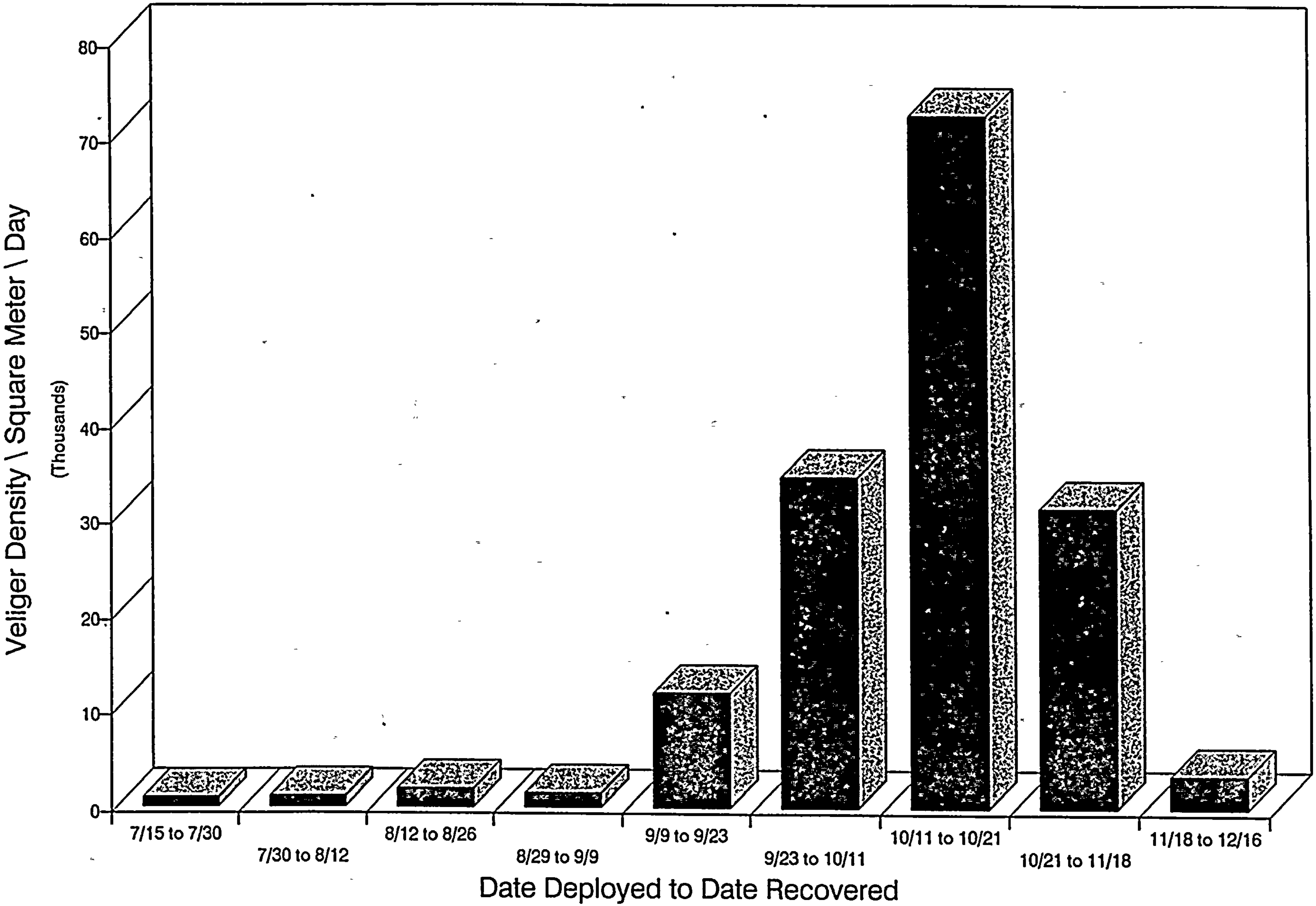
DATE	ESW-S	ESW-R	NESW-S	NESW-R	FOREBAY
6/04/93	0	0	0	0	0
6/17/93	0	0	0	0	0
7/01/93	0	320	320	1,547	0
7/15/93	0	5,013	373	960	0
7/30/93	NA[a]	266	266	427	12,267
8/12/93	107	6,613	1,280	906	15,467
8/26/93	2,074	1,653	1,973	2,240	26,209
9/09/93	160	427	1,333	1,173	19,787
9/23/93	3,040	2,027	267	267	165,274
10/11/93	320	1,013	320	9,066	619,733
10/21/93	NA[a]	1,280	747	4,480	721,973
11/18/93	267	213	320	533	870,411
12/16/93	160	53	53	107	92,908

[a]No sample - monitor disconnected or valve blocked, no water flow available.

Figure 3-3

ARTIFICIAL SUBSTRATE SETTLEMENT - FOREBAY LOCATION

AVERAGE DAILY SETTLEMENT PER SQUARE METER, D.C. COOK 1993



individuals were about 350 μm, perhaps the result of the small spawn observed on 1 November.

Cumulative settlement rates are shown in Table 3-3. Forebay post-veliger densities generally increased during the season, but remained less than 25,000/m^2 until the ClamTrol treatment on 11 September. Twelve days after the treatment, the density had increased to about 135,500/m^2. Densities increased to approximately 2 million/m^2 by 21 October. Substrates were then colonized by translocating adults, making accurate counts impossible in November and December. Translocating adults and juveniles also attached to the slides early in the program, before post-veliger settlement began. This additional surface area made assessment of early post-veliger settlement difficult. The accelerated settlement following the ClamTrol treatment exhibited the same trend noted on the periodic substrates for the following reasons:

- Lack of predator adult mussels in the forebay to control veligers
- Churned-up lake conditions in September, which brought more post-veligers into the intake forebay from the open lake
- An abundance of clean substrate upon which to settle following the ClamTrol treatment

Following the ClamTrol treatment, which coincided closely with the beginning of the heavy fall spawn, post-veliger settlement in the center forebay location increased rapidly. Only 12 days after treatment, post-veliger densities had exceeded 100,000/m^2. Over the next four weeks, post-veligers ranging in size from 175 to 500 μm settled on the artificial substrates at densities estimated at over 2 million/m^2. As these individuals grew and larger individuals translocated into the sampling area, the resulting settlement densities made cumulative estimates impractical because the settlement racks had become completely encrusted.

3.2.2 Service Water Systems

Periodic settlement densities for the service water systems are shown in Table 3-2 and Figures 3-4 and 3-5. Post-veligers first appeared on substrate collected from ESW return and NESW

TABLE 3-3

ARTIFICIAL SUBSTRATE SETTLEMENT-*CUMULATIVE* POST-VELIGER DENSITY PER SQUARE METER, D.C. COOK, 1993

DATE	ESW-S	ESW-R	NESW-S	NESW-R	FOREBAY
6/04/93	0	0	0	0	0
6/17/93	0	0	0	0	0
7/01/93	0	267	427	1,439	267
7/15/93	0	6,773	479	1,439	0
7/30/93	NA[a]	5,173	266	320	12,853
8/12/93	160	5,280	586	693	11,786
8/26/93	1,333	6,133	3,040	2,346	24,053
9/09/93	1,333	2,559	1,279	960	21,066
9/23/93	2,933	2,027	267	427	135,413
10/11/93	533	427	587	4,960	1.112M
10/21/93	NA[a]	960	640	3,093	2.059M
11/18/93	NA[a]	1,333	960	960	NA[b]

[a]No sample - monitor disconnected or valve blocked, no water flow.
[b]Substrates colonized by translocated adults - post-veliger counts not possible. Many adults fell off during retrieval of apparatus; therefore, unable to make an accurate count.

Figure 3-4

POST-VELIGER SETTLEMENT, NUMBER PER SQUARE METER
ESSENTIAL SERVICE WATER SYSTEM, D.C. COOK PLANT 1993

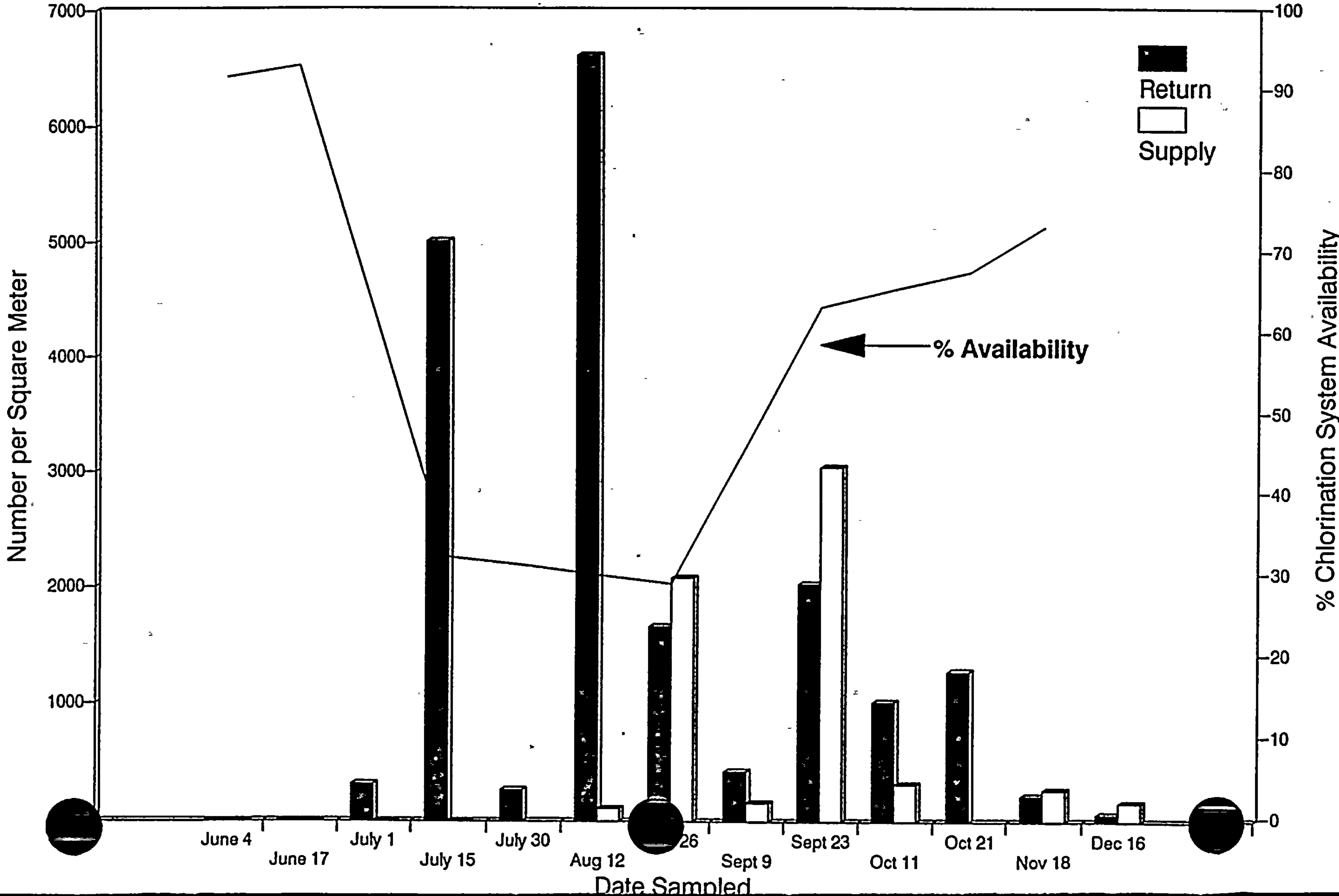
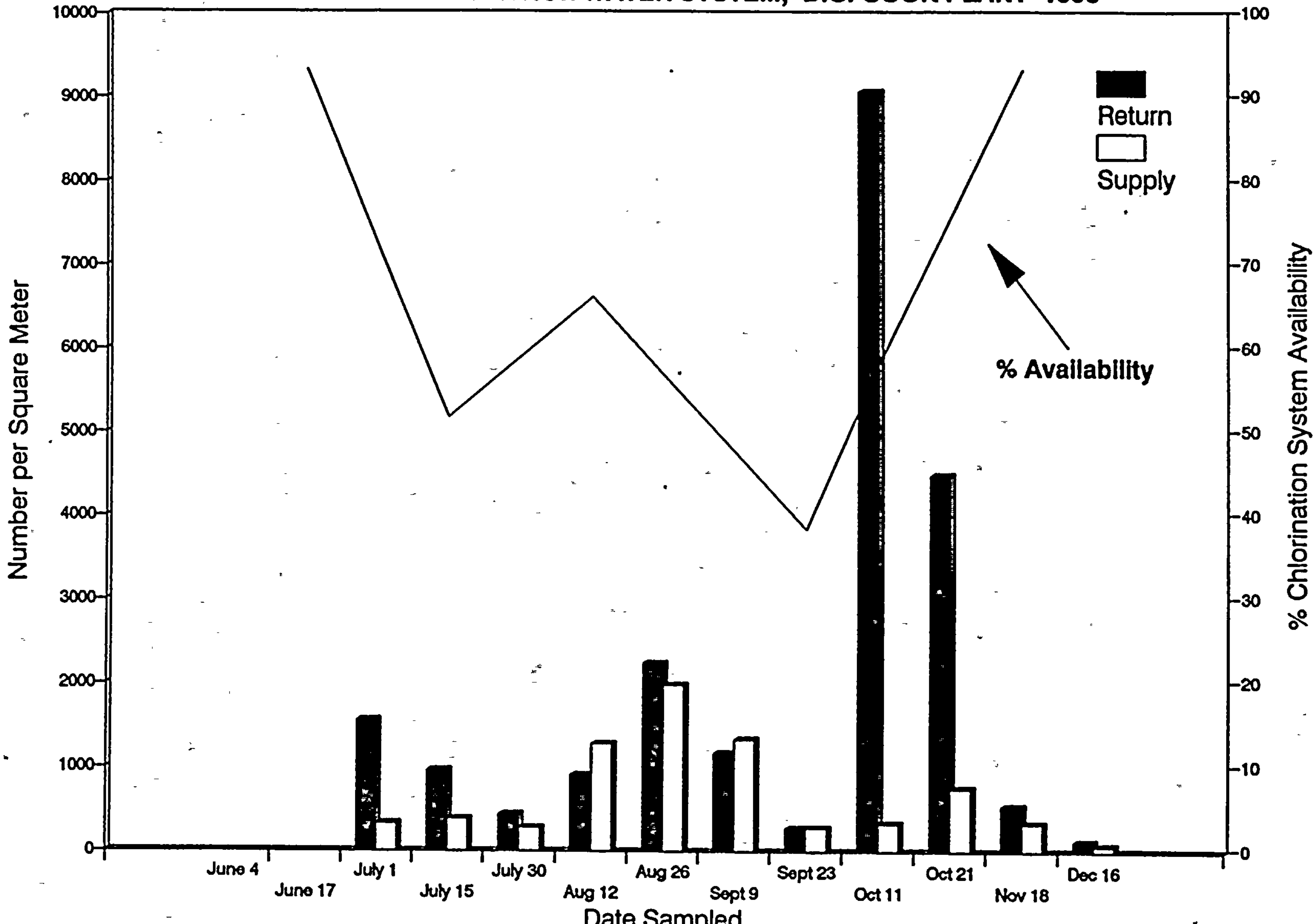


Figure 3-5

POST-VELIGER SETTLEMENT, NUMBER PER SQUARE METER
NON-ESSENTIAL SERVICE WATER SYSTEM, D.C. COOK PLANT 1993



supply and return on 1 July. They did not appear in the ESW supply, however, until 1[illegible] August.

Peak settlement on the return side of the ESW system occurred between 30 July and 12 August (6613/m^2). Peak settlement for the supply side was observed between 9 and 23 September (3040/m^2). The highest post-veliger densities observed on the return side of the NESW systems occurred between 23 September and 11 October (9066/m^2). Peak for the supply occurred during the latter half of August (1973/m^2).

Both systems are scheduled to be chlorinated for one 155-min period per day at 1.5 to 2.0 ppm TRC. This schedule is not always met because of mechanical breakdowns and other problems. During the 1993 sampling season, the chlorination schedule was interrupted on a number of occasions. Days without chlorination or with no TRC data for the ESW and NESW of both Unit 1 and Unit 2 are summarized in Table 3-4. (The full data set is presented in Appendix A.) This table indicates that the chlorination system operated well during May and June. However, for 21 and 15 days in July, there was no chlorination in the ESW and NESW systems, respectively. This continued in the ESW system for 18 of the first 19 days in August. The NESW chlorination system was out of service for the first few days in August (Unit 1) and the last eight days of the month (both units). Chlorination in September was unreliable during the first half of the month, but was more reliable in both service water systems during the latter half. During the first 10 days of October, there was no chlorination in the NESW system and at least five days were missed in the ESW system. Chlorination in both systems was fairly reliable for the remainder of the sampling season.

Another method of presenting the problems encountered by the chlorination system is to assess it in terms of percent availability for each month. Table 3-5 shows this availability to each service water system for both Unit 1 and Unit 2 and reflects the number of days during which chlorination occurred each month. As can be seen, all systems operated between 90 and 94% during May and June. Settling rates in the service water systems during these two months reflect the effectiveness of the chlorination system during periods of low densities. As the chlorination schedule was increasingly missed during July, August, September, and October,

SUMMARY OF DATES CHLORINATION SYSTEM WAS OUT OF SERVICE OR NO TRC DATA AVAILABLE

DATE	UNIT 1 ESW	UNIT 1 NESW	UNIT 2 ESW	UNIT 2 NESW
May				
1	NC	NC	NC	NC
2	NC	NC	NC	NC
10	ND[1]			
11	NC[2]	NC	NC	NC
12	ND			
18	ND			
20	ND			
June				
1	NC	NC	NC	NC
14	ND	ND	ND	ND
15	ND		ND	
16	ND		ND	
17	ND		ND	
18	NC	NC	NC	NC
July				
1		NC		NC
2	NC	NC	NC	NC
6	NC	NC	NC	NC
7	NC	NC	NC	NC
8	NC		NC	
12	NC		NC	
13	NC		NC	
14	NC		NC	
15	NC		NC	
16	NC		NC	
17-25	NC	NC	NC	NC
28	NC	NC	NC	NC
29	NC	NC	NC	NC
31	NC		NC	
August				
1	NC	NC	NC	
2	NC	NC	NC	

[1]ND — No TRC data, but chlorination occurred.
[2]NC — No chlorination.

TABLE 3-4 (Page 2 of 3)

SUMMARY OF DATES CHLORINATION SYSTEM
WAS OUT OF SERVICE OR NO TRC DATA AVAILABLE

DATE	UNIT 1 ESW	UNIT 1 NESW	UNIT 2 ESW	UNIT 2 NESW
August *(Continued)*				
3	NC	NC	NC	
4	NC		NC	
5	NC		NC	
6	NC		NC	
7	NC		NC	
8	NC		NC	NC
9	NC		NC	NC
10	NC		NC	
11	NC		NC	
12	NC		NC	
13	NC		NC	
15	NC		NC	
16	NC		NC	
17	NC		NC	
18	NC		NC	
19	NC		NC	
24-27	NC	NC	NC	NC
28		NC		NC
29		NC		NC
30		NC		NC
31		NC		NC
September				
1	NC	NC	NC	NC
2		NC		NC
3		NC		NC
4	NC	NC	NC	NC
5		NC		NC
6		NC		NC
8		NC		NC
9	NC	NC	NC	NC
10	NC	NC	NC	NC
11	NC	NC	NC	NC

NC — No chlorination.

TABLE 3-4 (Page 3 of 3)

SUMMARY OF DATES CHLORINATION SYSTEM
WAS OUT OF SERVICE OR NO TRC DATA AVAILABLE

DATE	UNIT 1 ESW	UNIT 1 NESW	UNIT 2 ESW	UNIT 2 NESW
September *(Continued)*				
12	NC	NC	NC	NC
13	NC	NC	NC	NC
14	NC	NC	NC	NC
15	NC	NC	NC	NC
16	NC		NC	
17	NC	NC	NC	NC
27				NC
28		NC		NC
29		NC		NC
30		NC		NC
October				
1		NC		NC
2		NC		NC
3		NC		NC
4	NC	NC	NC	NC
5-10	NC	NC	NC	NC
12	NC	NC	NC	NC
15		NC		NC
18	NC			
29	NC	NC	NC	NC
November				
18	NC	NC	NC	NC
19	NC	NC	NC	NC
20	NC		NC	
21-23	NC		NC	
24	NC		NC	
29	NC		NC	

[1]NC — No chlorination.

TABLE 3-5

PERCENT AVAILABILITY OF CHLORINATION SYSTEM FOR SERVICE WATER SYSTEMS

May-November 1993

MONTH	UNIT 1		UNIT 2	
	ESW	NESW	ESW	NESW
May	90.3	90.3	90.3	90.3
June	93.3	93.3	93.3	93.3
July	32.3	51.6	32.3	51.6
August	29.0	64.5	29.0	67.7
September	63.3	40.0	63.3	36.7
October	67.7	58.1	70.0	58.1
November	73.3	93.3	73.3	93.3

chlorination system availability ranged from 29 to 68% in the ESW system and from 36 to 68% in the NESW system. Settling increased in both service water systems during this same period. This reduction in chlorine availability occurred during the peak spawning period and enhanced the vulnerability of the service water systems to post-veliger settling.

The bioboxes were placed in the chlorinated service water systems at locations carrying low flows (less than 5 cfs), which allowed post-veliger settlement if chlorination was ineffective. The settlement rates observed on the substrates examined periodically thus reflect the effectiveness of the chlorination program as administered during the 1993 sampling season.

The service water systems data presented in Table 3-2 reflect the problems experienced in delivering chlorine to these systems during 1993: peak settlement densities in the ESW return system between mid-July and mid-August; in the ESW supply system between the end of August and the end of September; in the NESW return system between the third week of September and the third week of October; and in the NESW supply system between the month of August and early September. These periods of peak densities generally followed periods when the chlorination system was out of service for extended periods in the respective service water systems. It is also evident that as the chlorination system became more reliable (third week of October to mid-December), post-veliger settlement in the service water systems was controlled. Post-veligers were available in the water column as settlement rates in the forebay remained high (92,908 to 870,411/m^2) during this same period.

A comparison of densities on the return side of the service water systems with those on the supply side shows that on most sampling dates more settlement occurred on the return side. This suggests that the concentration of chlorine reaching the return side was reduced and less effective. This was most likely the result of chlorine uptake in the water column before the dosage reached the return side.

Review of the settlement rates in the service water systems (all sampling locations combined) indicates that rates were in excess of 1000/m^2 in 16 of the 50 samples (32%). These rates are cause for concern in the operation of the service water systems. Considering the chlorination

schedule followed in 1993, settlement rates between 0 and 100 are the best that could be expected. One reason is that the 155 min of continuous, i.e., interrupted, chlorine injection was followed by 21 hrs 25 min of no treatment. To be most effective, chlorination should be administered in four or five doses at 5 to 6-hr intervals. At these time intervals chlorine agitates post-veligers throughout the day, causing them not to put out bysal threads or to detach their temporary bysal threads and resuspend in the water column. To eliminate settling, a continuous (24 hrs/day) chlorination schedule may be necessary in light of the high number of veligers and post-veligers present in the intake water during the sampling season.

Cumulative settlement data collected from the side stream samplers located on the service water systems did not meet expectations. The increase in post-veliger densities followed by an increase in shell length over the course of the sampling season occurred only to a limited extent. Post-veliger/juvenile development proceeded until shell lengths attained 1.5 mm. No live juveniles with greater shell lengths were found inside the samplers or on the artificial substrates until the last sampling date, when three individuals ranging from 3 to 5 mm were observed in the NESW return sampler. The 1.5-mm "size limit" continued after peak densities were observed in the two systems (15 July on the return side of the ESW system and 11 October on the NESW system). It was obvious that larger zebra mussels found the samplers unsuitable habitat and either translocated or died. Mortality inside the samplers was difficult to estimate because of the silt accumulation and the transport of shells and shell fragments into the samplers from other locations in the system. Possible causes of this observed size limit phenomenon are chlorination activities, temperature fluctuations, light intensity, high noise levels, or some combination of these factors. Others have observed that post-veligers and juveniles can relocate to avoid stress. Irrespective of the reasons for the observed phenomenon, continued growth over the course of the season did not occur. It has been assumed that conditions in the sidestream samplers reflect conditions in the low-velocity-flow service water systems; therefore, the results reported here can be transferred to these systems. However, as a practical matter, the problem resulting from the 1993 ClamTrol treatment in the control room air conditioning system and plant air compressor suggests that continued growth may occur in some areas of service water systems despite chlorination. Therefore, the results of the cumulative substrate studies are promising but should be used with caution until more information has been collected.

CHAPTER 4

SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

Whole-water and artificial substrate sampling was initiated on 27 May 1993 and continued to 16 December 1993. Two spawning peaks occurred, in the third week of June and again in the period from September to mid-October. The second peak was the peak spawning period of the season.

Peak post-veliger settlement, as indicated by average daily settlement, occurred during the 11-21 October period. Considering the peak period of veliger density in the whole-water samples, this was expected. The following conditions also contributed to settlement:

- Churned-up lake conditions resulting from high winds
- Lack of predator adult mussels and uninhabitated substrate resulting from the September ClamTrol treatment

The timing of the ClamTrol treatment, the peak spawning activity, and lake conditions coincided to produce heavy post-veliger settlement in the forebay.

Post-veliger settlement in the service water systems depended more on chlorination frequency than on availability of post-veligers. Periods of heaviest settlement (mid-July to the third week of October) in the ESW and NESW systems corresponded to periods of no chlorination (see Tables 3-2 and 3-4). When the chlorination system was functioning properly, settlement in the service water systems was controlled as well as it could be, considering the chlorine delivery schedule. Specifically, the period of heaviest settlement in the forebay (which is not chlorinated) occurred between 21 October and 16 December 1993. During this same period, the chlorination schedule was maintained and settlement in the service water systems was low (less than $600/m^2$).

Results stemming from the cumulative settlement element of the monitoring program showed that initial post-veliger settlement took place as expected, but that growth of individuals during the course of the season did not occur. A maximum shell length of approximately 1.5 mm was reached but not exceeded. Possible explanations include mortality and/or stress-induced translocation of the juveniles out of the samplers. This was caused by a hostile environment that included chlorination among other potentially adverse factors. With the exception of chlorine, these factors could not be measured by the program as designed.

4.2 RECOMMENDATIONS

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

- Whole-water sampling should be initiated in April to determine the presence of veligers in the water column.
- Studies of post-veliger settlement substrates should be conducted from May (substrate set in April) through December. A special study currently being conducted will determine the need for winter post-veliger settlement sampling.
- The chlorination system and schedule should be upgraded to ensure appropriate intermittent or continuous delivery of chlorine to control post-veliger settlement.
- An observation made during 1993 (no treatment of the intake tunnels) suggests that the Cook plant can expect to see potentially heavy densities of veligers and post-veligers in the circulating and service water systems. It is reasonable to conclude that a substantial portion of these mussels come from spawning adults currently living in the intake tunnels. I&M should consider continuous treatment of these tunnels to prevent post-veliger settlement in these areas.

APPENDIX A

MAY CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
5/3/93	0.17	1.57	2.90
5/4/93	0.15	1.22	7.54
5/5/93	0.17	1.20	6.12
5/6/93	0.14	0.85	5.04
5/7/93	0.19	0.72	1.00
5/8/93	0.19	1.81	2.97
5/9/93	0.18	1.08	1.20
5/10/93	0.14	ND	6.45
5/11/93	---	---	---
5/12/93	0.16	ND	1.81
5/13/93	0.12	3.75	2.33
5/14/93	0.12	ND	1.53
5/15/93	0.17	1.25	3.55
5/16/93	0.16	2.35	4.87
5/17/93	0.14	0.96	2.14
5/18/93	0.16	ND	6.65
5/19/93	0.14	4.68	6.37
5/20/93	0.10	ND	3.30
5/21/93	0.11	4.75	2.13
5/22/93	0.14	0.40	2.22
5/23/93	0.09	0.43	3.85
5/24/93	0.08	0.27	3.18
5/25/93	0.09	0.44	3.02
5/26/93	0.07	3.62	6.03
5/27/93	0.10	2.32	8.14
5/28/93	0.08	0.58	1.10
5/29/93	0.12	0.70	5.50
5/30/93	0.11	4.23	1.30
5/31/93	0.10	0.48	4.38
Average	0.13	1.72	3.80

Comments: 1) No chlorination performed on 5/11/93 due to low supply NaOCL

2) ND - No Data - however, chlorination performed

MAY CHLORINATION - UNIT 2

	End of Pipe Average TRC - 155 min/day		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
5/3/93	0.18	3.07	7.75
5/4/93	0.16	3.34	4.87
5/5/93	0.18	2.83	1.32
5/6/93	0.16	1.90	1.12
5/7/93	0.19	1.90	1.75
5/8/93	0.20	2.89	3.13
5/9/93	0.18	3.10	5.90
5/10/93	0.16	3.65	1.75
5/11/93	---	---	---
5/12/93	0.16	1.16	4.50
5/13/93	0.14	1.76	6.49
5/14/93	0.16	1.15	5.24
5/15/93	0.18	1.98	3.12
5/16/93	0.18	1.11	1.41
5/17/93	0.19	0.40	5.79
5/18/93	0.19	1.70	1.80
5/19/93	0.23	2.10	2.26
5/20/93	0.18	4.80	3.20
5/21/93	0.20	2.26	3.38
5/22/93	0.17	0.88	4.50
5/23/93	0.19	4.22	1.33
5/24/93	0.14	1.07	3.05
5/25/93	0.19	5.30	0.65
5/26/93	0.18	3.55	1.50
5/27/93	0.19	2.11	2.10
5/28/93	0.18	5.56	4.08
5/29/93	0.18	4.90	1.95
5/30/93	0.20	0.40	3.18
5/31/93	0.20	1.48	4.74
Average	0.18	2.52	3.28

Comments: 1) No chlorination performed on 5/11/93 due to low supply NaOCL

JUNE CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
6/2/93	0.14	0.55	0.76
6/3/93	0.18	3.10	5.30
6/4/93	0.15	0.95	2.70
6/5/93	0.11	0.20	1.50
6/6/93	0.13	0.36	0.85
6/7/93	0.14	0.75	6.90
6/8/93	0.16	1.40	5.70
6/9/93	0.13	0.45	5.00
6/10/93	0.13	0.83	2.55
6/11/93	0.11	0.35	1.75
6/12/93	0.17	2.50	0.70
6/13/93	0.11	0.25	6.50
6/14/93	.045	ND	ND
6/15/93	.085	ND	2.10
6/16/93	.097	ND	1.54
6/17/93	0.07	ND	4.40
6/19/93	0.11	3.80	4.20
6/20/93	0.10	0.20	3.05
6/21/93	0.04	0.30	1.55
6/22/93	0.07	0.20	2.10
6/23/93	0.12	0.15	3.50
6/24/93	0.08	0.20	1.40
6/25/93	0.09	0.16	2.10
6/26/93	.075	0.10	1.80
6/27/93	0.08	0.08	2.45
6/28/93	.063	0.02	0.50
6/29/93	0.08	0.05	8.50
6/30/93	0.10	0.30	0.62
Average	.106	0.72	2.96

Comments: 1) ND - no data - however, chlorination was performed

JUNE CHLORINATION - UNIT 2

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
6/2/93	0.16	0.42	4.80
6/3/93	0.17	0.85	1.45
6/4/93	0.16	1.10	0.85
6/5/93	0.16	1.00	0.90
6/6/93	0.18	0.40	1.50
6/7/93	0.16	1.00	3.40
6/8/93	0.18	9.80	2.10
6/9/93	0.20	0.85	3.60
6/10/93	0.19	5.25	3.20
6/11/93	0.20	3.20	4.50
6/12/93	0.19	1.40	2.90
6/13/93	0.18	0.25	1.50
6/14/93	0.19	ND	ND
6/15/93	0.18	ND	3.70
6/16/93	.183	ND	4.62
6/17/93	0.17	ND	2.60
6/19/93	0.16	2.90	3.80
6/20/93	0.18	0.20	4.04
6/21/93	0.17	0.55	5.25
6/22/93	0.18	0.27	5.10
6/23/93	0.20	0.18	3.80
6/24/93	0.20	0.15	3.40
6/25/93	0.17	0.15	2.70
6/26/93	0.16	0.13	2.40
6/27/93	0.14	0.09	2.68
6/28/93	.122	0.03	1.38
6/29/93	.165	0.07	4.31
6/30/93	.185	0.35	2.12
Average	.174	1.27	3.06

Comments: 1) ND - no data - however, chlorination was performed

JULY CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
7/1/93	0.05	7.00	----
7/3/93	0.09	0.06	1.71
7/4/93	0.08	[a]0.04	14.64
7/5/93	0.06	0.02	0.64
7/8/93	0.02	[c]	4.95
7/9/93	.065	0.60	0.69
7/10/93	0.13	4.20	10.0
7/11/93	0.03	[b]0.21	[b]7.70
7/12/93	0.02	[c]	4.49
7/13/93	0.02	[c]	4.30
7/14/93	0.02	[c]	2.31
7/15/93	0.02	[c]	7.23
7/16/93	[d]0.02	[cd]	[d]3.43
7/26/93	.065	0.02	3.35
7/27/93	0.04	0.01	0.75
7/28/93	[f]0.02	----	----
7/30/93	.033	[e]1.75	1.80
7/31/93	.063	----	1.60
Average	.049	1.39	4.23

Comments: [a] ESW chlorination lasted 65 mins. due to flowmeter fouling

[b] ESW/NESW chlorination only - line break

[c] Not chlorinated

[d] Duration 105 minutes

[e] ESW secured after 40 min. (Circ water 115 minutes)

[f] Duration 10 minutes

Note: No chlorination performed on 7/2, 7/6, 7/7, 7/17-25, 7/29

JULY CHLORINATION - UNIT 2

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
7/1/93	0.07	11.4	----
7/3/93	0.11	0.06	0.15
7/4/93	0.13	[a]0.05	0.81
7/5/93	0.18	0.03	4.56
7/8/93	0.02	[c]	4.28
7/9/93	0.15	0.02	9.49
7/10/93	0.16	1.00	1.40
7/11/93	0.02	[b]0.21	[b]0.73
7/12/93	0.02	[c]	4.77
7/13/93	0.02	[c]	3.00
7/14/93	0.02	[c]	6.53
7/15/93	0.02	[c]	4.28
7/16/93	[d]0.02	[cd]	[d]6.80
7/26/93	0.13	0.02	1.30
7/27/93	0.14	0.01	6.37
7/28/93	[f]0.02	----	----
7/30/93	0.12	[e]0.45	2.40
7/31/93	0.16	----	2.70
Average	.088	1.33	3.72

Comments:

[a] ESW chlorination lasted 65 mins. due to flowmeter fouling

[b] ESW/NESW chlorination only - line break

[c] Not chlorinated

[d] Duration 105 minutes

[e] ESW secured after 40 min. (Circ water 115 minutes)

[f] Duration 10 minutes

Note: No chlorination performed on 7/2, 7/6, 7/7, 7/17-25, 7/29

AUGUST CHLORINATION - UNIT 1

	End of Pipe Average TRC - 155 min/day		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
8/1/93	.025	[a]	[b]
8/2/93	.025	[a]	[b]
8/3/93	.025	[a]	[b]
8/4/93	.045	[a]	.47
8/5/93	.043	[a]	1.8
8/6/93	.065	[a]	5.2
8/7/93	.143	[a]	5.4
8/8/93	.14	[a]	2.66
8/9/93	.165	[a]	1.8
8/10/93	0.07	[a]	.15
8/11/93	0.12	[a]	3.15
8/12/93	0.06	[a]	2.3
8/13/93	[d]0.05	[a]	2.3
8/14/93	0.09	[a]	5.0
8/15/93	0.10	[a]	2.89
8/16/93	0.076	[a]	5.5
8/17/93	0.074	[a]	7.96
8/18/93	0.042	[a]	.59
8/19/93	.068	[a]	5.0
8/20/93	.10	.25	15.1
8/21/93	.03	11.0	10.2
8/22/93	.08	2.65	3.25
8/23/93	.05	1.55	.20
8/28/93	.035	.55	<.00001
8/29/93	.14	1.65	[c]
8/30/93	.17	1.07	[c]
8/31/93	.15	1.92	[c]
Average	.13	2.58	4.05

Comments:
[a] ESW system leak - no chlorination

[b] NESW system leak - no chlorination

[c] NESW system maintenence - no chlorination

Note: No chlorination performed on 8/24-27 due to system maintenence

AUGUST CHLORINATION - UNIT 2

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
8/1/93	.188	[e]	1.65
8/2/93	.175	[e]	4.35
8/3/93	.2	[e]	5.7
8/4/93	.18	[e]	7.6
8/5/93	.193	[e]	5.3
8/6/93	[a].145	[e]	[g]2.4
8/10/93	0.18	[e]	2.3
8/11/93	[b]0.15	[e]	2.25
8/12/93	0.18	[e]	2.0
8/13/93	[c]0.19	[e]	1.37
8/14/93	[d]0.20	[f].85	2.4
8/15/93	0.15	[e]	1.63
8/16/93	0.184	[e]	2.42
8/17/93	0.172	[e]	.78
8/18/93	0.184	[e]	[h]7.30
8/19/93	.170	[e]	2.1
8/20/93	.20	2.20	1.0
8/21/93	[c].17	8.80	.07
8/22/93	[a].13	1272	3.70
8/23/93	.168	1.10	8.0
8/28/93	.12	.40	[i]
8/29/93	.11	1.88	[i]
8/30/93	.09	2.20	[i]
8/31/93	.11	1.62	[i]
Average	.15	2.31	3.22

Comments:

[a] 2-GRV-521 only diffuser open on U-2

[b] 2-GRV-522 only diffuser open on U-2

[c] 2-GRV-523 only diffuser open on U-2

[d] 2-GRV-524 only diffuser open on U-2

[e] NESW system down - broken valve

[f] GRV-530 busted after daily clorination

[g] 2-CL-132 just barely cracked open

[h] Bias flow to 2 NESW

[i] No data

Note: No chlorination performed on 8/7-9, and 8/24-27 due to system maintenence

SEPTEMBER CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
9/2/93	0.15	1.62	[c]
9/3/93	0.06	1.33	[c]
9/5/93	0.12	4.58	[c]
9/6/93	0.11	1.90	[c]
9/6/93	0.14	1.72	[c]
9/7/93	.115	1.67	1.71
9/8/93	.088	2.16	
9/16/93	.055		4.21
9/18/93	.185	1.86	21.5
9/19/93	0.14	1.26	15.8
9/20/93	.130	1.23	6.67
9/21/93	.118	1.81	5.38
9/22/93	.143	8.02	2.93
9/23/93	.120	1.28	2.34
9/24/93	[a]0.11	0.95	2.34
9/25/93	.17	2.65	6.56
9/26/93	.155	4.65	6.89
9/27/93	.14	.56	[d]
9/28/93	[b].13	[b].88	[d]
9/29/93	.14	.42	[d]
9/30/93	.13	2.4	[d]
Average	.13	2.15	6.94

Comments: [a] Chlorination for 60 minutes only on CIRC

[b] Chlorination for 80 minutes

[c] NESW system down for maintenance

[d] No data

Note: No chlorination Sept:1,4,9-15,17 due to maintenance or repairs

SEPTEMBER CHLORINATION - UNIT 2

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
9/2/93	0.09	1.91	[c]
9/3/93	0.08	.02	[c]
9/5/93	0.10	3.63	[c]
9/6/93	0.08	2.20	[c]
9/6/93	0.10	.12	[c]
9/7/93	.073	1.65	3.55
9/8/93	.085	2.25	
9/16/93	.108		23.0
9/18/93	.18	1.95	2.89
9/19/93	0.16	1.47	2.77
9/20/93	.17	.74	2.15
9/21/93	.16	2.43	1.87
9/22/93	.173	.10	2.78
9/23/93	.180	.05	3.82
9/24/93	[a]0.21	0.22	2.51
9/25/93	.18	1.65	1.39
9/26/93	.20	2.56	1.45
9/27/93	.17	.46	[d]
9/28/93	[b].15	[b]1.03	[d]
9/29/93	.15	4.75	[d]
9/30/93	.15	2.75	[d]
Average	.14	1.60	4.38

Comments: [a] Chlorination for 60 minutes only on CIRC

[b] Chlorination for 80 minutes

[c] NESW system down for maintenance

[d] No data

Note: No chlorination Sept: 1,4,9-15,17 due to maintenance or repairs

OCTOBER CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
10/1/93	0.10	3.78	[d]
10/2/93	0.11	1.88	[d]
10/3/93	0.15	2.75	[d]
10/4/93	[a]0.10		[d]
10/11/93	[b]0.15	[b]0.07	[b]8.2
10/13/93	.17	0.68	5.35
10/14/93	.20	3.02	4.6
10/15/93	.19	3.19	
10/16/93	.19	4.8	5.6
10/17/93	0.18	3.86	5.65
10/18/93	.17		2.45
10/19/93	.152	2.18	3.89
10/20/93	[c].11	[c]1.97	[c]3.21
10/21/93	.15	3.72	4.74
10/22/93	0.14	1.44	4.73
10/23/93	.186	4.15	4.65
10/24/93	.14	1.49	4.5
10/25/93	.11	2.41	3.3
10/26/93	.11	3.3	.65
10/27/93	.16	.5	4.2
10/28/93	.14	1.64	6.05
10/30/93	.17	5.2	2.95
10/31/93	.15	4.2	3.22
Average	.15	2.68	4.33

Comments: [a] Chlorination stopped after 30 minutes due to massive failure of GRV

[b] Chlorination for 130 minutes

[c] Chlorination for 133 minutes

[d] NESW down for repair

Note: No chlorination Oct 5-10 due to a control valve leak
On October 12, Circ not treated, ESW and NESW treated continuous
On October 29, whole system treated for 15 minutes only

OCTOBER CHLORINATION - UNIT 2

Date	Circ (ave) ppm	ESW ppm	NESW ppm
	End of Pipe Average TRC - 155 min/day		
10/1/93	.19	3.15	[d]
10/2/93	0.19	2.58	[d]
10/3/93	0.22	2.15	[d]
10/4/93	[a]0.14		[d]
10/11/93	[b]0.16	[b]2.0	[b].82
10/13/93	.17	1.90	0.98
10/14/93	.19	3.20	.1.42
10/15/93	.20	3.45	
10/16/93	.187	2.95	3.25
10/17/93	0.17	3.56	4.21
10/18/93	.16	.35	4.92
10/19/93	.073	3.07	3.21
10/20/93	[c].11	[c]2.87	[c]2.89
10/21/93	.135	3.87	4.05
10/22/93	0.16	1.85	.72
10/23/93	.19	2.45	3.25
10/24/93	.17	2.12	1.48
10/25/93	.13	3.13	2.55
10/26/93	.15	3.05	8.20
10/27/93	.15	1.32	3.15
10/28/93	.16	2.80	2.48
10/30/93	.15	1.85	5.69
10/31/93	.17	0.98	5.85
Average	.16	2.48	3.28

Comments: [a] Chlorination stopped after 30 minutes due to massive failure of GRV

[b] Chlorination for 130 minutes

[c] Chlorination for 133 minutes

[d] NESW down for repair

Note: No chlorination Oct 5-10 due to a control valve leak
On October 12, Circ not treated, ESW and NESW treated continuous
On October 29, whole system treated for 15 minutes only

NOVEMBER CHLORINATION - UNIT 1

	End of Pipe Average TRC - 155 min/day		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
11/1/93	0.10	.22	3.62
11/2/93	0.11	.10	4.80
11/3/93	0.11	0.11	7.84
11/4/93	0.10	0.14	7.90
11/5/93	0.11	0.09	5.12
11/6/93	.11	0.14	3.3
11/7/93	.12	0.30	4.11
11/8/93	.13	0.12	2.40
11/9/93	.10	.15	4.10
11/10/93	0.10	3.1	3.05
11/11/93	.08	3.39	4.59
11/12/93	.13	2.29	4.45
11/13/93	.11	2.36	8.26
11/14/93	.10	1.25	2.05
11/15/93	0.15	2.40	5.82
11/16/93	.13	0.51	3.72
11/17/93	.16	0.46	4.34
11/18/93	[a].02	[b]	
11/19/93	.15	[b]	
11/20/93	.11	[b]	6.04
11/24/93	.12		12.5
11/25/93	.15	.72	5.88
11/26/93	.14	.56	2.98
11/27/93	.11	.90	3.27
11/28/93	.16	1.42	6.12
11/29/93	.15		7.89
11/30/93	.13	.73	2.75
Average	.12	.98	5.08

Comments: [a] Chlorination run for 91 minutes

[b] ESW control valve leak - no chlorination

Note: No chlorination Nov 21-23, ran low on chlorine

NOVEMBER CHLORINATION - UNIT 2

	End of Pipe Average TRC - 155 min/day		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
11/1/93	.14	.14	6.85
11/2/93	.14	.05	5.41
11/3/93	.11	.10	3.84
11/4/93	.11	.14	.26
11/5/93	.14	.09	6.44
11/6/93	.14	.14	8.5
11/7/93	.17	.07	8.01
11/8/93	.18	.16	9.65
11/9/93	.16	.10	7.30
11/10/93	.15	3.1	6.85
11/11/93	.16	2.65	6.25
11/12/93	.2	1.42	4.60
11/13/93	.15	2.12	1.50
11/14/93	.17	1.8	7.22
11/15/93	.19	2.92	4.75
11/16/93	.19	0.10	9.30
11/17/93	.19	0.27	7.76
11/18/93	[a].04	[b]	
11/19/93	.16	[b]	
11/20/93	.17	[b]	4.76
11/24/93	.11		6.9
11/25/93	.19	.78	3.98
11/26/93	.18	.65	7.06
11/27/93	.18	1.55	5.27
11/28/93	.17	1.48	3.58
11/29/93	.17		3.30
11/30/93	.20	1.75	9.71
Average	.16	.98	5.96

Comments: [a] Chlorination run for 91 minutes

[b] ESW control valve leak - no chlorination

Note: No chlorination Nov 21-23, ran low on chlorine

DECEMBER CHLORINATION

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
UNIT 1			
12/1/93	.13	.16	2.65
12/2/93	.16	.56	6.42
12/3/93	.11	.96	6.75
12/4/93	<.02	.03	1.25
12/5/93	<.02	<.02	<.02
Average	.08	.34	3.41
UNIT 2			
12/1/93	.20	2.05	8.50
12/2/93	.17	.88	4.35
12/3/93	.12	1.32	.93
12/4/93	<.02	.02	.27
12/5/93	<.02	<.02	<.02
Average	.10	.85	2.81

BRAND
Brand Utility Services, Inc.

Quality Results from Quality People

28 June 1993
Eric Mallen, Senior Performance Engineer
Indiana Michigan Power Company
D.C. Cook Nuclear Power Station
One Cook Place
Bridgman, MI 49106

Subject: Zebra Mussel Infestation Report

The attached report represents the completion of the underwater Zebra Mussel inspection performed within the screenhouse, west of the T.W.S. and Trash-racks Units 1 & 2. If you have any questions or comments with respect to this report, please feel free to contact either Todd Miller or myself at your convenience.

Sincerely,

Thomas E. Owczarzak
BUSI Site Coordinator
Underwater Construction Division

cc:	J. Carlson	I&M
	K. Tamms	AEP
	J. Lawton	BUSI
	B. Feeley	BUSI
	T. Miller	BUSI
	Job File	80021

740 W. Western Avenue Muskegon, Michigan 49440 (616) 726-4016 Fax (616) 722-7200

Indiana and Michigan Power Company
D.C. Cook Nuclear Power Station
Units 1 and 2 Zebra Mussel Infestation Report

28 June 1993

Indiana and Michigan Power Company Contract Number C-8484
Brand Utility Services, Inc. Job Number 80021

Site Coordinator: Thomas E. Owczarzak
Foreman/Shift Supervisor: Todd Miller

TABLE OF CONTENTS

Indiana and Michigan Power Company
D.C. Cook Nuclear Power Station
Units 1 and 2 Zebra Mussel Infestation Report
28 June 1993

1.0 Purpose

The specific areas of concern were as follows:

T.W.S. Bays
- -Vertical walls
- -West(lake side) face of T.W.S.
- -East(pump side) back of trashracks/columns

Trashracks
- -West(lake side) face of trashracks
- -West(lake side) face of support columns

Keyways
- -Vertical face north/northwest side
- -Vertical face south/southwest side

Deflector Walls
- -Vertical face west(lake side)
- -Vertical face east(pump side)

This report is intended to be used in conjunction with the detailed videotape documentation of the inspections which is being submitted along with this report.

2.0 Limitations

Visibility:

TWS Bays	-	5-7 ft.
Trashracks	-	5-6 ft.
Keyways	-	3-5 ft.
Deflector Walls	-	5-7 ft.

Current:

TWS Bays	-	1-2 ft. p/sec.
Trashracks	-	1-3 ft. p/sec.
Keyways	-	1-3 ft. p/sec.
Deflector Walls	-	west side 4 ft. p/sec. east side negligible

I & M Power Company
D.C.Cook Nuclear Station
Zebra Mussel Report
28 June 93

Water Temperature:

TWS Bays	-	56 degrees +/-
Trashracks	-	56 degrees +/-
Keyways	-	56 degrees +/-
Deflector Walls	-	56 degrees +/-

Operating Status:

TWS Bays	-	Units 1 & 2 generating power
Trashracks	-	Units 1 & 2 generating power
Keyways	-	Units 1 & 2 generating power
Deflector Walls	-	Units 1 & 2 generating power

Access:

TWS Bays	-	Permanent plant access ladders
Trashracks	-	Temporary Divers ladder
Keyways	-	Temporary Divers ladder
Deflector	-	Temporary Divers ladder

3.0 Inspection Technique

Crew:

1 - Shift Foreman
1 - Inspection Diver
1 - Tender

Equipment:

1 - Set surface-supplied diving equipment
1 - U/W video camera/surface support equipment
1 - Divers hot-water system
1 - Back-up/emergency air supply system

Method: TWS Bays - The diver enters the TWS bay through the permanent manways in the screenhouse floor descending down the access ladder to the water level, at this point the diver begins his/her dive, leaves surface and continues to bottom of TWS bay. The diver now begins the detailed inspection by sight, touch, and measuring. Next the diver performs an U/W (underwater) video inspection of the findings.

Method (continued):

Trashracks, Keyways, Deflector Walls - The diver enters the main-forebay through the removable-grating descending down the temporary divers ladder which is secured to the trashracks and support members. Once the diver reaches the water level he/she has approx: 10' of ladder left to use in the descending process, at this point the diver physically climbs down the trashrack until reaching bottom. The diver now begins a detailed inspection by sight, touch, and measuring. Next the diver performs an U/W (underwater) video inspection of the findings.

Note: The above method's are performed over and over again until all inspection's are complete.

4.0 Findings

The zebra mussel inspection revealed a high percentage of mussel growth, 90% of the mussel coverage was a make up mussels only 1/8" to 1/2" in size. Generally the heaviest mussel coverage is in the areas with moderate to high flow, with the extremely high and flow areas being less populated. What the diver found was that in the most populated areas the mussels were several layers thick.

NOTE: All areas inspected were completely water blasted clean approx: 1 year ago.

4.1 T.W.S. Bays:

1-1 From the bottom of the bay (elevation 546) up approx: 15' (elevation 531) the walls have 100% coverage and in many areas the mussels are several layers thick. From the 15' mark (elevation 531) the mussel coverage decreases to approx: 80% and continues to thin out until there is no apparent mussel growth.

1-2 Relativity the same conditions exsists as in TWS 1-1

4.1 T.W.S. Bays (continued):

1-3 From the bottom of the bay (elevation 546) up approx: 15' (elevation 561) the walls have 100% coverage and several layers thick. From the 15' mark there is 80% single layer coverage, at the 25' mark there is very little growth.

1-4 From the bottom of the bay (elevation 546) up approx: 18' (elevation 564) the walls are covered approx: 95% with mussels which are several layers thick. From the 18' mark there is 80% mussel coverage with just the single layer coverage, from this point to the surface there is very little growth.

1-5 From the bottom of the bay (elevation 546) up approx: 15' (elevation 561) the walls have 100% coverage, as in TWS bay 1-3 and several layers thick. From the 15' mark there is single layer coverage, and again at approx: 25' mark there is nominal growth.

1-6 From the bottom of the bay (elevation 546) ascending upward at approx: 15' (elevation 561) the walls have 100% mussel coverage and they are a few layers thick and at the 17' mark upward towards the 22' mark there is approx: 80% coverage, above that there is no very little growth.

1-7 Almost all the areas in this bay had 50% coverage, several layers thick. We believe this is coused by the main deflector wall causing differant flow patterns within this bay.

2-1 Starting from the bottom (elevation 546) moving in an upward direction there is 80% coverage until the 15' mark (elevation 561). From the 15' mark upward to the 20'mark there is only 40% coverage from then on very sparse growth exsists. We believe this is caused again because of the main deflector wall.

2-2 From the bottom (elevation 546) upward to the 15' mark the mussel coverage is approx: 80%, from the 15' mark upward until the 22' mark there is 40% mussel coverage, and continuing upward there is very little growth.

4.1 T.W.S. Bays (continued)

2-3 From the bottom of the bay upward until the 21' mark there is 80% mussel coverage, between the bottom and the 21'mark, the mussels are several layers thick. Above the 21'mark sparse growth.

2-4 From the bottom (elevation 546) until the 15' mark there is 85% coverage with the mussels being several layers thick. At the 15' mark ascending to the 20' mark there is 40% mussel coverage. Again above the 15' mark there is little growth.

2-5 From the bottom of the bay there is 100% mussel growth only upward approx: 6'and between the 6' mark and the 15' mark the coverage is 80%, above the 15' mark the growth of zebra mussels thins out to zero.

2-6 From the bottom of the bay up to the 20' mark the coverage varys from 80-100% with some area's having growth approx: 1/2 " thick.

2-7 From the bottom there are patches of adult mussels upward to the 10'mark with these areas being 70% covered. From the 10' mark the mussel coverage is 100% up to the 25' mark and from there the growth is very sparce.

4.2 Trashracks:

The trashracks extend from bottom elevation 546' to their top elevation of 591'throughout the entire screenhouse main forebay. All the racks had moderate zebra mussel growth, not as dense as was seen in the TWS bays. Most of the growth was noted as being between the 4' mark (elevation 550') and the 20'mark (elevation 566'). In these areas the mussel coverage was approx: 80% or less again not as dense as in the TWS bays. From the 20' mark and above there was very little growth. The extremely high flow areas had only sparse mussel growth and in the areas that have very low flow the higher the density of mussel growth with algea also being part of the mediun in some areas.

4.3 Keyways:

The keyways between the trashracks had a very dense population of mussels. From the bottom of the main forebay (elevation 546') upward to approx: the 24' mark (elevation 570') the zebra mussel coverage was 100% and several layers thick in many locations. The makeup of the population was 90%-95% immature mussels and again the flow patterns play an important part in the mussel buildup.

4.4 Deflector Walls:

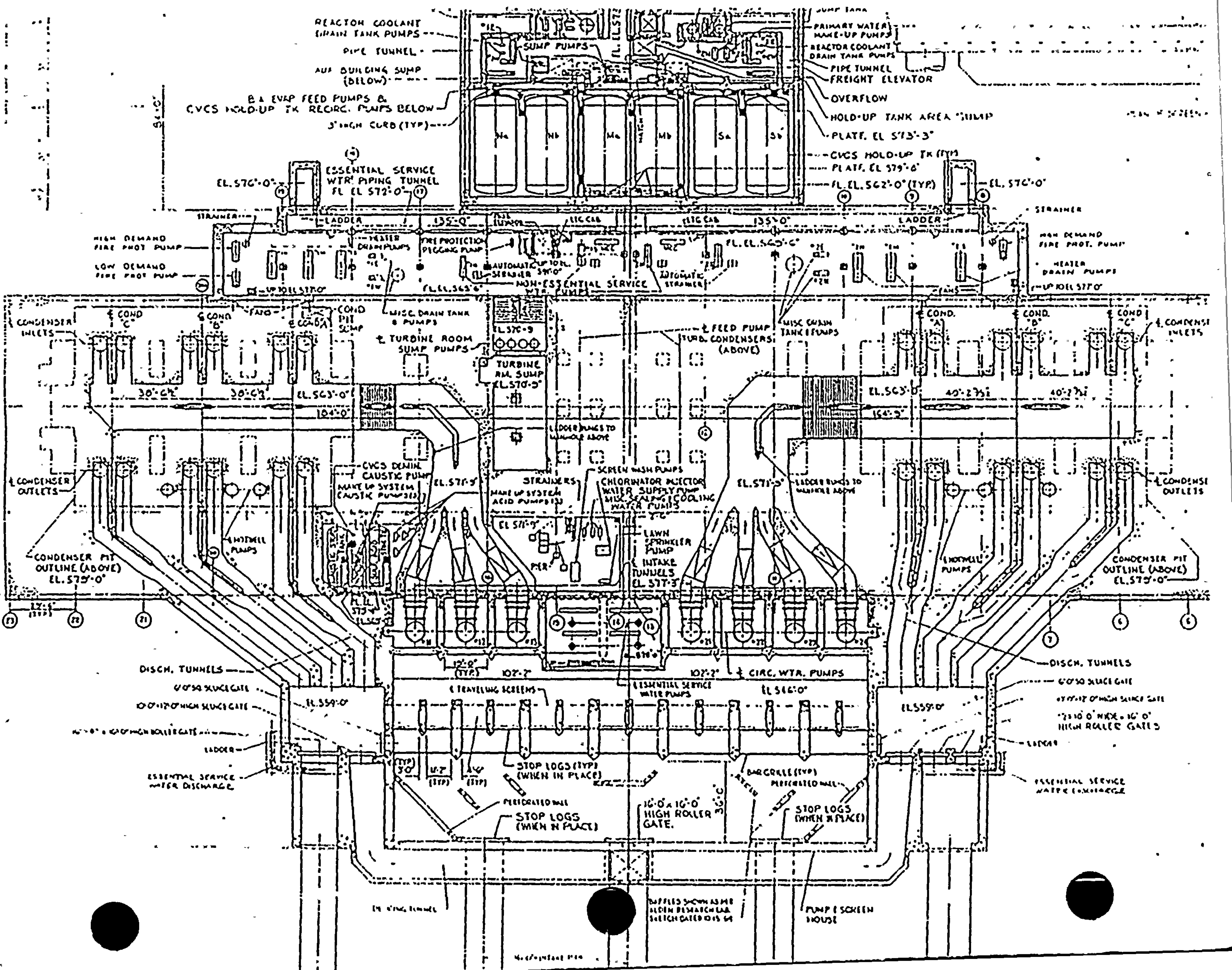
There are five (5) deflector walls. One (1) main in front of TWS bays 1-7/2-1 centerline of the Center Intake Tunnel. Two (2) walls infront of TWS bays 1-3/1-4 which are offset North Intake Tunnel. Two (2) walls infront of TWS bays 2-4/2-5 offset South Intake Tunnel. All deflector walls had 80%-100% mussel coverage on their north, south, and east sides from the bottom (elevation 546) upward to approx: 20' mark (elevation 566). The west sides of the deflector walls (facing the flow) was only sparsely populated.

NOTE: The remaining walls within the screenhouse main-forebay had 80% mussel coverage from the bottom upward to the 20' mark, these were immature mussels. Above the 20' mark there was sparse growth. At the mouth of the Intake Tunnels there was 100% mussel coverage with the makeup being 40% adults and 60% being immature zebra mussels.

5.0 Comments and Recommendations

It is recommended that the chemical treatments continue, physical removal of mussels by divers from all components within the screenhouse, to dispose of the mussels into dumpsters, and the addition of a spray-wash system that adequately removes mussels from the TWS basket mesh. Also a spray-wash system that can remove mussels that attach themselves to the face of the TWS baskets, since these mussels are being carried over because there is no mechanical means of removal.

We welcome the opportunity to discuss any new modifications nessessary, any asspect of this report.



REACTOR COOLANT DRAIN TANK PUMPS
PIPE TUNNEL
SUMP PUMPS
PRIMARY WATER MAKE-UP PUMPS
REACTOR COOLANT DRAIN TANK PUMPS
PIPE TUNNEL
FREIGHT ELEVATOR
OVERFLOW
HOLD-UP TANK AREA SUMP
PLATF. EL 573'-3"
PLATF. EL 579'-6"
FL. EL. 562'-0" (TYP.)
3" HIGH CURB (TYP)
ESSENTIAL SERVICE WTR. PIPING TUNNEL FL. EL. 572'-0"
EL. 576'-0"
STRAINER
LADDER
135'-0"
HIGH DEMAND FIRE PROT. PUMP
LOW DEMAND FIRE PROT. PUMP
HEATER DRAIN PUMPS
FIRE PROTECTION PEGGING PUMP
NON-ESSENTIAL SERVICE WTR. PUMPS
FL. EL. 565'-6"
CONDENSER INLETS
COND PIT SUMP
MISC. DRAIN TANK & PUMPS
℄ TURBINE ROOM SUMP PUMPS
TURBINE RM. SUMP EL. 570'-5"
℄ FEED PUMP
TURB. CONDENSERS (ABOVE)
MISC. DRAIN TANK & PUMPS
EL. 563'-0"
104'-0"
164'-5"
CVCS DEMIN. CAUSTIC PUMP
MAKE UP SYSTEM CAUSTIC PUMPS
MAKE UP SYSTEM ACID PUMPS
STRAINERS
SCREEN WASH PUMPS
CHLORINATOR INJECTOR WATER SUPPLY PUMP
LAWN SPRINKLER PUMP
INTAKE TUNNELS EL. 577'-3"
℄ CONDENSER OUTLETS
HOTWELL PUMPS
CONDENSER PIT OUTLINE (ABOVE) EL. 575'-0"
DISCH. TUNNELS
102'-2"
℄ CIRC. WTR. PUMPS
℄ TRAVELING SCREENS
ESSENTIAL SERVICE WATER PUMPS
EL. 559'-0"
EL. 566'-0"
LADDER
ESSENTIAL SERVICE WATER DISCHARGE
STOP LOGS (TYP) (WHEN IN PLACE)
PERFORATED WALL
STOP LOGS (WHEN IN PLACE)
16'-0" x 16'-0" HIGH ROLLER GATE.
BAR GRILLE (TYP)
HIGH ROLLER GATES
PUMP & SCREEN HOUSE

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October 19, 1993

Indiana Michigan Power Company
D.C. Cook Nuclear Station
One Cook Place
Bridgman, MI 49106

Attention: Mr. Eric Mallen

Regarding: Molluscicide Treatment Assessment
AEP Contract No. C-8484
BUSI Job No. 80021.12

Dear Mr. Mallen:

BUSI is pleased to submit the following inspection report detailing the effectiveness of the molluscicide treatment of the units one and two forebays and traveling water screen bays.

The report consists of a written section of detailed findings and a videotape illustrating the conditions of the treated areas.

If you have any questions or comments regarding this information, please feel free to contact us at your earliest convenience.

Sincerely,

Douglas T. Weaver
Underwater Construction Division

DTW/jjm

Attachment(s)

INDIANA MICHIGAN POWER COMPANY
D.C. COOK NUCLEAR PLANT

MOLLUSCICIDE TREATMENT ASSESSMENT

AEP Contract No. C-8484
BUSI Job No. 80021.12

Date of Treatment: 9/11/93
Date of Assessment: 9/22/93

Submitted By: Douglas T. Weaver

TABLE OF CONTENTS

1.0 Detailed Findings

1.1 Unit One Forebay

1.1.1 At the west wall between the center intake and north intake tunnels, the estimated kill ratio is ninety-five percent, with a seventy percent covering of dead mussels attached by their bissel threads. On the floor, there is a build up of loose mussels covering an area of two feet in width at the wall expanding to eight feet wide toward the trash racks. The depth of the pile ranges from 6" to three feet. (Please refer to Attachment 3. .)

1.1.2 The wall running across the northwest corner dividing the forebay from the Unit 1 trash trap has an estimated kill ratio of ninety-five percent. Approximately ninety percent of the area is covered by mussels attached by the bissel threads. A concentration of loose mussels runs the length of the floor covering an area of two feet in width by one foot deep. (Please refer to Attachment 3. .)

1.1.3 Deflector Wall "A"

On the pump side, the wall is 100% covered with attached mussels 1' thick. Additionally, the floor is covered with mussels along the entire length of the wall to the key way #1. The build up measures approximately four feet wide by two feet in depth. The kill ratio here is approximately ninety-five percent. The lake side of the wall is clear due to the high flow. (Please refer to Attachment 3. .)

1.1.4 Deflector Wall "B"

The wall has a one hundred percent kill ratio. On the pump side, approximately sixty percent of the wall is covered with attached mussels. On the lake side, there are no attached mussels due to the high flow.

1.0 Detailed Findings (Continued)

1.2 Unit Two Forebay

1.2.1 The west wall between the center intake and the south intake tunnels has a kill ratio of approximately ninety-five percent. Ninety percent of the dead mussels are still attached to the walls. On the floor, there is a pile of mussels which runs the length of the wall, extending into the bay up to deflector wall "D". The area measures ten feet in width and varies between eight inches and five feet in depth. (Please refer to Attachment 3. .)

1.2.2 The wall running across the southwest corner dividing the forebay from the Unit Two trash trap has an estimated kill ratio of ninety-five percent. 90% covering of the mussels are attached by their bissel threads. On the floor there is an accumulation of mussels which extends along the length of the wall covering an area of two feet in width by one foot in depth.

1.2.3 Deflector Wall "C"

The pump side of deflector wall "C" has an estimated kill ratio of ninety-five percent. 100% covering of the mussels are attached to the wall. The floor there is an accumulation of mussels which extends to the south from key way #3 to key way #4, and to the east from the wall through the trash racks. The lake side of the wall is clean due to the high flow.

1.2.4 Deflector Wall "D"

There is an estimated kill ratio of approximately ten percent on the pump side of the deflector wall. A 100% covering of live mussels which are firmly attached. There is a build up of mussels on the floor which extends the length of the wall, covering an area of two feet wide by one foot deep. (Please refer to Attachment 3. .) The lake side of the wall is clean due to the high flow.

1.0 Detailed Findings (Continued)

1.2 Unit Two Forebay

1.2.5 Deflector Wall "E"

The pump side of the wall has an estimated kill ratio of ninety-five percent. Ninety percent of the area is covered with attached mussels. There are no loose mussels on the floor. The lake side of the wall is clean.

1.3 Trash Racks and Key Ways

1.3.1 The trash racks in front of traveling water screens 1-1 and 1-2, trash racks along the north wall and key way #1 are covered by a six foot wide strip of mussels extending from the floor to the water surface. The kill ratio for this area is ninety-five percent. (Please refer to Attachment 3. .)

1.3.2 There is an estimated kill ratio of ninety-five percent on key way #1. A pile of loose mussels extends out to deflector wall "A", and there is a ninety-percent covering of dead mussels which are still attached.

1.3.3 The trash racks in front of traveling water screen's 1-3 and 1-4 have a 6' wide strip of mussels from the floor to the water surface along keyway #1 and keyway #2. This area is 100% covered with hanging dead mussels. The approximate kill ratio for this area is 95%. No loose mussel build up.

1.3.4 Key way #2 has an estimated kill ratio of approximately ninety-five percent on both the north and south sides. Attached mussels cover approximately ninety-five percent of the area. There is no accumulation of loose mussels in the area.

1.3.5 Due to high flow, divers were unable to assess trash racks 1-5 and 1-6.

1.0 Detailed Findings (Continued)

1.3 <u>Trash Racks and Key Ways (Continued)</u>

1.3.6 On both the north and south sides of key way #3, there is a kill ratio of approximately ninety-five percent. Attached mussels cover ninety-five percent of the area, and there is an accumulation of dead mussels on the floor. (Please refer to Section 1.2.3 for location and measurements.)

1.3.7 Trash racks 1-7 and 2-1 are approximately fifty percent covered with attached mussels. There are loose mussels accumulated (please refer to Section 1.2.3 and Attachment 3. for location and measurements.) There is an estimated kill ratio of ninety-five percent in this area.

1.3.8 Key way #4 has an approximated kill ratio of one hundred percent. Eighty-five percent of the area on both the north and south sides is covered with attached mussels. For locations and measurements of loose mussels, please refer to Section 1.2.3 and Attachment 3. .

1.3.9 Trash rack 2-2 has no signs of mussel growth or dead mussels as it is an area of very high flow. Trash rack 2-3 is approximately fifty percent covered by attached dead mussels. There is no accumulation of loose mussels. The estimated kill ratio in this area is ninety-five percent.

1.3.10 On the south side of key way #5, coverage is estimated at eighty percent. On the north side, approximately fifty percent of the area is covered. There are no loose mussels on the floors of either side. The kill ratio for both sides is ten percent.

1.3.11 There is coverage of about thirty percent on both trash racks 2-4 and 2-5 with an estimated kill ratio of twenty percent for both. There is no accumulation of loose mussels on the floor.

1.0 Detailed Findings (Continued)

1.3 Trash Racks and Key Ways (Continued)

1.3.12 Key way #6 has coverage estimated at seventy percent with a kill ratio of ninety-five percent on both the north and south sides. There are no loose mussels on the floor.

1.3.13 There is an estimated kill ratio of one hundred percent for both trash racks 2-6 and 2-7. Approximately twenty percent of the area is covered with dead mussels attached by their bissel threads. An accumulation of loose mussels covers an area of approximately two feet wide by one foot in depth at the south end of 2-7.

1.4 Traveling Water Screen Bays (T.W.S.B.)

To provide a more accurate assessment of the kill ratio in the traveling water screen bays, the kill ratios and coverages were noted at three points in each bay: the surface, the mid-way point and at floor level.

1.4.1 T.W.S.B. 1-1 has approximately one hundred percent coverage at the surface, with an estimated kill ratio of eighty percent. At the midway point, coverage decreases to about eighty percent with a kill ratio of fifty percent. At floor level, there is one hundred percent coverage with a kill ratio of seventy-five percent. All of the mussels are attached, with the exception of loose mussels which have accumulated in the northeast corner with a depth of about two feet.

1.4.2 At all three points in T.W.S.B. 1-2, there is estimated coverage of one hundred percent with a kill ratio of ninety-five percent. The dead mussels are still attached by the bissel threads. There is an accumulation of about three feet of loose mussels on the floor in the southeast corner.

1.0 Detailed Findings (Continued)

1.4 Traveling Water Screen Bays (T.W.S.B.) (Continued)

1.4.3 T.W.S.B. 1-3 has coverage of approximately ninety percent at the surface with a kill ratio of ninety-five percent. At the midway point, coverage decreases to approximately twenty percent, with a kill ratio of fifty percent. At floor level, the coverage is about twenty percent with a kill ratio of twenty percent. The majority of the dead mussels are loosely attached. In the northeast corner, there is a three foot pile of loose mussels.

1.4.4 T.W.S.B. 1-4 has approximated coverage of eighty percent throughout. At the surface, the kill ratio is about eighty percent. At the midway point, the kill ratio decreases to approximately seventy-five percent. On the bottom, the kill ratio is estimated at fifty percent. In the southwest corner there is a build up of mussels about five feet deep. Most of the dead mussels are still attached by the bissel threads.

1.4.5 T.W.S.B. 1-5 has about ninety percent coverage at the surface, with a kill ratio of approximately ninety-five percent. At the midway point, coverage approaches seventy percent, with a kill ratio of eighty percent. At the bottom, there is eighty percent coverage with a kill ratio of ninety-five percent. An accumulation of loose mussels runs the entire length of the bay with a depth of three feet.

1.4.6 T.W.S.B. 1-6 shows coverage of approximately eighty percent at the surface with a kill ratio of ninety-five percent. At the midway point, the coverage decreases to ninety percent with a kill ratio of ninety percent. At floor level coverage is estimated at eighty percent with a ninety-five percent kill ratio. There are no accumulations of loose mussels on the floor.

1.0 **Detailed Findings (Continued)**

1.4 Traveling Water Screen Bays (T.W.S.B.) (Continued)

1.4.7 At the surface, T.W.S.B. 1-7 exhibits coverage of approximately twenty percent with a kill ratio of ninety percent. At the midway point, coverage increases to ninety percent with at kill ratio of ten percent. At floor level, coverage is complete with approximately ninety percent of the mussels surviving. Across the trash rack, there is an accumulation of loose mussels covering an area four feet wide by two feet in depth.

1.4.8 T.W.S.B. 2-1 has eighty percent coverage at the surface with a kill ratio of fifty percent. At the midway point, coverage is one hundred percent with a twenty percent kill ratio. At floor level, there is eighty percent coverage with an estimated kill ratio of twenty percent. There are loose mussels built up across the trash rack covering an area of four feet wide by two feet in depth.

1.4.9 There is ninety percent coverage at the surface of T.W.S.B. 2-2 with an estimated kill ratio of thirty percent. There is one hundred percent coverage at the midway and floor level points, with five percent and zero percent kill ratios, respectively. Along the north wall, there is an accumulation of mussel debris covering an area measuring three feet wide by two feet deep. The area of coverage begins at the trash rack, extending across the front of the traveling water screen.

1.4.10 At the surface of T.W.S.B. 2-3, there is coverage of approximately eighty percent with a kill ratio of fifty percent. At the midway and floor level points, coverage increases to one hundred percent with kill ratios of thirty and twenty percents respectively. There is an accumulation of loose mussels measuring approximately eight feet wide by eight feet deep in front of the traveling water screen.

1.4.11 Divers were unable to assess the conditions of T.W.S.B. 2-4 due to high flow.

1.0 Detailed Findings (Continued)

1.4 Traveling Water Screen Bays (T.W.S.B.) (Continued)

1.4.12 T.W.S.B. 2-5 has approximately twenty percent coverage at the surface with a kill ratio of about ninety-five percent. At the midway point, coverage is about fifty percent with a survival rate of twenty percent. The floor level exhibits one hundred percent coverage with a kill ratio of fifty percent. At the southeast corner of the bay, there is a concentration of mussel debris about two feet deep.

1.4.13 At the surface and midway points, T.W.S.B. 2-6 exhibits coverage of ninety percent, with kill ratios of eighty and ninety-five percents respectively. At floor level, there is eighty percent coverage with a ten percent survival rate. The entire floor of the bay is covered by a two inch layer of loose mussels.

1.4.14 There is one hundred percent coverage at the surface of T.W.S.B. 2-7 with an estimated kill ratio of ninety-five percent. At the midway point, coverage decreases to ninety percent with a kill ratio of ninety-five percent. At the floor level there is ninety percent coverage with a fifty percent survival rate. At the south wall, there is an accumulation of dead mussels about three feet deep.

2.0 Conclusion

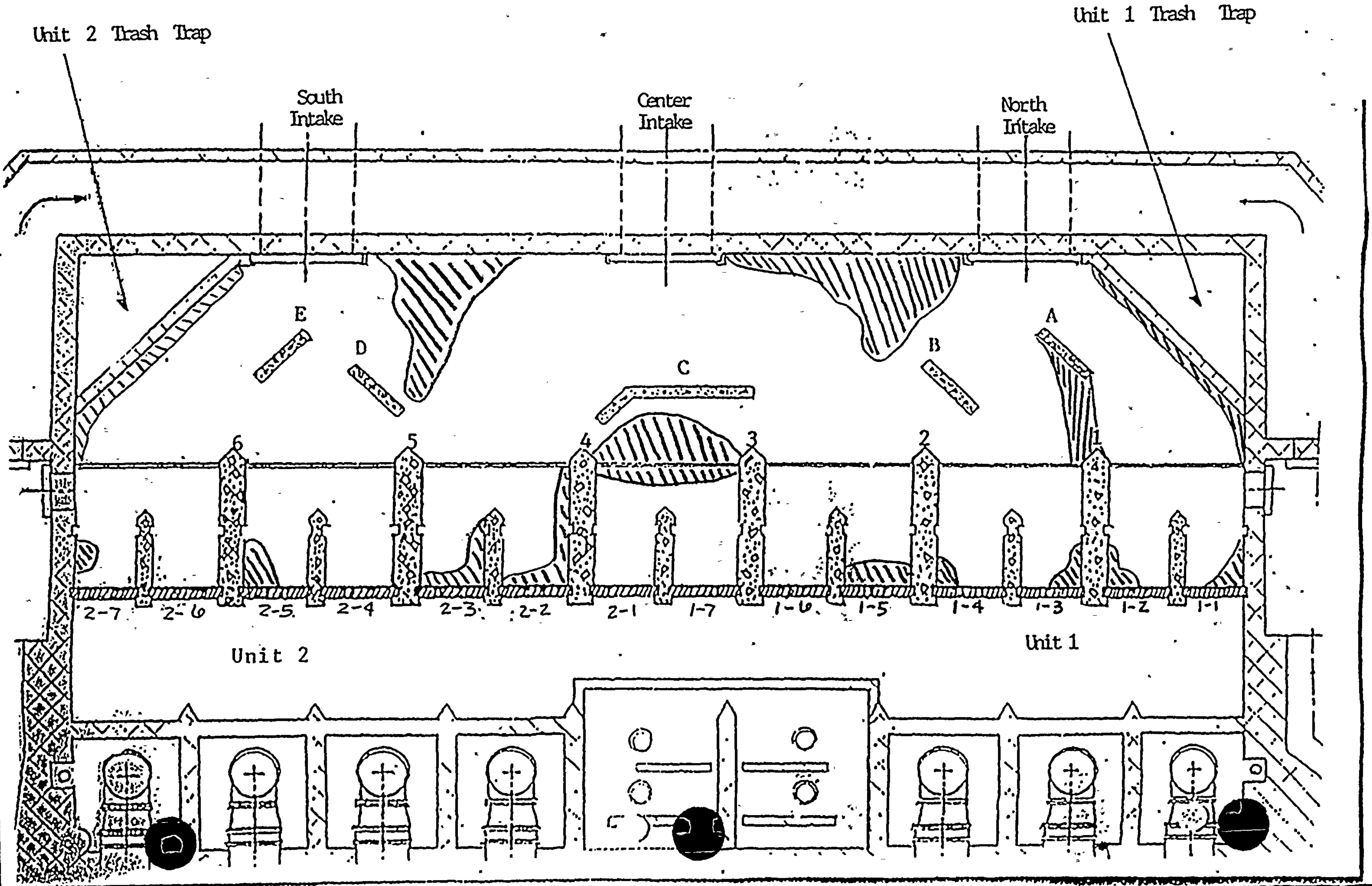
The over all effectiveness of the molluscicide treatment breaks down in this way. In the unit one and unit two forebay area's the molluscicide was eighty-five percent successful.

In the unit one traveling water screen bay's the over all successfulness decreases to seventy percent, and decreases further in the unit two traveling water screen bay's to fifty-five percent.

As referred to earlier and seen in the video tape. There is some accumulation of loose mussel shells through out the treated area with a more substantial amount of dead mussels that have no fallen or been washed away by flow. A greater accumulation of loose mussel shells should be anticipated in the nest several weeks.

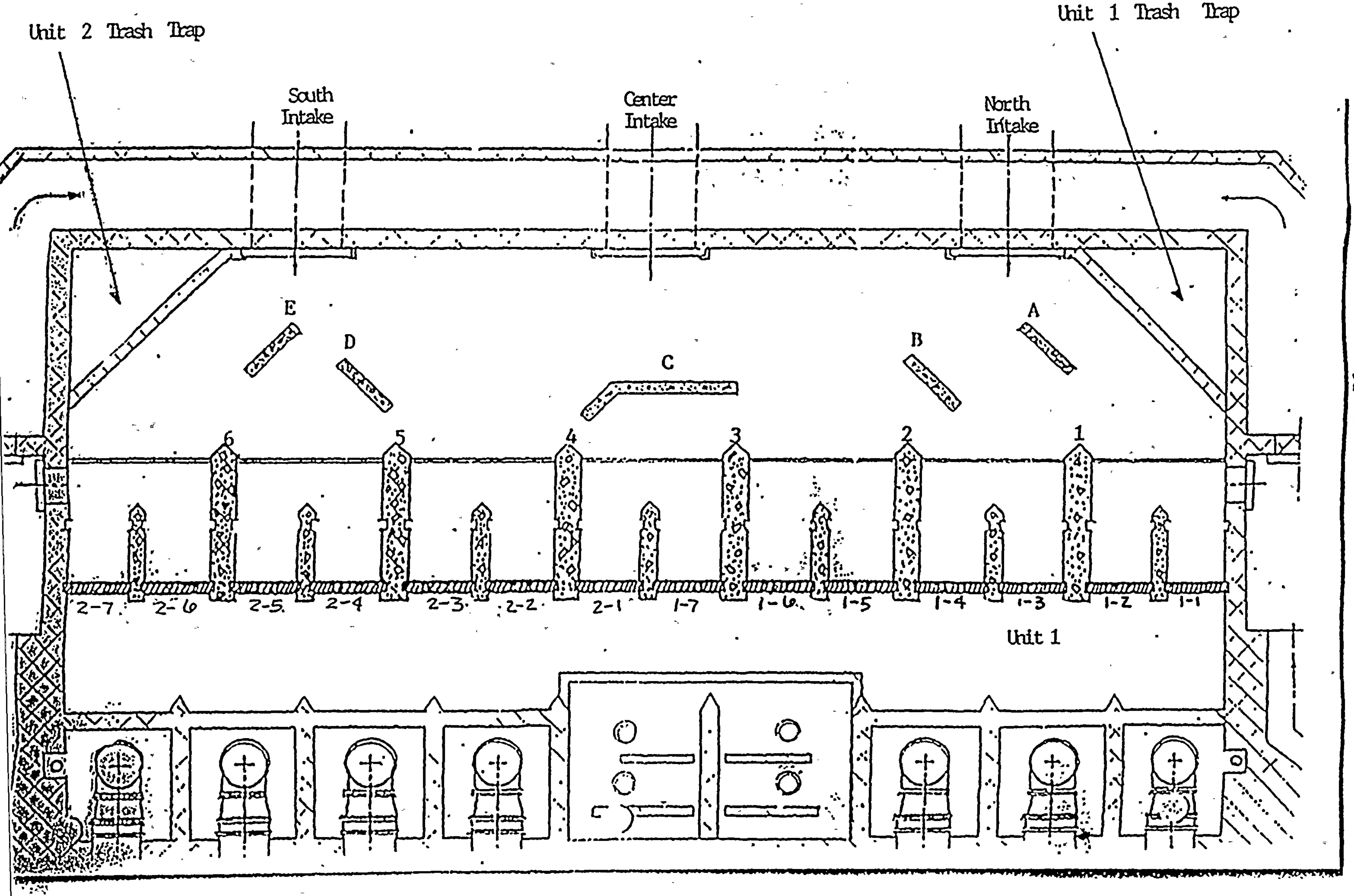
It should also be noted several weeks once the mussels has fallen leaving behind it's bissel threads. The attached bissel thread could excelerate reinfestation of the thread area's.

Attachment 3.1.0 Loose Mussel Build Up



AIV-75

Attachment 3.1.1 Kill Ratio



AIV-76

Aquatic Issues - Whole Effluent Toxicity Testing

Whole effluent toxicity testing was performed by the Plant during Clam-trol treatments to the North and South Intake Tunnels and the Circulating Water System in 1992, and included in its zebra mussel control report to the Michigan DNR in April of 1993. A whole effluent toxicity test was also performed in September of 1993 with sulfur hexafluoride (SF6) gas in Lake Michigan water. The results of the whole effluent toxicity testing are included in the following reports and prove that the plant's discharges were non-toxic as a result of the treatments.

Indiana Michigan
Power Company
One Summit Square
P.O. Box 60
Fort Wayne, IN 46801
219 425 2111

INDIANA
MICHIGAN
POWER

Fred P. Morley
District Supervisor
Surface Water Quality Division
Michigan Department of Natural Resources
P. O. Box 355
Plainwell, MI 49080

April 27, 1993

Dear Mr. Morley:

The 1992 zebra mussel control program, which was a combination of chlorination and Clam-Trol treatments, has been completed and the results evaluated. This letter reviews the correspondence we have had regarding zebra mussel treatment and NPDES permit compliance plans and reports on the compliance status of the entire zebra mussel control program with the NPDES Permit effluent limits, the success of the program, the results of the whole effluent toxicity ("WET") testing, other significant events. My letter to you dated July 30, 1992 stated a written report covering these four areas would be submitted to you.

Your letter of April 24, 1992 responded to I&M's request of December 3, 1992 to use the Betz Industrial molluscicide, Clam-Trol, CT-1, for zebra mussel control and to use bentonite clay to detoxify the Clam-Trol treated water before being discharged to Lake Michigan. Your letter imposed these conditions on the approval to use Clam-Trol:

- o The daily maximum effluent limit for Clam-Trol is 0.05 mg/l at outfalls 001 and 002.

- o A plan to assure that the maximum effluent limit for Clam-Trol of 0.05 mg/l is met at outfalls 001 and 002 is submitted to and approved by the Surface Water Quality Division, Plainwell District Supervisor before the first application of Clam-Trol.

- o A plan to conduct 48-hr. WET tests on each outfall, 001 and 002, during the application of Clam-Trol, is submitted to and approved by the Surface Water Quality Division, Plainwell District Supervisor before the first application of Clam-Trol. These tests must be conducted when the effluent is detoxified with bentonite, as well as when it is not detoxified.

- o Notification of the Surface Water Quality Division, Plainwell District Supervisor, one week before each application of Clam-Trol.

My letter of June 9, 1992 transmitted the WET testing study plan to you. The WET testing plan described how and where the effluent samples were to be taken, how they would be shipped to the bioassay testing laboratory, how the toxicity tests would be conducted in the laboratory, how the WET test results would be interpreted, and how I&M would respond to a variety of possible WET test results.

Mr. Bantjes responded to the WET testing study plan on July 16, 1992. His letter approved the study plan with a few modifications. Mr. Bantjes also expressed concern that I&M would be spot treating certain components of the Cook Nuclear Plant that were not part of the original request to use Clam-Trol. He stated approval was to treat the circulating water and essential service water systems three times a year each, for a total of six treatments per year for the life of the NPDES permit. If spot applications were in addition to the plan for intermittent treatments, then Cook Nuclear Plant would need to submit a modified plan for chronic WET testing.

In my letter of July 30, 1992, I described four phases of treatment, two less than the six treatments a year approved earlier by MDNR.

<u>Phases 1 & 2</u> - Treat the center and north intake tunnels.
<u>Phase 3</u> - Treat the Units 1 and 2 circulatory water system.
<u>Phase 4</u> - Spot treat components of the essential service water system (rather than treating the entire system, which would require far more Clam-Trol).

My letter included a schedule for conducting these four phases of treatment in 1992 and explained how the treatments would be carried out. I also included an example to illustrate how treating components of the essential service water system rather than the entire system would reduce the amount of Clam-Trol used. The major benefit to reducing the amount of Clam-Trol used is that far less of this chemical is discharged into Lake Michigan.

<u>Compliance with Effluent Limits</u>

Compliance with effluent limits was determined by chemical analyses of the detoxified effluent. Water samples were pumped from the discharge tunnel manways and analyzed spectrophotometrically (Attachment 1) in a laboratory set-up in the plant screenhouse. All water samples collected from the Unit 1 and Unit 2 discharge tunnels during treatment Phases 1, 2, and 3 (conducted August 12-13, September 11-12, and September 16, 1992, respectively) showed Clam-Trol concentrations were less than detectable. Attachment 2 is a set of the laboratory data sheets of all Clam-Trol analyses during these treatments and the calibration curves. The detection limit is 0.2 mg/l of Clam-Trol active ingredient.

Attachment 3 is a set of the Phase 4, essential service water system components treatments, (December 17, 1992) chemical feed logs. Discharge concentrations were calculated to be less than 0.034 mg/l of Clam-Trol active ingredient. These calculated values are higher than the actual values, because they do not account for the Clam-Trol demand of the lake water.

Therefore, chemical analyses and discharge concentration calculations all showed that the 0.05 mg/l effluent limit for Clam-Trol was met at all times during all four phases of the Clam-Trol treatments.

Effectiveness of Zebra Mussel Control

The effectiveness of the zebra mussel control was measured by diver inspections of underwater equipment and structures and by sidestream biobox monitors connected to the circulating water and non-essential service water systems. Diver reports showed zebra mussel infestations from one to four inches thick were completely removed except for some widely scattered zebra mussels following the Clam-Trol treatments. The bioboxes, contained about 100 zebra mussels per box, and between 87 and 99% zebra mussels were killed by the Clam-Trol treatment. Based upon these results, the treatment program was rated as producing 95% or higher mortality to zebra mussels settled within the plant.

The success of the essential service water system Phase 4 treatments was measured by comparing water flow rates through the treated heat exchanges and the inlet vs. outlet pressure differential before and after the treatments. Three containment spray heat exchangers were treated with Clam-Trol in Phase 4, two heat exchangers showed improved performance and the third showed no change.

WET Testing Results

The WET testing study results are presented in detail in Attachment 4. Acute 48-hour toxicity tests were conducted with Daphnia pulex on 100%, 50%, 25%, 12.5%, 6.25%, and 0% effluent. The median effective concentration (EC_{50}) was calculated for all tests. No tests resulted in effluent toxicity greater than EC_{50} using 100% effluent.

Other Significant Events

During the Phase 3 circulating water system treatment, the cooling water discharge had a slight color difference from the natural lake water color. This observation was reported by telephone to your office.

As always I will be happy to answer any questions or listen to any comments you have regarding this letter and the attachments. The treatment program effectiveness and negative WET test results were pleasing. As stated in our WET testing plan (page 5) and approved in Mr. Bantjes's letter of July 16, 1992, we will discontinue the WET testing on future Clam-Trol treatments. We will comply with all other conditions of your letter of April 24, 1992 and Mr. Bantjes's letter of July 16, 1992.

Very truly yours,

Donald L. Baker

Donald L. Baker
Environmental Affairs Director

DLB/AEG/wfv/01
Enclosures

bcc: A. J. Ahern/T. E. Webb
A. A. Blind
D. M. Fitzgerald
E. E. Fitzpatrick
D. E. Heydlauff
K. D. Mack
M. R. Robida/A. E. Gaulke/J. P. Novotny
W. E. Walters

BETZ

analytical data

CLAM-TROL® CT-1 Mollusk Control Agent METHYL ORANGE METHOD

APPARATUS REQUIRED

	Code
Beaker, glass, 50 mL (2 required)	**
Cylinder, graduated, 25 mL	2622
Funnel Rack, separatory	936
Funnel, separatory, with a Teflon stopcock, 250 mL (2 required)	**
Glass Rod	114
Optical Cell, (2 required)	**
Safety Bulb, rubber	1575
Spectrophotometer	**

GENERAL APPARATUS *

	Code
Cylinder, graduated, 100 mL	121
Cylinder, graduated, 250 mL	917
Flask, volumetric, 1 L, glass (4 required)	935
Pipet, glass, graduated, 1 mL	140
Pipet, glass, volumetric, 1 mL	866
Pipet, glass, volumetric, 3 mL	**
Pipet, glass, volumetric, 5 mL	124
Pipet, glass, volumetric, 10 mL	123
Pipet, glass, volumetric, 15 mL	861
Pipet, glass, volumetric, 20 mL	1278
Pipet, glass, volumetric, 25 mL	117
Pipet, glass, volumetric, 30 mL	**

* The general apparatus required for the test is determined by the specific test procedure used.

** Apparatus not available through Betz Lab Supply should be obtained through a local supplier.

CHEMICALS REQUIRED

	Code
1, 2 - Dichloroethane (reagent grade or equivalent)	1666
CT-1 Buffer Reagent	1591
Methanol (reagent grade or equivalent)	322
Drying Reagent, with a plastic dipper	1271

SUMMARY OF METHOD

In this procedure the dye in the CT-1 Buffer Reagent complexes with the active ingredients in Clam-Trol CT-1. This complex is extracted into 1, 2 - dichloroethane. The organic layer containing the complex is separated from the aqueous layer and dried with a drying reagent containing anhydrous sodium sulfate. The color intensity of the 1, 2 dichloroethane layer is then measured in a spectrophotometer at 415 nm.

This method must be customized to each specific application. Vary the volumes of sample, CT-1 Buffer Reagent, and 1, 2 - dichloroethane according to the test range (see Table 1). If a higher absorbance is needed, increase the volume of sample or decrease the volume of 1, 2 - dichloroethane. When increasing the sample volume it may be necessary to increase the volume of CT-1 Buffer Reagent used. For samples < 150 mL use 10 mL of CT-1 Buffer Reagent; for samples between 150 and 300 mL use 15 mL of CT-1 Buffer Reagent. Make sure that enough 1, 2 - dichloroethane is used to leave a small plug of solvent in the separatory funnel when the bottom layer of solvent is removed and to fill the optical cell properly.

GENERAL PROCEDURE

Use a well-ventilated or hooded area to run the test. Always use a safety bulb when pipetting liquids.

1,2 - Dichloroethane (also known as Ethylene Dichloride) is a priority pollutant and a specifically-listed RCRA-regulated material subject to specific disposal restrictions and/or prohibitions. For this reason, all used 1,2 - dichloroethane should be segregated from other waste streams. Dispose of waste 1,2 - dichloroethane in an approved manner (e.g., labpacking or incineration).

NOTES

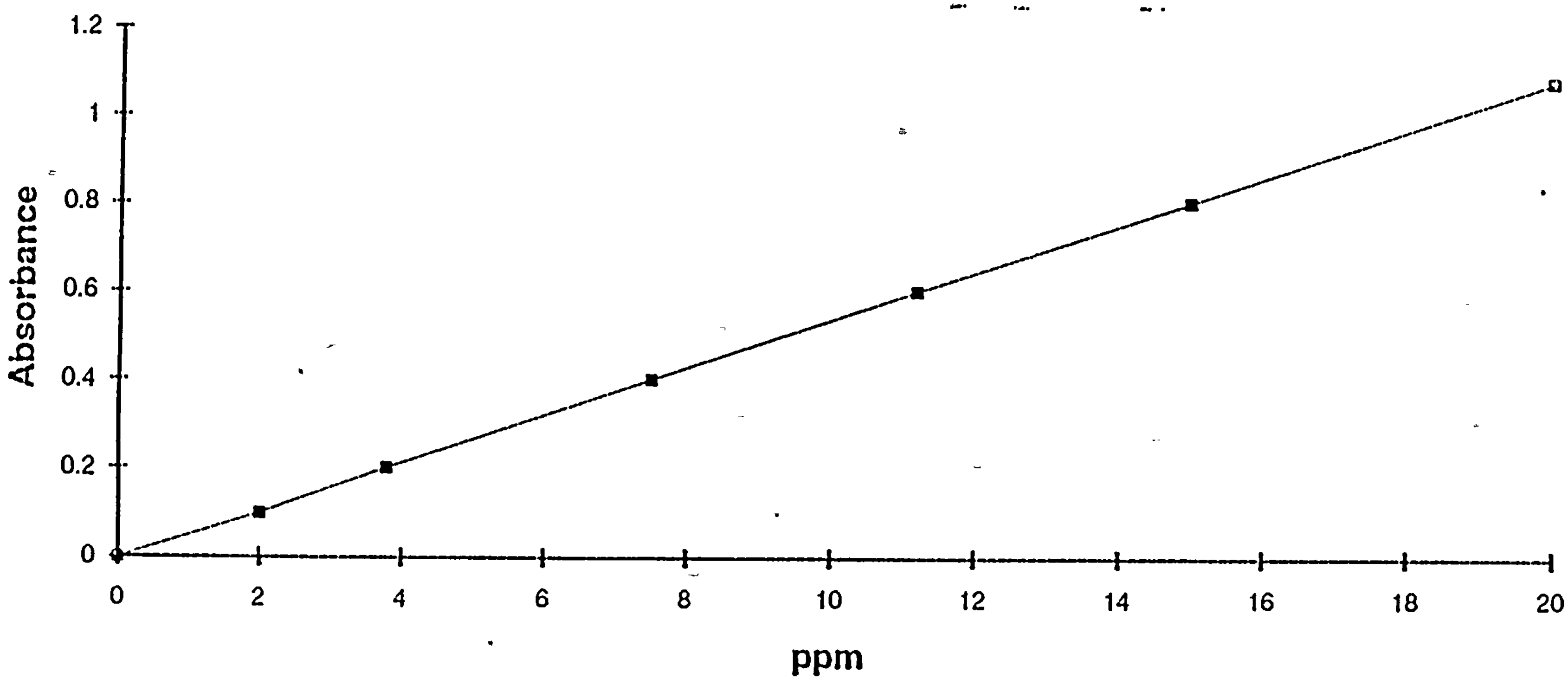
1. For maximum accuracy the calibration curve should be checked by every operator using this test and should be verified a minimum of twice per month using a freshly prepared CT-1 standard.
2. A blank measurement (the blank should be a sample of the system water prior to CT-I treatment) must be recorded for each set of samples. The blank reading may vary slightly; however, the absolute difference between the sample and the blank remains relatively constant.
3. Chlorine causes a negative interference in the test. This can be eliminated by adding 0.1 N Sodium Thiosulfate (Code 235) to the water sample before running the test. The amount added is based on the concentration of chlorine in the system. For a 100-mL water sample containing 0.3 mg/L chlorine, add 10 drops of 0.1 N Sodium Thiosulfate to remove the interference.
4. A slight emulsion may form when using natural water samples. When this happens, vary step 5 of the procedure. Shake the funnel for 30 sec, vent it, then allow it to stand for 5 min. Gently invert the funnel once then allow the funnel to stand for 5 min.
5. It is important to vent the separatory funnel both before and after shaking it. Otherwise, a pressure will build up in the funnel that can cause the stopper to be forced out of the top of the funnel.
6. Use caution when inserting or removing the sample cell in the photometer. The 1, 2 - dichloroethane can damage the cell compartment.
7. It is imperative that the sample cells are kept clea during the running of the test. It is recom[illegible]d tha the cells are cleaned after each measu[illegible] usin the following procedure:
   a) Rinse the cell three times with distilled (o deionized) water.
   b) Rinse the cell three times with methanol.
   c) Rinse the cell three times with 1, 2 - dichloro-ethane to remove methanol from the cell.
8. Turbidity can interfere with this test procedure Turbidity may:
   - create an emulsion in the 1,2, - dichloro-ethane layer that does not separate after standing for 10 min when the funnel is shaken .
   - create a positive interference. (A yellow color is extracted into the 1,2 - dichloro-ethane layer.)

These problems can be removed by centrifuging th sample (10 min at 3500 rpm or 30 min at 2500 rpm) befo performing step 1 of the procedure.

9. If you need to change test conditions (i.e., use diffe ent volumes than those in Table 1), con[illegible]e Ana lytical Testing and Development Grou[illegible]evos for assistance.
10. This method is adapted from Wang, L. K.; Langly, F. *Ind. Eng. Chem., Prod. Res. Dev.*, 1975, 14, 210-212.

August 11, 1992

North and Center Intake
CT-1 High Range Calibration Curve
(1cm cell)

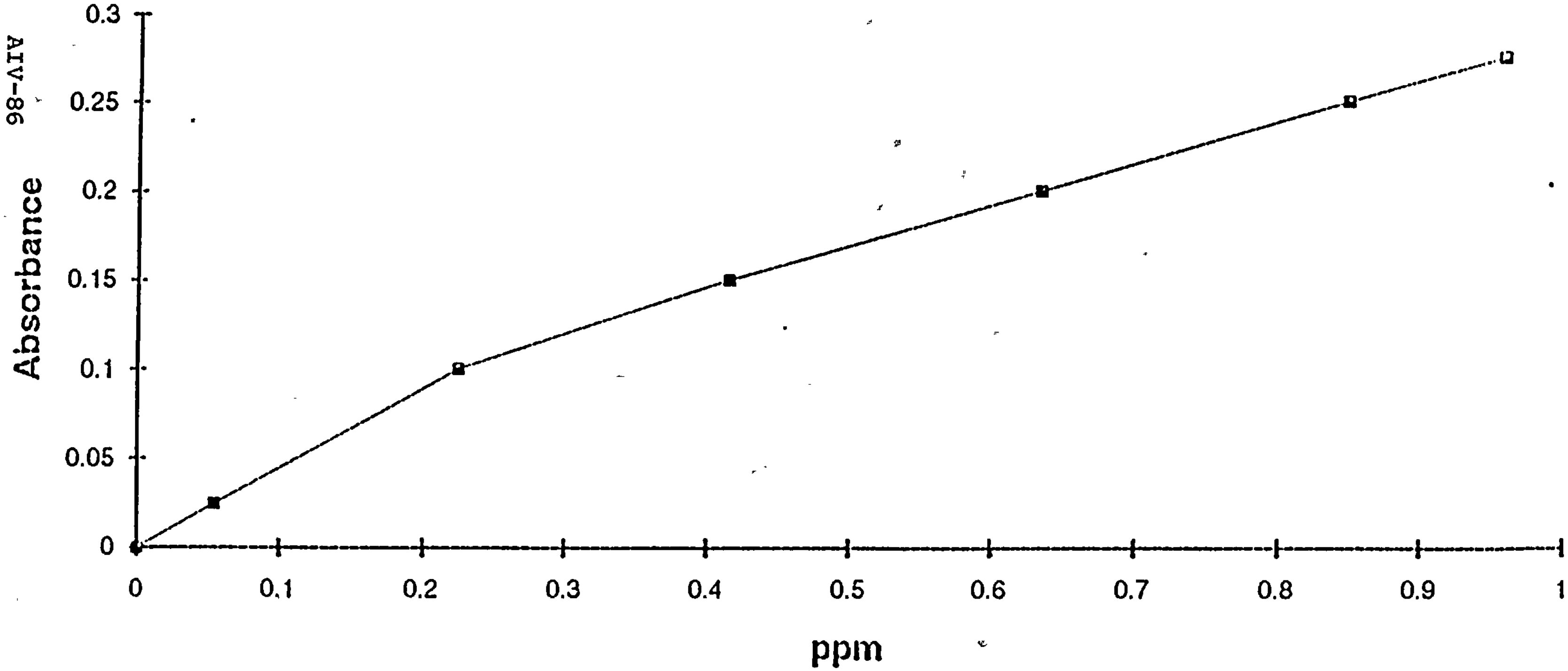


AIV-85

ATTACHMENT 2

August 11, 1992

North and Center Intake
CT-1 Low Range Calibration Curve
(5cm cell)



Attachment #6

North Intake Tunnel Manway
Sample Location

Date 8/13/92

Reviewed By [signature]

Blank Absorbance .108

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Con. CT-1 ppm	Initials
2000	72 °F	LESS THAN	DETECTABLE	N/A	DGW
2025	71 °F	4.375	4.267	16.4 PPM	DGW
2055	72 °F	7.384	7.492	>20 ppm	DGW
2110	71 °F	OVER	RANGE	N/A >20 ppm	DGW
2138	71 °F	OVER	RANGE	>20 ppm	DGW
2215	71 °F	6.000	5.892	20 ppm	DGW
2339	71 °F	OVER	RANGE	>20 ppm	DGW
0035	71F	5.200	5.092	19.5ppm	[illegible]
0240	71 °F	5.843	5.735	19.9 ppm	DGW
0540	71F	3.584	3.476	14.5ppm	PK

Unit #2 Discharge
Sample Location

8/12/92
Date

[signature]
Reviewed By

Blank Absorbance .108

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Con. CT-1 ppm	Initials
2000	73°F	LESS THAN	DETECTABLE	—	DGW
2025	72°F	LESS THAN	DETECTABLE	—	DGW
2055	72°F	LESS THAN	DETECTABLE	—	DGW
2110	71°F	LESS THAN	DETECTABLE	—	DGW
2138	71°F	LESS THAN	DETECTABLE	—	DGW
2215	71°F	LESS THAN	DETECTABLE	—	DGW
2335	71°F	LESS THAN	DETECTABLE	—	DGW
0035	71F	Less than	Detectable	—	PK
0240	71°F	LESS THAN	DETECTABLE	—	DGW
0540	71F	Less than	Detectable	—	PK

Unit #2 Condenser Outlet
Sample Location

8/13/92
Date

Reviewed By

Blank Absorbance .108

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Con. CT-1 ppm	Initials
0120	68°F	0.848	0.740	4.3 ppm	PK
0545	68F	0.346	0.238	0.8 ppm	PK

Center Intake Tunnel Manway
Sample Location

Date: 9/11/92 ~~8/25/92~~ 9/11/92

Reviewed By: [signature]

Blank Absorbance .118

Standard Result ________ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Con. CT-1 ppm	Initials
09:45PM	18°C	0.090	0.0	< 0.2	WRJ
22:00	18°C	3.88	3.762	16.4	WRJ
22:30	18°C	6.00	5.882	25.0	WRJ
9/12/92 02:00	18°C	4.260 ~~3.044~~ 9/12	4.142	18.5	WRJ
06:00	18°C	4.441	4.323	18.8	MKR
10:00	16°C	0.681	0.563	2.3	WRJ

U-L Discharge
Sample Location

9/11/92
Date

E.M.
Reviewed By

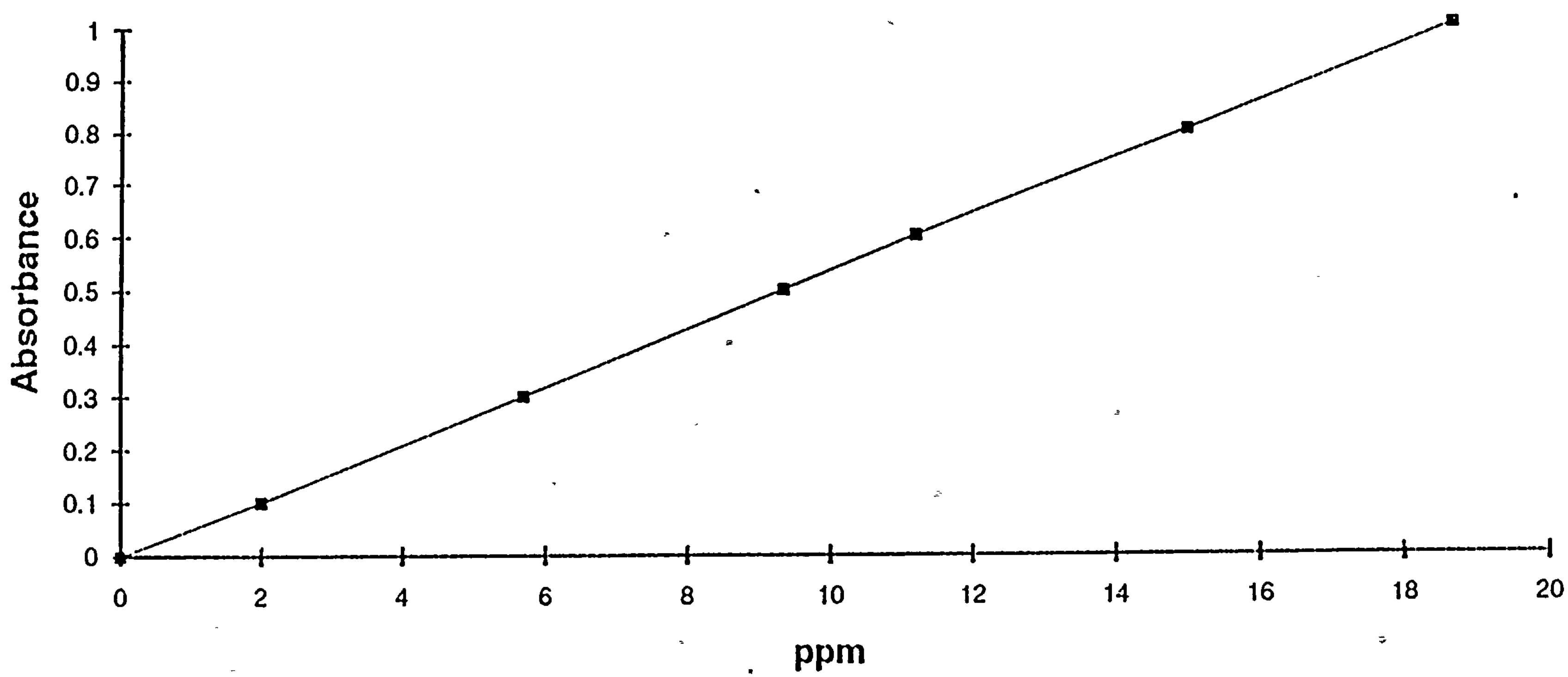
Blank Absorbance .118

Standard Result ________ ppm

	Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Con. CT-1 ppm	Initials
	22:00	18°C	0.076	0.0	<0.2	WEJ
	23:00	18°C	0.110	0.0	<0.2	WEJ
9/12/92	02:00	18°C	0.044	0.0	<0.2	WEJ
	06:00	18°C	0.120	0.002	<0.2	MKR
	10:00	18°C	0.128	0.010	<0.2	WEJ

September 16, 1992

Circulating Water System
CT-1 High Range Calibration Curve
(1cm cell)

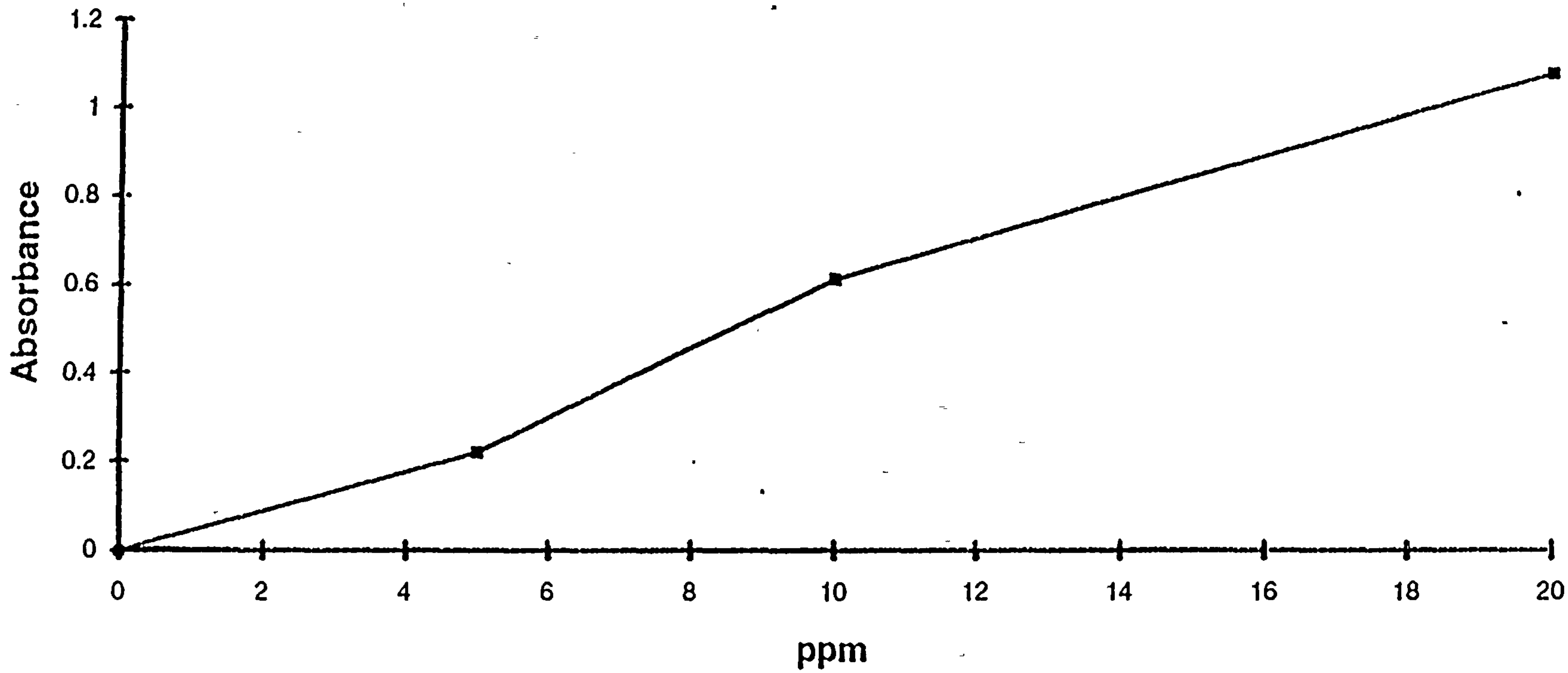


AIV-93

September 16, 1992

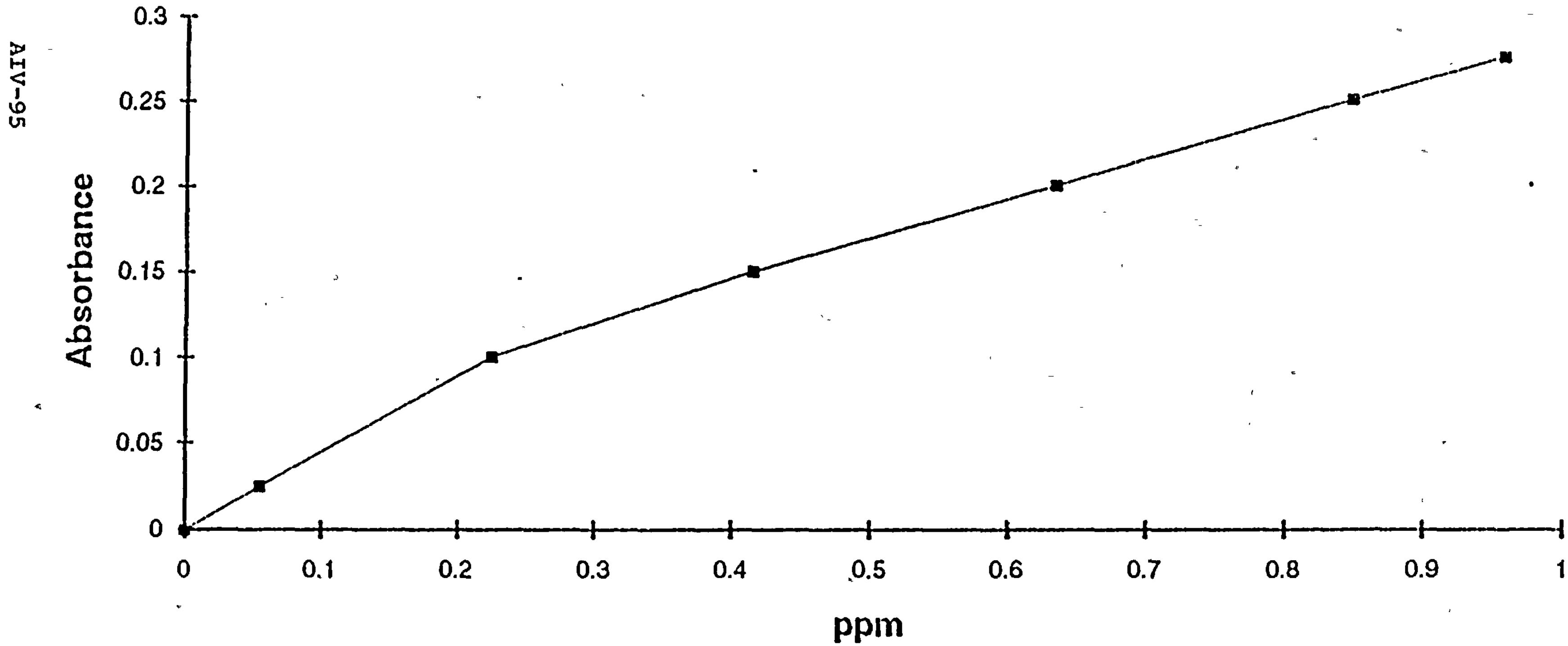
Circulating Water System
CT-1 High Range Calibration Curve
(1cm cell)

AIV-94



September 16, 1992

Circulating Water System
CT-1 Low Range Calibration Curve
(5cm cell)



UNIT #1 DISCH.
Sample Location

9-16-92
Date

Reviewed

Blank Absorbance .139

Standard Result ________ ppm

M/ File

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
0930	18°C	LESS THAN DETECT		<.2	DGW
1105	17°C		"		DGW
1245	18°C		"		DGW
1657	18°C		"		DGW
2045	17°C		"		DGW

VALUES ARE STATISTICALLY INVALID FOR VALUES LE[SS] THAN .2 ppm THEREFORE RESULTS ARE REPORTED [AS] "LESS THAN DETECTABLE."

UNIT #2 DISCH
Sample Location

9-16-92
Date

Reviewed By

Blank Absorbance .139

Standard Result ______ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
0930	18°C	LESS THAN DETECT.		<.2	DGW
1105	17°C		"		DGW
1245	18°C		"		DGW
1657	18°C		"		DGW
2046	18°C		"		DGW

VALUES ARE STATISTICALLY INVALID FOR VALUES LESS THAN .2 ppm THEREFORE RESULTS ARE REPORTED AS "LESS THAN DETECTABLE."

Bio box INLET
Sample Location

Date 2/16/92

Reviewed By

Blank Absorbance .058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
0845	18°C	0	0	0	PK
0903	18°C	.360	.302	5.6	PK
0920	18°C	.617	.559	10.3	DGW
0936	18°C	.826	.768	14.3	PK
0954	18°C	.896	.838	15.4	PK
1010	18°C	1.140	1.082	20	PK
1034	18°C	.860	.802	15.1	PK
1055	18°C	.868	.810	15.1	DGW
1135	18°C	.320	.272	5.1	DGW
1207	18°C	.804	.746	13.9	DGW
1320	18°C	.796	.738	13.8	[illegible]
1412	18°C	1.235	1.177	OVER RANGE >20	K
1623	18°C	OVER	RANGE	>20	PK
1732	18°C	1.080	1.022	19.0	PK
1900	18°C	.920	.862	16.0	PK
2050	18°C	OVER	RANGE	>20	DGW

1 ESW Inlet
Sample Location

9/16/92
Date

[signature]
Reviewed By

Blank Absorbance .058

Standard Result ____________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1120	17°C	.384	.326	6.2	DGW
1455	17°C	.884	.826	15.5	PK
1959	17°C	~~.616~~ .720 PK	.662 ~~720~~ PK	12.2	PK

1 ESW Return
Sample Location

9/16/92
Date

Reviewed By

Blank Absorbance .058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1120	17°C	.419	.361	6.8	EGW
1455	17°C	.836	.778	14.5	PK

**12 THP 6020 ENV.109
ATTACHMENT 1

U-2 NBSW OUTLET BIOBOX
Sample Location

9/16/92
Date

[signature]
Reviewed By

Blank Absorbance .058

Standard Result ________ ppm.

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1152	21°C	.617	.569	10.5	PK
1455	21°C	1.140	1.082	20	PK
1959	21°C	.768	.710	13.1	PK

U-2 ESW RETURN
Sample Location

9/16/92
Date

Reviewed By

Blank Absorbance '058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initial
1152	18°C	.523	.465	8.7	PK
1455	18°C	1.000	.942	17.6	PK

**12 THP 6020 ENV.109
ATTACHMENT 1

W-2 COND OUT
Sample Location

9/16/92
Date

[signature]
Reviewed By

Blank Absorbance .058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1152	17°C	.674	.616	11.5 ~~10.5~~	PK
1712	17°C	.734	.676	12.5	DGW
2050	17°C	.990	.932	17.3	DGW

Unit#2 TWS 2-7
Sample Location

9/16/92
Date

[illegible]
Reviewed By

Blank Absorbance '058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1320	18°C	.746	.688	12.8	PK

**12 THP 6020 ENV.109
ATTACHMENT 1

13 Circ Pump
Sample Location

9/16/92
Date

[illegible]
Reviewed By

Blank Absorbance .058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1415	17°C	.295	.237	4.5	PK

1-1 TWS
Sample Location

9/16/92
Date

Reviewed

Blank Absorbance .058

Standard Result ________ ppm

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. CT-1 ppm	Initials
1500	18C	.408	.350	6.5	PK
1619	18°C	.623	.565	10.6	PK

CHEMICAL FEED LOG

Unit #1 West CTS
Heat Exchanger Treated

Time/Date	Est. CT-1 Inventory Gallons 320 gals. @ 42 inches	Feed Rate CT-1 ml./min.	Feed Conc. CT-1 ppm (Calculated in Att.3)	Flow Rate thru Hx gpm (Calculated in Att.2) and Control Room AC flow gpm	Circ. Water Dilution Rate gpm (Calculated in Att.3)	Calculated discharge Conc. ppm (Calculated in Att.3)	Hach Test Results CT-1 Present? Y/N	Comments	Initials
1230/11/23/92	320	88	51	465	690,000	0.034	NA	22% pp stroke	C.W.
1630/11/23/92	309	88	51	465	690,000	0.034	Y	22% pp stroke	C.W.
0946/11/24/92	267/35 in.	87	51	465	690,000	0.034	Y	no changes to pp stroke	C.W.
1607/11/24/92	251/33 in.	88	51	465	690,000	0.034	Y	no change to pp stroke	C.W.
1110/11/25/92	206/27 in.	86	50	465	690,000	0.034	Y	no change to pp stroke	C.W.
Shutdown	chem-treat	feed @	1110 hrs.	on 11/25/92					

AIV-107

CHEMICAL FEED LOG

Unit #2 West CTS
Heat Exchanger Treated

Time/Date	Est. CT-1 Inventory Gallons 320 gals. @ 42 inches	Feed Rate CT-1 ml./min.	Feed Conc. CT-1 ppm (Calculated in Att.3)	Flow Rate thru Hx gpm (Calculated in Att.2) and Control Room AC flow gpm	Circ. Water Dilution Rate gpm (Calculated in Att.3)	Calculated discharge Conc. ppm (Calculated in Att.3)	Hach Test Results CT-1 Present? Y/N	Comments	Initials
1200/11/23/92	320	67	50	361	920,000	.020	NA	14% pp stroke	C.M.
1630/11/23/92	309	70	52	361	920,000	.021	Y	14% pp stroke	C.M.
0936/11/24/92	267 / 35 in.	66	49	361	920,000	.019	Y	no changes to pump stroke	C.M.
1609/11/24/92	251 / 33 in.	68	50	361	920,000	.020	Y	stepped 40 stroke	C.M.
1100/11/25/92	206 / 27 in	70	52	361	920,000	.021	Y	No change in pp stroke	C.M.
	Shutdown	Chem-trol	feed at	1110 hrs on	11/25/92				

AIV-108

AIV-109

CHEMICAL FEED LOG

Unit #1 East CTS Heat Exchanger
Heat Exchanger Treated

Time/Date	Est. CT-1 Inventory Gallons	Feed Rate CT-1 ml./min.	Feed Conc. CT-1 ppm (Calculated in Att.3)	Flow Rate thru Hx gpm (Calculated in Att.2) and Control Room AC flow gpm	Circ. Water Dilution Rate gpm (Calculated in Att.3)	Calculated discharge Conc. ppm (Calculated in Att.3)	Hach Test Results CT-1 Present? Y/N	Comments	Initials
1250/12/9/92	206/27 in	73	51	390	690,000	0.029	Y	Slight color change	[illegible]
1430/12/9/92	206/27 in	73	51	390	690,000	0.029	Y		[illegible]
1314/12/10/92	183/24 in	73	51	390	690,000	0.029	Y		[illegible]
1308/12/11/92	152/20 in	73	51	390	690,000	0.029	Y		[illegible]
			Stopped chemical feed at 1330 hrs on 12/11/92						

Reviewed by [signature] / 12-17-92

REPORT ON THE WHOLE EFFLUENT TOXICITY TEST FOR DETOXIFIED CLAM-TROL EFFLUENT AT DONALD C. COOK NUCLEAR PLANT

American Electric Power Service Corporation

and

Indiana Michigan Power Company

February 22, 1993

AIV-110

WHOLE EFFLUENT TOXICITY TEST

Introduction

The Michigan Department of Natural Resources (MDNR) issued a letter modification for the Donald C. Cook Nuclear Plant approving the use of the proprietary molluscicide Clam-Trol, CT-1 (Betz Industrial). The letter, dated April 24, 1992, from Mr. Fred Morley to Mr. Donald Baker, Indiana Michigan Power Company (I&M), allowed the use of Clam-Trol if the effluent contained Clam-Trol concentrations equal to or less than 0.05 mg/l. Since the detection limit for Clam-Trol is 0.2 mg/l, the MDNR required whole effluent toxicity (WET) testing to assure compliance with the state water quality standard provision prohibiting the discharge of toxic materials in toxic amounts.

The MDNR also required I&M to submit a study plan describing how the WET testing would be performed. Mr. Baker sent I&M's study plan to Mr. Morley by letter dated June 9, 1992. I&M's study plan described how and where the effluent streams would be sampled from Outfalls 001 and 002, and how the samples would be shipped, analyzed, and reported to the MDNR. This plan also described how the data would be evaluated and specified testing to be conducted should any single test produce an EC_{50} less than 100% effluent.

The letter modification of the Cook Plant NPDES Permit was conditional on the study plan being approved by the MDNR. MDNR notified I&M by letter dated July 16, 1992 that the study plan was acceptable.

Treatment of the Cook Plant for zebra mussel control has evolved from attempts to treat the entire plant in one operation to treating components of the plant in separate operations. The intake tunnels are treated individually, the circulating water system is treated as one system and components of the essential service water (ESW) and non-essential service water (NESW) systems are treated as needed.

Treatment Program Completed In 1992

The north and center intake water tunnels were treated with Clam-Trol on August 12 and 13 and September 11 and 12, 1992, respectively. The circulating water system was treated on September 16 with Clam-Trol. Water samples were collected during each of these three periods as described in the approved study plan. These samples of detoxified effluent were split and then shipped to a contract laboratory and to the MDNR toxicity testing laboratory for analyses. The contract laboratory conducted a 48-hour acute toxicity test using *Daphnia pulex* on each of the three water samples. At the same time the detoxified effluent samples were being analyzed, a series of bentonite clay solutions were being tested for impact on the test organisms. *Daphnia* sp. and other zooplankters can be adversely affected by mechanical (rather than chemically toxic) means when exposed to excessive amounts of suspended clay. These clay blank test series were conducted using Lake Michigan water and the same clay used to detoxify the Clam-Trol. Lake Michigan water used for dilution of the detoxified effluent tests and the clay blank tests was collected before the Clam-Trol treatments began.

Methods

Water samples were collected from the discharge tunnel manways using a submerged pump at the beginning of the treatment, at the fourth hour, at the eighth hour and at the twelfth hour of treatment. Samples were collected from Unit 2 discharge manway and composited in one container. At the end of the test, a sample was removed from the composited sample container and shipped to the contract laboratory. During treatments to the north and center intake tunnels on August 12-13 and September 11-12, 1992, there was no effluent from the Unit 1 discharge tunnel. During the circulating water system treatment on September 16, samples were collected from both the Unit 1 and Unit 2 discharge tunnel manways and composited into one container, from which the water for WET testing was taken.

The laboratory followed the procedure for conducting 48-hour EC_{50} acute toxicity tests according to the EPA protocol, "Method for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms," EPA/600/4-85/013. A dilution series of 100%, 50%, 25%, 12.5%, 6.25% and 0% (control) effluent was set up. Lake Michigan water filtered to remove native zooplankton was used for dilution. Four 30 ml beakers were set up for each test concentration and 25 ml of test solution was put in each beaker. Five *Daphnia pulex* juveniles (<24 hours old) were placed in each beaker. Temperature was maintained at 25°± 1°C. Temperature, DO, and conductivity were measured every 24 hours. The effects were recorded every 24 hours. Organisms that failed to remain in the water column for five seconds after a gentle prod or swirling the beaker were considered effected. Results are reported as acute 48-hour EC_{50} values.

A test series of bentonite clay blanks was conducted the same as the detoxified Clam-Trol effluent. Filtered Lake Michigan water was mixed with the same concentration of bentonite clay used to detoxify the Clam-Trol. This concentration of bentonite clay was tested at 100%, 50%, 25%, 12.5%, 6.25% and 0% (control).

Results

Whole Effluent Toxicity tests were conducted August 15 through 17, September 13 through 15, and September 17 through 19, 1992. Table 1 shows the immobility percentages of the detoxified Clam-Trol effluent and the bentonite clay blank test concentrations. Immobility results exceeded the EC_{50} for 100% effluent at all detoxified effluent and clay blank test concentrations. The highest immobility result was 30% for the detoxified Clam- effluent samples and 25% for the bentonite clay blanks at the 100% effluent concentration. One test series was technically invalid because the control (0% effluent) had >10% immobility. Except for the immobility observed at the control concentration in the detoxified effluent test conducted on September 13-15, toxicity was low and the immobilities that were observed followed a similar pattern as the clay blank test series. Immobility percentage differences between the detoxified Clam-Trol and clay blank test concentrations were usually 5% or less.

Discussion

The 70% immobility value obtained for the control test on September 13-15 would appear to be an anomolous value, since the bentonite clay blank control

using Lake Michigan water supplied to the contract laboratory in the same shipment showed 0% immobility. Three of the four control replicates showed all or nearly all test organisms were immobilized and in one of the four replicates none of the organisms were immobilized during the 48-hour test. An examination of the laboratory sheet for the treatment concentrations shows that the organisms in the replicates were immobilized in nearly equal numbers, e.g., the 50% and 100% effluent replicates had one or two immobilized organisms. None of the treatment replicates individually accounted for all of the immobilities, which would indicate a contaminated replicate. The immobilities were equally distributed among the replicates. There is no water quality parameter that was measured before, during, or after the toxicity test that indicates a problem for Daphnia pulex's well being.

Given the general lack of immobilization response of organisms in the different treatment concentrations tested on any given date and the similarity of test results from one test date to the nest, there was little difference between the detoxified Clam-Trol effluent and the bentonite clay blanks effects on the test organisms. All tests were in compliance with the requirement that the 48-hour EC_{50} for Daphnia exceed 100% effluent, in other words the tests showed that effluent toxicity was less than the toxicity needed to produce an EC_{50} in 100% effluent. The lack of toxicity indicates the detoxified effluent had little impact on the Lake Michigan aquatic community.

TABLE 1

Daphnia pulex 48-hour Percent Immobility Values Obtained from Whole Effluent Toxicity Tests Conducted with Detoxified Clam-Trol in Lake Michigan Water and Bentonite Clay Blank Test Run in Lake Michigan Water (clay blank immobility percentages in parentheses)

Test Date	Control (0%)	6.25%	12.5%	25%	50%	100%
Aug 15-17	0% (0%)	0% (0%)	0% (10%)	15% (0%)	0% (10%)	25% (5%)
Sep. 13-15	70% (0%)	0% (5%)	15% (10%)	20% (25%)	30% (20%)	30% [illegible]
Sep 17-19	0% (5%)	0% (5%)	10% (5%)	10% (5%)	5% (0%)	15% (5%)

GLEC

GREAT LAKES ENVIRONMENTAL CENTER

739 Hastings Street
Traverse City, Michigan 49684
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Fax (614) 297-8866

October 12, 1993

Mr. John Carlson
Indiana Michigan Power Company
Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106

Dear John:

TOXICITY TEST REPORT FOR SULFUR HEXAFLUORIDE GAS (SF6)

We have completed our analyses of the 48-hour Ceriodaphnia dubia and 96-hour fathead minnow (Pimephales promelas) static renewal-acute toxicity tests performed with sulfur hexafluoride (SF6) gas in Lake Michigan water. The Lake Michigan water sample was collected by Indiana Michigan Company personnel on September 28, 1993. The sample was transported overnight to Great Lakes Environmental Center (GLEC), and we received the sample in good condition on September 29, 1993.

The C. dubia and fathead minnow tests were conducted in accordance with GLEC Standard Operating Procedures, which are based on procedures developed by U.S. EPA (Peltier and Weber, 1990, Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fourth Edition, EPA/600/4-90/027) and ASTM (Standard Guide for Conducting Acute Toxicity Tests with Fishes, Macroinvertabrates and Amphibians, E729-88a, 1993).

It is our understanding that the Cook Nuclear Plant currently injects SF6 into approximately 690,000 gpm of noncontact cooling water at a rate of 5 cfm, which is equivalent to a rate of 54 μl/L of SF6 gas. The fathead minnow acute toxicity test was initiated on October 1, 1993, using an undiluted Lake Michigan water sample that was injected with sulfur hexafluoride gas at a rate of 108 μl/L (twice the plant's injection rate). The gas was injected into a sealed airtight chamber using a gas injection syringe. After injection, the sample was shaken and thoroughly mixed for one minute. This sample was then used as the highest test concentration. A reconstituted laboratory water (Hardness = 172 mg/L $CaCO_3$) was used to prepare nominal test concentrations of 54, 27, 14, and 7 μl/L SF6 gas. Twenty fathead minnows (3 days old at test initiation) were exposed for 96 hours in groups of ten, in 250 ml glass beakers, each containing 200 ml of test solution (65 x 60 mm of solution in the beakers). Each day the test solutions were carefully renewed by siphoning most of the old solutions from the beakers; freshly prepared solutions were added back to each test chamber daily and the number of surviving fish was recorded. The SF6 concentrations in the test chambers were not measured analytically.

AIV-117

FAXED 10-13-93 — 04:00pm. to MDNR (Sylvia Heaton)

The Ceriodaphnia dubia acute toxicity test was initiated simultaneously with the fathead minnow test using identical exposure concentrations. In each C. dubia test concentration we exposed 20 animals (<24 hours old at test initiation) in groups of five in 30 ml glass beakers, each containing 25 mls of test solution (40 x 45 mm of solution in the beakers). After 24 hours the animals were transferred to fresh solutions using a wide bore pipet, and the number of surviving or dead animals was recorded.

The reconstituted water used in C. dubia and fathead minnow toxicity testing is prepared according to EPA methods (Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fourth Edition, EPA/600/4-90/027). We used dechlorinated reverse osmosis (R/O) treated municipal water for the culture of fathead minnows, and Boardman River water (headwaters) for culturing our C. dubia. Deionized reverse-osmosis (R/O) treated municipal water is the base water, to which reagent-grade salts are added to prepare each batch of reconstituted water.

The results of the C. dubia and fathead minnow tests indicate that the sulfur hexafluoride gas injected into the Lake Michigan water sample was not acutely toxic. There was 100 percent survival of the C. dubia in the 7, 14, 27, and 108 µl/L SF6 concentrations, and 95 percent survival in the laboratory water controls and the 54 µl/L SF6 concentration (Table 1). Therefore, the 48-hour LC_{50} value was greater than 108 µl/L SF6 gas. The water chemistry data for the C. dubia test are summarized in Table 2.

In the fathead minnow test there was 100 percent survival in the 7, 54, and 108 µl/L SF6 concentrations and in the laboratory water controls (Table 3). There was 95 percent survival in the 14 and 27 µl/L test concentrations. Because there was less than 50 percent mortality in the 108 µl/L test concentration, the 96-hour LC_{50} for fathead minnows was also greater than 108 µl/L SF6 gas. The water chemistry data for the fathead minnow test are summarized in Table 4.

In summary, neither C. dubia nor fathead minnow survival was affected by any of the SF6 concentrations we tested, including the 108 µl/L (highest test concentration) and 54 µl/L (present application of SF6) test concentrations.

Copies of the raw data sheets and standard reference toxicant data for the acute effluent toxicity tests are included with this report in Appendices A and B.

If you have any questions or comments concerning the results of these toxicity tests, please contact either me or Mick DeGraeve at (616) 941-2230.

Thank you for the opportunity to provide this service to the Indiana Michigan Power Company. We appreciate your business and hope we can be of further service to you in the future. I will be in contact with you to arrange for the visit we have discussed.

Sincerely,

Dennis J. McCauley

Dennis J. McCauley
Research Scientist

DJM:dm
Enclosures

TABLE 1. RESULTS OF A 48-HOUR CERIODAPHNIA DUBIA STATIC RENEWAL ACUTE TOXICITY TEST WITH SULFUR HEXAFLUORIDE GAS (SF6) INJECTED INTO A SAMPLE OF LAKE MICHIGAN WATER (GLC# 1765) RECEIVED ON SEPTEMBER 28, 1993, FROM COOK NUCLEAR PLANT NEAR BRIDGMAN, MICHIGAN USING RECONSTITUTED LABORATORY WATER AS DILUTION WATER (TEST DATES: OCTOBER 1-3, 1993)

Test Concentration (µl/L)	Percent Survival (N = 20)	
	24hr	48hr[a]
Laboratory Water Control	95	95
7 µl/L	100	100
14 µl/L	100	100
27 µl/L	100	100
54 µl/L	95	95
108 µl/L	100	100

[a] 48-hour LC_{50} value was not calculable (greater than 108 µl/L).

TABLE 2. WATER CHEMISTRY SUMMARY FOR A 48-HOUR *CERIODAPHNIA DUBIA* STATIC RENEWAL-ACUTE TOXICITY TEST WITH SULFUR HEXAFLUORIDE GAS (SF6) INJECTED INTO A SAMPLE OF LAKE MICHIGAN WATER (GLC# 1765) RECEIVED ON SEPTEMBER 28, 1993, FROM COOK NUCLEAR POWER PLANT NEAR BRIDGMAN, MICHIGAN USING RECONSTITUTED LABORATORY WATER AS DILUTION WATER (TEST DATES: OCTOBER 1-3, 1993)

Test Concentration (µl/L)	pH[a]		Dissolved[a] Oxygen (mg/L)		Temperature[a] (°C)		Specific[b] Conductivity (µmhos/cm)	Alkalinity[c] (mg/L $CaCO_3$)	Hardness[c] (mg/L $CaCO_3$)
	Mean	Range	Mean	Range	Mean	Range	Mean		
Laboratory Water Control	8.2	(8.1-8.4)	8.6	(8.0-9.0)	24.6	(24.1-25.0)	537	104	172
7 µl/L	8.3	(8.2-8.4)	8.6	(8.0-9.0)	24.6	(24.1-25.0)	557		
14 µl/L	8.3	(8.2-8.4)	8.6	(8.0-9.2)	24.6	(24.1-25.0)	543		
27 µl/L	8.3	(8.3-8.4)	8.7	(8.0-9.4)	24.6	(24.1-25.0)	511		
54 µl/L	8.3	(8.2-8.4)	8.7	(8.0-9.4)	24.7	(24.2-25.0)	445		
108 µl/L	8.2	(8.1-8.4)	9.0	(8.0-9.8)	24.8	(24.3-25.0)	304	106	128

a Measurements were made daily in each test chamber.

b A single measurement was made at the beginning of the test on a composite sample before distribution to the test chambers and at the end of the test on a composite sample.

c Alkalinity and hardness measurements were made upon preparation of the reconstituted laboratory water and upon arrival at the laboratory of the effluent.

TABLE 3. RESULTS OF A 96-HOUR FATHEAD MINNOW STATIC RENEWAL ACUTE TOXICITY TEST WITH SULFUR HEXAFLUORIDE GAS (SF6) INJECTED INTO A SAMPLE OF LAKE MICHIGAN WATER (GLC# 1765) RECEIVED ON SEPTEMBER 28, 1993, FROM COOK NUCLEAR POWER PLANT NEAR BRIDGMAN, MICHIGAN USING RECONSTITUTED LABORATORY WATER AS DILUTION WATER (TEST DATES: OCTOBER 1-5, 1993)

Test Concentration (µl/L)	Percent Survival (N = 20)			
	24hr	48hr	72hr	96hr*
Laboratory Water Control	100	100	100	100
7 µl/L	100	100	100	100
14 µl/L	100	95	95	95
27 µl/L	100	100	95	95
54 µl/L	100	100	100	100
108 µl/L	100	100	100	100

* 96-hour LC_{50} value was not calculable (greater than 108 µl/L).

TABLE 4. WATER CHEMISTRY SUMMARY FOR A 96-HOUR FATHEAD MINNOW STATIC RENEWAL ACUTE TOXICITY TEST WITH SULFUR HEXAFLUORIDE GAS INJECTED INTO A LAKE MICHIGAN WATER SAMPLE (GLEC# 1765) RECEIVED ON SEPTEMBER 28, 1993, FROM COOK NUCLEAR PLANT NEAR BRIDGMAN, MICHIGAN USING RECONSTITUTED LABORATORY WATER AS DILUTION WATER (TEST DATES: OCTOBER 1-5, 1993)

Test Concentration (µl/L)	pH[a]		Dissolved[a] Oxygen (mg/L)		Temperature[a] (°C)		Specific[a] Conductivity (µmhos/cm)		Alkalinity[b]	Hardness[b]
	New	Old	New	Old	New	Old	New	Old	(mg/L $CaCO_3$)	(mg/L $CaCO_3$)
Laboratory Water Control	8.2 (8.2-8.4)	8.1 (7.9-8.2)	8.8 (8.8-8.9)	6.9 (6.2-7.5)	25.0 (25.0-25.0)	24.6 (24.2-25.3)	537 (494-566)	539 (539-539)	104 (104-104)	172 (172-172)
7 µl/L	8.3 (8.2-8.4)	8.1 (7.9-8.2)	8.9 (8.8-9.0)	7.5 (7.1-8.0)	25.0 (25.0-25.0)	24.6 (24.2-25.2)	556 (537-587)	547 (547-547)		
14 µl/L	8.3 (8.2-8.3)	8.2 (8.1-8.2)	9.0 (9.0-9.2)	7.4 (6.6-8.0)	25.0 (25.0-25.0)	24.6 (24.2-25.1)	539 (531-557)	531 (531-531)		
27 µl/L	8.3 (8.2-8.3)	8.1 (8.0-8.2)	9.1 (8.9-9.4)	7.1 (6.5-8.0)	25.0 (25.0-25.0)	24.6 (24.3-25.1)	514 (502-516)	502 (502-516)		
54 µl/L	8.2 (8.2-8.3)	8.1 (8.1-8.2)	9.2 (9.0-9.4)	7.2 (6.9-7.6)	25.0 (25.0-25.0)	24.6 (24.0-25.1)	444 (440-450)	438 (438-438)		
108 µl/L	8.1 (8.1-8.2)	8.0 (7.4-8.2)	9.8 (9.6-10.2)	7.5 (7.4-7.6)	25.0 (25.0-25.0)	24.6 (24.1-25.2)	311 (303-316)	304 (304-304)	106 (106-106)	128 (128-128)

a Measurements were made on new test solutions and old test solutions. The numbers represent the mean and range (in parentheses) of measurements observed during the test.

b Alkalinity and hardness measurements were made upon preparation of the reconstituted laboratory water and upon arrival of the sample.

APPENDIX A

RAW DATA SHEETS

DAILY RENEWAL Cerio daphnia

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: N036-00
Test Species: ~~D Magna~~ C dubia
Investigators:

Type of Test: SF Gas
No. Daphnids/Chamber: 5
No. of Chambers: 4
Age of Daphnids: ≤24 hrs

Dilution Water: HR # 499
GLC and/or Batch No.: 1765
Test Temperature: 25±1°C
Incubator #: 2
Photoperiod: 16:8

Date / Time	Test Day	Tech. Init.	Treatment Level	Control (HB.)				~~5%~~ A (7 µl/L)				~~12%~~ B (14 µl/L)				~~25%~~ C (27 µl/L)				~~50%~~ D (54 µl/L)				~~100%~~ E (108 µl/L)			
			Replicate Number	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10/1/93 4:30 pm	0	JLC	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.35				8.35				8.33				8.30				8.24				8.08			
			DO (mg/L)	8.8				8.8				8.9				9.0				9.0				9.8			
			Sp.Cond.(umhos/cm)	494				537				530				516				450				303			
4:00 pm	1	DM	No. Live	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5
			~~Observations~~ Sp Con	N	566	O		N	587	O		N	557	O		N	515	O		N	440	O		N	314	O	
			pH	8.17		8.07		8.20		8.31		8.24		8.40		8.29		8.42		8.25		8.41		8.15		8.42	
			DO (mg/L)	8.9		7.6		9.0		8.4		9.2		8.3		9.4		8.3		9.4		8.4		9.7		8.4	
			Temperature (°C)	25.0		24.2		25.0		24.1		25.0		24.1		25.0		24.1		25.0		24.4		25.0		24.7	
10/3/93 4:30 pm	2	JLC	No. Live	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5
			Observations Sp Con	[illegible]				[illegible]	[illegible]			[illegible]				[illegible]				[illegible]				[illegible]			
			pH	8.16				8.26				8.25				8.30				8.28				8.2[illegible]			
			DO (mg/L)	8.0				8.0				8.0				8.0				8.0				8.[illegible]			
			Sp.Cond.(umhos/cm)	550				548				541				501				444				276			
			Temperature (°C)	24.3				24.3				24.2				24.3				24.2				24.3			

Observation Key:
DOB - Dried Out on Beaker
ERR - Erratic S[illegible]
F - Floater
PM - Particulate Matter
FS - Film on Surface
IMM - Immobile

Reviewed by: D McG[illegible]
Date: 7 Oct 93

AIV-124

FISH 96-HOUR STATIC ACUTE TOXICITY TEST

172

Test Material: [illegible]ok Nuclear
Project No.: [illegible]030-00
Test Species: FHM
Technicians:

Type of Test: SF Gas
No. Fish/Chamber: 10
No. of Chambers: 2
Age of Fish: ~~≤ 24 hr~~ 3 days (ft Chesapeake)

Dilution Water: HR #499
GLC and/or Batch No.: 1765
Test Temperature: 25±1°C
Incubator #: 2
Photoperiod: 16:8

AIV-125

Date Time	Test Day	Tech. Init.	Treatment Level	HR Control 1	Control 2	~~6~~ 1074 ½ A 1	A 2	~~12~~ 1014 ½ B 1	B 2	~~25~~ 1027 C 1	C 2	~~50~~ 1054 D 1	D 2	~~100~~ 1108 E 1	E 2
			Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2
10/1/93 4pm	0	BLV	Temperature	25.0		25.0		25.0		25.0		25.0		25.0	
			pH	8.35		8.35		8.33		8.30		8.24		8.08	
			DO (mg/L)	8.8		8.8		8.9		9.0		9.0		9.8	
			Sp.Cond.(umhos/cm)	494		531		530		516		450		303	
5:00 pm	1	DLM	No. Live	10	10	10	10	10	10	10	10	10	10	10	10
			~~Observations~~ Sp.Con	N 566	O 7.77	N 587	O 8.20	N 557	O 8.17	N 515	O 8.01	N 440	O 8.11	N 314	O 8.15
			pH	8.17	~~7.8~~	8.20	~~8.34~~	8.24	~~8.46~~	8.27	~~8.02~~	8.25	~~8.14~~	8.15	~~8.12~~
			DO (mg/L)	8.9	~~7.6~~ 7.3	9.0	~~8.1~~ 7.9	9.2	~~8.3~~ 7.8	9.4	~~8.3~~ 7.2	9.4	~~8.4~~ 7.3	9.7	~~8.1~~ 7.6
			Temperature (°C)	25.0	24.2	25.0	24.2	25.0	24.2	25.0	24.2	25.0	24.0	25.0	24.1
10/3 3pm	2	BLV	No. Live	10	~~8~~ ~~9~~ 10	10	10	10	9 Found	10	10	10	10	10	10
			~~Observations~~ Sp.Con	550		544		531		510		442		316	
			pH	8.22	8.23	8.30	8.24	8.27	8.20	8.29	8.17	8.25	8.10	8.12	8.27
			DO (mg/L)	8.8	7.5	8.9	8.0	9.0	8.0	9.1	8.0	9.1	7.6	9.6	7.5
			Temperature (°C)	25.0	24.3	25.0	24.3	25.0	24.2	25.0	24.3	25.0	24.2	25.0	24.2
10/4/93 3:30 3pm	3	PV	No. Live	10	10	10	10	10	~~10~~ 9	10	9	10	10	10	10
			Observations											1 S[illegible]	
			pH	8.17	7.93	8.19	8.08	8.24	8.08	8.24	8.02	8.21	8.08	8.14	8.10
			DO (mg/L)	8.8	6.2	8.8	7.1	9.0	7.0	8.9	6.5	9.2	7.1	10.2	7.6
			Temperature (°C)	25.0	25.3	25.0	25.2	25.0	25.1	25.0	25.1	25.0	25.1	25.0	25.2
10/5/93 3:40	4	PV	No. Live	10	10	10	10	10	9	10	9	10	10	10	10
			Observations												
			pH	8.13		8.23		8.18		8.18		8.20		8.24	
			DO (mg/L)	6.5		7.1		6.6		6.6		6.9		7.4	
			Sp.Cond.(umhos/cm)	539		547		531		502		438		304	
			Temperature (°C)	24.4		24.8		24.9		24.9		24.9		24.9	

Observation Key: DOB - Dried Out on Beaker PM - Particulate Matter ERR - Erratic Swimming FS - Film on Surface F - Floater IMM - Immobile

Reviewed by: DM McCauley Date: 7 Oct 93

EFFLUENT AND RECEIVING WATER
CHECK-IN FORM

Client: Cook Nuclear Project No.: NC36 - 00

Investigators: PL

INITIAL WATER CHEMISTRY (UPON RECEIPT)

Date: 9-29-93	Initials PL	Cook Nuclear (L. Mich)		
GLC No.		1765		
Collection Date (time interval)	PL	9-28-93		
Temperature	PL	13.4°C		

WATER CHEMISTRY AT TEST TEMPERATURES

Date: 9-29-93	Initials PL	Cook Nuclear		
GLC No.	PL	1765		
Temperature	PL	25.0		
pH	PL	8.13		
Dissolved Oxygen (mg/L)	PL	9.2		
Conductivity (umhos's/cm)	PL	281		
Hardness (mg/L)	PL	3.2 128		
Alkalinity (mg/L)	PL	5.31 106		
Total Chlorine (mg/L)*	/			
Total Ammonia (mg/L)*	/			

* Check with project manager to see if necessary

Great Lakes Environmental Center
739 [illegible]ings Street
Tr[illegible] City, MI 49684
Phone: (616) 941-2230
Fax: (616) 941-2240

CHAIN OF CUSTODY RECORD

(TO BE COMPLETED ON-SITE AND SUBMITTED WITH SAMPLES)

Facility: D.C. Cook Nuclear Plant, Ind. Mich Power
Location: Bridgman, MICH - LAKE MICHIGAN
Contact Person: John Carlson
Phone Number: 616 465 5901 ext 1153

Collector: J Carlson
Date: 8-23-93 0910
Witness: [illegible]
Date: 8/23/93

AIV-127

SAMPLE ID	DATE/TIME OF SAMPLE	VOLUME COLLECTED	SAMPLE COLLECTOR	SAMPLE CONTAINER	DESCRIPTION (Type of sample, source, physical characteristics)	PRESERVATION	ANALYSES REQUIRED
U-2 Circ. Discharge	9-28-93/0910	1 Gallon	J. Carlson	Cubitainer	Lake Michigan	—	Tox Test per contr
↓	↓	↓	↓	↓	↓	—	↓
						—	
						—	
						—	

TRANSFER OF SAMPLES:
(First signature is sampler, last signature is authorized laboratory representative.)

	SHIPPER	RECEIVER	DATE	TIME
1.	[signature]	[signature]	9-28-93	7:10 Am
2.				

Condition of Sample Upon Receipt

13.4°C (cold packs NO ice)

INDIANA MICHIGAN POWER COMPANY
Donald C. Cook Nuclear Plant

616-4 6-2840

12 OAP 3130 SMD.004
Attachment 1

Shipping Memorandum

Ship To:
Name Great Lakes ...
Street Address 739 Hastings
City, State Traverse City MI
Zip Code 49684
Attention Denis ...
P.A. No. ...

From:
Indiana Michigan Power Company
Cook Nuclear Plant
One Cook Place
Bridgman MI 49106

This Area Stores Use Only 1 2 1 ...
Carrier Utilized: 771224 3662.

QUANTITY	ITEM DESCRIPTION	BOX SIZE L x H x W	WEIGHT
1	LAKE ...	...	...
TOTAL 1			TOTAL 60

Reason For Shipment

Shipping Priority

[ ] Normal
[ ] Rush
[ ] Saturday Delivery
[ ] Other Fed Ex Priority
[ ] Pre-Paid
[ ] Collect

Originator

Originator (Print) ...
Originator Ph. Ext No. ...
R.U. Number ...
Account Number ...
Vendor ...
P.O Number ...
Declared Value ...

Stores Shipping Data

Date Delivered To Stores ...
Date Shipped ...
Stores Attendant ...
Stores Dept. Approval

S.M. NUMBER
...

Remarks:

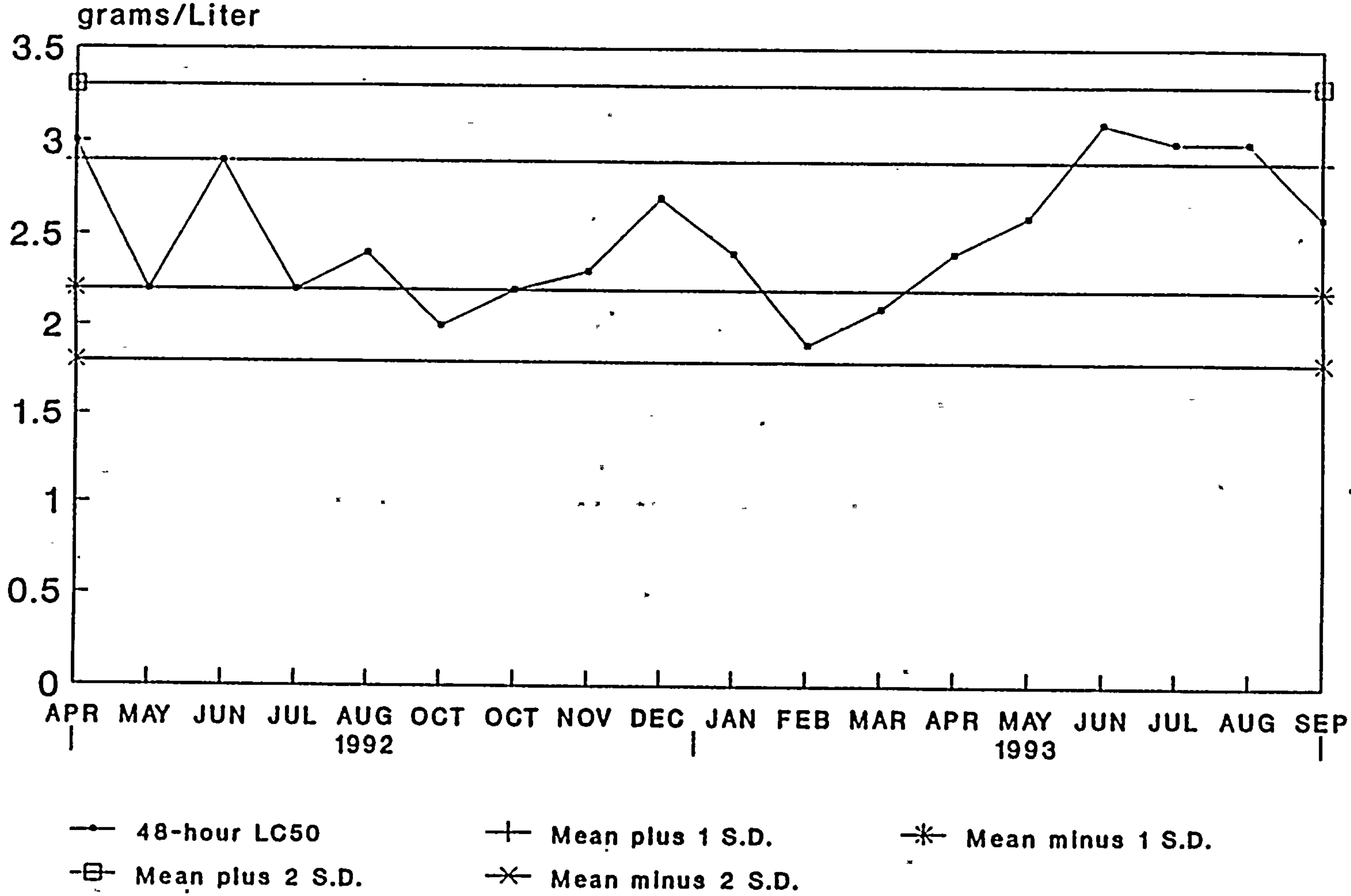
COPIES SENT TO:
Cook Site Purchasing
Fort Wayne General Accounting
Stores File
Originator

AIV-128

APPENDIX B

STANDARD REFERENCE TOXICANT DATA

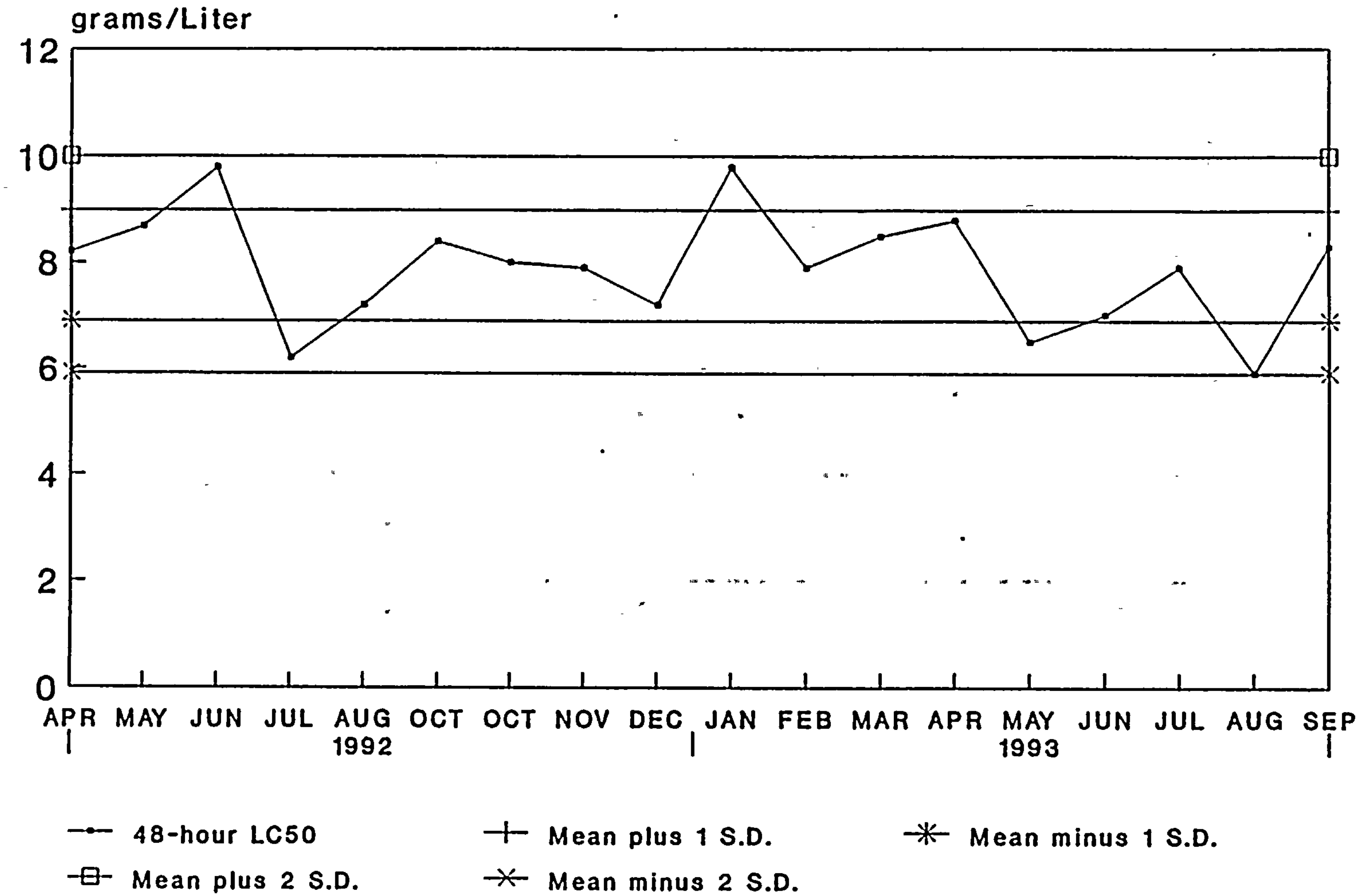
GREAT LAKES ENVIRONMENTAL CENTER
Sodium Chloride (NaCl) Toxicity Data
1992 - 1993



Ceriodaphnia dubia Survival

AIV-130

GREAT LAKES E[illegible]RONMENTAL CENTER
Sodium Chloride (NaCl) Toxicity Data
1992 - 1993



Fathead Minnow Survival

AIV-131

APPENDIX V

ANNUAL REPORT: RADIOLOGICAL ENVIRONMENTAL

MONITORING PROGRAM

1993

DONALD C. COOK NUCLEAR PLANT

UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1993 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1993

Prepared by

Indiana Michigan Power Company
and
Teledyne Isotopes

April 15, 1994

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

APPENDICES

TABLE OF CONTENTS (Cont)

LIST OF FIGURES

LIST OF TRENDING GRAPHS

LIST OF TABLES

SUMMARY

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK POWER NUCLEAR PLANT

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY

This report summarizes the collection and analysis of various environmental sample media in 1993 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.

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

I. INTRODUCTION

I. INTRODUCTION

The Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program (REMP) is conducted in compliance with NRC Regulatory Guide 1.21 and 4.1, licensing commitments, and Technical Specifications. The REMP was developed in accordance with the NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, November 1979. A synopsis of the sampling program and maps can be found in Section II, Sampling and Analysis Program. This report represents the Annual Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1, 1993 through December 31, 1993.

A. The Donald C. Cook Nuclear Plant of Indiana Michigan Power Company is located on the southeastern shore of Lake Michigan approximately one mile northwest of Bridgman, Michigan. The plant consists of two pressurized water reactors, Unit 1, 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 1993. 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 through 6. Also for each sample medium the sample collection frequency, type of analysis, and frequency of analysis are listed.

TABL[illegible]

DONALD C. COOK NU[illegible]R PLANT- 1993

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Environmental (TLD's)						
ONS-1	(A-1)	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°		
ONS-7	(A-7)	2103 ft.		36°		
ONS-8	(A-8)	2208 ft.		82°		
ONS-9	(A-9)	1368 ft.		149°		
ONS-10	(A-10)	1390 ft.		127°		
ONS-11	(A-11)	1969 ft.		11°		
ONS-12	(A-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	(OFS-1)	4.5 mi	NE			
Stevensville Substation	(OFS-2)	3.6 mi	NE			
Pole #B296-13	(OFS-3)	5.1 mi	NE			
Pole #B350-72	(OFS-4)	4.1 mi	E			
Intersection of Shawnee & Cleveland, Pole #B387-32	(OFS-5)	4.2 mi	ESE			
Snow Rd., East of Holden Rd., #B426-1	(OFS-6)	4.9 mi	SE			
Bridgman Substation	(OFS-7)	2.5 mi	S			
California Rd., Pole #B424-20	(OFS-8)	4.0 mi	S			
Riggles Rd., Pole B369-214	(OFS-9)	4.4 mi	ESE			
Intersection of Red Arrow Hwy., & Hildebrant Rd.,Pole #B422-152	(OFS-10)	3.8 mi	S			
Intersection of Snow Rd. & Baldwin Rd., Pole #B424-12	(OFS-11)	3.8 mi	S			

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1993

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°		
Non Technical Specification Related Wells						
Steam Generator Storage Facility	(SGRP-1)	0.8 mi		95°		
Steam Generator Storage Facility	(SGRP-2)	0.7 mi		92°		Gross Beta/Quarterly
Steam Generator Storage Facility	(SGRP-4)	0.7 mi		93°	Quarterly	Gross Alpha/Quarterly
Steam Generator Storage Facility	(SGRP-5)	0.7 mi		92°		Gamma Isotopic/Quarterly

TABLE 1 [illegible].)
DONALD C. COOK NU[illegible]R PLANT- 1993
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	0.3 mi	S		Daily	Gamma Isotopic/Monthly
Lake Michigan Shoreline		L-3	0.2 mi	N			Composite
Lake Michigan Shoreline		L-4	500 ft	S			Tritium/Quarterly Composite
Lake Michigan Shoreline		L-5	500 ft	N			
Sediment							
Lake Michigan Shoreline		L-2	0.3 mi	S			
Lake Michigan Shoreline		L-3	0.2 mi	N		Semi-annually	Gamma Isotopic/Semi-
Lake Michigan Shoreline		L-4	500 ft	S			Annually
Lake Michigan Shoreline		L-5	500 ft	N			
Milk-Indicator							
Totzke Farm	Baroda	Totzke	5.1 mi	ENE			
Schuler Farm	Baroda	Schuler	4.1 mi	SE			
Warmbien Farm	Three Oaks	Warmbien	7.7 mi	S		14 Days	I-131 Sample
Freehling Farm	Buchanan	Freehling	7.0 mi	SE			
Milk-Background							
Wyant Farm	Dowagaic	Wyant	20.7 mi	E		Once every	Gamma Isotopic/Sample
Livinghouse Farm	La Porte	Livinghouse	20.0 mi	S		14 Days	I-131/ Sample

TABLE 1 (Cont.)
DONALD C. COOK NUCLEAR PLANT- 1993
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		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 J		At time of harvest	Gamma Isotopic at time of harvest.
Approximately 20 miles from the Plant			Sector A		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

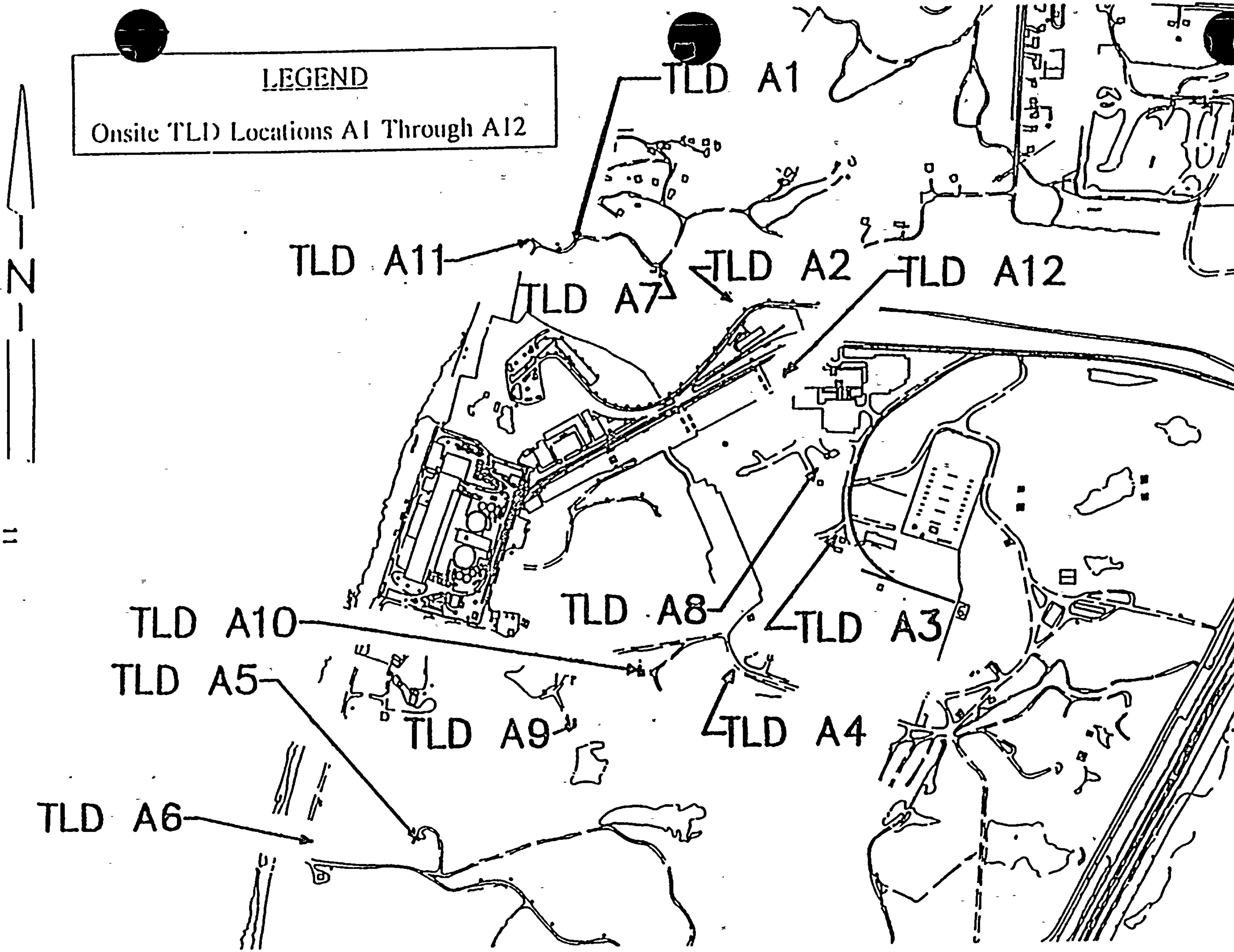

LEGEND
Onsite TLD Locations A1 Through A12
N
TLD A1
TLD A11
TLD A2
TLD A7
TLD A12
TLD A8
TLD A3
TLD A10
TLD A5
TLD A9
TLD A4
TLD A6

Figure 1

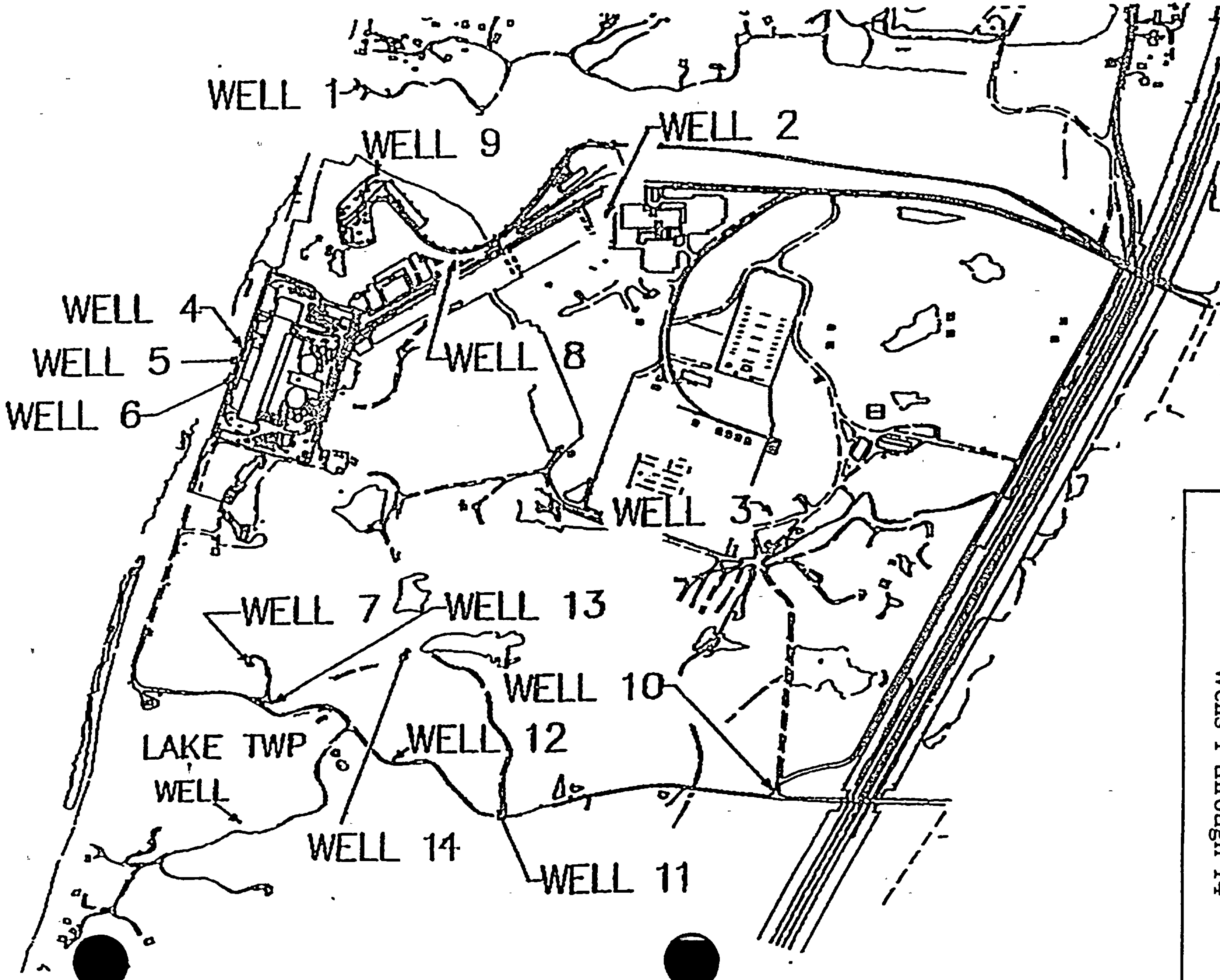


FIGURE 2

LEGEND
Onsite Groundwater Locatio
Wells 1 through 14

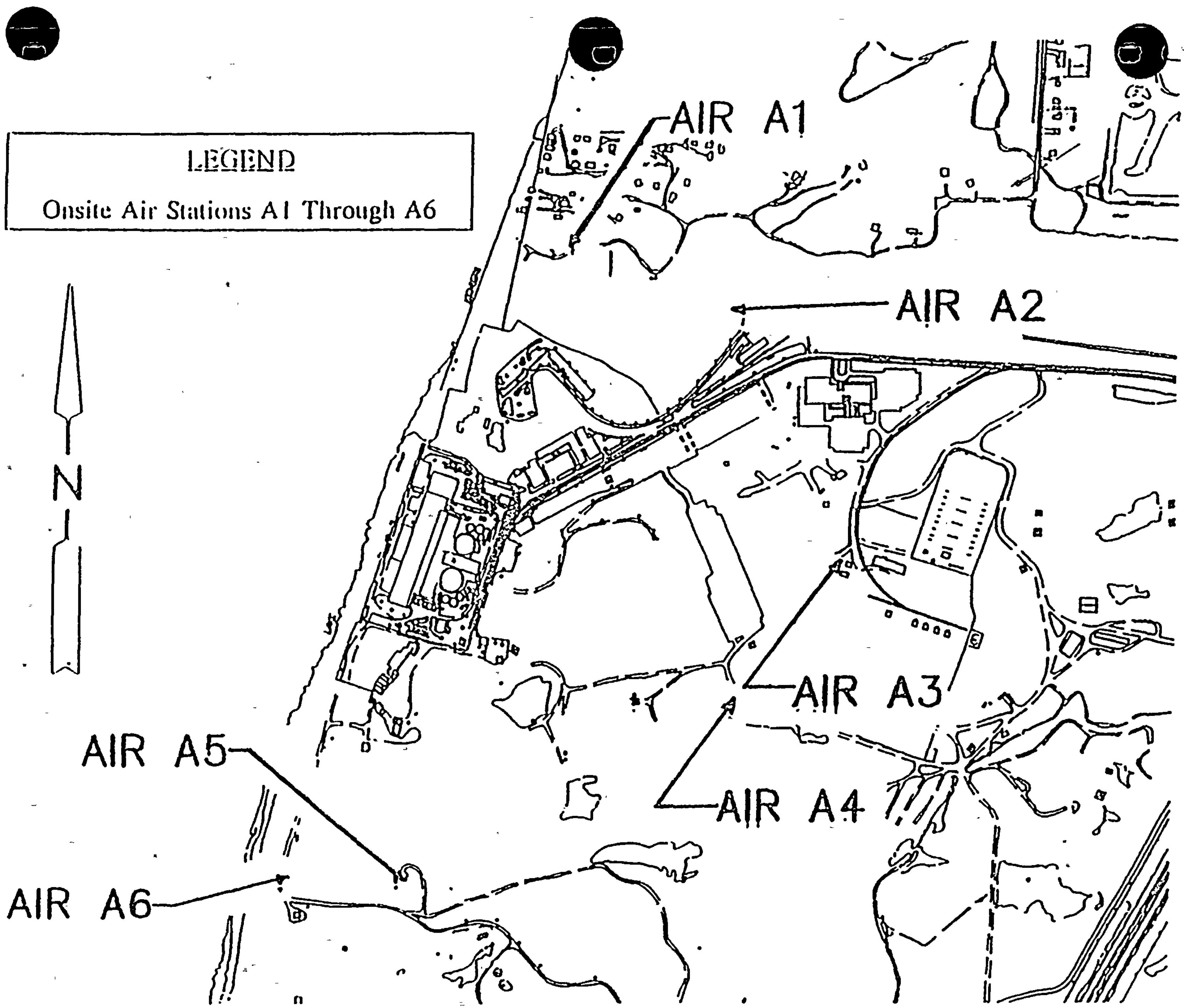

LEGEND
Onsite Air Stations A1 Through A6
N
AIR A1
AIR A2
AIR A3
AIR A4
AIR A5
AIR A6

Figure 3

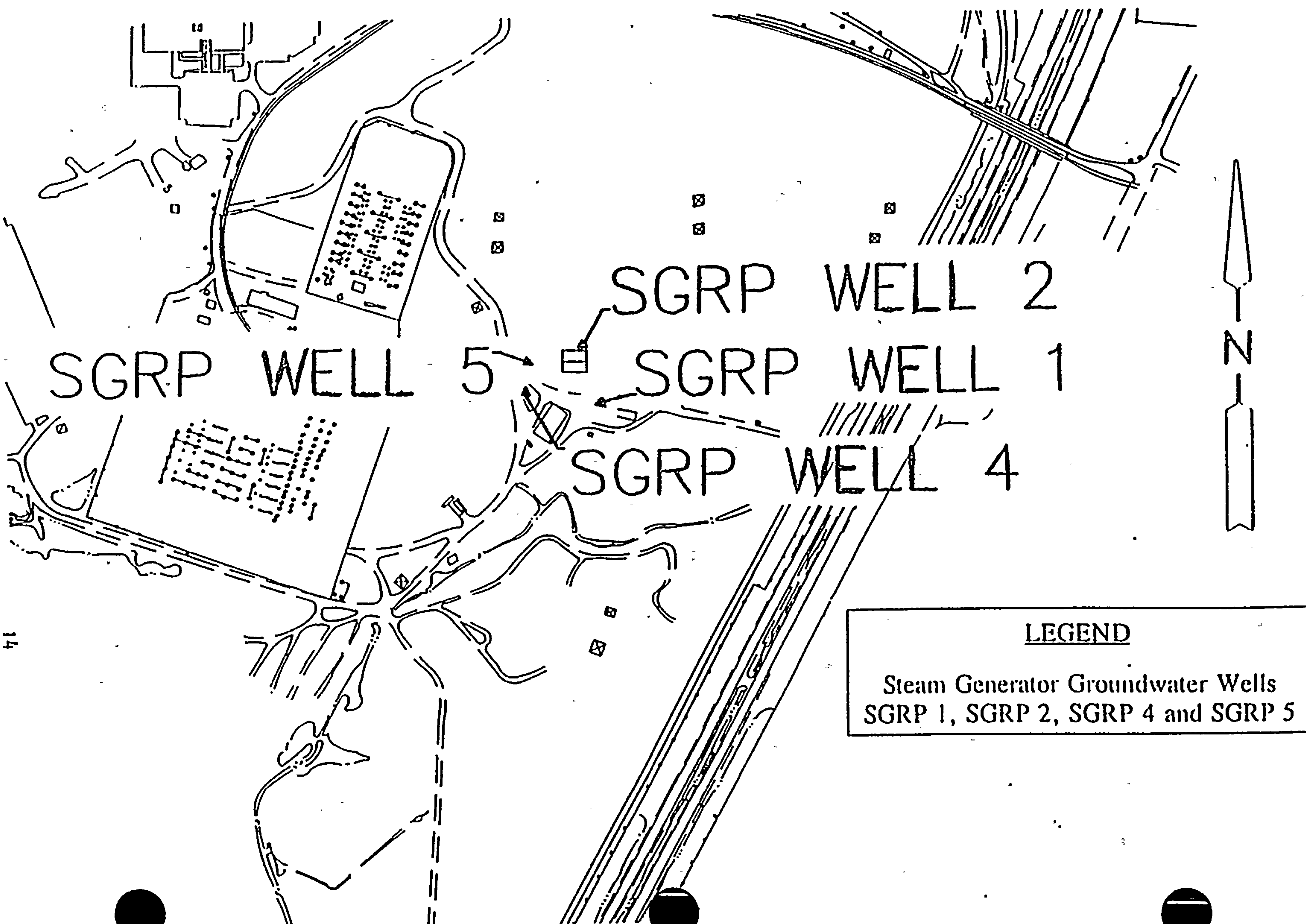
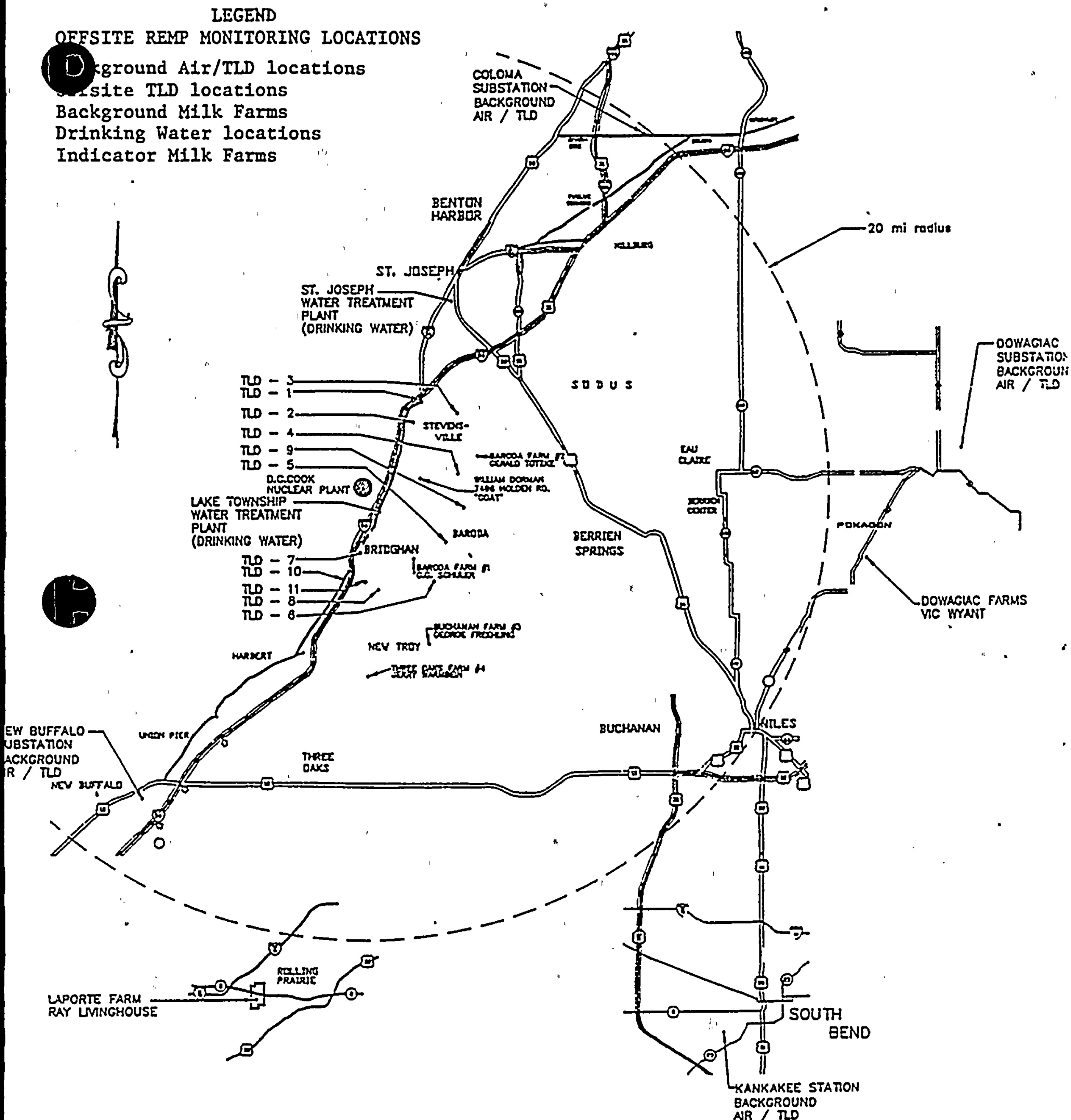

SGRP WELL 2
SGRP WELL 5
SGRP WELL 1
SGRP WELL 4
N
LEGEND
Steam Generator Groundwater Wells
SGRP 1, SGRP 2, SGRP 4 and SGRP 5

Figure 4

FIGURE 5

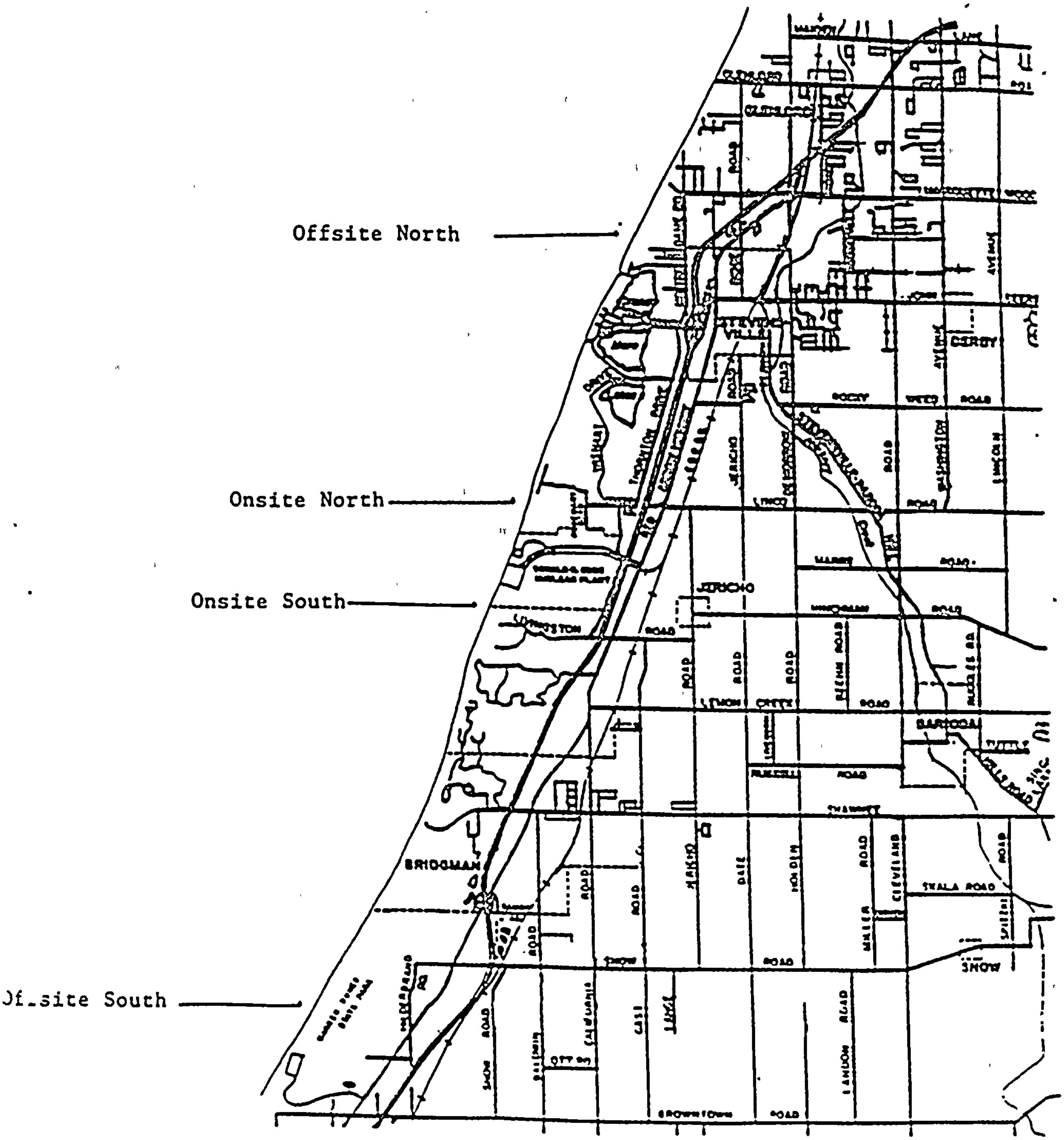


LEGEND
OFFSITE REMP MONITORING LOCATIONS
kground Air/TLD locations
site TLD locations
Background Milk Farms
Drinking Water locations
Indicator Milk Farms
COLOMA SUBSTATION BACKGROUND AIR / TLD
BENTON HARBOR
20 mi radius
ST. JOSEPH
ST. JOSEPH WATER TREATMENT PLANT (DRINKING WATER)
TLD – 3
TLD – 1
TLD – 2
TLD – 4
TLD – 9
TLD – 5
D.C.COOK NUCLEAR PLANT
LAKE TOWNSHIP WATER TREATMENT PLANT (DRINKING WATER)
TLD – 7
TLD – 10
TLD – 11
TLD – 8
TLD – 6
STEVENS-VILLE
SODUS
BARODA
BRIDGMAN
BERRIEN SPRINGS
EAU CLAIRE
POKAGON
DOWAGIAC SUBSTATION BACKGROUND AIR / TLD
DOWAGIAC FARMS VIC WYANT
NEW TROY
HARBERT
NEW BUFFALO SUBSTATION BACKGROUND AIR / TLD
NEW BUFFALO
THREE OAKS
BUCHANAN
NILES
ROLLING PRAIRIE
LAPORTE FARM RAY LIVINGHOUSE
SOUTH BEND
KANKAKEE STATION BACKGROUND AIR / TLD

Figure 6

SAMPLING LOCATIONS

FISH COLLECTED FOR RADIOLOGICAL ANALYSIS



III. SUMMARY AND DISCUSSION OF 1993 ANALYTICAL RESULTS

III. SUMMARY AND DISCUSSION OF 1993 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 1993 were analyzed by Teledyne Isotopes, Inc. (TI) in Westwood, New Jersey. The procedures and specifications followed at Teledyne Isotopes are in accordance with the Teledyne Isotopes Quality Assurance Manual and are explained in the Teledyne Isotopes Analytical Procedures. A synopsis of analytical procedures used for the environmental samples are proved in Appendix C. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Appendix D.

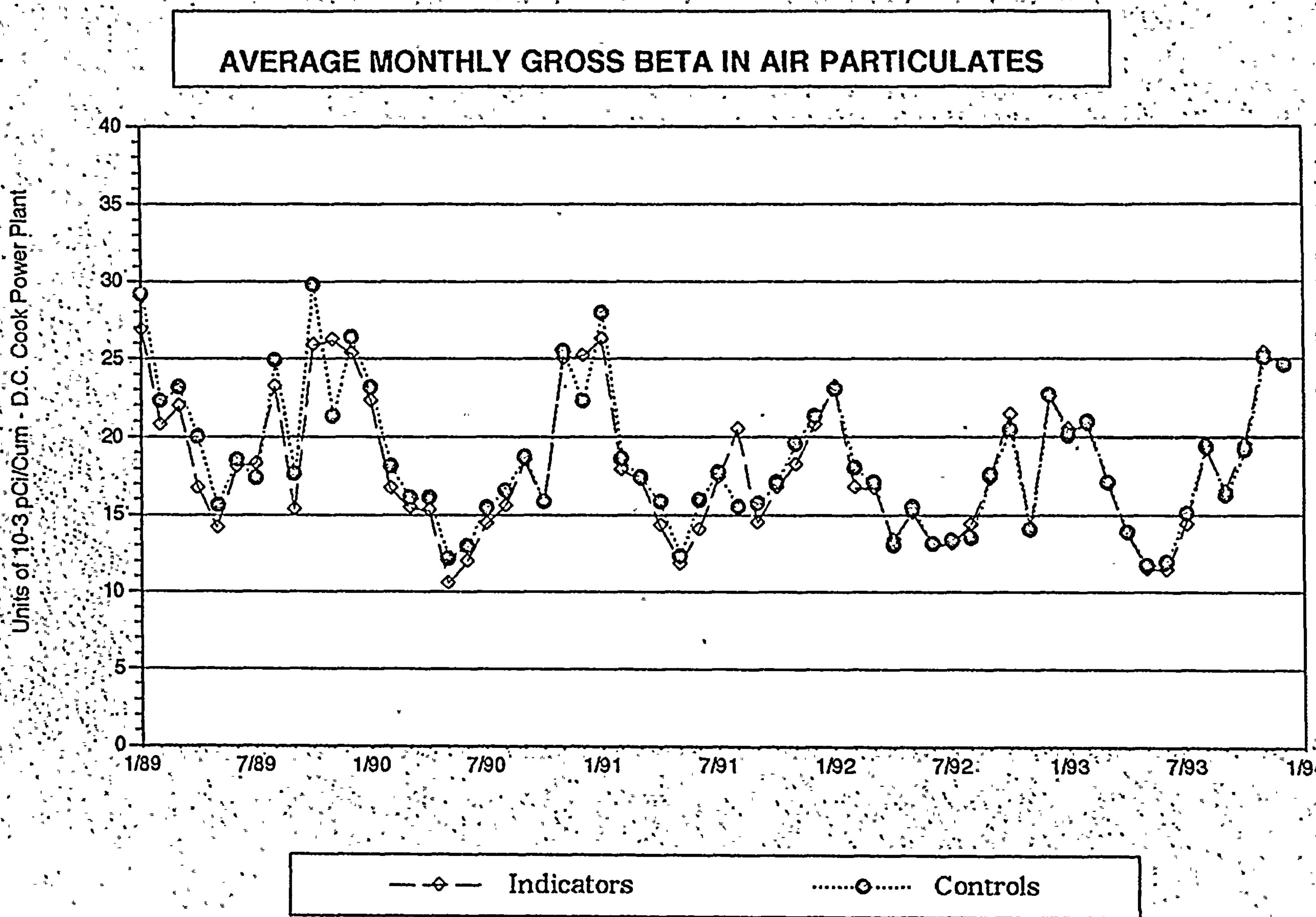
Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. Teledyne Isotopes analytical methods meet or exceed the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring, Revision 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 gross beta activities are presented in Table B-1. The measurement

Trending Graph - 1



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 0.018 pCi/m^3 with a range of individual values between 0.003 and 0.036 pCi/m^3. The average gross beta concentration of the four control locations was 0.018 pCi/m^3 with a range between 0.006 and 0.035 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 1993 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 0.112 pCi/m^3 and the values ranged from 0.083 to 0.135 pCi/m^3. The average concentration for the indicator locations was 0.118 pCi/m^3 with a range of 0.090 to 0.149 pCi/m^3. These values are typical of beryllium-7 measured at various locations throughout the United States. Naturally occurring potassium-40, probably from dust, was measured in seven of the twenty-four indicator quarterly composites with an average concentration of 0.012 pCi/m^3 and a range of 0.004 to 0.032 pCi/m^3. Potassium-40 was measured in four of the sixteen control quarterly composites with a concentration of 0.005 pCi/m^3 and a range of 0.004 to 0.006 pCi/m^3. No other gamma emitting radioactivity was detected.

B. <u>Airborne Iodine</u>

Airborne particulate samples are collected with a constant flow oil less pump at 56 LPM using a 47 mm particulate filter. Teda-3B 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. A

results were below the lower level of detection with no positive activity detected.

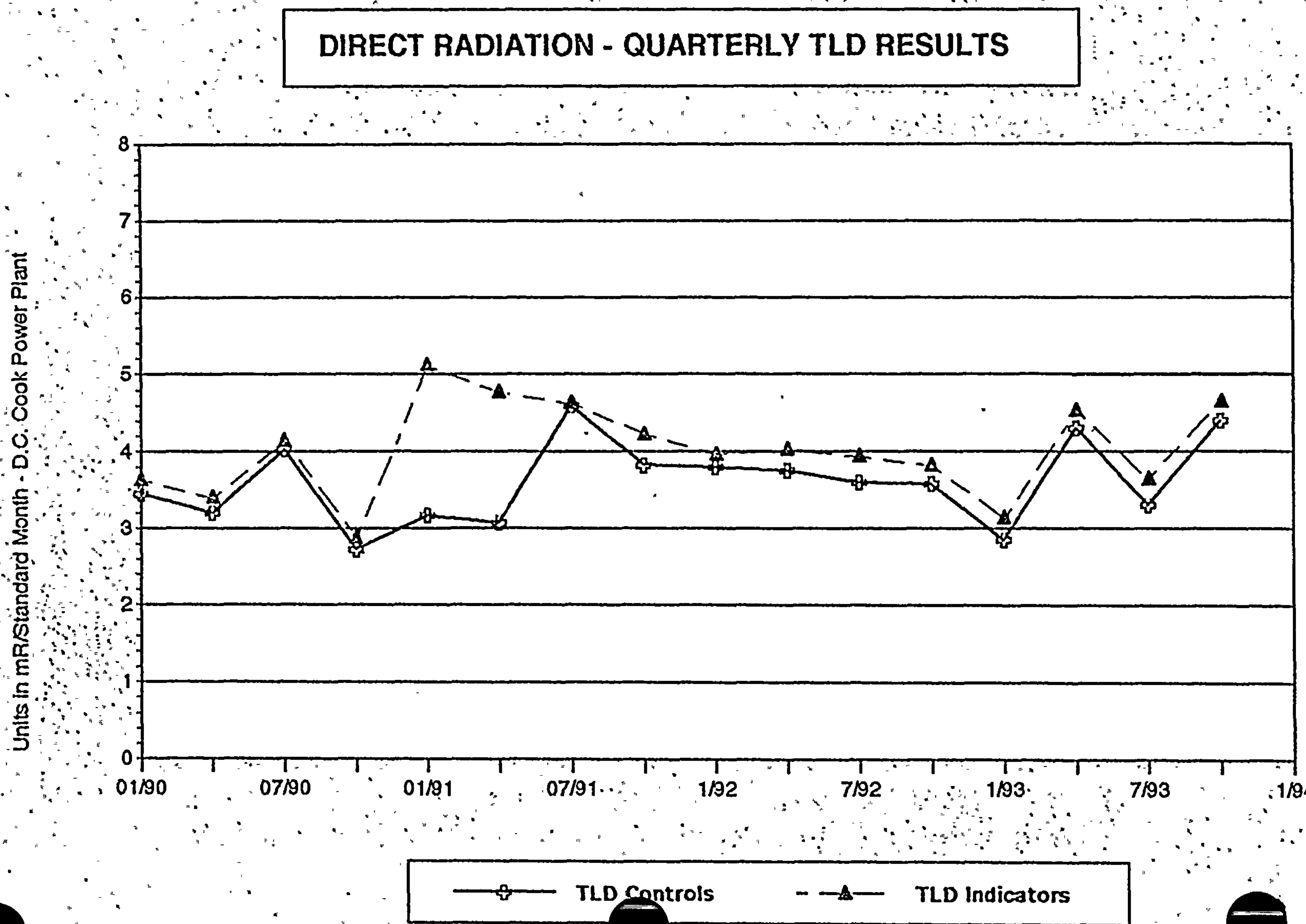
C. Direct Radiation - Thermoluminescent Dosimeters

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 3.71 mR/standard month with a range of 2.7 to 5.0 mR/standard month. The annual accumulation of indicator samples had a measurement of 3.98 mR/standard month with a range of 2.4 to 5.9 mR/standard month. The 1993 annual average in the environs of the D. C. Cook 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

One liter surface water samples from the intake forebay and from four shoreline locations, all within 0.3 mile of the two reactors were collected and composited daily over a monthly period. The samples were analyzed for iodine-131 by the radiochemical technique described on page 79. No iodine-131 was detected. The quarterly composite was analyzed for tritium by liquid scintillation method described on page 74. Naturally occurring potassium-40 and cesium-

Trending Graph - 2



137 were not measured during 1993. Tritium was detected in 7 of the 20 samples analyzed with an average concentration of 166 pCi/liter and a range of 140 to 190 pCi/liter. This is lower than the 12 measurements in 1992 which had an average concentration of 554 pCi/liter. During the preoperational period tritium was measured in surface water samples at concentrations of approximately 400 pCi/liter. Naturally occurring gamma emitting isotopes were detected using gamma ray spectroscopy.

E. Groundwater

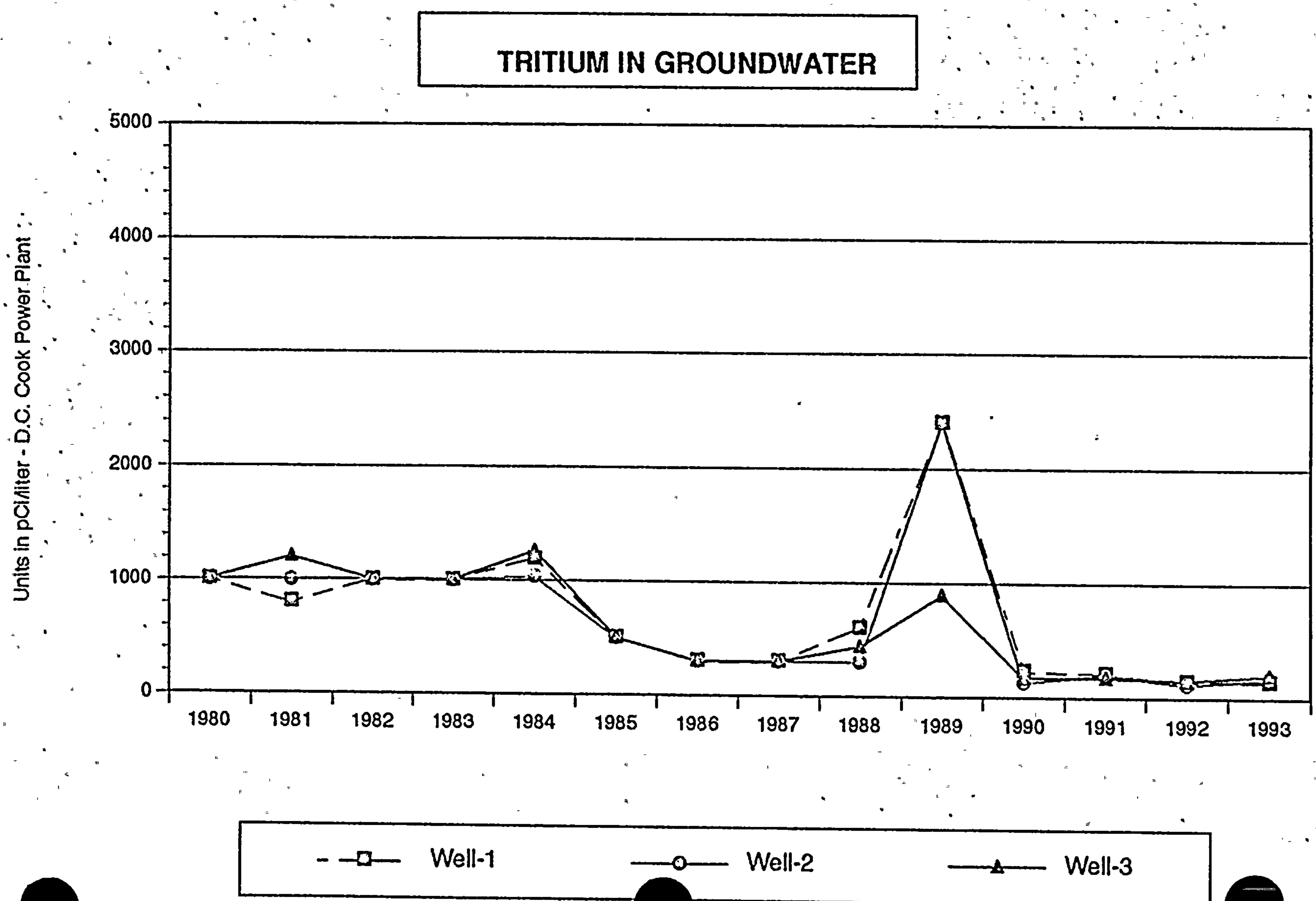
Water samples are collected quarterly from fourteen wells, all within 3300 feet of the reactors. First, a static water elevation is determined and three well bore volumes are purged from the well using a groundwater pump. A one gallon sample is then obtained. The samples are analyzed for gamma emitters and tritium. The results are presented in Table B-6. Naturally occurring potassium-40 was measured in one sample with a concentration of 58.8 pCi/liter. Thorium-228 was measured in one sample with a concentration of 10.9 pCi/liter. No other gamma emitting isotopes were detected. The groundwater wells W-4, W-5, W-6, W-7, W-8, W-11, W-12, W-13 and W-14 had measurable tritium activity throughout 1993. Tritium was measured in 23 of the 56 samples at the locations with an average concentration of 647 pCi/liter and a range of 200 to 1200 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 1993 in Trending Graph 3.

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

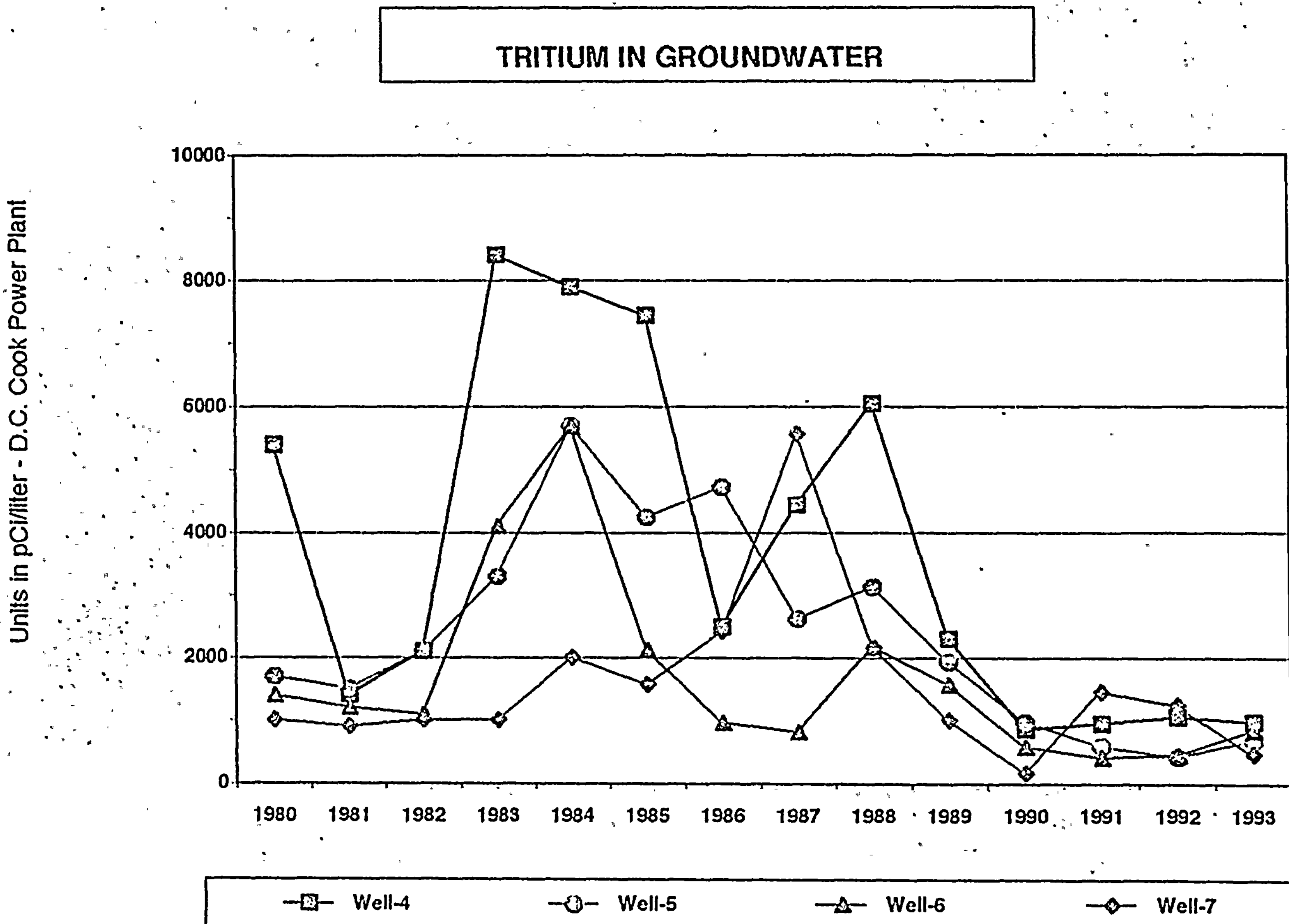
F. Drinking Water

Daily samples are collected at the intake of the purification plants for St. Joseph and Lake Township. The 500 ml daily samples at

Trending Graph - 3

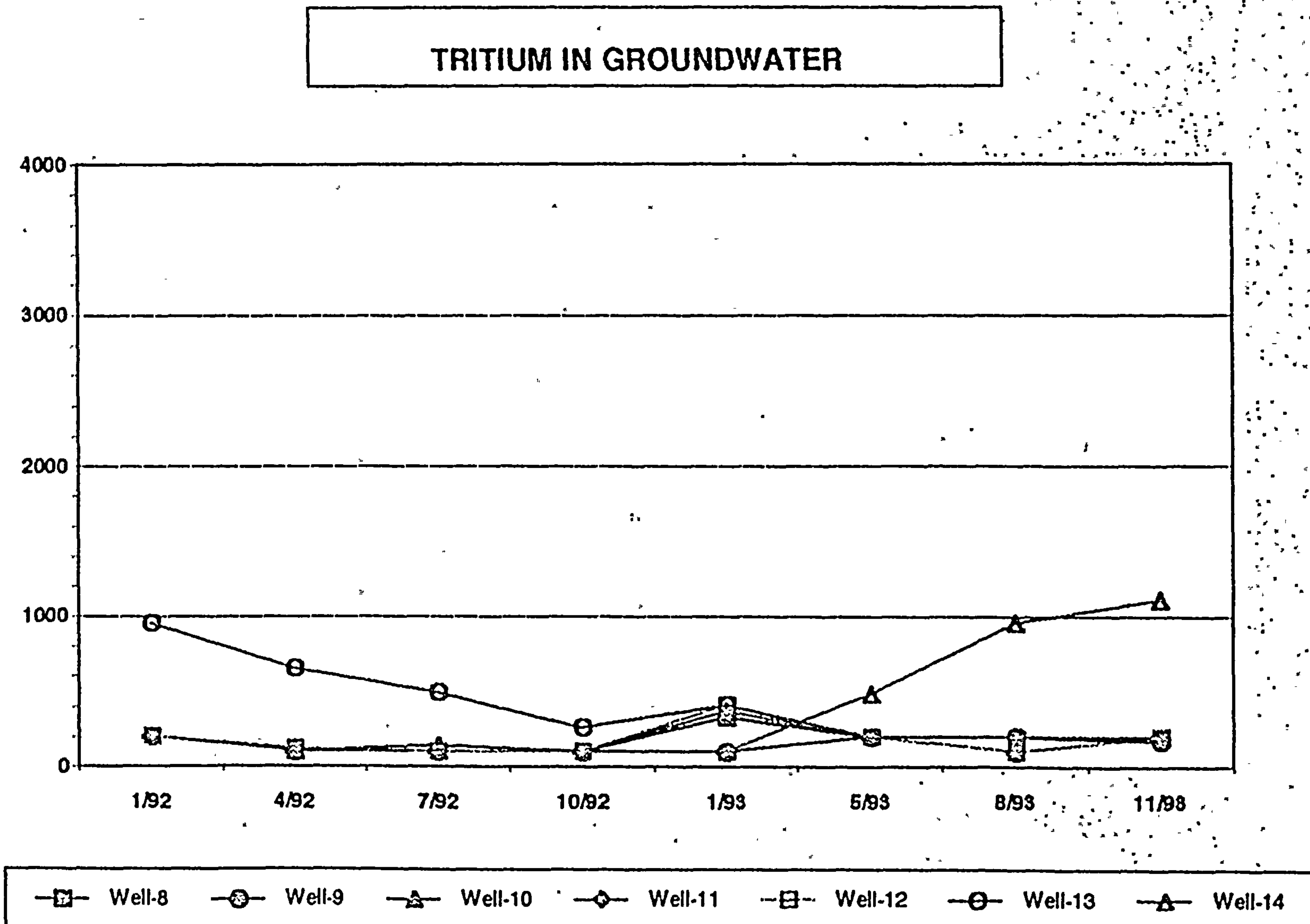


Trending Graph - 3 (Cont.)



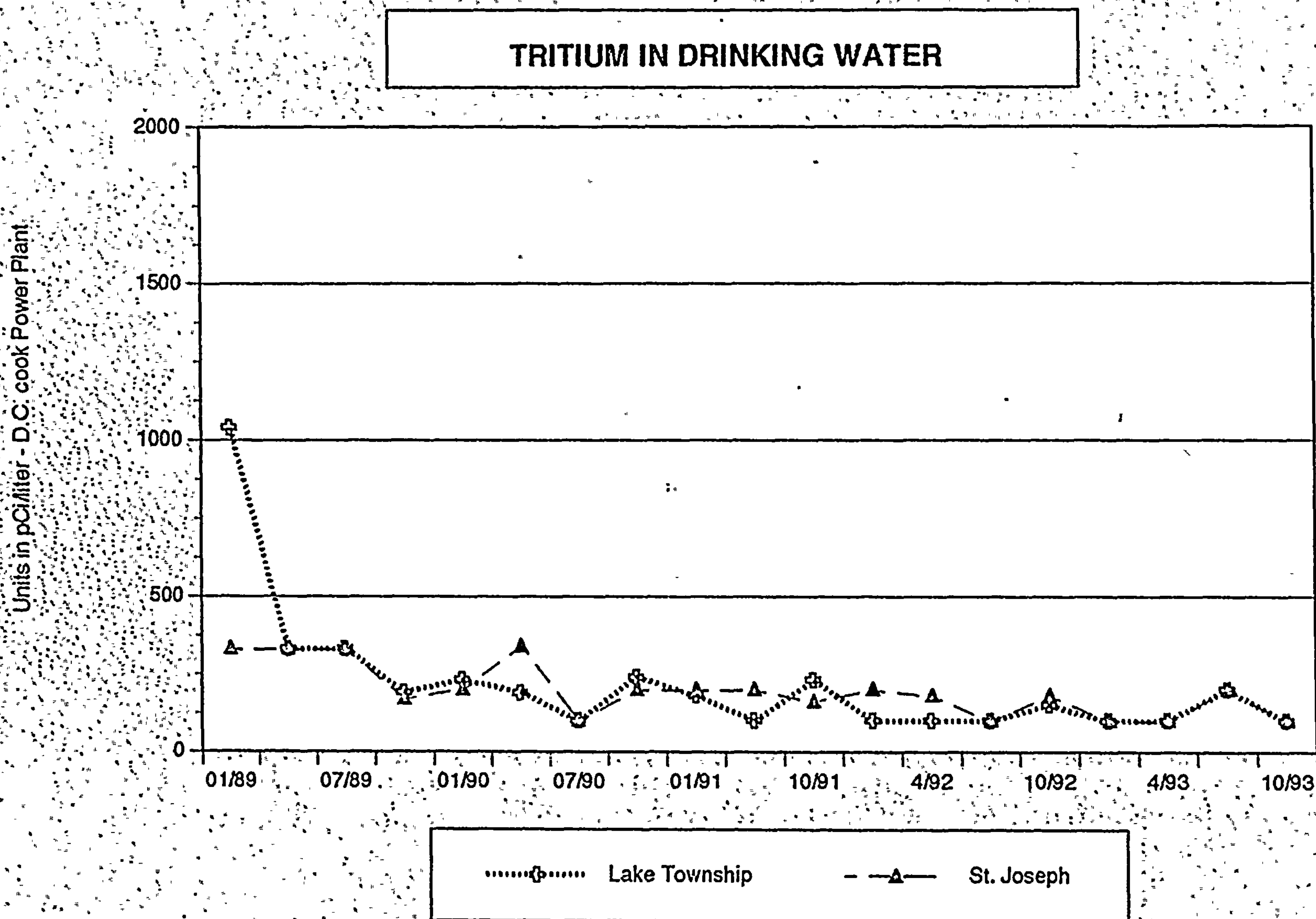
Units in pCi/liter - D.C. Cook Power Plant

Trending Graph - 3 (Cont.)



Well 14 added to the program in 1993.

Trending Graph - 4



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 3.4 pCi/liter and a range from 2.0 to 5.0 pCi/liter. Gross beta activity was measured in all twenty-six samples from the St. Joseph intake with an average concentration of 3.9 pCi/liter and a range from 2.5 to 7.3 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 in drinking water is 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 four 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 May and November one sample was collected from each location L2, L3, L4 and L5. Gamma ray spectroscopy detected naturally occurring potassium-40 and in all samples. The average potassium-40 concentration was 5609 pCi/kg (dry weight) with a range from 3660 to 6930 pCi/kg (dry weight). Thorium-228, also naturally occurring was measured in all samples with an average concentration of 129 pCi/kg (dry weight) with a range from 96.5 to 158 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 500 gallon bulk tank 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 bisulfate 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 156 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 1993 the average potassium-40 concentration for the control locations was 1342 pCi/liter with a range of 1120 to 1610 pCi/liter. The indicator locations had an average concentration of 1393 pCi/liter and a range of 1080 to 1790. There were no detections of iodine-131 during 1993. Cesium-137 was not detected during 1993.

I. Fish

Using gill nets in approximately twenty feet of water in Lake Michigan, 4.5 pounds of fish are collected 2 per/year from each of four locations. The samples are then analyzed by gamma ray spectroscopy. Naturally occurring potassium-40 was measured in all samples with an average concentration of 3174 pCi/kg (wet weight) and a range of 2520 to 3870 pCi/kg (wet weight). Cesium-137 was measured in three of the eight fish samples with an average concentration of 68.3 pCi/kg (wet weight) and a range of 58.6 to 74.3 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. They consist of 5 pounds of grapes, 1 pound of grape leaves and 5 pounds of broadleaves. Naturally occurring potassium-40 was measured in all five samples with an average concentration of 3102 pCi/kg (wet weight) and a range of 1890 to 6460 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in all samples with an average concentration of 1978 pCi/kg (wet weight) and a range of 131 to 3980 pCi/kg (wet weight).

IV. CONCLUSIONS

IV. CONCLUSIONS

The results of the 1993 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 1993 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 1993. No iodine-131 was detected in charcoal filters in 1993.

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 four locations in Lake Michigan. The samples are analyzed quarterly for tritium, and monthly for gamma emitting isotopes. No gamma emitters were detected during 1993. Tritium was measured and the concentrations were at normal background levels.

Groundwater samples were collected quarterly at fourteen wells, all within 3300 feet of the reactors. The three wells within 500 feet have measurable tritium which is attributed to the operation of the plant. The

tritium levels in 1993 compare well with those measured in 1992. The highest concentration measured in 1993 was 1200 pCi/liter while the highest concentration measured during 1992 was 1500 pCi/liter. The tritium levels in groundwater have been plotted for the last decade and are shown in trending graph 3. Potassium-40, a naturally occurring nuclide was observed in one sample during 1993. 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 for gamma emitting isotopes and 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 measured in four of the eight quarterly composite samples with background levels that were lower than those measured during 1992.

Sediment samples can be a sensitive indicator of discharges from nuclear power stations. Sediment samples are collected semiannually along the shoreline of Lake Michigan at four locations in close proximity of the reactors. The samples were analyzed by gamma ray spectroscopy 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 1993, 1992 or 1991. Potassium-40 was measured in all milk samples at normal background levels. Cesium-137 was not detected in 1993.

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 three samples.

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

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

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

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

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

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

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

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

APPENDIX A
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1993

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/m³)	I-131	518	-(0/310) -	N/A	N/A	-(0/208) -	0
Airborne Particulates (1E-03 pCi/m³)	Gross Beta (Weekly)	518	17.7(310/310) (3.2-36)	A-3 Onsite 2407 ft.	18.5(52/52) (8.1-33)	17.8(208/208) (5.7-35)	0
	Gamma	40					
	Be-7	40	118(24/24) (90.4-149)	A-3 Onsite 2407 ft.	122(4/4) (96.2-137)	112(16/16) (83.2-135)	0
	K-40	40	11.9(7/24) (4.27-32.2)	A-5 Onsite 1895 ft.	19.1(2/4) (6.07-32.2)	4.85(4/16) (3.92-5.91)	0
Direct Radiation (mR/Standard Month)	Gamma Dose Quarterly	107	3.98(91/91) (2.4-5.9)	OFS-8 4.0 mi S	4.58(4/4) (3.7-5.2)	3.71(16/16) (2.7-5.0)	0

(a/b) [illegible]of samples with detectable activity to total number of samples [illegible]zed.

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, 1993

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/liter)	Gamma	65	(0/65) -	N/A		(0/0) -	0
	H-3	20	166(7/20) (140-190)	L-2 0.3 mi S	190(1/4) -	-(0/0) -	0
Groundwater (pCi/liter)	Gamma	56					
	K-40	56	58.8(1/56) -	Well 3 3279 ft.	58.8(1/4) -	-(0/0) -	0
	Th-228	56	10.9(1/56) -	Well 12 2631 ft.	10.9(1/4) -	-(0/0) -	0
	H-3	56	647(23/56) (200-1200)	Well 4 418 ft.	980(3/4) (790-1200)	-(0/0) -	0
Drinking Water (pCi/liter)	Gross Beta	52	3.66(52/52) (2.0-7.3)	STJ 9.0 mi NE	3.93(26/26) (2.5-7.3)	-(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, 1993

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Sediment (pCi/kg dry)	Gamma	8					
	K-40	8	5609(8/8) (3660-6930)	L-2 0.3 mi S	6250(2/2) (5570-6930)	-(0/0) -	0
	Ra-226	8	-(0/8) -			-(0/0) -	0
	Th-228	8	129(8/8) (96.5-158)	L-2 0.3 mi S	157(2/2) (155-158)	-(0/0) -	0
Milk (pCi/liter)	Gamma	156					
	K-40	156	1393(104/104) (1080-1790)	Totzke 5.1 mi ENE	1449(26/26) (1240-1630)	1342(52/52) (1120-1610)	0
	I-131	156	-(0/104) -	N/A	N/A	-(0/52) -	0
	Cs-137	156	-(0/104) -	N/A	N/A	-(0/52) -	0

(a/b) N[illegible] of samples with detectable activity to total number of samples a[illegible]zed.

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, 1993

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
Fish (pCi/kg wet)	Gamma	8					
	K-40	8	3174(8/8) (2520-3870)	OFS-North 3.5 mi N	3460(2/2) (3050-3870)	-(0/0) -	0
	Cs-137	8	68.3(3/8) (58.6-74.3)	OFS-North 3.5 mi N	74.3(1/2) -	-(0/0) -	0
Food/Vegetation (pCi/kg wet)	Gamma	5					
	Be-7	5	1978(5/5) (131-3980)	Sector B Variable	2144(2/2) (807-3480)	-(0/0) -	0
	K-40	5	3102(5/5) (1890-6460)	Sector B Variable	4330(2/2) (2200-6460)	-(0/0) -	0
	Cs-137	5	-(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

T[illegible]B-1

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

COLLECTION DATES	STATION CODES										
	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
JANUARY 93											
01/04/93	15 ± 2	14 ± 2	15 ± 2	18 ± 2	15 ± 2	14 ± 2	16 ± 2	14 ± 2	16 ± 2	14 ± 2	15 ± 3
01/11/93	29 ± 2	29 ± 2	31 ± 2	27 ± 2	31 ± 2	31 ± 2	26 ± 2	29 ± 2	29 ± 2	27 ± 2	29 ± 4
01/18/93	21 ± 2	21 ± 2	22 ± 2	22 ± 2	21 ± 2	22 ± 2	20 ± 2	22 ± 2	22 ± 2	25 ± 2	22 ± 3
01/25/93	15 ± 2	16 ± 2	16 ± 2	16 ± 2	15 ± 2	18 ± 2	15 ± 2	15 ± 2	15 ± 2	17 ± 2	16 ± 2
02/01/93	20 ± 2	20 ± 2	21 ± 2	20 ± 2	18 ± 2	21 ± 2	20 ± 2	20 ± 2	20 ± 2	20 ± 2	20 ± 2
FEBRUARY											
02/08/93	18 ± 2	20 ± 2	19 ± 2	19 ± 2	17 ± 2	22 ± 2	18 ± 2	21 ± 2	17 ± 2	18 ± 2	19 ± 3
02/15/93	21 ± 2	21 ± 2	19 ± 2	18 ± 2	22 ± 2	20 ± 2	20 ± 2	20 ± 2	21 ± 2	23 ± 2	20 ± 3
02/22/93	25 ± 2	22 ± 2	25 ± 2	26 ± 2	25 ± 2	24 ± 2	24 ± 2	26 ± 2	24 ± 2	20 ± 2	24 ± 4
03/01/93	20 ± 2	18 ± 2	21 ± 2	18 ± 2	18 ± 2	19 ± 2	20 ± 2	21 ± 2	21 ± 2	21 ± 2	20 ± 3
MARCH											
03/08/93	30 ± 2	1.3 ± 0.7(a)	29 ± 2	24 ± 2	27 ± 2	26 ± 2	24 ± 2	29 ± 2	25 ± 2	30 ± 2	27 ± 5
03/15/93	17 ± 2	(b)	16 ± 2	14 ± 2	19 ± 2	17 ± 2	18 ± 2	16 ± 2	15 ± 2	17 ± 2	17 ± 3
03/22/93	19 ± 2	(b)	18 ± 2	15 ± 2	19 ± 2	18 ± 2	17 ± 2	17 ± 2	19 ± 2	17 ± 2	18 ± 3
03/29/93	8.7 ± 1.5	10 ± 2	8.1 ± 1.4	6.9 ± 1.4	7.1 ± 1.4	7.5 ± 1.4	6.2 ± 1.3	7.0 ± 1.4	8.5 ± 1.5	7.8 ± 1.4	8 ± 2
Quarter Avg.	20 ± 12	19 ± 10	20 ± 12	19 ± 11	20 ± 12	20 ± 11	19 ± 10	20 ± 12	19 ± 11	20 ± 12	20 ± 1

(a) Power failure; results in total pCi and not included in averages.
(b) Power failure; sample unavailable.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
APRIL											
04/05/93	16 ± 2	15 ± 2	15 ± 2	12 ± 2	14 ± 2	13 ± 2	12 ± 2	13 ± 2	14 ± 2	14 ± 2	14 ± 3
04/12/93	10 ± 2	11 ± 2	11 ± 2	9.3 ± 1.7	9.4 ± 1.7	9.0 ± 1.7	9.0 ± 1.7	12 ± 2	7.9 ± 1.6	12 ± 2	10 ± 3
04/19/93	14 ± 2	14 ± 2	16 ± 2	15 ± 2	14 ± 2	12 ± 2	14 ± 2	14 ± 2	14 ± 2	13 ± 2	14 ± 2
04/26/93	16 ± 2	21 ± 2	17 ± 2	15 ± 2	18 ± 2	16 ± 2	15 ± 2	15 ± 2	15 ± 2	16 ± 2	16 ± 4
05/03/93	15 ± 2	14 ± 2	18 ± 2	11 ± 2	18 ± 2	3.3 ± 1.1	10 ± 2	23 ± 2	1.7 ± 0.7 (a)	17 ± 2	14 ± 11
MAY											
05/10/93	16 ± 2	15 ± 2	15 ± 2	15 ± 2	14 ± 2	13 ± 2	10 ± 2	15 ± 2	15 ± 2	15 ± 2	14 ± 3
05/17/93	8.2 ± 1.6	13 ± 2	12 ± 2	15 ± 2	12 ± 2	12 ± 2	11 ± 2	24 ± 2	11 ± 2	15 ± 2	13 ± 9
05/24/93	11 ± 2	11 ± 2	11 ± 2	12 ± 2	3.2 ± 0.8(a)	12 ± 2	9.7 ± 1.5	10 ± 2	9.6 ± 1.5	12 ± 2	11 ± 2
05/31/93	10 ± 2	8.8 ± 1.5	9.9 ± 1.5	9.8 ± 1.5	8.4 ± 1.4	8.3 ± 1.4	7.6 ± 1.4	10 ± 2	5.7 ± 1.0	6.1 ± 1.0	9 ± 3
JUNE											
06/07/93	9.9 ± 1.6	7.7 ± 1.5	12 ± 2	9.2 ± 1.6	10 ± 2	12 ± 1	9.3 ± 1.6	13 ± 2	9.3 ± 1.6 (b)	14 ± 2	11 ± 4
06/14/93	11 ± 2	13 ± 2	17 ± 2	13 ± 2	15 ± 2	15 ± 2	14 ± 2	15 ± 2	12 ± 2 (b)	15 ± 2	15 ± 2
06/21/93	10 ± 2	6.7 ± 1.4	8.5 ± 1.5	10 ± 2	7.9 ± 1.5	8.8 ± 1.5	12 ± 2	8.8 ± 1.6	8.0 ± 1.7	13 ± 2	9 ± 3
06/28/93	12 ± 2	12 ± 2	13 ± 2	13 ± 2	13 ± 2	14 ± 2	12 ± 2	12 ± 2	13 ± 2	12 ± 2	13 ± 1
Quarterly Avg.	12 ± 6	12 ± 7	13 ± 6	12 ± 5	12 ± 8	11 ± 7	11 ± 4	14 ± 9	11 ± 7	13 ± 5	12 ± 2

(a) Power [illegible]re; results in total pCi and not included in averages.
(b) Powe[illegible]: low volume. Not included in averages.

TA[illegible]1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
JULY											
07/05/93	14 ± 2	14 ± 2	15 ± 2	14 ± 2	15 ± 2	14 ± 2	16 ± 2	14 ± 1	13 ± 2	17 ± 2	15 ± 2
07/12/93	14 ± 2	14 ± 2	16 ± 2	12 ± 2	14 ± 2	14 ± 2	13 ± 2	12 ± 2	16 ± 2	16 ± 2	14 ± 3
07/19/93	14 ± 2	14 ± 2	13 ± 2	14 ± 2	12 ± 2	13 ± 2	10 ± 2	13 ± 2	13 ± 2	14 ± 2	13 ± 2
07/26/93	14 ± 2	10 ± 2	13 ± 2	14 ± 2	14 ± 2	14 ± 2	15 ± 2	24 ± 3 (a)	16 ± 2	15 ± 2	15 ± 7
08/02/93	19 ± 2	16 ± 8 (b)	18 ± 2	17 ± 2	16 ± 2	16 ± 2	17 ± 2	14 ± 2	16 ± 2	17 ± 2	17 ± 3
AUGUST											
08/09/93	13 ± 2	11 ± 5 (b)	14 ± 2	13 ± 2	13 ± 2	13 ± 2	11 ± 2	12 ± 2	13 ± 2	13 ± 2	13 ± 2
08/16/93	19 ± 8 (b)	< 7 (b)	29 ± 2	27 ± 2	24 ± 2	26 ± 2	20 ± 2	22 ± 2	25 ± 2	27 ± 2	24 ± 7
08/23/93	18 ± 2	< 20 (b)	20 ± 2	20 ± 2	22 ± 2	17 ± 2	21 ± 2	18 ± 2	18 ± 2	22 ± 2	20 ± 4
08/30/93	22 ± 2	2.5 ± 0.8 (b)	260 ± 3 (c)	17 ± 2	23 ± 2	22 ± 2	22 ± 2	22 ± 2	22 ± 2	22 ± 2	22 ± 4
SEPTEMBER											
09/06/93	19 ± 2	16 ± 2	16 ± 2	14 ± 2	15 ± 2	13 ± 2	15 ± 2	14 ± 2	14 ± 2	14 ± 2	15 ± 3
09/13/93	18 ± 2	17 ± 2	16 ± 2	19 ± 2	17 ± 2	16 ± 2	17 ± 2	18 ± 2	19 ± 2	17 ± 2	17 ± 2
09/20/93	22 ± 5 (b)	18 ± 2	18 ± 2	14 ± 2	16 ± 2	17 ± 2	17 ± 2	16 ± 2	16 ± 2	18 ± 2	17 ± 4
09/27/93	18 ± 2	0.79 ± 0.54 (c)	21 ± 2	19 ± 2	17 ± 2	17 ± 2	17 ± 2	18 ± 2	18 ± 2	18 ± 2	18 ± 3
10/04/93	14 ± 2 (b)	14 ± 2	17 ± 2	14 ± 2	14 ± 2	14 ± 2	14 ± 2	13 ± 2	16 ± 2	16 ± 2	15 ± 3
Quarterly Avg.	17 ± 6	15 ± 5	17 ± 9	16 ± 8	17 ± 8	16 ± 7	16 ± 7	16 ± 8	17 ± 7	18 ± 8	17 ± 2

(a) Low sample volume; unit replaced.
(b) Power failure; low sample volume. Not included in averages.
(c) Total pCi and not included in averages. No measurable sample volume.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
OCTOBER											
10/11/93	22 ± 2	22 ± 2	21 ± 2	20 ± 2	22 ± 2	22 ± 2	22 ± 2	22 ± 2	20 ± 2	22 ± 2	22 ± 2
10/18/93	20 ± 2	19 ± 2	22 ± 2	20 ± 2	21 ± 2	20 ± 2	21 ± 2	18 ± 2	19 ± 2	18 ± 2	20 ± 3
10/25/93	24 ± 2	27 ± 2	23 ± 2	26 ± 2	23 ± 2	23 ± 2	26 ± 2	27 ± 2	26 ± 2	23 ± 2	25 ± 4
11/01/93	10 ± 2	12 ± 2	14 ± 2	16 ± 2	11 ± 2	11 ± 2	13 ± 2	11 ± 2	11 ± 2	12 ± 2	12 ± 4
NOVEMBER											
11/08/93	20 ± 2	18 ± 2	22 ± 2	20 ± 2	< 1 (a)	< 1 (a)	19 ± 2	20 ± 2	19 ± 2	21 ± 2	20 ± 3
11/15/93	27 ± 2	29 ± 2	30 ± 2	27 ± 2	31 ± 3	28 ± 3	28 ± 2	33 ± 3	29 ± 2	29 ± 2	29 ± 4
11/22/93	19 ± 2	19 ± 2	20 ± 2	20 ± 2	24 ± 2	22 ± 2	25 ± 2	23 ± 2	22 ± 2	20 ± 2	21 ± 4
11/29/93	26 ± 2	30 ± 3	31 ± 3	31 ± 3	35 ± 3	29 ± 2	31 ± 3	30 ± 3	31 ± 3	21 ± 2	30 ± 7
DECEMBER											
12/06/93	30 ± 2	28 ± 2	33 ± 2	32 ± 2	36 ± 3	33 ± 3	29 ± 2	32 ± 2	35 ± 3	29 ± 2	32 ± 5
12/13/93	21 ± 2	19 ± 2	24 ± 2	21 ± 2	22 ± 2	21 ± 2	22 ± 2	24 ± 2	22 ± 2	22 ± 2	22 ± 3
12/20/93	27 ± 2	21 ± 2	22 ± 2	22 ± 2	28 ± 2	22 ± 2	22 ± 2	20 ± 2	23 ± 2	18 ± 2	23 ± 6
12/27/93	26 ± 2	20 ± 2	21 ± 2	20 ± 2	24 ± 2	20 ± 2	22 ± 2	25 ± 2	26 ± 2	22 ± 2	23 ± 5
Quarter Avg.	23 ± 11	22 ± 11	24 ± 11	23 ± 10	25 ± 14	23 ± 11	23 ± 10	24 ± 13	24 ± 13	21 ± 9	23 ± 2
Annual Avg.	18 ± 12	17 ± 12	19 ± 12	17 ± 11	18 ± 14	17 ± 12	17 ± 12	18 ± 13	18 ± 13	18 ± 10	18 ± 12

(a) Power [illegible]: results in total PCi and not included in averages.

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 12/28/92-03/29/93	Second Quarter 03/29/93-06/28/93	Third Quarter 06/28/93-09/27/93	Fourth Quarter 09/27/93-01/03/94	Average ± 2 s.d.
A-1	Be-7	130 ± 13	110 ± 11	111 ± 11	126 ± 13	119 ± 20
	K-40	4.27 ± 2.42	< 7	< 9	< 4	4.27 ± 2.42
	Cs-134	< 0.2	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.3	< 0.3	-
A-2	Be-7	87.3 ± 8.7	101 ± 10	113 ± 11	106 ± 11	102 ± 22
	K-40	< 6	< 10	11.5 ± 3.5	4.52 ± 2.13	8.01 ± 9.87
	Cs-134	< 0.3	< 0.3	< 0.6	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.6	< 0.2	-
A-3	Be-7	96.2 ± 9.6	137 ± 14	137 ± 14	119 ± 12	122 ± 39
	K-40	< 7	< 4	< 5	< 10	-
	Cs-134	< 0.4	< 0.2	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.3	-
A-4	Be-7	90.4 ± 9.0	97.4 ± 9.7	146 ± 15	125 ± 13	115 ± 51
	K-40	< 5	< 7	< 5	< 4	-
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.4	< 0.3	< 0.3	< 0.2	-
A-5	Be-7	106 ± 11	116 ± 12	134 ± 13	120 ± 12	119 ± 23
	K-40	< 5	< 5	6.07 ± 2.18	32.2 ± 3.5	19.1 ± 37.0
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.4	< 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} $pCi/m^3 \pm 2$ sigma

Stations	Nuclides	First Quarter 12/28/92-03/29/93	Second Quarter 03/29/93-06/28/93	Third Quarter 06/28/93-09/27/93	Fourth Quarter 09/27/93-01/03/94	Average ± 2 s.d.
A-6	Be-7	100 ± 10	102 ± 10	109 ± 11	149 ± 15	115 ± 46
	K-40	< 10	< 9	12.9 ± 2.8	< 6	12.9 ± 2.8
	Cs-134	< 0.4	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.4	< 0.3	< 0.3	< 0.3	-
Coloma	Be-7	104 ± 10	108 ± 11	111 ± 11	117 ± 12	110 ± 11
	K-40	4.62 ± 2.42	< 5	< 10	3.92 ± 2.22	4. 27 ± 0.99
	Cs-134	< 0.3	< 0.2	< 0.4	< 0.2	-
	Cs-137	< 0.3	< 0.4	< 0.3	< 0.2	-
Dowagiac	Be-7	83.2 ± 8.3	121 ± 12	108 ± 11	135 ± 13	112 ± 44
	K-40	5.91 ± 2.39	< 4	< 4	< 6	5.91 ± 2.39
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
New Buffalo	Be-7	99.5 ± 9.9	120 ± 12	113 ± 11	118 ± 12	113 ± 18
	K-40	< 5	< 5	< 9	< 5	-
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-
South Bend	Be-7	107 ± 11	116 ± 12	125 ± 13	110 ± 11	115 ± 16
	K-40	< 4	< 7	< 4	4.93 ± 2.23	4.93 ± 2.23
	Cs-134	< 0.3	< 0.4	< 0.2	< 0.3	-
	Cs-137	< 0.2	< 0.3	< 0.2	< 0.3	-

Typical LLDs are found in Table B-12. All other gamma emi[illegible]ere <LLD.

TABLE B-3

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
JANUARY 93										
01/04/93	< 20	< 20	< 20	< 20	< 7	< 10	< 10	< 10	< 8	< 10
01/11/93	< 10	< 10	< 10	< 10	< 9	< 10	< 9	< 9	< 7	< 9
01/18/93	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 8	< 10
01/25/93	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 8	< 20
02/01/93	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 8	< 10
FEBRUARY										
02/08/93	< 10	< 10	< 10	< 10	< 6	< 20	< 20	< 20	< 10	< 20
02/15/93	< 10	< 10	< 10	< 10	< 5 (a)	< 20	< 20	< 20	< 10	< 20
02/22/93	< 10	< 10	< 10	< 10	< 6	< 10	< 10	< 10	< 8	< 10
03/01/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
MARCH										
03/08/93	< 20	< 9 (a)	< 20	< 20	< 8	< 9	< 9	< 9	< 9	< 6
03/15/93	< 10	(b)	< 10	< 10	< 10	< 10	< 9	< 9	< 9	< 9
03/22/93	< 10	(b)	< 10	< 10	< 10	< 6	< 20	< 20	< 20	< 20
03/29/93	< 10	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 10	< 20

(a) Power failure; results in total pCi.
(b) Power failure; sample unavailable.

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
APRIL										
04/05/93	< 10	< 10	< 10	< 10	< 6	< 20	< 20	< 20	< 10	< 20
04/12/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
04/19/93	< 10	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 10	< 20
04/26/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
05/03/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 7 (a)	< 20
MAY										
05/10/93	< 20	< 20	< 20	< 20	< 9	< 20	< 20	< 20	< 10	< 20
05/17/93	< 10	< 10	< 10	< 10	< 7	< 10	< 10	< 10	< 8	< 10
05/24/93	< 20	< 20	< 20	< 20	< 4 (a)	< 9	< 8	< 8	< 5	< 9
05/31/93	< 10	< 10	< 10	< 10	< 8	< 9	< 9	< 10	< 7	< 10
JUNE										
06/07/93	< 30	< 10	< 10	< 20	< 9	< 20	< 20	< 20	< 10 (b)	< 20
06/14/93	< 10	< 10	< 10	< 10	< 8	< 10	< 10	< 10	< 8 (b)	< 10
06/21/93	< 20	< 20	< 20	< 20	< 10	< 10	< 20	< 10	< 10	< 20
06/28/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20

(a) Po[illegible]lure; results in total pCi.
(b) P[illegible]lure; low volume.

T[illegible]B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
JULY										
07/05/93	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
07/12/93	< 10	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 10	< 20
07/19/93	< 10	< 10	< 10	< 10	< 6	< 20	< 20	< 20	< 10	< 20
07/26/93	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 30 (a)	< 10	< 20
08/02/93	< 20	< 100 (b)	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
AUGUST										
08/09/93	< 10	< 40 (b)	< 10	< 10	< 8	< 10	< 10	< 10	< 7	< 10
08/16/93	< 60 (b)	< 500 (b)	< 10	< 10	< 8	< 10	< 10	< 10	< 9	< 10
08/23/93	< 20	< 60 (b)	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
08/30/93	< 20	< 8 (d)	< 300 (c)	< 20	< 10	< 20	< 20	< 20	< 10	< 20
SEPTEMBER										
09/06/93	< 20	< 20	< 7	< 20	< 20	< 10	< 10	< 10	< 7	< 10
09/13/93	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 8	< 10
09/20/93	< 50 (b)	< 20	< 20	< 20	< 7	< 10	< 20	< 20	< 9	< 20
09/27/93	< 10	< 9 (c)	< 20	< 20	< 6	< 10	< 10	< 10	< 9	< 10
10/04/93	< 10 (b)	< 10	< 10	< 10	< 6	< 10	< 10	< 10	< 8	< 10

(a) Low sample volume: unit replaced.
(b) Power failure: low sample volume. LLD could not be met.
(c) Total pCi. LLD could not be met due to no measurable 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

COLLECTION DATES	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
					STATION CODES					
OCTOBER										
10/11/93	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
10/18/93	< 20	< 20	< 20	< 20	< 7	< 20	< 10	< 20	< 9	< 20
10/25/93	< 10	< 10	< 10	< 10	< 9	< 9	< 10	< 10	< 7	< 10
11/01/93	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
NOVEMBER										
11/08/93	< 20	< 20	< 20	< 20	< 5 (a)	< 10 (a)	< 20	< 20	< 20	< 20
11/15/93	< 10	< 10	< 10	< 10	< 10	< 30	< 20	< 20	< 10	< 20
11/22/93	< 10	< 10	< 10	< 10	< 6	< 8	< 8	< 8	< 6	< 8
11/29/93	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 10	< 20
DECEMBER										
12/06/93	< 10	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 7	< 20
12/13/93	< 20	< 20	< 20	< 20	< 7	< 8	< 8	< 8	< 6	< 8
12/20/93	< 10	< 10	< 10	< 10	< 8	< 20	< 20	< 20	< 10	< 20
12/27/93	< 20	< 20	< 20	< 20	< 10	< 20	< 10	< 10	< 9	< 10

(a) Pow[illegible]tage; results in total pCi.

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 01/03/93-04/04/93	SECOND QUARTER 04/04/93-07/11/93	THIRD QUARTER 07/11/93-10/03/93	FOURTH QUARTER 10/03/93-01/02/94	AVERAGE ± 2 s.d.
A-1	2.8 ± 0.1	4.0 ± 0.0	3.4 ± 0.4	5.9 ± 2.8	4.0 ± 2.7
A-2	3.1 ± 0.3	4.2 ± 0.6	3.4 ± 0.5	4.5 ± 0.4	3.8 ± 1.3
A-3	2.4 ± 0.1	3.6 ± 0.3	2.9 ± 0.4	4.1 ± 0.6	3.3 ± 1.5
A-4	3.1 ± 0.2	4.3 ± 0.4	3.6 ± 0.2	4.6 ± 0.4	3.9 ± 1.4
A-5	2.9 ± 0.2	4.2 ± 0.2	3.1 ± 1.0	4.7 ± 0.9	3.7 ± 1.7
A-6	2.7 ± 0.1	4.7 ± 0.9	3.2 ± 0.6	4.2 ± 0.3	3.7 ± 1.8
A-7	3.1 ± 0.5	4.7 ± 0.5	3.6 ± 0.4	4.5 ± 0.6	4.0 ± 1.5
A-8	3.1 ± 0.3	4.5 ± 0.4	3.3 ± 0.6	4.6 ± 0.5	3.9 ± 1.6
A-9	3.1 ± 0.2	4.0 ± 0.5	3.6 ± 0.5	4.7 ± 0.4	3.9 ± 1.4
A-10	2.5 ± 0.2	4.1 ± 0.7	3.0 ± 0.6	3.9 ± 0.5	3.4 ± 1.5
A-11	3.2 ± 0.3	4.7 ± 0.9	3.7 ± 0.7	4.6 ± 0.4	4.1 ± 1.4
A-12	3.2 ± 0.2	4.6 ± 0.8	3.8 ± 0.6	4.4 ± 1.8	4.0 ± 1.3
OFS-1	3.0 ± 0.5	4.8 ± 0.9	3.6 ± 0.7	4.2 ± 0.5	3.9 ± 1.5
OFS-2	3.2 ± 0.3	4.9 ± 0.9	3.7 ± 0.7	4.6 ± 0.3	4.1 ± 1.6
OFS-3	3.1 ± 0.4	5.1 ± 0.6	3.7 ± 0.6	4.7 ± 0.9	4.2 ± 1.8
OFS-4	3.6 ± 0.5	5.0 ± 0.4	4.3 ± 0.8	(b)	4.3 ± 1.4
OFS-5	3.4 ± 0.2	4.6 ± 0.4	3.8 ± 0.6	4.6 ± 0.4	4.1 ± 1.2
OFS-6	3.9 ± 0.4	(a)	4.3 ± 1.0	5.5 ± 0.3	4.6 ± 1.7
OFS-7	3.1 ± 0.2	4.0 ± 0.3	3.5 ± 0.3	4.4 ± 0.2	3.8 ± 1.1
OFS-8	3.7 ± 0.2	5.2 ± 0.2	4.2 ± 0.7	5.2 ± 0.3	4.6 ± 1.5
OFS-9	3.3 ± 0.2	4.6 ± 0.3	4.4 ± 2.2	4.9 ± 0.5	4.3 ± 1.4
OFS-10	3.0 ± 0.2	4.8 ± 0.5	3.6 ± 0.5	4.5 ± 0.4	4.0 ± 1.7
OFS-11	3.8 ± 0.2	5.1 ± 0.4	4.0 ± 0.8	5.3 ± 0.8	4.6 ± 1.5
NBF	2.9 ± 0.2	4.2 ± 0.8	3.4 ± 0.4	4.5 ± 0.8	3.8 ± 1.5
SBN	3.1 ± 0.2	5.0 ± 0.8	3.8 ± 0.3	4.8 ± 0.4	4.2 ± 1.8
DOW	2.7 ± 0.4	4.0 ± 0.4	2.9 ± 0.6	4.1 ± 0.2	3.4 ± 1.5
COL	2.7 ± 0.3	4.0 ± 0.3	3.1 ± 0.6	4.2 ± 0.4	3.5 ± 1.4
Average ± 2 s.d.	3.1 ± 0.7	4.5 ± 0.9	3.6 ± 0.8	4.6 ± 0.9	3.9 ± 1.5

(a) TLD missing along with pole it was attached to.
(b) TLD missing.
* 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
L-1 (Condenser Circ.)	01/07/93	< 0.3	< 70	150 ± 80
	02/04/93	< 0.2	< 100	
	03/04/93	< 0.7	< 70	
	04/01/93	< 0.4	< 60	< 200
	04/29/93	< 0.3	< 100	
	05/27/93	< 0.1	< 60	
	06/24/93	< 0.2	< 80	
	07/22/93	< 0.4	< 60	< 100
	08/19/93	< 0.5	< 90	
	09/17/93	< 0.4	< 60	
	10/14/93	< 0.4	< 90	< 200
	11/11/93	< 0.4	< 90	
	12/09/93	< 0.4	< 60	
L-2 (South Comp)	01/07/93	< 0.3	< 50	190 ± 80
	02/04/93	< 0.2	< 70	
	03/04/93	< 0.6	< 70	
	04/01/93	< 0.5	< 50	< 200
	04/29/93	< 0.3	< 100	
	05/27/93	< 0.2	< 50	
	06/24/93	< 0.2	< 90	
	07/22/93	< 0.4	< 50	< 100
	08/19/93	< 0.4	< 90	
	09/17/93	< 0.4	< 50	
	10/14/93	< 0.4	< 60	< 200
	11/11/93	< 0.3	< 90	
	12/09/93	< 0.5	< 60	

* 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
L-3 (North Comp)	01/07/93	< 0.3	< 100	140 ± 80
	02/04/93	< 0.2	< 70	
	03/04/93	< 0.7	< 100	
	04/01/93	< 0.5	< 70	< 200
	04/29/93	< 0.3	< 200	
	05/27/93	< 0.2	< 70	
	06/24/93	< 0.2	< 80	
	07/22/93	< 0.4	< 60	170 ± 100
	08/19/93	< 0.4	< 50	
	09/17/93	< 0.3	< 90	
	10/14/93	< 0.4	< 100	< 200
	11/11/93	< 0.3	< 100	
	12/09/93	< 0.4	< 70	
L-4 (South 500)	01/07/93	< 0.3	< 100	190 ± 80
	02/06/93	< 0.2	< 100	
	03/04/93	< 0.6	< 50	
	04/01/93	< 0.5	< 50	< 200
	04/29/93	< 0.3	< 60	
	05/27/93	< 0.2	< 50	
	06/24/93	< 0.2	< 60	
	07/22/93	< 0.4	< 100	180 ± 100
	08/19/93	< 0.4	< 50	
	09/17/93	< 0.4	< 60	
	10/14/93	< 0.4	< 50	< 200
	11/11/93	< 0.3	< 60	
	12/09/93	< 0.5	< 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
L-5	01/07/93	< 0.2	< 100	< 100
(North 500)	02/04/93	< 0.2	< 70	
	03/04/93	< 0.8	< 40	
	04/01/93	< 0.6	< 60	< 200
	04/29/93	< 0.3	< 60	
	05/27/93	< 0.2	< 100	
	06/24/93	< 0.2	< 100	
	07/22/93	< 0.4	< 50	140 ± 100
	08/19/93	< 0.3	< 40	
	09/17/93	< 0.4	< 100	
	10/14/93	< 0.4	< 50	< 200
	11/11/93	< 0.4	< 50	
	12/09/93	< 0.5	< 100	

* 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 QUARTERLY GROUNDWATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	K-40	Tritium
Well - 1	01/31/93	< 0.1	< 50	< 100
	05/02/93	< 0.1	< 60	< 200
	08/01/93	< 0.2	< 50	< 100
	11/07/93	< 0.2	< 50	< 200
Well - 2	01/31/93	< 0.1	< 70	< 100
	05/02/93	< 0.1	< 90	< 200
	08/01/93	< 0.2	< 70	< 200
	11/07/93	< 0.2	< 60	< 200
Well - 3	01/31/93	< 0.2	< 100	< 200
	05/02/93	< 0.2	< 60	< 200
	08/01/93	< 0.2	58.8 ± 25.3	< 200
	11/07/93	< 0.2	< 80	< 200
Well - 4	02/03/93	< 0.2	< 50	< 100
	05/03/93	< 0.1	< 100	790 ± 140
	08/01/93	< 0.2	< 40	950 ± 130
	11/07/93	< 0.2	< 50	1200 ± 100
Well - 5	02/03/93	< 0.1	< 60	310 ± 80
	05/03/93	< 0.2	< 50	1000 ± 100
	08/01/93	< 0.2	< 50	860 ± 130
	11/07/93	< 0.2	< 50	580 ± 120
Well - 6	02/03/93	< 0.1	< 100	410 ± 80
	05/03/93	< 0.1	< 70	1100 ± 100
	08/01/93	< 0.2	< 50	1200 ± 120
	11/11/93	< 0.2	< 50	670 ± 120
Well - 7	01/31/93	< 0.2	< 70	650 ± 100
	05/02/93	< 0.1	< 70	400 ± 120
	08/01/93	< 0.2	< 60	340 ± 110
	11/11/93	< 0.2	< 100	< 100

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

TABLE B-6 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN QUARTERLY GROUNDWATER

Results in Units of pCi/liter ± 2 sigma

STATION	Collection Date	I-131	K-40	Tritium
Well - 8	01/31/93	< 0.1	< 50	330 ± 100
	05/02/93	< 0.1	< 40	< 200
	08/01/93	< 0.2	< 90	< 100
	11/07/93	< 0.2	< 60	< 200
Well - 9	01/31/93	< 0.1	< 40	< 100
	05/02/93	< 0.1	< 100	< 200
	08/01/93	< 0.3	< 50	< 100
	11/07/93	< 0.3	< 50	< 200
Well - 10	01/31/93	< 0.1	< 60	< 100
	05/02/93	< 0.1	< 300	< 200
	08/01/93	< 0.2	< 40	< 100
	11/07/93	< 0.2	< 40	< 200
Well - 11	01/31/93	< 0.1	< 80	370 ± 100
	05/02/93	< 0.1	< 90	< 200
	08/01/93	< 0.2	< 80	< 200
	11/07/93	< 0.2	< 40	< 200
Well - 12	01/31/93	< 0.1	< 40	410 ± 100
	05/02/93	< 0.1	< 80	< 200
	08/01/93 (a)	< 0.2	< 80	< 100
	11/07/93	< 0.2	< 80	< 200
Well - 13	01/31/93	< 0.1	< 50	410 ± 100
	05/02/93	< 0.1	< 80	200 ± 120
	08/01/93	< 0.2	< 50	< 200
	11/07/93	< 0.2	< 70	170 ± 110
Well - 14	01/31/93	< 0.1	< 80	< 100
	05/03/93	< 0.1	< 100	480 ± 130
	08/01/93	< 0.2	< 40	950 ± 130
	11/11/93	< 0.2	< 100	1100 ± 100
Average ± 2 s.d.			58.8 ± 25.3	647 ± 670

(a) Thorium-228 was measured at 10.9 ± 3.2 pCi/liter.

* 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
Lake Township				
01/07/93	2.7 ± 0.9	< LLD	< 0.3	< 100
01/21/93	4.1 ± 1.0	< LLD	< 0.2	
02/04/93	3.7 ± 0.9	< LLD	< 0.5	
02/18/93	3.7 ± 0.9	< LLD	< 0.2	
03/04/93	3.6 ± 1.3	< LLD	< 0.3	
03/18/93	3.3 ± 1.0	< LLD	< 0.3	
04/01/93	3.3 ± 1.0	< LLD	< 0.4	< 100
04/15/93	2.0 ± 1.0	< LLD	< 0.2	
04/29/93	4.2 ± 1.3	< LLD	< 0.3	
05/13/93	3.2 ± 1.0	< LLD	< 0.3	
05/27/93	3.4 ± 1.1	< LLD	< 0.2	
06/10/93	3.3 ± 1.0	< LLD	< 0.3	
06/24/93	3.4 ± 1.0	< LLD	< 0.3	
07/08/93	4.2 ± 1.3	< LLD	< 0.3	< 200
07/22/93	3.6 ± 1.0	< LLD	< 0.2	
08/05/93	5.0 ± 1.1	< LLD	< 0.4	
08/19/93	2.9 ± 1.0	< LLD	< 0.3	
09/02/93	2.7 ± 1.0	< LLD	< 0.3	
09/16/93	3.0 ± 1.0	< LLD	< 0.3	
09/30/93	2.5 ± 1.0	< LLD	< 0.2	
10/14/93	3.5 ± 1.1	< LLD	< 0.3	< 100
10/28/93	3.6 ± 1.0	< LLD	< 0.3	
11/11/93	3.0 ± 1.0	< LLD	< 0.7	
11/25/93	4.2 ± 1.2	< LLD	< 0.3	
12/09/93	3.2 ± 1.0	< LLD	< 0.3	
12/23/93	2.8 ± 1.0	< LLD	< 0.2	
Average ± 2 s. d.	3.4 ± 1.3			

* 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
St. Joseph				
01/07/93	4.7 ± 1.0	< LLD	< 0.2	< 100
01/21/93	4.2 ± 1.0	< LLD	< 0.2	
02/04/93	4.9 ± 1.1	< LLD	< 0.4	
02/18/93	4.5 ± 1.0	< LLD	< 0.3	
03/04/93	3.6 ± 1.4	< LLD	< 0.4	
03/18/93	3.6 ± 1.1	< LLD	< 0.3	
04/01/93	3.2 ± 1.0	< LLD	< 0.3	< 100
04/15/93	3.5 ± 1.2	< LLD	< 0.3	
04/29/93	4.6 ± 1.4	< LLD	< 0.2	
05/13/93	2.5 ± 1.0	< LLD	< 0.3	
05/27/93	3.0 ± 1.1	< LLD	< 0.2	
06/10/93	2.5 ± 1.0	< LLD	< 0.3	
06/24/93	4.0 ± 1.1	< LLD	< 0.3	
07/08/93	4.1 ± 1.3	< LLD	< 0.4	< 200
07/22/93	3.8 ± 1.1	< LLD	< 0.2	
08/05/93	4.3 ± 1.1	< LLD	< 0.4	
08/19/93	4.0 ± 1.1	< LLD	< 0.2	
09/02/93	2.9 ± 1.1	< LLD	< 0.3	
09/16/93	4.7 ± 1.2	< LLD	< 0.3	
09/30/93	7.3 ± 1.5	< LLD	< 0.3	
10/14/93	3.1 ± 1.0	< LLD	< 0.4	< 100
10/28/93	4.5 ± 1.1	< LLD	< 0.3	
11/11/93	3.0 ± 1.0	< LLD	< 0.6	
11/25/93	3.7 ± 1.2	< LLD	< 0.4	
12/09/93	3.2 ± 1.0	< LLD	< 0.3	
12/23/93	4.6 ± 1.1	< LLD	< 0.2	
Average ± 2 s. d.	3.9 ± 2.0			

* 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
L-2	05/16/93	< 200	6930 ± 690	< 30	< 400	155 ± 24
L-3	05/16/93	< 100	6060 ± 610	< 20	< 300	96.5 ± 16.7
L-4	05/16/93	< 200	6870 ± 690	< 20	< 400	155 ± 28
L-5	05/16/93	< 200	5440 ± 540	< 20	< 400	107 ± 23
L-2	11/14/93	< 200	5570 ± 560	< 20	< 400	158 ± 30
L-3	11/14/93	< 200	3660 ± 400	< 30	< 600	103 ± 29
L-4	11/14/93	< 200	5230 ± 520	< 20	< 400	130 ± 28
L-5	11/14/93	< 200	5110 ± 510	< 30	< 400	124 ± 21
Average ± 2 s.d.			5609 ± 2106			129 ± 50

* 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 GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES					
		SHULER	TOTZKE	FREEHLING	WARMBEIN	LIVINGHOUSE	WYANT
01/08/93	K-40	1190 ± 120	1380 ± 140	1290 ± 130	1230 ± 120	1360 ± 140	1260 ± 130
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1
01/22/93	K-40	1280 ± 130	1410 ± 140	1260 ± 130	1450 ± 150	1290 ± 130	1230 ± 120
	I-131	< 0.2	< 0.2	< 0.2	< 0.3	< 0.2	< 0.2
02/05/93	K-40	1250 ± 130	1430 ± 140	1280 ± 130	1410 ± 140	1370 ± 140	1330 ± 130
	I-131	< 0.4	< 0.1	< 0.6	< 0.2	< 0.1	< 0.1
02/19/93	K-40	1080 ± 110	1460 ± 150	1400 ± 140	1540 ± 150	1220 ± 120	1120 ± 110
	I-131	< 0.2	< 0.2	< 0.1	< 0.2	< 0.1	< 0.4
03/05/93	K-40	1390 ± 140	1490 ± 150	1430 ± 140	1440 ± 140	1300 ± 130	1190 ± 120
	I-131	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2
03/19/93	K-40	1550 ± 150	1400 ± 140	1400 ± 140	1290 ± 130	1240 ± 120	1380 ± 140
	I-131	< 0.3	< 0.2	< 0.3	< 0.2	< 0.2	< 0.1
04/02/93	K-40	1320 ± 130	1530 ± 150	1200 ± 120	1370 ± 140	1340 ± 130	1140 ± 110
	I-131	< 0.2	< 0.3	< 0.2	< 0.2	< 0.2	< 0.2
04/16/93	K-40	1650 ± 160	1320 ± 130	1790 ± 180	1430 ± 140	1400 ± 140	1350 ± 140
	I-131	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
04/30/93	K-40	1190 ± 120	1410 ± 140	1430 ± 140	1320 ± 130	1400 ± 140	1180 ± 120
	I-131	< 0.1	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2

ypical 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 GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES					
		SHULER	TOTZKE	FREEHLING	WARMBEIN	LIVINGHOUSE	WYANT
05/14/93	K-40	1290 ± 130	1410 ± 140	1220 ± 120	1470 ± 150	1340 ± 130	1300 ± 130
	I-131	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
05/28/93	K-40	1280 ± 130	1320 ± 130	1370 ± 140	1240 ± 120	1410 ± 140	1330 ± 130
	I-131	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2
06/11/93	K-40	1160 ± 120	1530 ± 150	1450 ± 140	1450 ± 150	1260 ± 130	1290 ± 130
	I-131	< 0.2	< 0.1	< 0.3	< 0.3	< 0.2	< 0.2
06/25/93	K-40	1260 ± 130	1540 ± 150	1240 ± 120	1540 ± 150	1500 ± 150	1290 ± 130
	I-131	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2
07/09/93	K-40	1400 ± 140	1310 ± 130	1340 ± 130	1440 ± 140	1400 ± 140	1470 ± 150
	I-131	< 0.2	< 0.1	< 0.2	< 0.1	< 0.2	< 0.2
07/23/93	K-40	1290 ± 130	1450 ± 150	1230 ± 120	1420 ± 140	1380 ± 140	1280 ± 130
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1
08/06/93	K-40	1290 ± 130	1440 ± 140	1240 ± 120	1680 ± 170	1510 ± 150	1270 ± 130
	I-131	< 0.2	< 0.2	< 0.2	< 0.3	< 0.2	< 0.2
08/20/93	K-40	1260 ± 130	1540 ± 150	1240 ± 120	1370 ± 140	1610 ± 160	1250 ± 130
	I-131	< 0.2	< 0.2	< 0.5	< 0.2	< 0.3	< 0.2
09/03/93	K-40	1500 ± 150	1450 ± 150	1390 ± 140	1480 ± 150	1330 ± 130	1280 ± 130
	I-131	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
09/17/93	K-40	1380 ± 140	1240 ± 120	1200 ± 120	1320 ± 130	1360 ± 140	1460 ± 150
	I-131	< 0.1	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2

* 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 GAMMA EMITTERS* IN MILK

Results In Units of pCi/liter ± 2 sigma

COLLECTION DATES	ANALYSIS	STATION CODES SHULER	TOTZKE	FREEHLING	WARMBEIN	LIVINGHOUSE	WYANT
10/01/93	K-40 I-131	1290 ± 130 < 0.2	1630 ± 160 < 0.2	1360 ± 140 < 0.2	1390 ± 140 < 0.2	1380 ± 140 < 0.2	1330 ± 130 < 0.2
10/15/93	K-40 I-131	1380 ± 140 < 0.2	1440 ± 140 < 0.2	1410 ± 140 < 0.2	1430 ± 140 < 0.2	1440 ± 140 < 0.2	1490 ± 150 < 0.2
10/29/93	K-40 I-131	1630 ± 160 < 0.2	1580 ± 160 < 0.3	1290 ± 130 < 0.4	1490 ± 150 < 0.4	1290 ± 130 < 0.2	1430 ± 140 < 0.3
11/12/93	K-40 I-131	1480 ± 150 < 0.2	1500 ± 150 < 0.2	1450 ± 150 < 0.3	1460 ± 150 < 0.2	1290 ± 130 < 0.3	1260 ± 130 < 0.2
11/26/93	K-40 I-131	1450 ± 140 (a) < 0.7	1580 ± 160 < 0.1	1470 ± 150 < 0.1	1370 ± 140 < 0.2	1550 ± 150 < 0.2	1340 ± 130 < 0.2
12/10/93	K-40 I-131	1410 ± 140 < 0.2	1430 ± 140 < 0.2	1510 ± 150 < 0.2	1410 ± 140 < 0.2	1440 ± 140 < 0.2	1300 ± 130 < 0.2
12/24/93	K-40 I-131	1290 ± 130 < 0.3	1450 ± 150 < 0.2	1410 ± 140 < 0.2	1560 ± 160 < 0.2	1450 ± 140 < 0.2	1350 ± 130 < 0.2

ample spilled in transit.

* 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
06/23/93	OFS-South	Long Nose Sucker	< 300	2650 ± 400	< 40	< 500	< 50
06/23/93	ONS-South	Red Horse Carp/Sucker	< 200	2990 ± 380	< 30	< 500	< 40
06/23/93	ONS-North	Red Horse Carp	< 400	3520 ± 490	< 40	< 700	< 60
06/24/93	OFS-North	Long Nose Sucker/Perch	< 200	3870 ± 410	< 30	< 500	< 40
09/17/93	OFS-South	Whitefish	< 100	2520 ± 250	< 20	< 200	< 20
09/17/93	ONS-South		< 100	3440 ± 340	71.9 ± 12.3	< 200	< 20
09/17/93	ONS-North	Walleye/Sucker	< 200	3350 ± 340	58.6 ± 15.1	< 300	< 30
09/17/93	OFS-North	Whitefish/Walleye	< 200	3050 ± 300	74.3 ± 14.0	< 300	< 20
Average ± 2 s.d.				**3174 ± 913**	**68.3 ± 16.9**		

* 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
09/29/93	SECTOR-B	Grapes	807 ± 102	6460 ± 650	< 30	< 10
09/29/93	SECTOR-J	Grapes	131 ± 31	2640 ± 260	< 8	< 4
09/29/93	SECTOR-B	Grape Leaves	3480 ± 350	2200 ± 220	< 20	< 10
09/29/93	SECTOR-J	Grape Leaves	3980 ± 400	2320 ± 230	< 30	< 10
10/07/93	SECTOR-A	Broadleaf	1490 ± 190	1890 ± 230	< 40	< 20
Average ± 2 s.d.			1978 ± 3359	3102 ± 3793		

* 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

	TI LLD	Tech Spec LLD	Rept Level
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

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 du[illegible] 1993 on samples collected for the D.C. Cook Plant's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by Indiana Michigan and Teledyne Isotopes and include those recommended by the USNRC Regulatory Guide 4.8,BTP, Rev. 1, November 1979.

ANALYSIS TITLE	PAGE
Gross Beta Analysis of Air Particulate Samples	71
Gross Beta Analysis of Water Samples	72
Analysis of Samples for Tritium (Liquid Scintillation)	74
Analysis of Samples for Strontium-89 and -90	75
Total Water	75
Milk	75
Soil and Sediment	75
Organic Solids	[illegible]
Air Particulates	76
Analysis of Samples for Iodine-131	79
Milk or Water	79
Gamma Spectrometry of Samples	80
Milk and Water	80
Dried Solids other than Soils and Sediment	80
Fish	80
Soils and Sediments	80
Charcoal Cartridges (Air Iodine)	80
Airborne Particulates	81
Environmental Dosimetry	83

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:

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 STRONTIUM-89 AND -90

Water

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a minimum of 5 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Milk

Stable strontium carrier is added to 1 liter of sample and the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved in 3M HNO_3. This solution is passed through a crown ether extraction column to isolate elemental strontium. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Soil and Sediment

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrochloric acid. The mixture is filtered and strontium is precipitated from the liquid

portion as phosphate. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Organic Solids

A wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in hydrochloric acid. The sample is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(NO_3)$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a minimum of 5 days period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Air Particulates

Stable strontium carrier is added to the sample and it is leached in nitric acid to bring deposits into solution. The mixture is then filtered and the filtrate is reduced in volume by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide,

dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with 80 mg/cm^2 aluminum absorber for level beta counting.

Calculations of the results, two sigma errors and lower limits of detection (LLD) are expressed in activity of pCi/volume or pCi/mass:

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

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

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, 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:

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
	M_s	=	mass of PdI_2 on the standard mount, mg
	M	=	mass of PdI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

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

Dried Solids Other Than Soils and Sediments

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

Fish

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

Soils and Sediments

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

Charcoal Cartridges (Air Iodine)

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a Ge(Li) detector and up to four on the side of the Ge(Li) detector. Each Ge(Li) detector is calibrated for both positions. The detection limit for I-131 of each charcoal cartridge can be determined

(assuming no positive I-131) uniquely from the volume of air which passed through it. In the event I-131 is observed in the initial counting of a set, each charcoal cartridge is then counted separately, positioned on the face of the detector

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

Following the field exposure period the TLDs are placed in a Teledyne Isotopes Model 8300. One fourth of the rectangular TLD is heated at a time and the measured light emission (luminescence) is recorded. The TLD is then annealed and exposed to a known Cs-137 dose; each area is then read again. This provides a calibration of each area of each TLD after every field use. The transit controls are read in the same manner.

Calculations of results and the two sigma error in net milliRoentgen (mR):

RESULT $D = (D_1+D_2+D_3+D_4)/4$

TWO SIGMA ERROR = $2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$

WHERE:

	D_1	=	the net mR of area 1 of the TLD, and similarly for D_2, D_3, and D_4
	D1	=	$I_1 K/R_1 - A$
	I_1	=	the instrument reading of the field dose in area 1
	K	=	the known exposure by the Cs-137 source
	R_1	=	the instrument reading due to the Cs-137 dose on area 1
	A	=	average dose in mR, calculated in similar manner as above, of the transit control TLDs
	D	=	the average net mR of all 4 areas of the TLD.

APPENDIX D
SUMMARY OF EPA INTERLABORATORY COMPARISONS

EPA INTERLABORATORY COMPARISON PROGRAM

Teledyne Isotopes participates in the 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 1993 data summary tables are presented for isotopes in the various sample media applicable to the Donald C. Cook 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 1993
Environmental

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Isotopes Result(b)	Deviation(c)	
01/15/93	Water	Sr-89	15.0 ± 5.0	12.67 ± 1.15	-0.81	
		Sr-90	10.0 ± 5.0	8.33 ± 1.15	-0.58	
01/29/93	Water	Gr-Alpha	34.0 ± 9.0	17.33 ± 1.15	-3.21	(d)
		Gr-Beta	44.0 ± 5.0	52.00 ± 1.00	2.77	(e)
02/05/93	Water	I-131	100.0 ± 10.0	106.67 ± 5.77	1.15	
03/05/93	Water	Ra-226	9.8 ± 1.5	7.67 ± 0.12	-2.46	(f)
		Ra-228	18.5 ± 4.6	19.33 ± 2.31	0.31	
04/20/93	Water	Gr-Alpha	95.0 ± 24.0	94.33 ± 1.15	-0.05	
		Ra-226	24.9 ± 3.7	19.00 ± 1.00	-2.76	(f)
		Ra-228	19.0 ± 4.8	18.33 ± 0.58	-0.24	
		Gr-Beta	177.0 ± 27.0	150.0 ± 0.00	-1.73	
		Sr-89	41.0 ± 5.0	35.33 ± 1.53	-1.96	
		Sr-90	29.0 ± 5.0	27.33 ± 0.58	-0.58	
		Co-60	39.0 ± 5.0	40.67 ± 3.51	0.58	
		Cs-134	27.0 ± 5.0	23.67 ± 1.53	-1.15	
		Cs-137	32.0 ± 5.0	34.33 ± 2.08	0.81	
06/04/93	Water	H-3	9844.0 ± 984.0	9366.67 ± 152.75	-0.84	
06/11/93	Water	Co-60	15.0 ± 5.0	16.33 ± 1.53	0.46	
		Zn-65	103.0 ± 10.0	121.33 ± 20.09	3.18	(g)
		Ru-106	119.0 ± 12.0	106.33 ± 15.89	-1.83	
		Cs-134	5.0 ± 5.0	5.67 ± 0.58	0.23	
		Cs-137	5.0 ± 5.0	6.67 ± 0.58	0.58	
		Ba-133	99.0 ± 10.0	104.33 ± 9.29	0.92	
07/16/93	Water	Sr-89	34.0 ± 5.0	31.67 ± 2.52	-0.81	
		Sr-90	25.0 ± 5.0	24.00 ± 0.00	-0.35	
07/23/93	Water	Gr-Alpha	15.0 ± 5.0	18.67 ± 2.08	1.27	
		Gr-Beta	43.0 ± 6.9	42.67 ± 2.52	-0.08	
08/27/93	Air Filter	Gr-Alpha	19.0 ± 5.0	17.00 ± 0.00	-0.69	
		Gr-Beta	47.0 ± 5.0	49.00 ± 1.73	0.69	
		Sr-90	19.0 ± 5.0	17.67 ± 0.58	-0.46	
		Cs-137	9.0 ± 5.0	9.67 ± 0.58	0.23	
09/09/93	Water	Ra-226	14.9 ± 2.2	15.33 ± 0.58	0.34	
		Ra-228	20.4 ± 5.1	20.67 ± 1.15	0.09	

EPA INTERLABORATORY COMPARISON PROGRAM 1993
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Isotopes Result(b)			
09/24/93	Milk	Sr-89	30.0 ±	5.0	35.67 ±	3.51	1.96	
		Sr-90	25.0 ±	5.0	24.00 ±	1.73	-0.35	
		I-131	120.0 ±	12.0	126.67 ±	5.77	0.96	
		Cs-137	49.0 ±	5.0	50.67 ±	1.15	0.58	
		K	1679.0 ±	84.0	1620.00 ±	17.32	-1.22	
10/08/93	Water	I-131	117.0 ±	12.0	103.33 ±	5.77	-1.97	
10/19/93	Water	Gr-Beta	58.0 ±	10.0	51.33 ±	3.21	-1.15	
		Sr-89	15.0 ±	5.0	15.00 ±	1.00	0.00	
		Sr-90	10.0 ±	5.0	10.00 ±	0.00	0.00	
		Co-60	10.0 ±	5.0	12.00 ±	1.00	0.69	
		Cs-134	12.0 ±	5.0	9.00 ±	1.00	-1.04	
		Cs-137	10.0 ±	5.0	12.67 ±	2.52	0.92	
		Gr-Alpha	40.0 ±	10.0	39.67 ±	0.58	-0.06	
		Ra-226	9.9 ±	1.5	10.10 ±	0.79	0.23	
		Ra-228	12.5 ±	3.1	14.67 ±	1.15	1.21	
10/29/93	Water	Gr-Alpha	20.0 ±	5.0	20.33 ±	2.08	0.12	
		Gr-Beta	15.0 ±	5.0	15.67 ±	2.08	0.23	
[illegible]/5/93	Water	H-3	7398.0 ±	740.0	6900.00 ±	100.00	-1.17	
11/12/93	Water	Co-60	30.0 ±	5.0	28.67 ±	2.89	-0.46	
		Zn-65	150.0 ±	15.0	152.00 ±	9.17	0.23	
		Ru-106	201.0 ±	20.0	177.33 ±	5.51	-2.05	(h)
		Cs-134	59.0 ±	5.0	53.33 ±	4.93	-1.96	
		Cs-137	40.0 ±	5.0	41.33 ±	3.06	0.46	
		Ba-133	79.0 ±	8.0	69.33 ±	3.06	-2.09	(i)

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 EPA switched from Am-241 to Th-230 alpha spike. We calibrated with Th-230, using sodium nitrate to generate a self-absorption curve. The EPA water, however has minerals which have greater self-absorption than the sodium nitrate matrix. The EPA has agreed to send us a gallon of their water which we can use to prepare a self-absorption curve with Th-230.

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Isotopes Result(b)

(e) By oversight, we did not use the special self-absorption curve which we had previously derived using EPA water and Cs-137 standard. We will use the EPA curve in the future. We may also re-derive this curve using a water sample which the EPA has agreed to send us.

(f) The counting data and backgrounds were verified. Possibly some efficiencies used were erroneously high, causing low values. A less likely cause is an error in dilution. New Ra-226 standards will be prepared. Closer monitoring of out of control efficiencies will be done and extra care in preparation of the sample will be maintained.

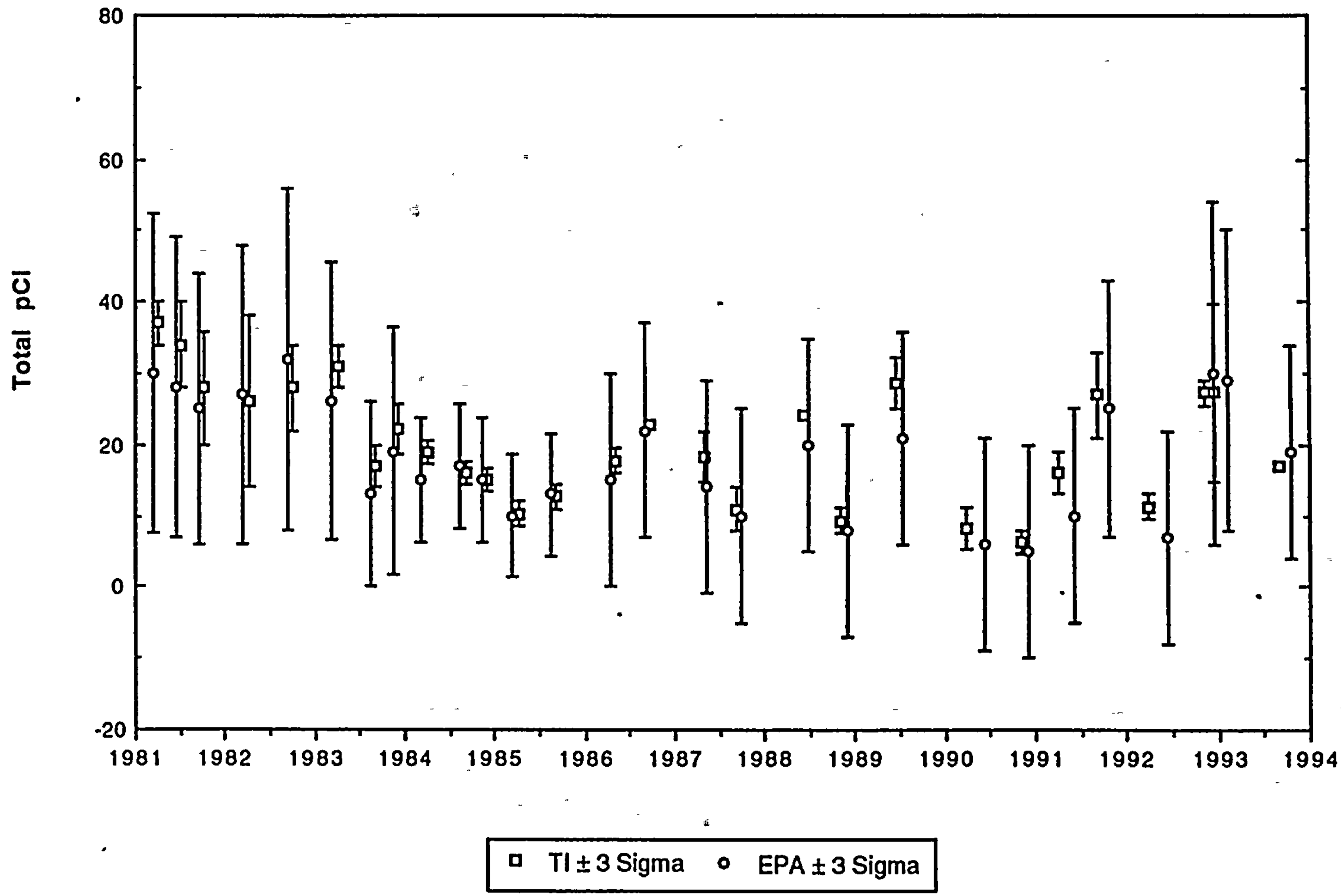
(g) The calculations were checked and found to be correct. The results of six gamma emitting isotopes were reported to the EPA. The results of four were within 1 normalized deviation; a fifth, within 2 normalized deviations. Only the Zn-65 average was outside the control limits. There is no obvious reason why one isotope should be outside the control limits, while five other isotopes were within control limits.

(h) Although the TI average (177.3) was 2.05 deviations low compared to the EPA value, the agreement was good with the average (175.2) of 173 participants. The data [illegible] reviewed for accuracy including half life and branching intensity used. No problems were found. No corrective action anticipated because of the good agreement with the average of all participants.

(i) No problems were found with the calculations. Three other isotopes were within 1 deviation, so it's unlikely that a general problem exists. If compared to the average of all participants, the TI results would undoubtedly be within 2 deviations. The Ba-137 results were within +1 deviation for the past two cross checks, thus there is not a trend. No corrective action anticipated at this time.

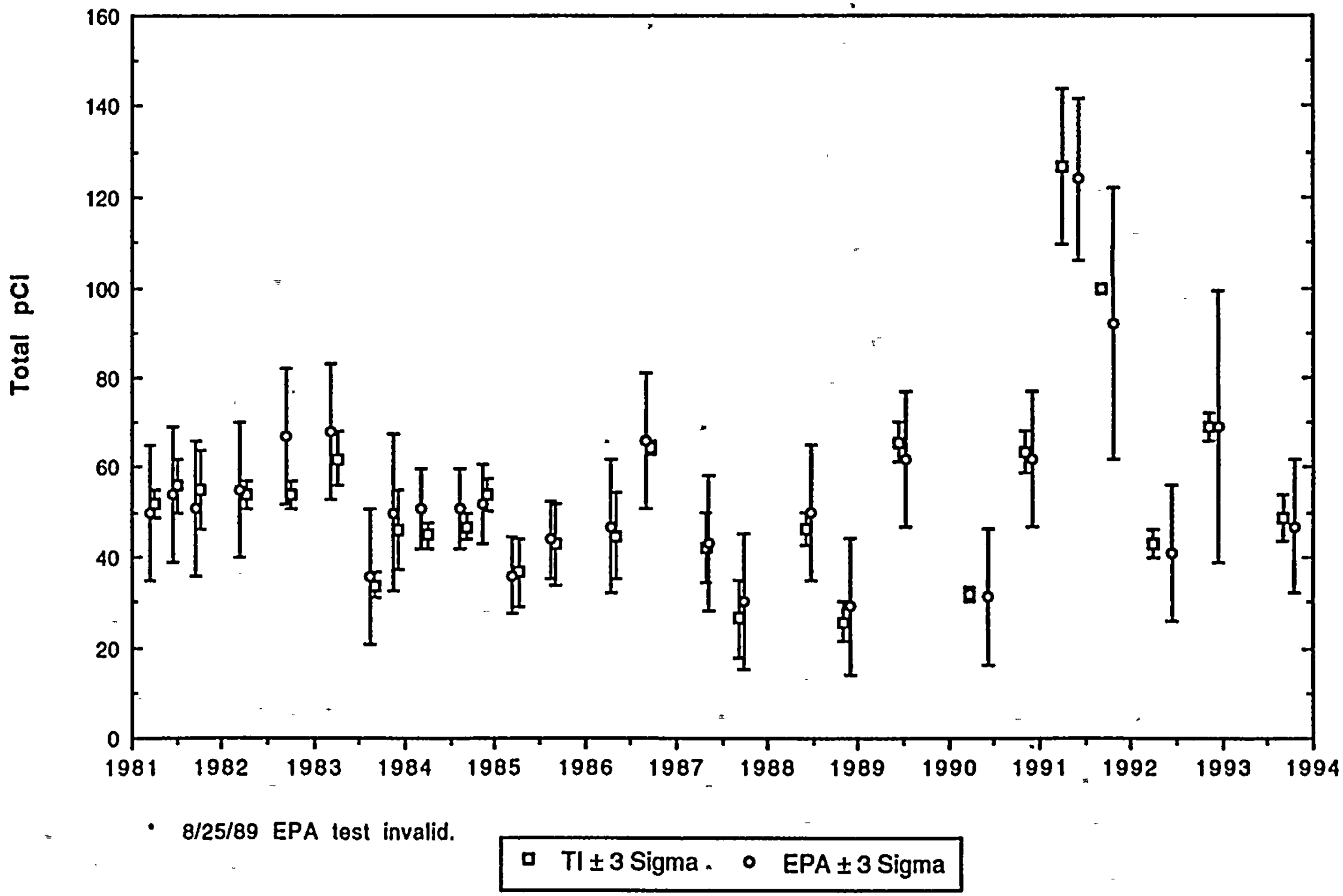
EPA CROSS CHECK PROGRAM

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



EPA CROSS CHECK PROGRAM

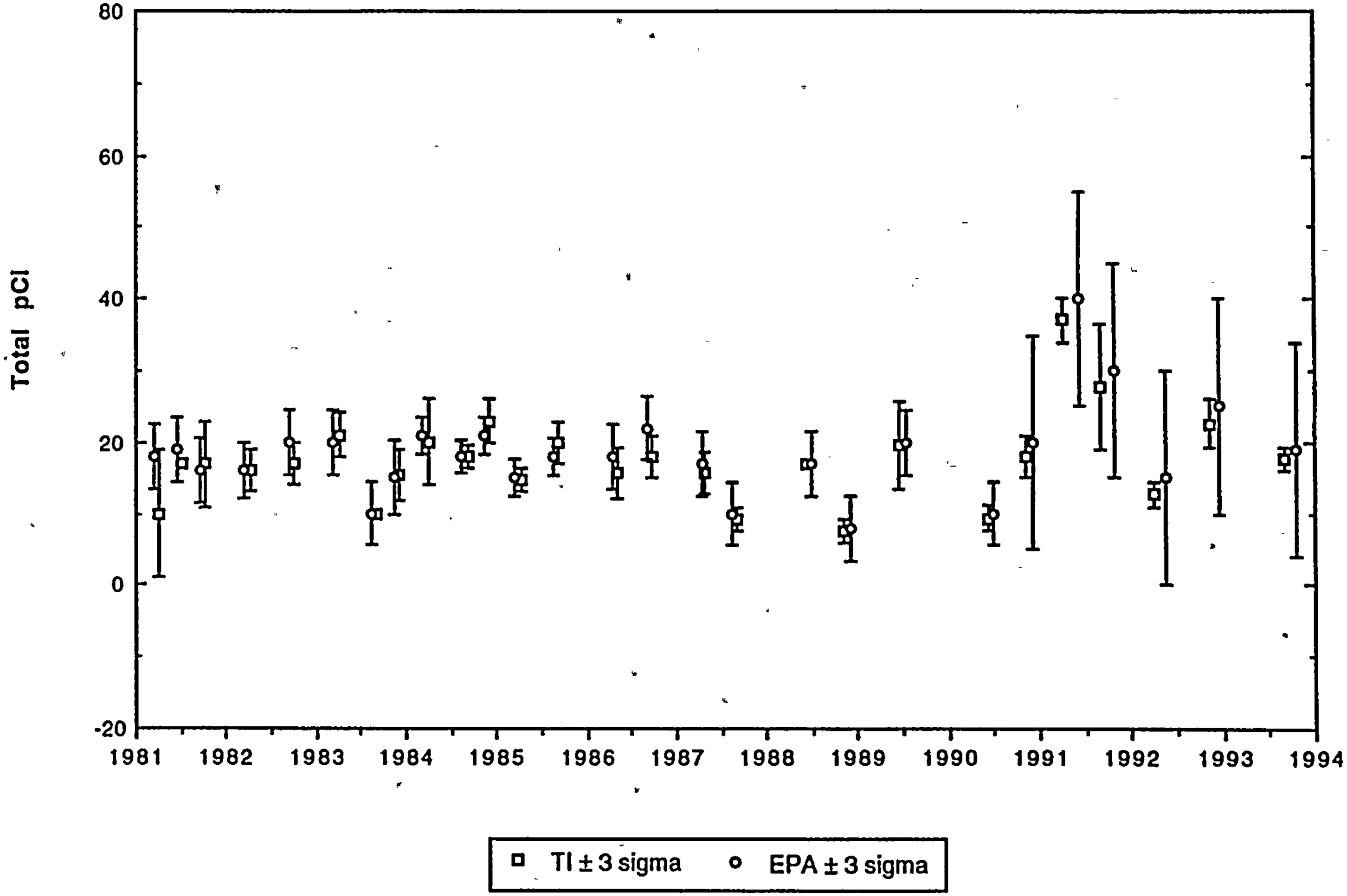
GROSS BETA IN AIR PARTICULATES (pg. 1 of 1)



* 8/25/89 EPA test invalid.

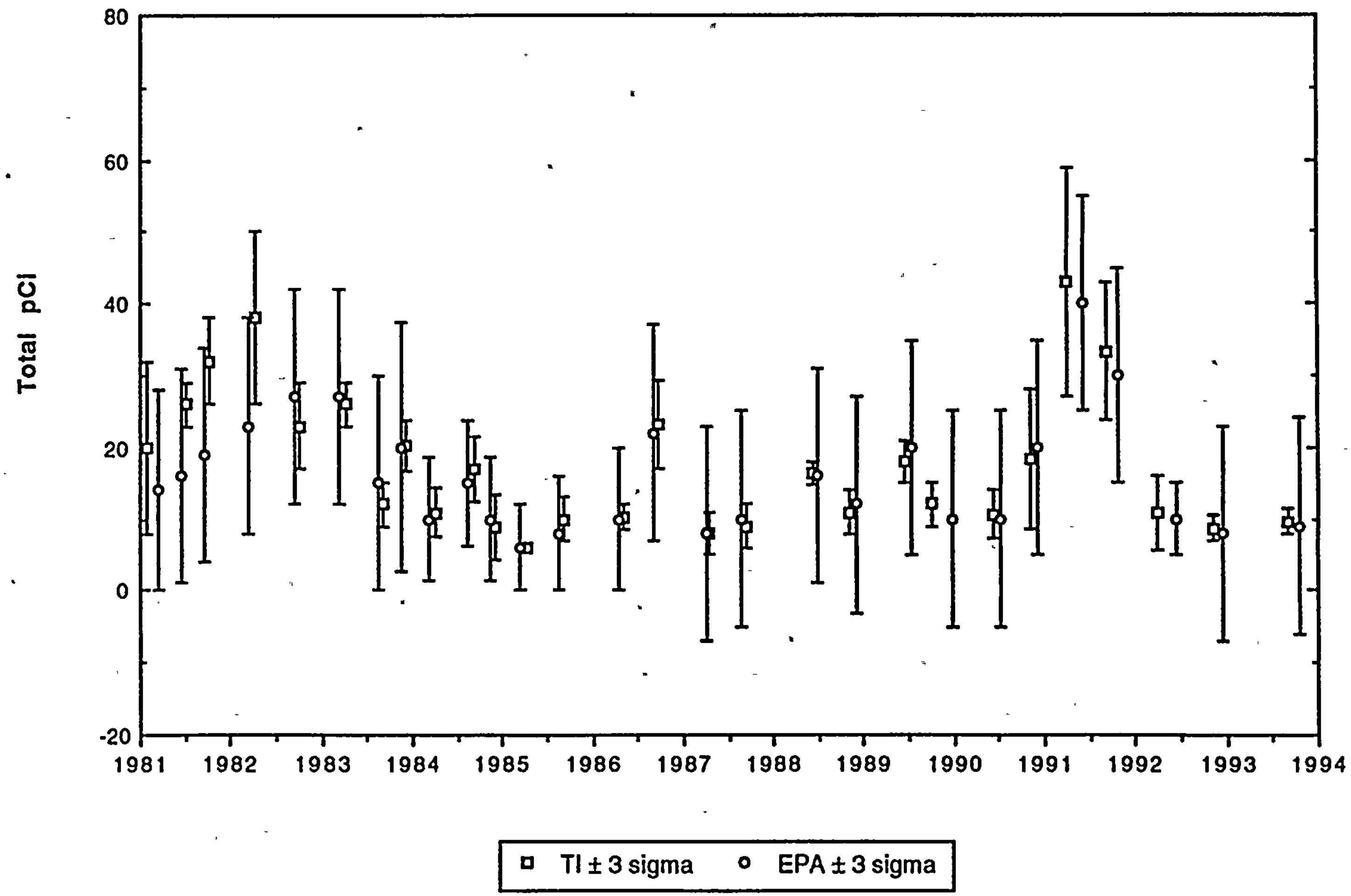
EPA CROSS CHECK PROGRAM

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



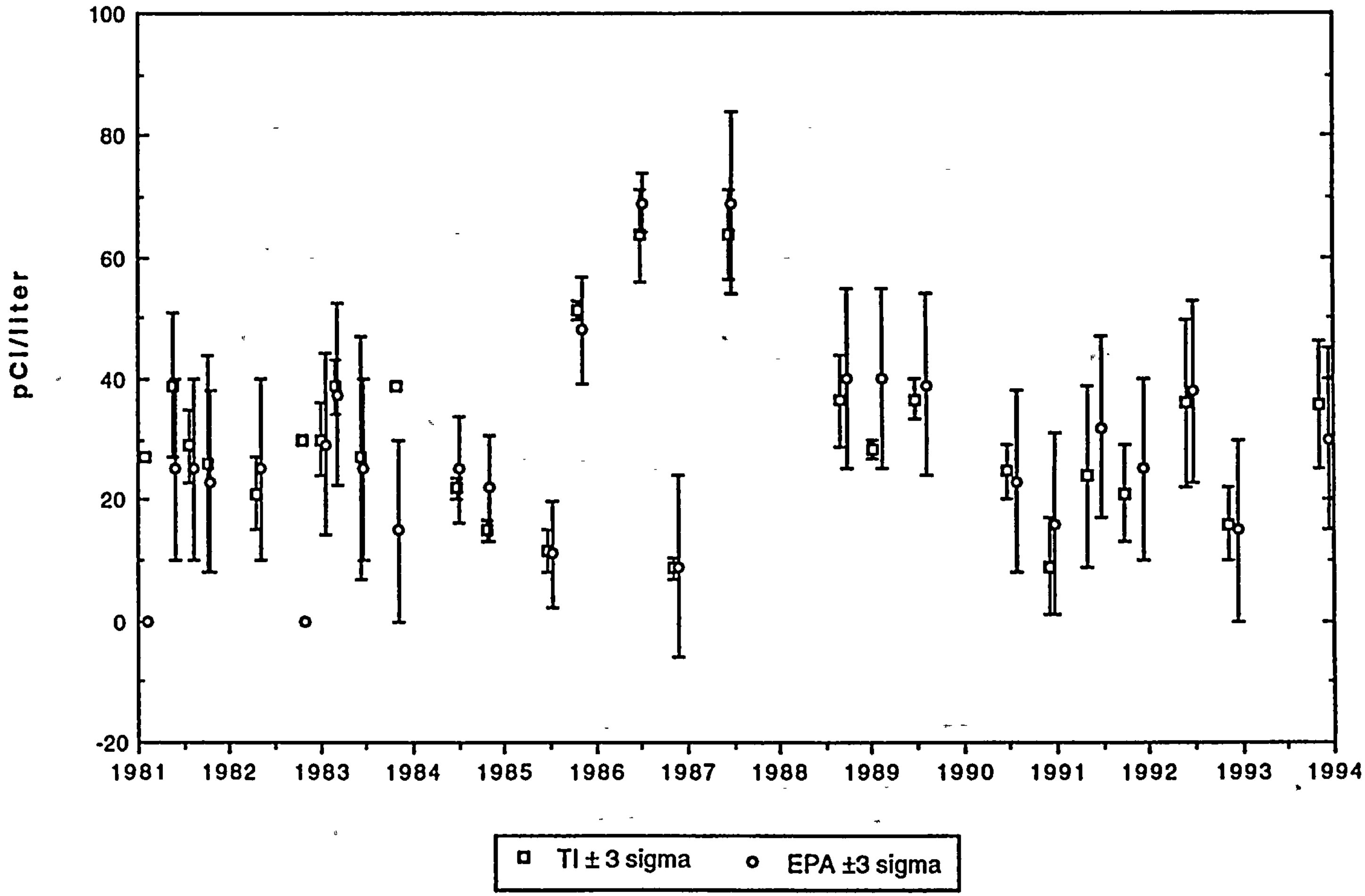
EPA CROSS CHECK PROGRAM

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



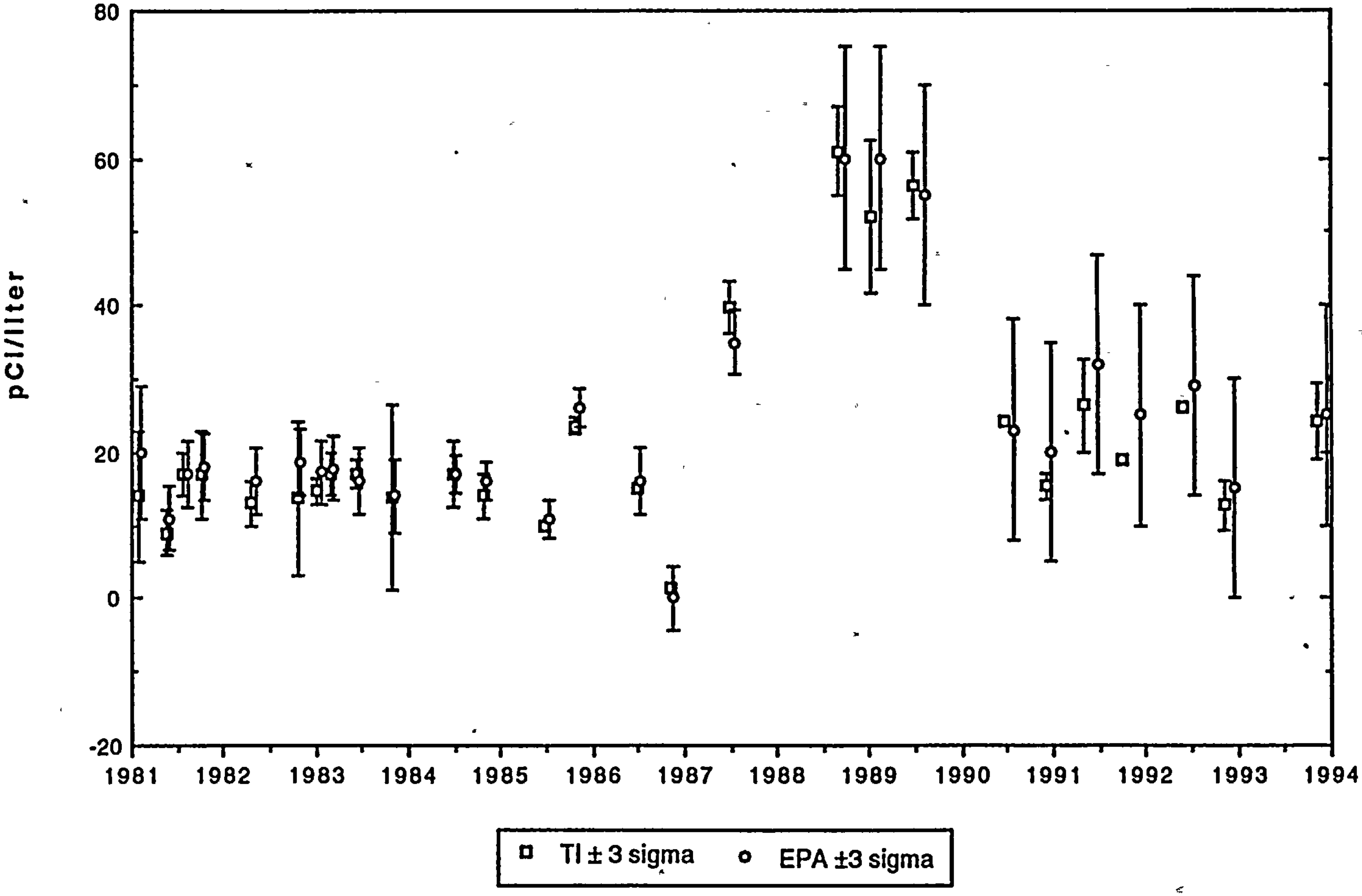
EPA CROSS CHECK PROGRAM

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



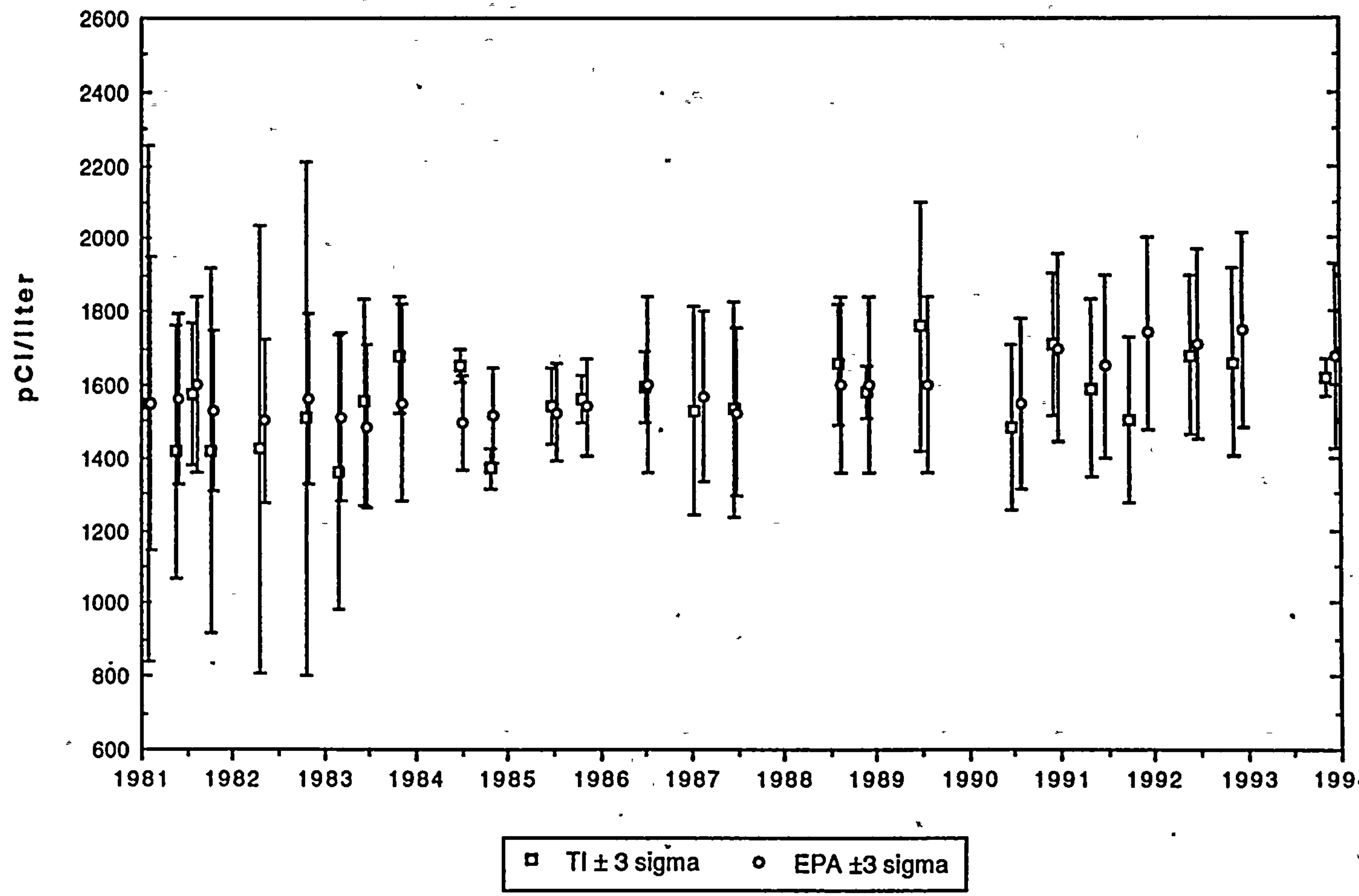
EPA CROSS CHECK PROGRAM

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

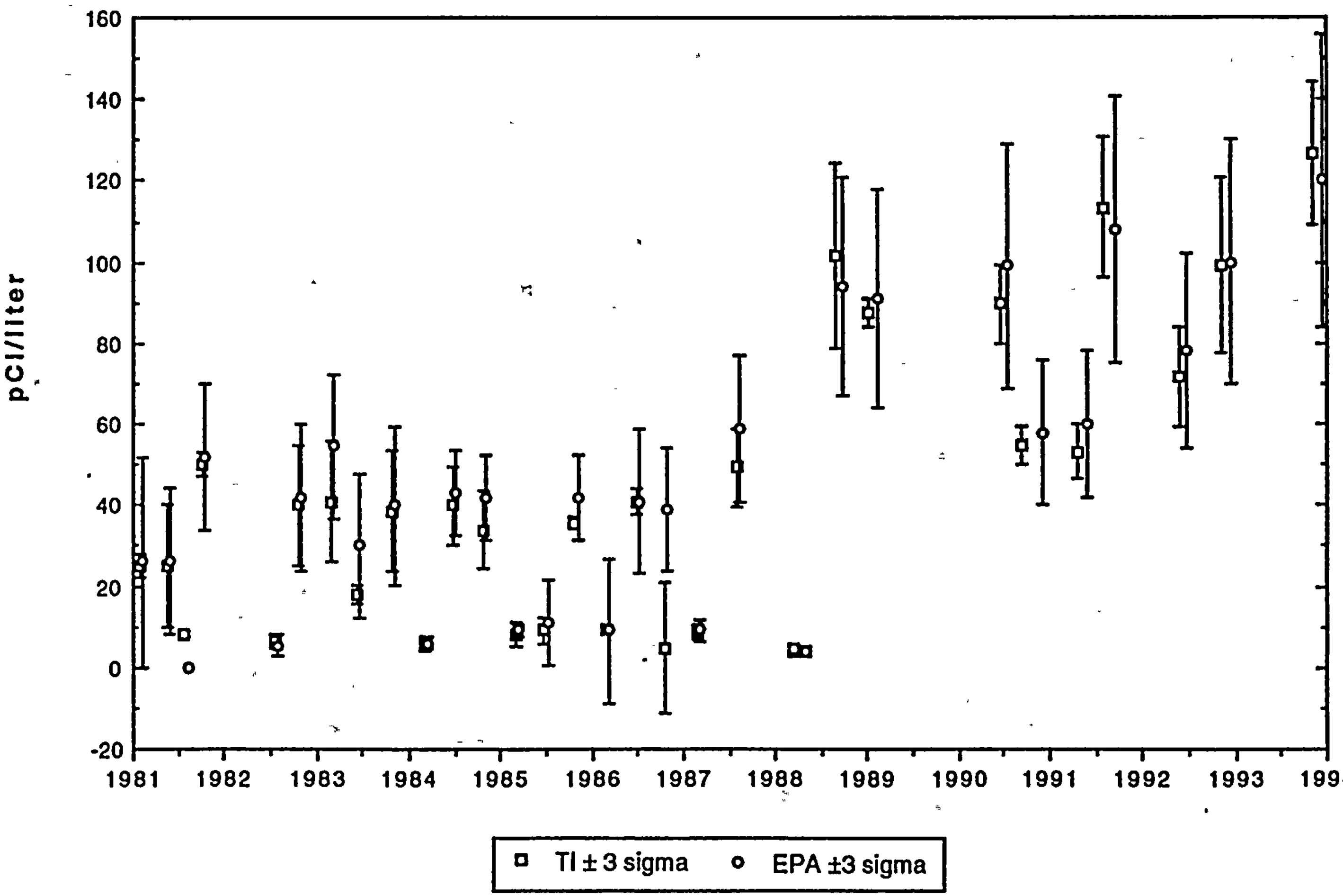


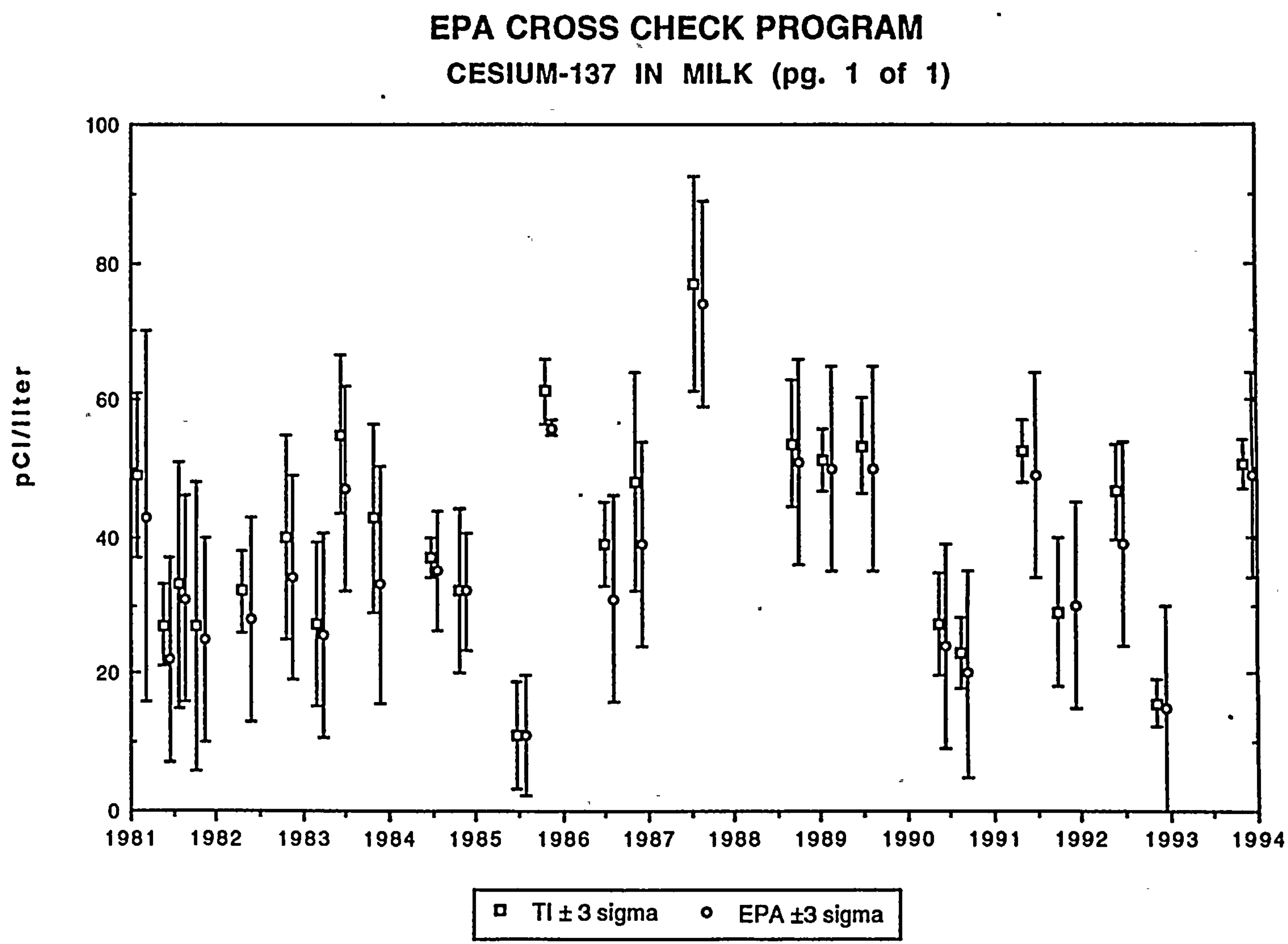
EPA CROSS CHECK PROGRAM

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



EPA CROSS CHECK PROGRAM
IODINE-131 IN MILK (pg. 1 of 1)

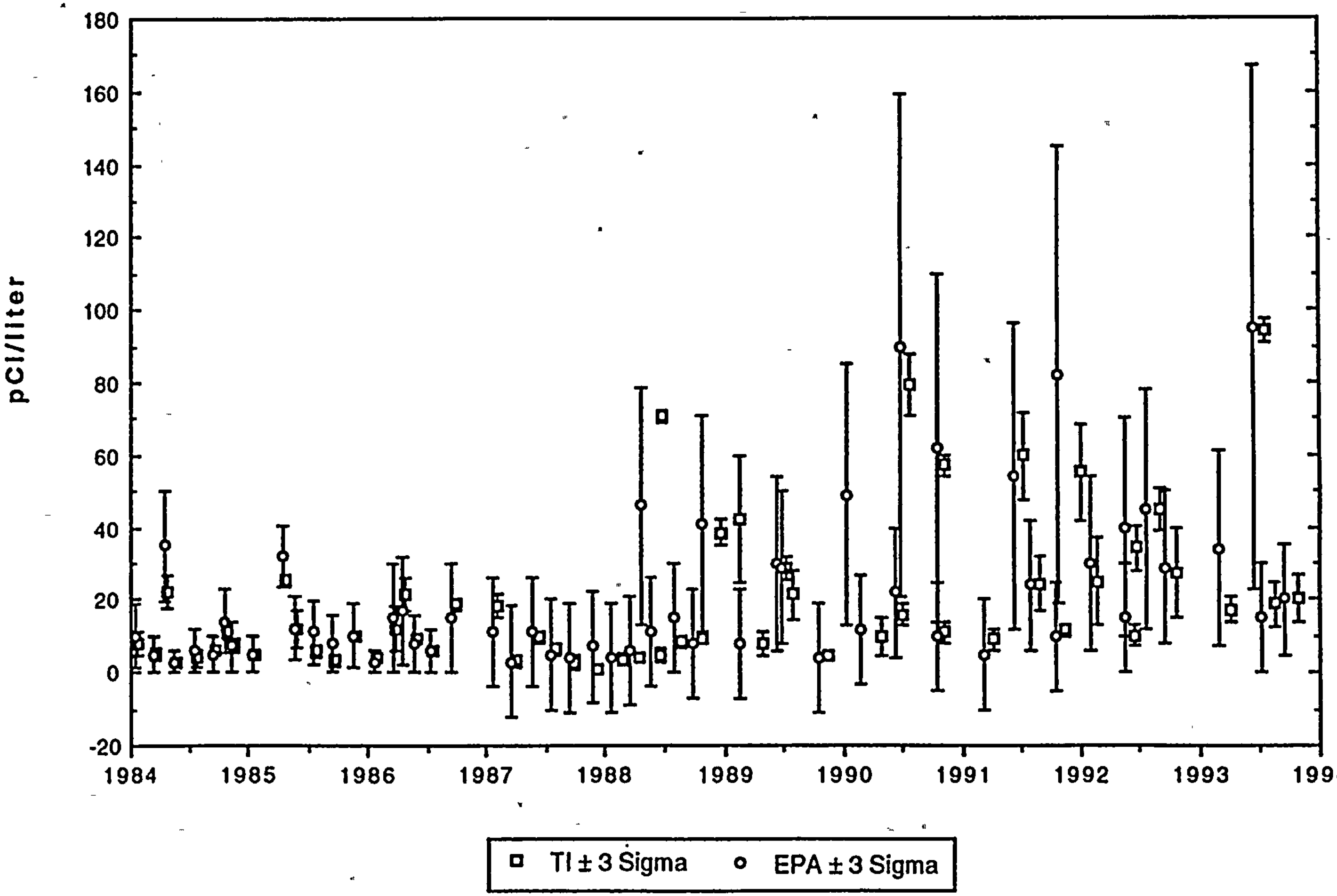




EPA CROSS CHECK PROGRAM
CESIUM-137 IN MILK (pg. 1 of 1)
pCi/liter
100
80
60
40
20
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
TI ± 3 sigma
EPA ±3 sigma

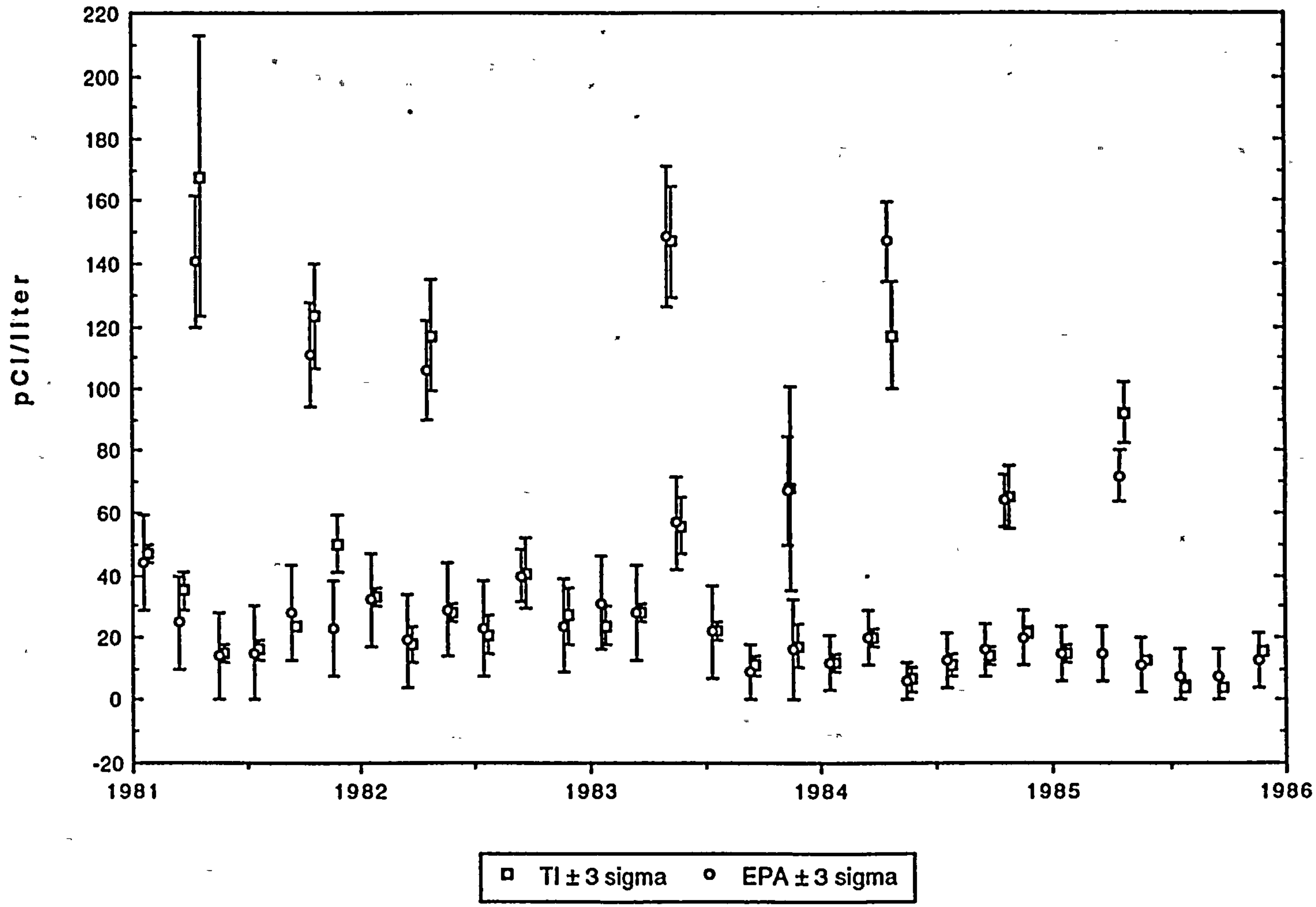
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)

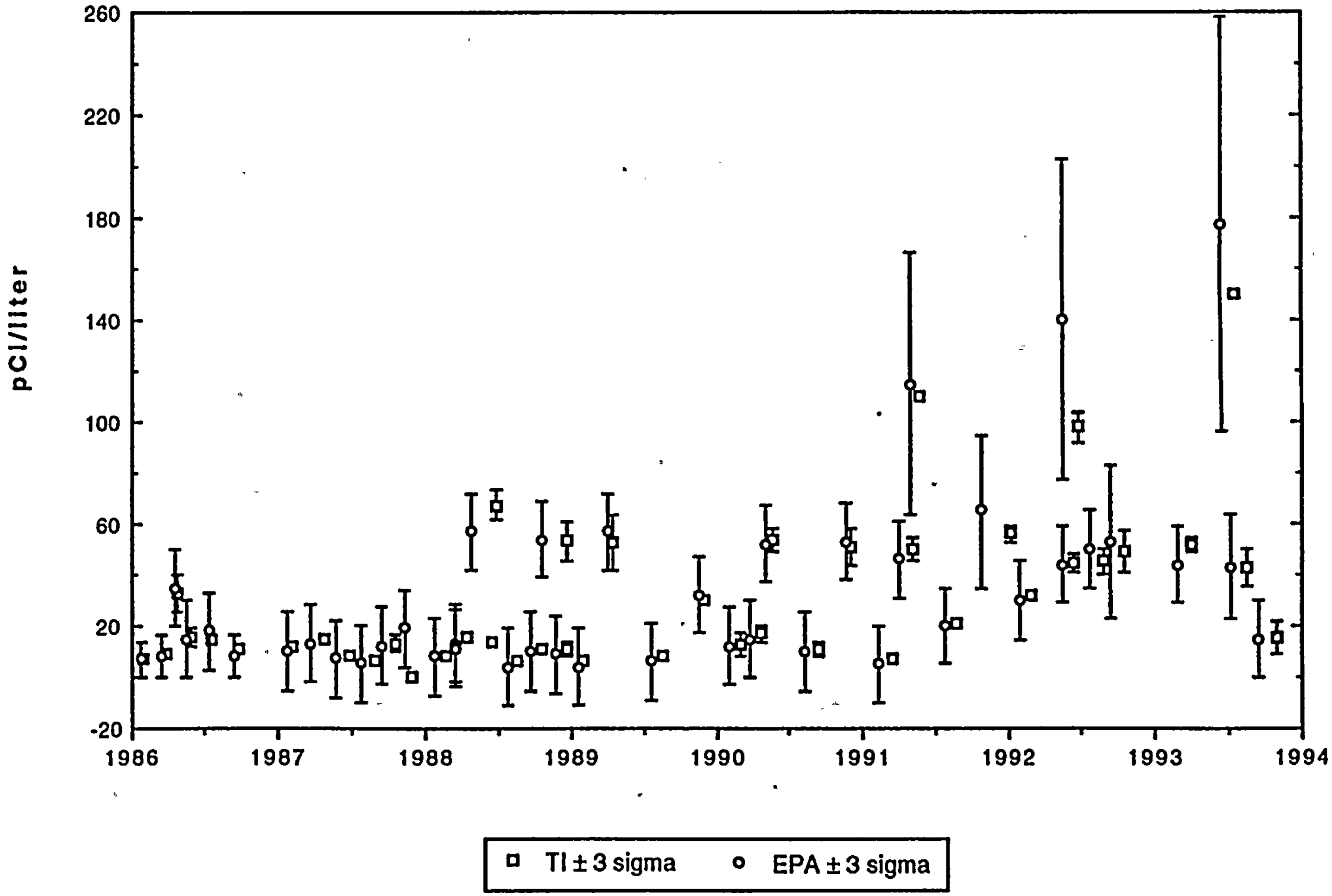


EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)

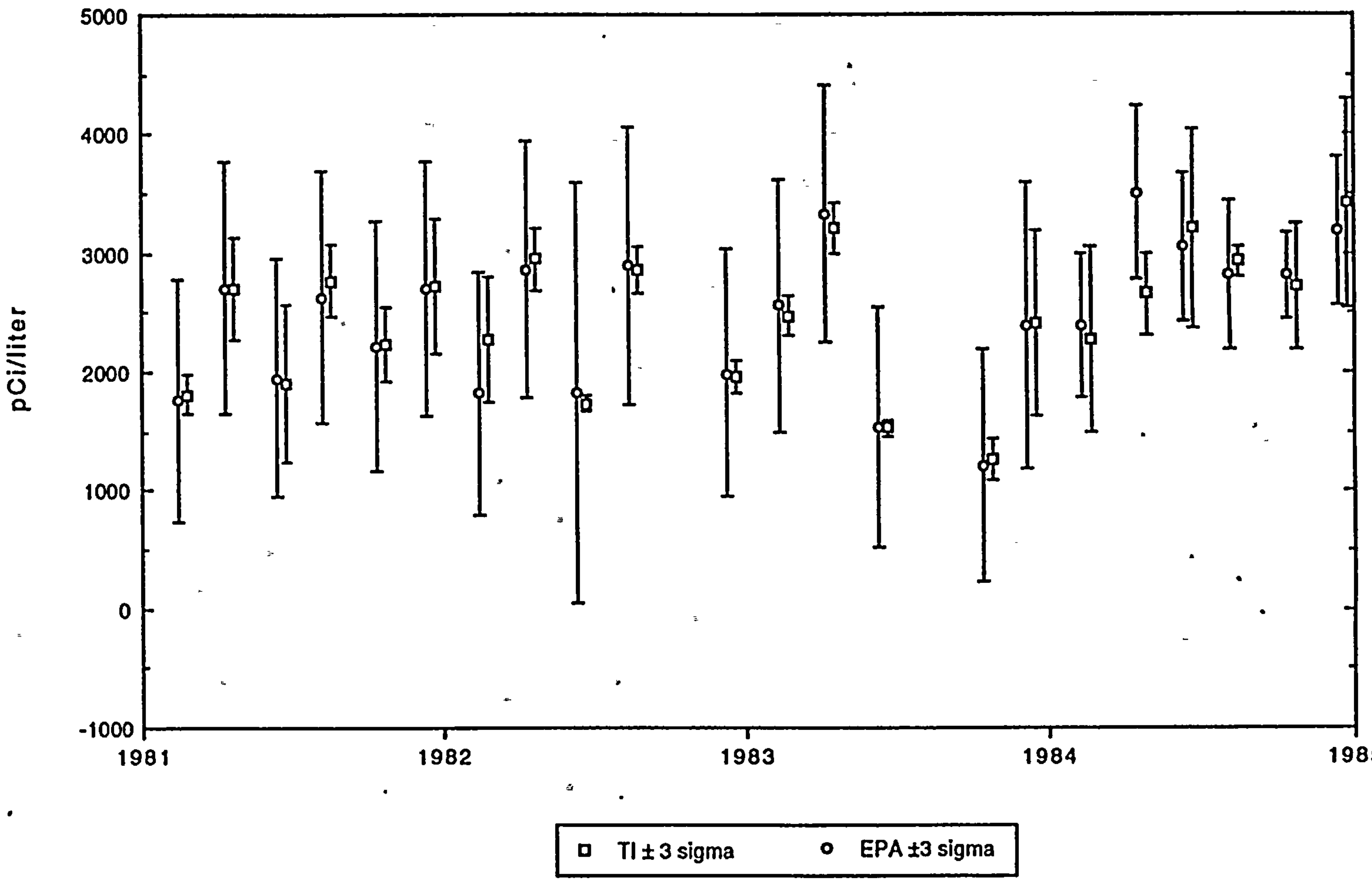


EPA CROSS CHECK PROGRAM
GROSS BETA IN WATER (pg. 2 of 2)



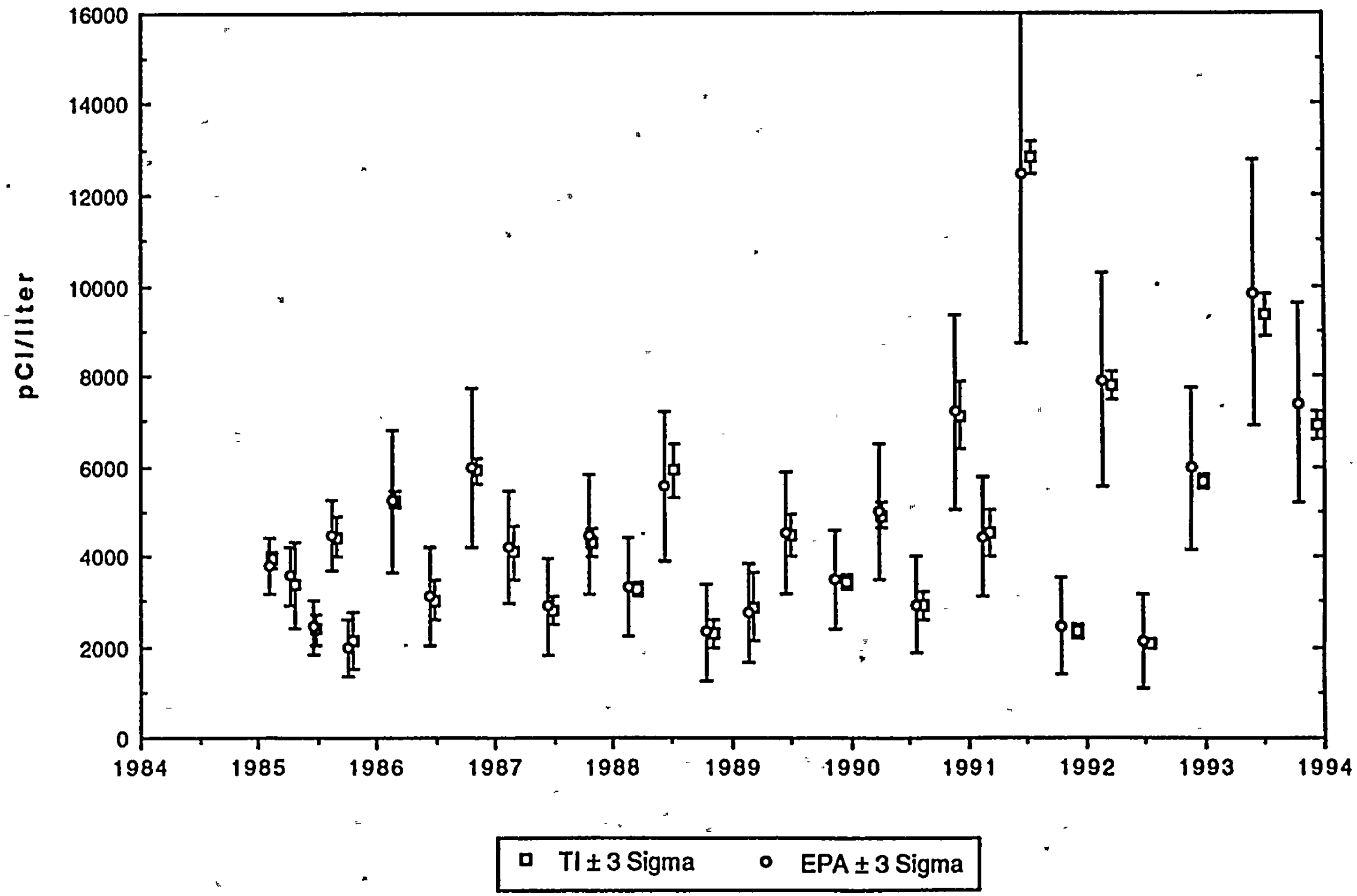
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



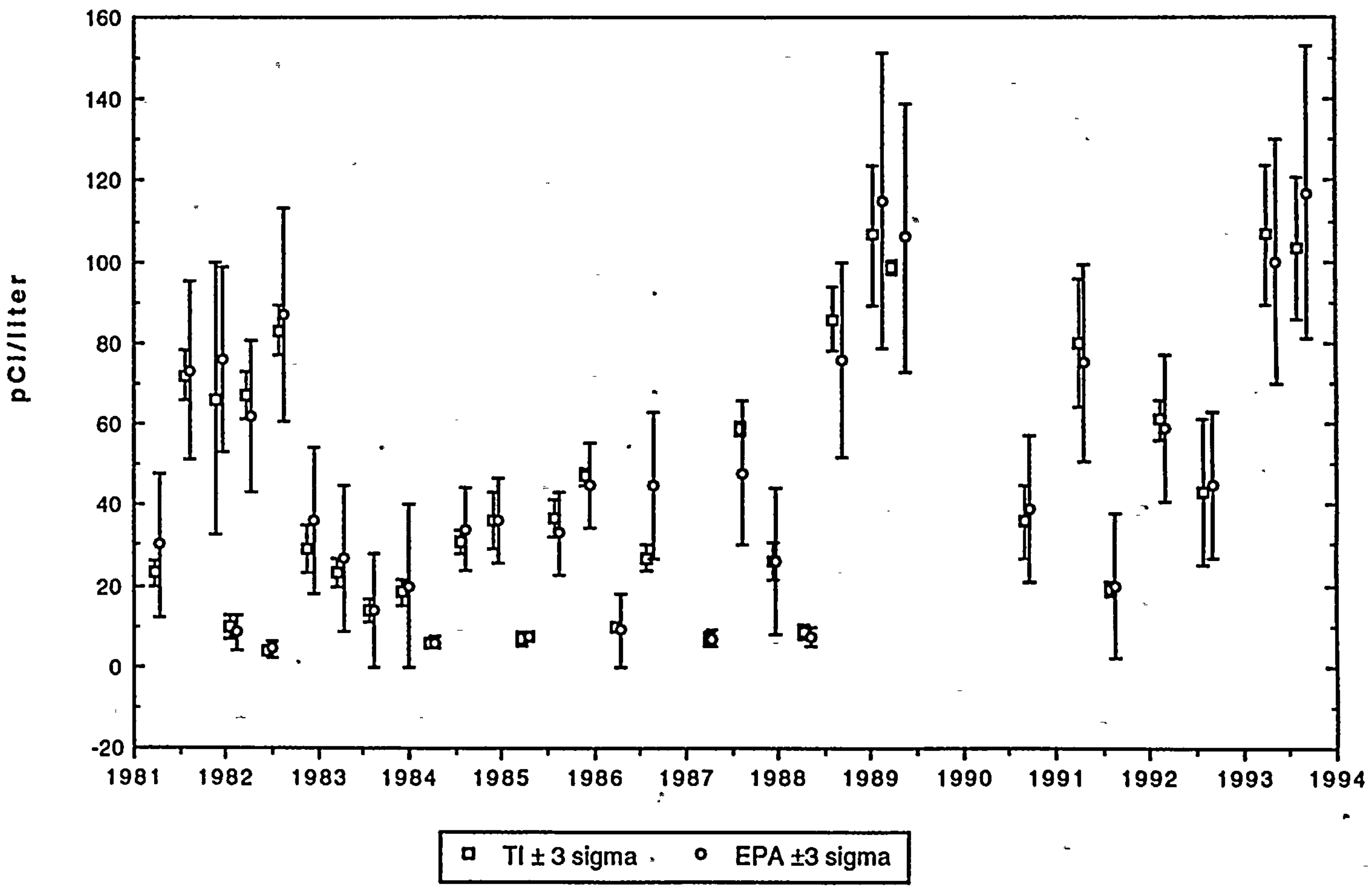
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 2 of 2)



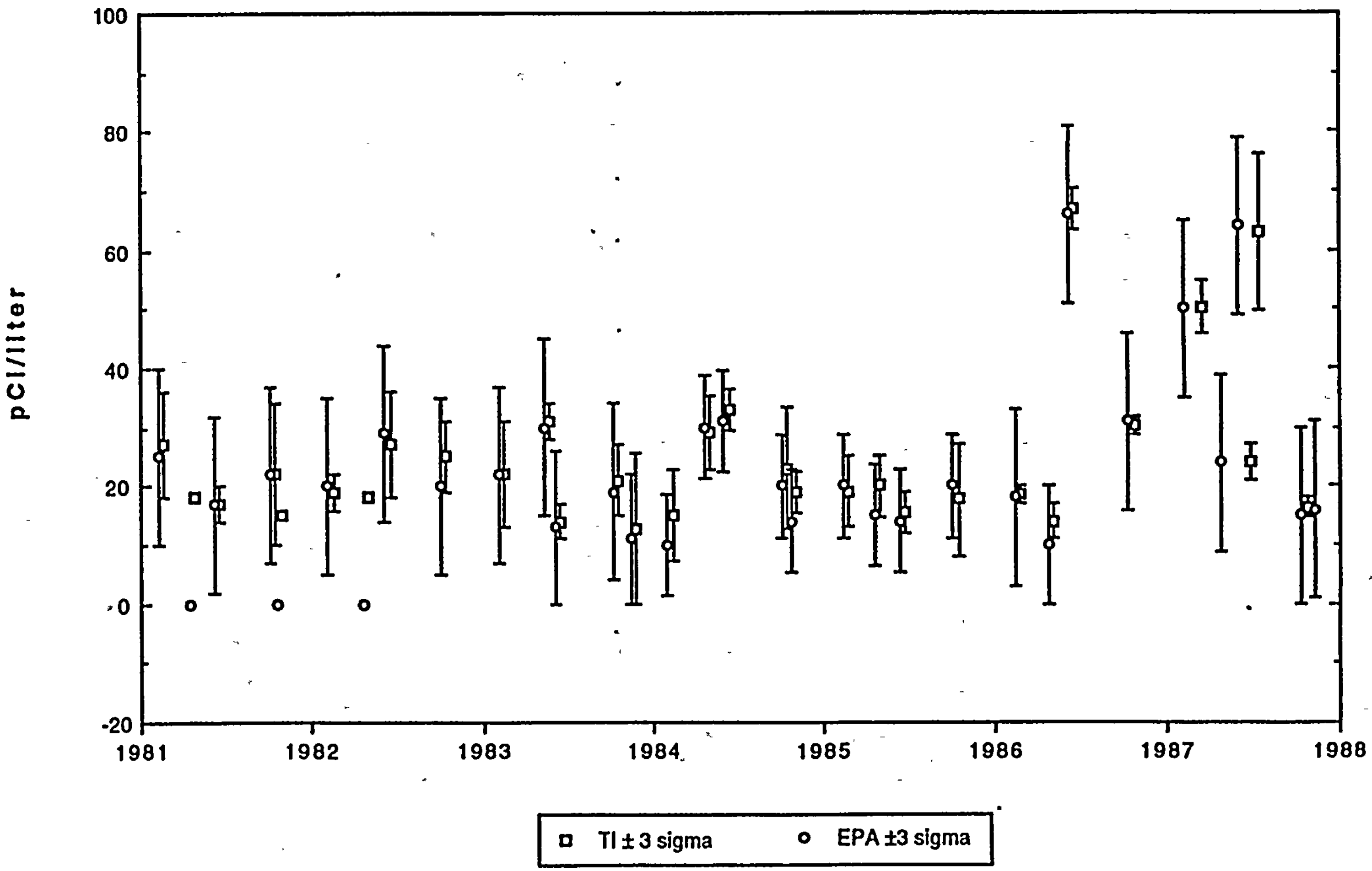
EPA CROSS CHECK PROGRAM

IODINE-131 IN WATER



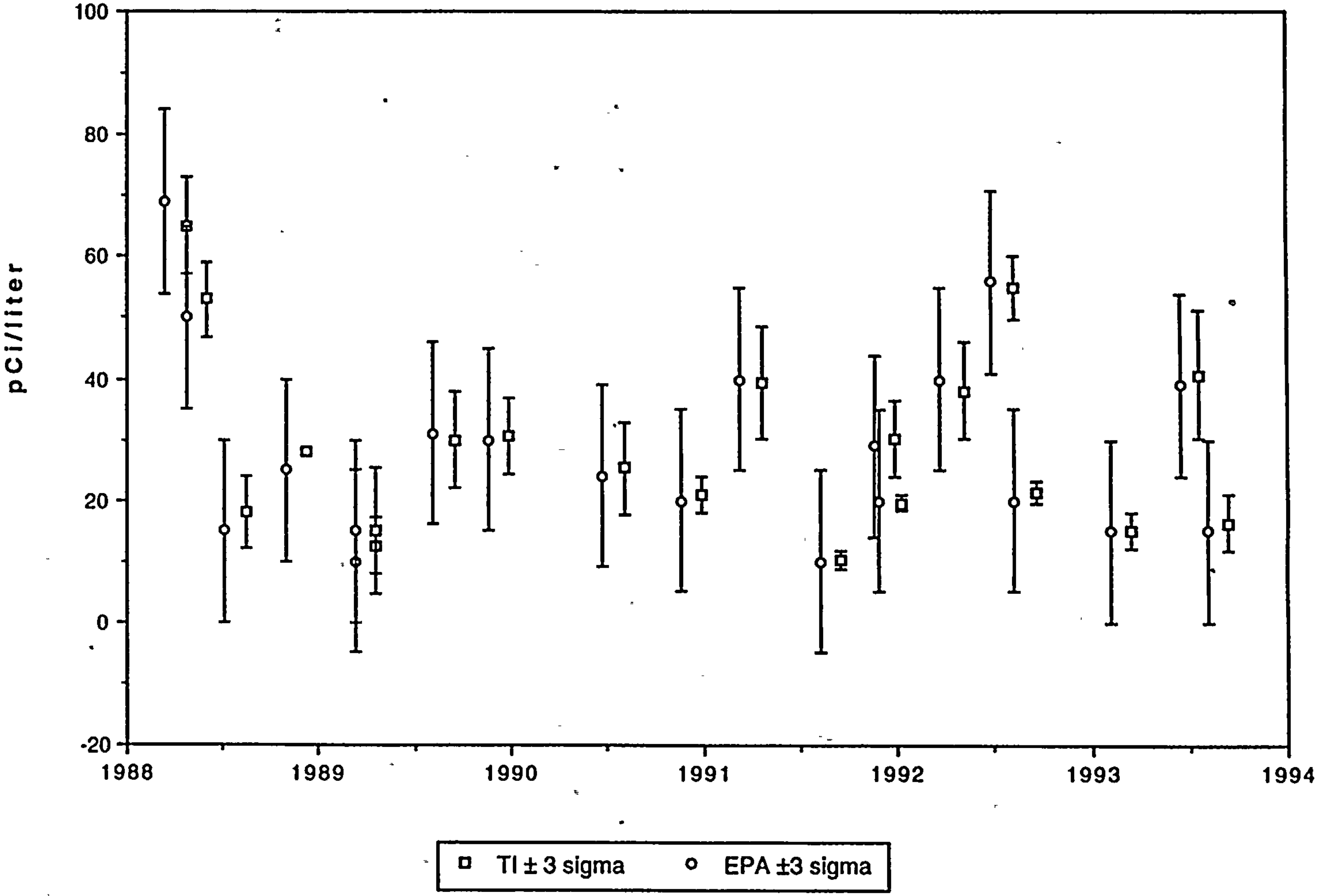
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



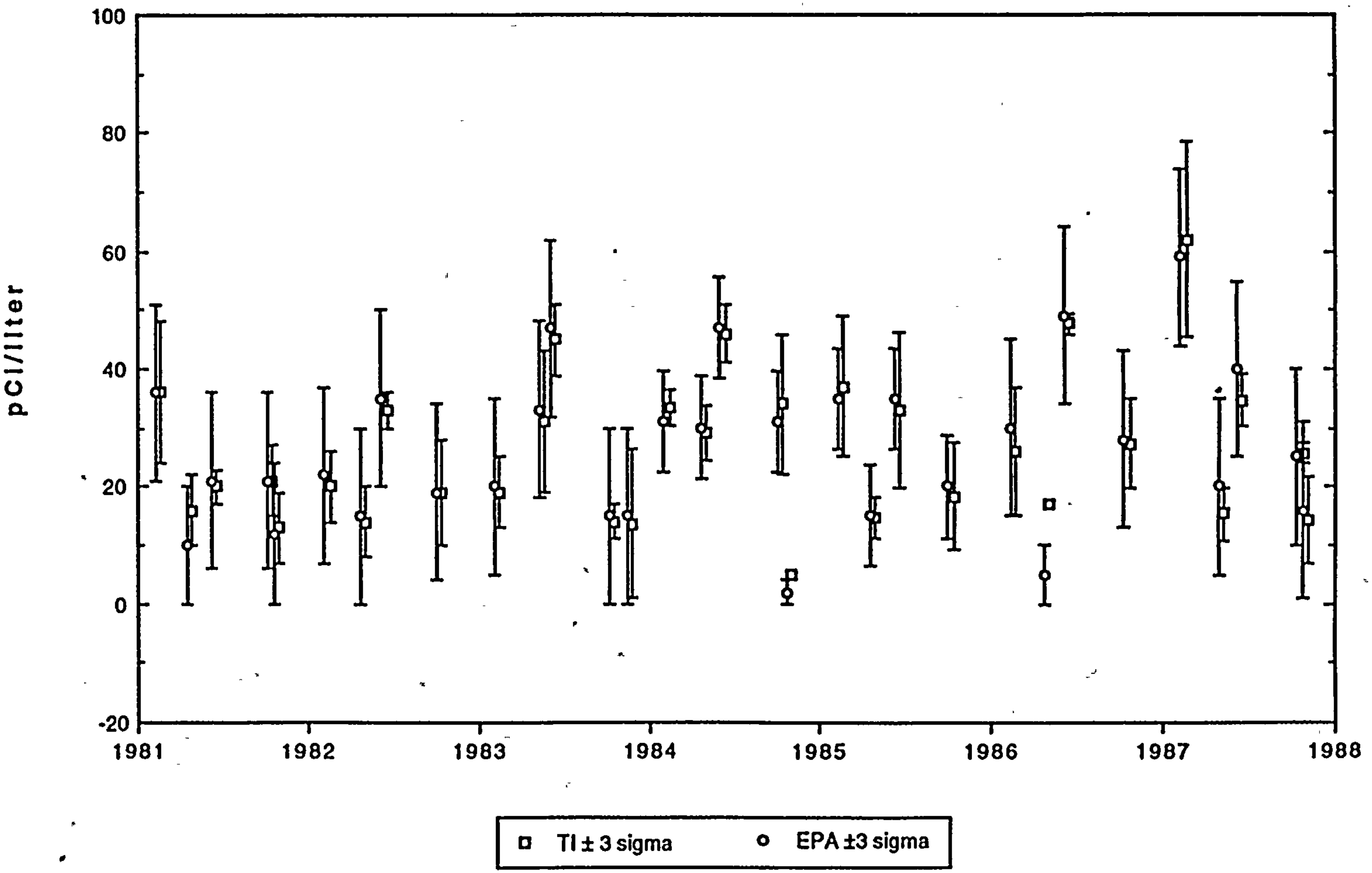
EPA CROSS CHECK PROGRAM

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



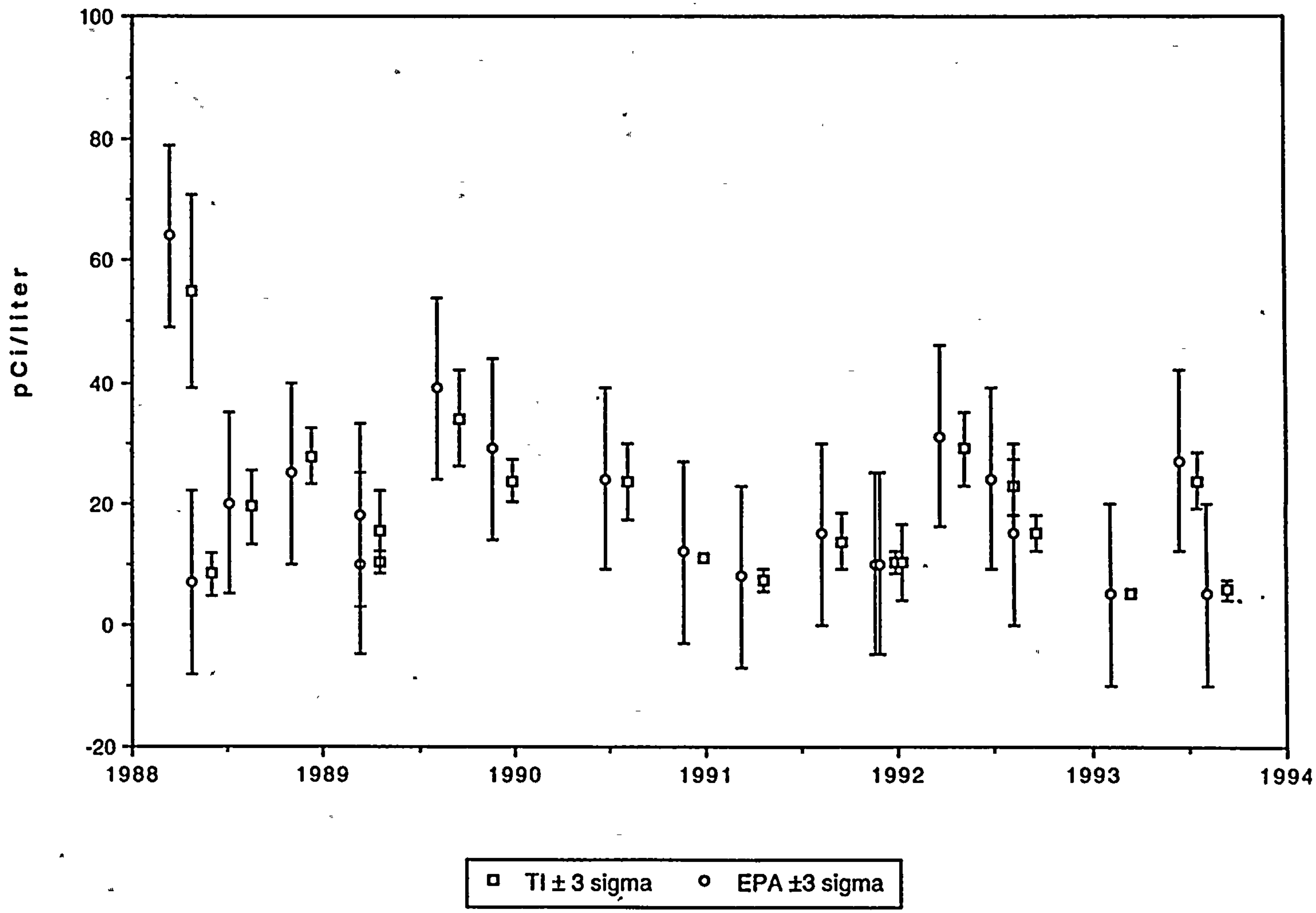
EPA CROSS CHECK PROGRAM

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



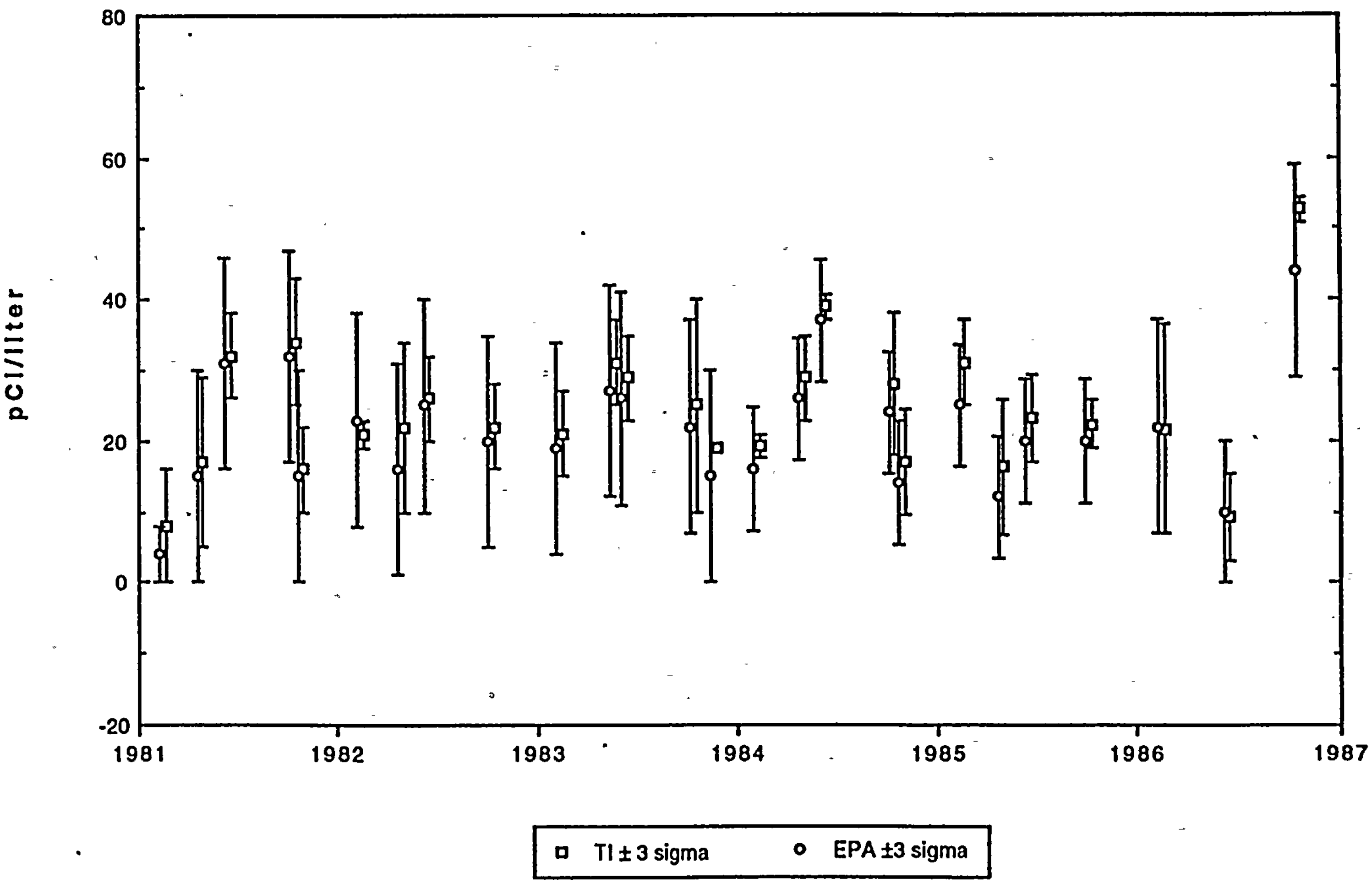
EPA CROSS CHECK PROGRAM

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



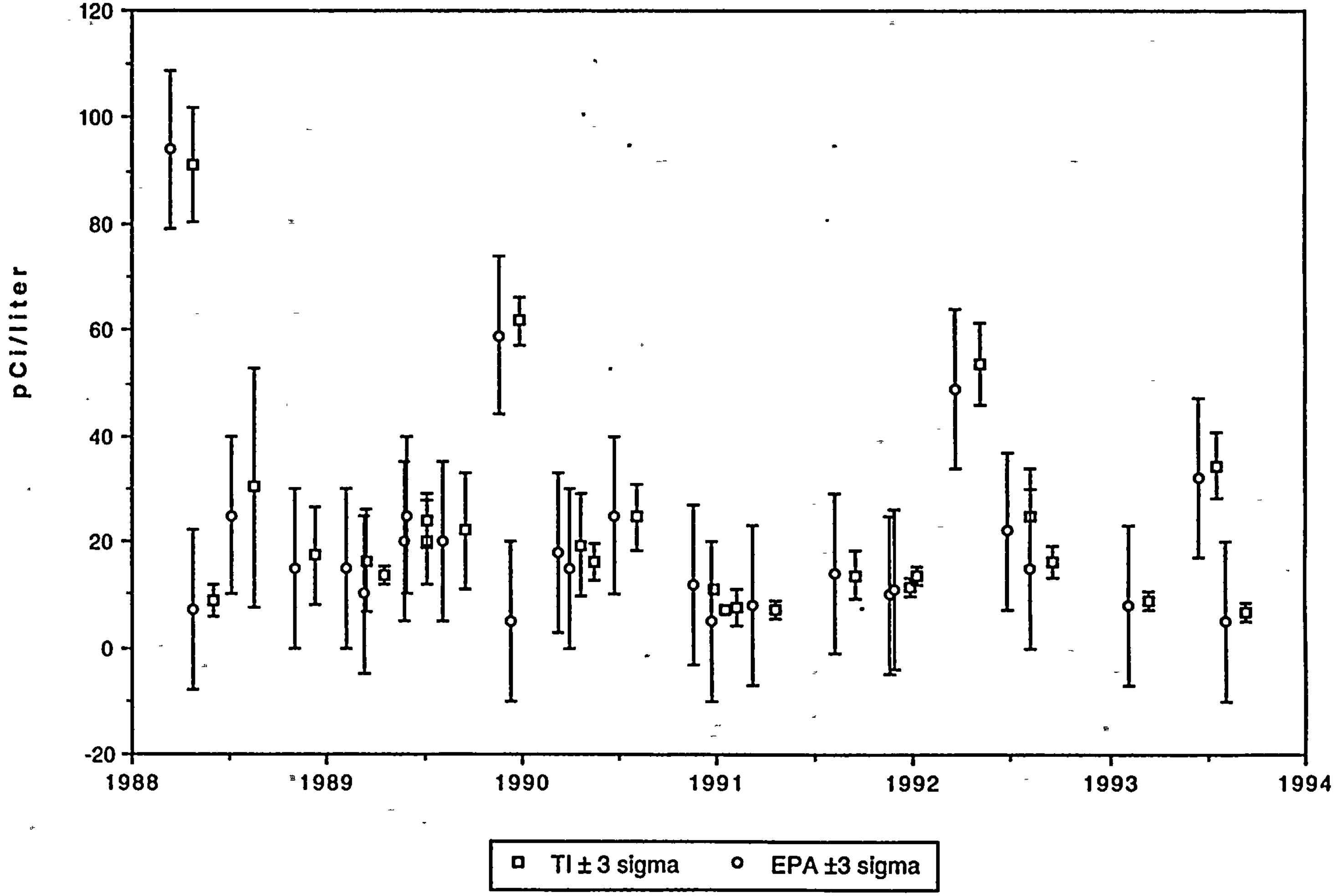
EPA CROSS CHECK PROGRAM

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



EPA CROSS CHECK PROGRAM

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



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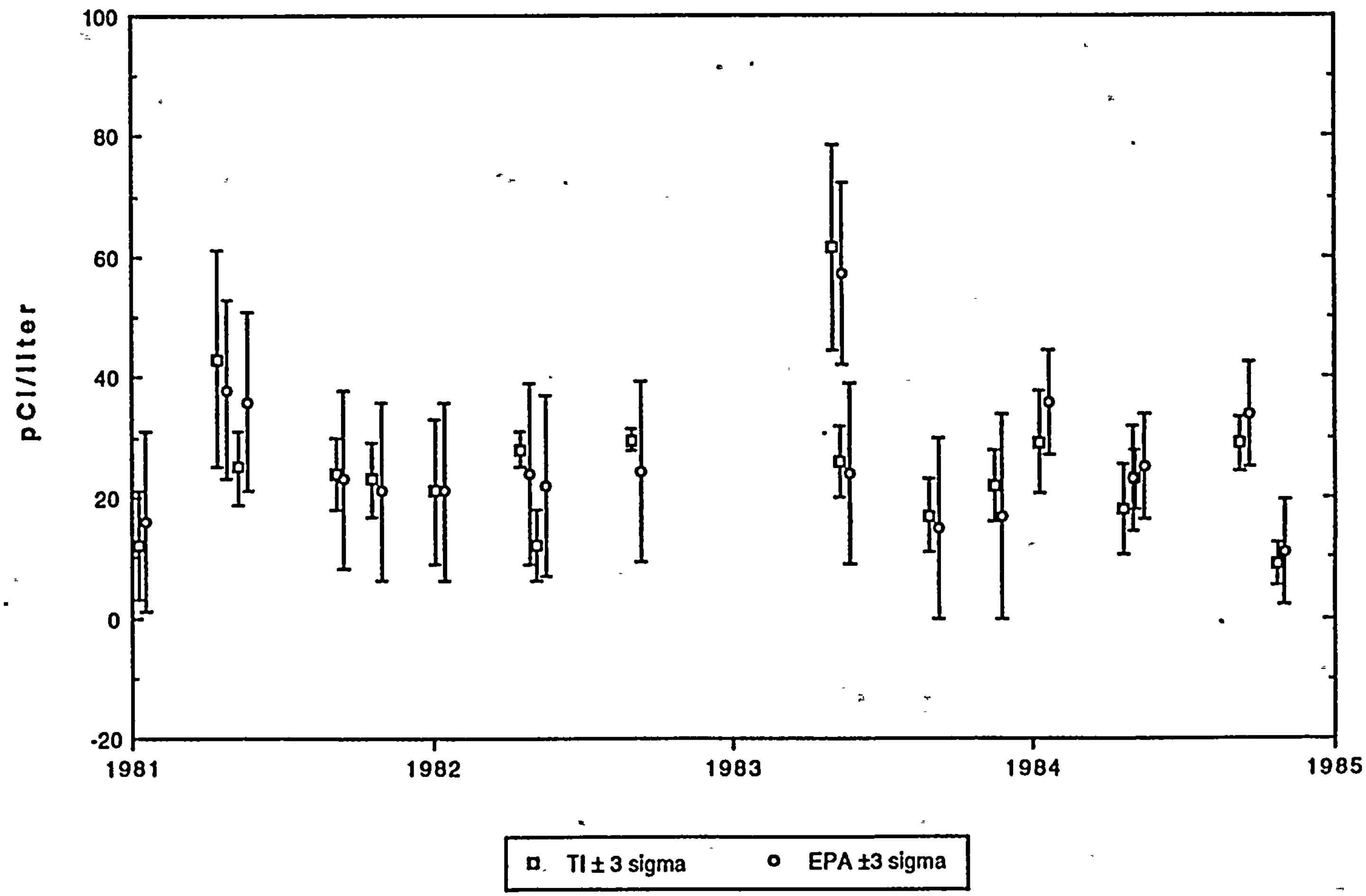
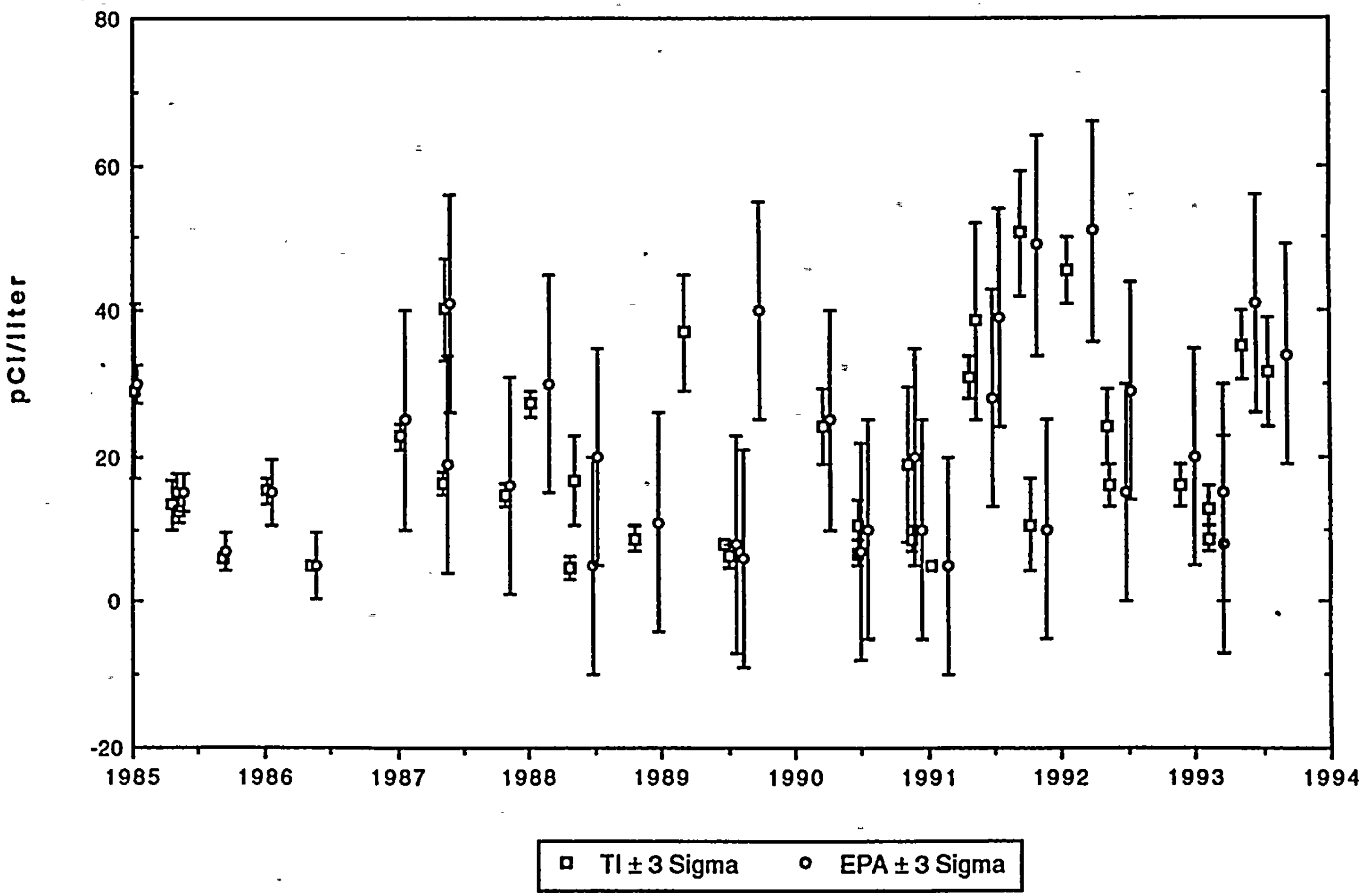
STRONTIUM-89 IN WATER (pg. 1 of 2)



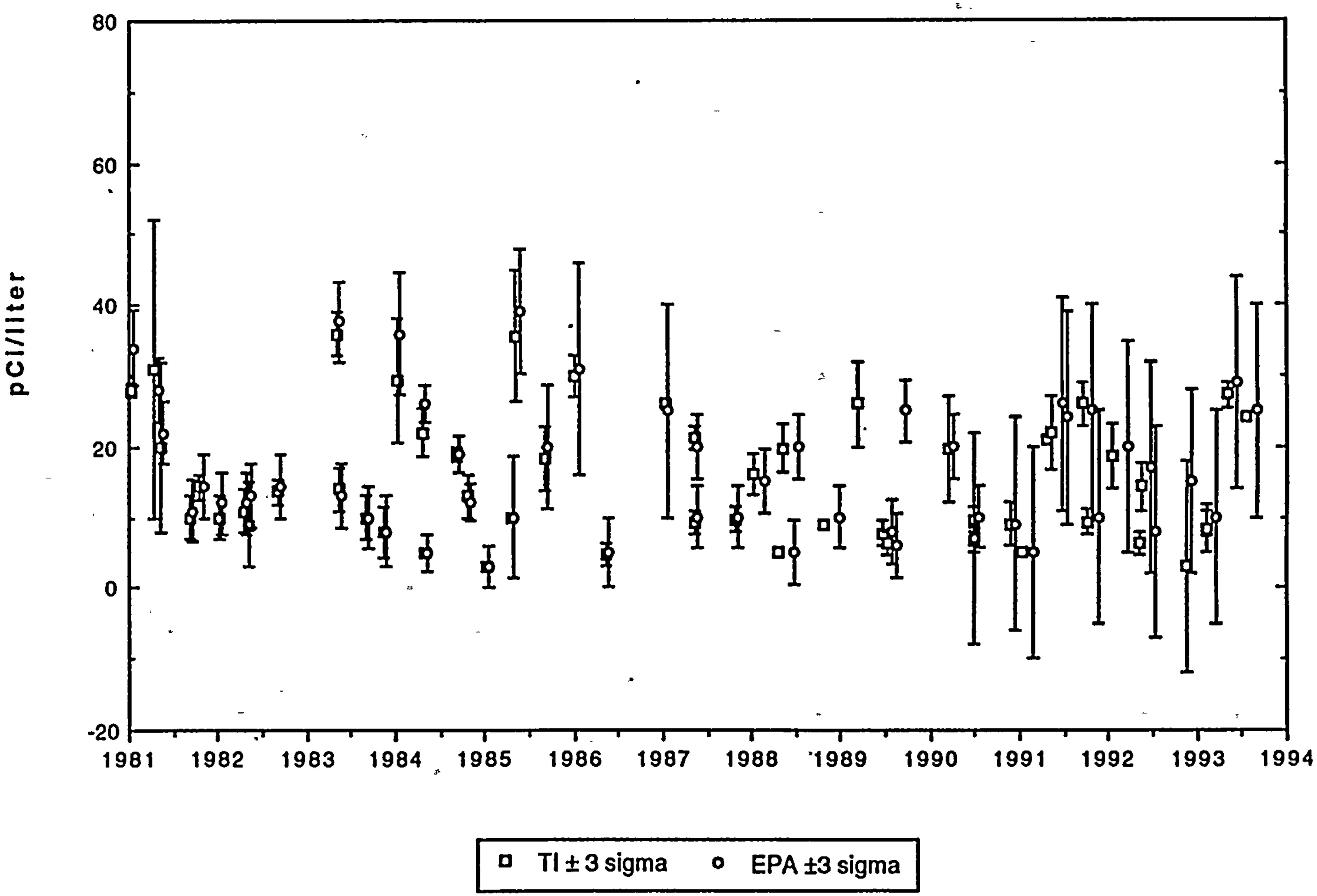
EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER (pg. 2 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 1993 are listed at the end of this appendix. Where possible, the causes of the deviations have been corrected to prevent recurrence.

There were nine incidences involving air samplers during 1993. Seven incidences were due to tripped breakers resulting from voltage surges. These power surges are attributed to thunderstorm activity where lightning strikes a power line, initiating a sure of power to the air sampler, tripping the breaker.

Surge protectors were installed in all REMP air stations on 10/11/93 to prevent damage to the equipment, however the incoming power is not "conditioned" to prevent tripping the breakers.

On 3/8/93 air station A2 was without power due to a defective section of underground power cable. The damaged section of this cable was replaced and continuous sampling resumed until August/September of 1993. The underground cable was reinspected and determined to be in sound condition. All electrical components at this air station were replaced in an effort to rectify the situation. In February 1994 a similar situation occurred involving lack of power to air station A2. The root cause has been determined to be a "supplemental section" of underground cable joining the main underground power line to an associated electrical meter. The section of underground cable was replaced and there have been no indications of power problems at air station A2.

In May 1993, the New Buffalo air sampler was identified to have a defective fuse holder. This air sampler was immediately replaced with a functional air sampler and continuous sampling resumed.

It should be noted that all REMP air samplers were upgraded in June 1993. The new air samplers have more sophisticated data collection capabilities and are more efficient than the previous models. During the interim some of the volumes from the new air samplers were calculated manually until all quality control issues had been resolved.

There were two incidences involving missing TLDs from offiste locations. The TLDs are placed in a wire mesh holder approximately 4 feet above grade. The Plant has since relocated the TLDs 8 feet above grade and placed a more visible label on the TLD holders identifying them as Cook Plant property.

All of the milk samples were collected during 1993, however one sample was collected the day after it was scheduled. On 1/22/93 the milk wholesaler arrived at the Warmbein Dairy Farm earlier than scheduled and emptied the collection tank. The sample collector returned on 1/23/93 and collected the sample within the allowable Technical Specifications grace period.

REMP EXCEPTIONS FOR SCHEDULED SAMPLING AND ANALYSIS DURING 1993

Station	Description	Date of Sampling	Reason(s) for Loss/ Exception
QC Program	Gross Beta	01/14/93	Gross beta replicate sample #99805 reanalyzed, acceptable results.
Warmbein	Milk	01/22/93	Tank empty, sample collected 01/23/93.
A-2	Air	03/08/93/ 03/22/93	Underground cable supplying power to air station was damaged.
New Buffalo	Air	05/03/93/	Defective fuse holder/blown fuse.
A5	Air	05/24/93	Tripped breakers attributed to thunderstorm activity.
Dowagiac	Air	05/31/93	Tripped breakers attributed to thunderstorm activity.
A2	Air	08/02/93- 08/30/93 09/20/93- 09/27/93	Tripped breakers. Electrical components replaced. Possible voltage surge due to thunder- storm activity.
A1	Air	08/16/93 09/20/93	Tripped breakers attributed to thunderstorm activity. Surge protectors installed 10/11/93.
A3	Air	08/30/93	Tripped breakers attributed to thunderstorm activity. Surge protectors installed 10/11/93.
A5/A6	Air	11/08/93	Primary fuse in overhead power lines tripped.
OFS-6	TLD	2nd Qtr.	TLD missing.
OFS-4	TLD	4th Qtr.	TLD missing.

APPENDIX F
1993 LAND USE CENSUS

APPENDIX F

SUMMARY OF THE 1993 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 1993 Land Use Census. The following is a summary of the 1993 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 Cook Power Plant was conducted on August 30, 1993.

In 1993 there were two deletions and one addition to the Michigan Department of Agriculture's list of dairy farms in Berrien County Michigan. The deleted farms were not part of the REMP Milk Sampling Program.

The previously identified milk animal, a goat owned by Sue Dorman continues to be the closest milk producing animal to the Cook 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 Plant. The residential survey was completed on September 15, 1993 using an updated list of all new residential building permits issued during the previous year. The closest residence to the Plant in each sector remains unchanged from the previous year.

Broadleaf Survey

In accordance with Technical Specification (T/S) 3.12.2, 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 1993 were less than the Technical Specification LLDs.

Figure 7

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Milk Farm Survey - 1993

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	5.1	Gerald Totzke	6744 Totzke Rd., Baroda
	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, Sno[illegible] 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., Buchana
	b	7.0	George Freehling	2221 W. Glendora Rd., Buchana
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.

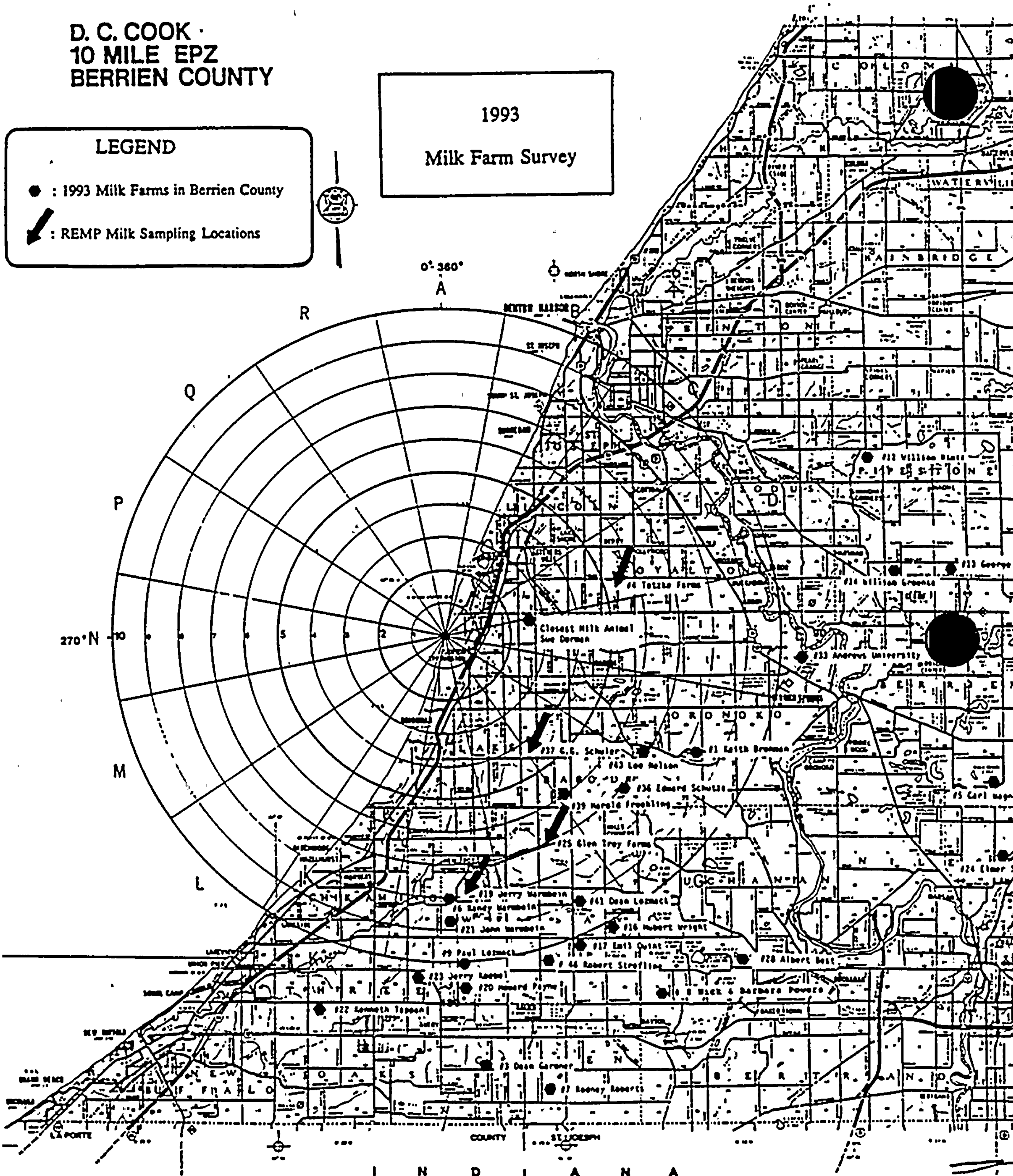
Figure 8

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Residential Land Use Survey - 1993

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		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.


D. C. COOK
10 MILE EPZ
BERRIEN COUNTY
LEGEND
: 1993 Milk Farms in Berrien County
: REMP Milk Sampling Locations
1993
Milk Farm Survey
0°-360°
A
B
R
Q
P
270°N
M
L
I N D I A N A

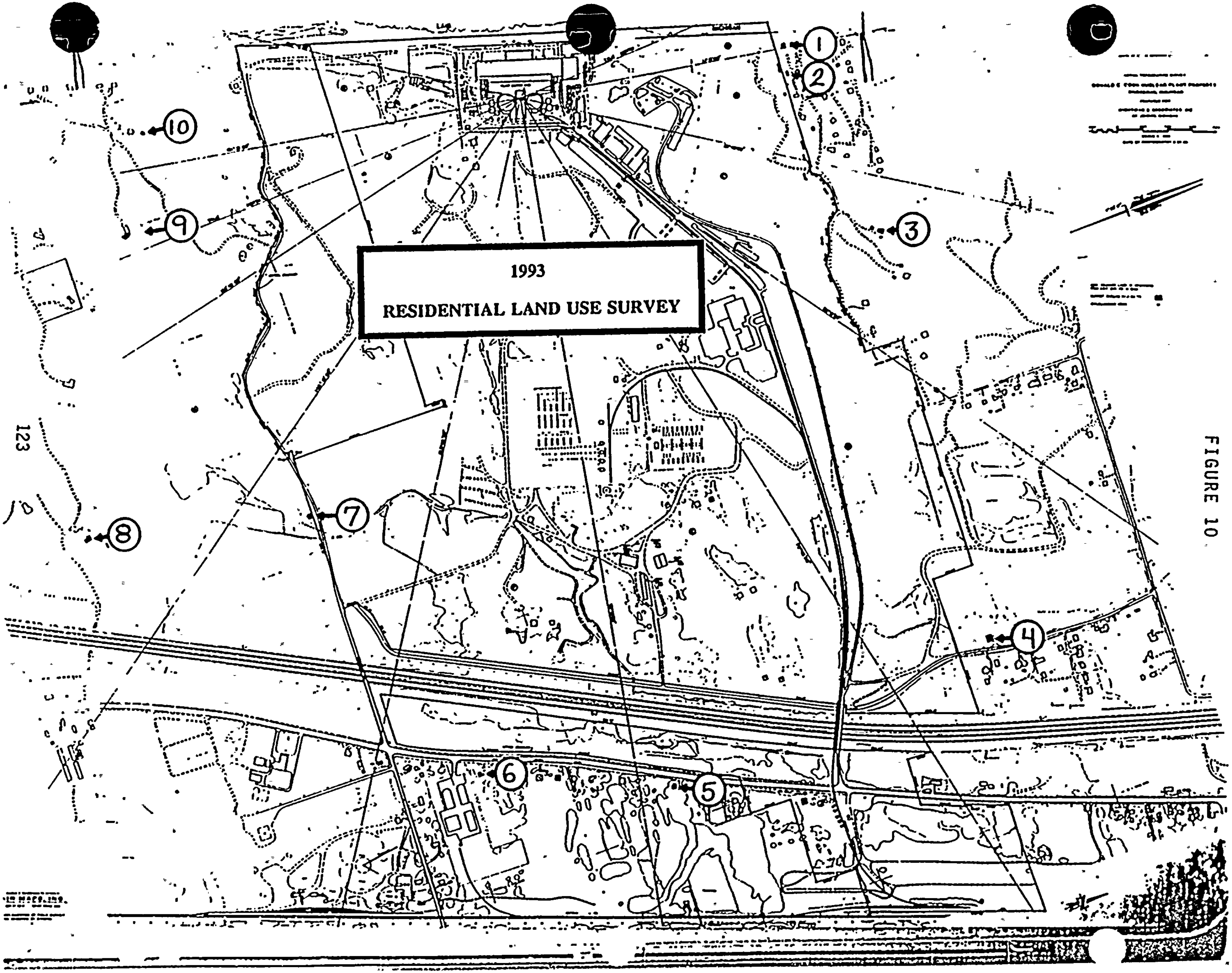


FIGURE 10

APPENDIX G
SUMMARY OF THE PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

SUMMARY OF THE PREOPERATIONAL RADIOLOGICAL MONITORING PROGRAM

A preoperational radiological environmental monitoring program was performed for the Donald C. Cook Nuclear Plant from August 1971 until the initial criticality of Unit 1 on January 18, 1975. The analyses of samples collected in the vicinity of the nuclear power plant were performed by Eberline Instrument Corporation. The summary of the preoperational program presented in this appendix is based on the seven semi-annual reports covering the period. The purpose of this summary is to provide a comparison of the radioactivity measured in the environs of the plant during the pre-start up of Unit 1 and the radioactivity measured in 1993.

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

1993. Analyses performed during the preoperational but not required in 1993, 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 REMP QUALITY CONTROL PROGRAM

SUMMARY OF THE REMP QUALITY CONTROL PROGRAM

The plant procedure for implementing the quality control program references Regulatory Guide 4.15. The program utilizes blank, replicate and spiked samples within four different parameters; gamma isotopic, tritium, iodine and gross beta. The blank and replicate samples are prepared at the D.C. Cook Plant and the spiked samples are prepared by Teledyne Isotopes.

Twenty-seven quality control samples were performed during 1993. Twenty six samples had acceptable results. One of the gross beta replicate samples was slightly outside the acceptable range. This sample was reanalyzed and gave acceptable results. Teledyne conducted an investigation and could not determine a root cause.

APPENDIX I
SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

The following tables list the blanks and spiked water samples analyzed during 1993 for the Teledyne Isotopes In-house Quality Assurance Program. Analysis date is analogous to collection date to identify weekly analysis of samples.

Two analyses for gross beta activity were marginally outside the specified acceptable ranges. If the counting errors were included in the assessment of spike results all measurements would be within acceptable ranges. No documented corrective action was taken because in accordance with Section 9.1 of our Quality Control Manual (IWL-0032-365), the acceptance criteria for a particular analysis "is within 3 standard deviations of the EPA one sigma, one determination as specified in the Environmental Radioactive Laboratory Studies Program EPA-600/4-81-004, Table 3, Page 8". For gross beta activity below 100 pCi/l the control level at which corrective action must be taken is ± 15 pCi/l. The quality assurance department operationally investigates gross beta spike results which exceed the one standard deviation, one determination levels (± 5 pCi/l), because of previous experience in reporting results within that level. Control charts for gross alpha and beta spikes did not indicate any bias in results.

For the tritium spikes by liquid scintillation counting (10 ml aliquots) the three standard deviations of the EPA one sigma, one determination would be greater than 1000 pCi/l for a spike level of 1400 pCi/l. The quality assurance department operationally investigates tritium spike results which exceed ± 200 pCi/l. Control charts indicated a slight low bias in tritium spike results with one measurement outside the 15% operational acceptance criteria. If the counting errors were included in the assessments of spike results all measurements would be within acceptable ranges.

Teledyne Isotopes In-House Spiked Sample Results - 1993
Water

Analysis	Spike Levels (pCi/L)	Acceptable Range (pC
Gross Alpha	1.1 ± 0.5 E 01	0.6 - 1.6 E 01
Gross Beta	2.2 ± 0.5 E 01	1.7 - 2.7 E 01
Gamma (Cs-137)	2.2 ± 0.3 E 04	1.9 - 2.5 E 04
H-3 (LS)	1.4 ± 0.2 E 03	1.2 - 1.6 E 03

GROSS ALPHA

TI #	Analysis Date	Activity (pCi/l)
00868	01/06/93	1.2 ± 0.2 E 01
01769	01/13/93	9.3 ± 1.6 E 00
02250	01/20/93	1.4 ± 0.2 E 01
02959	01/27/93	1.1 ± 0.2 E 01
03556	02/03/93	1.1 ± 0.2 E 01
04474	02/10/93	1.3 ± 0.2 E 01
04837	02/17/93	1.5 ± 0.2 E 01
05584	02/24/93	1.4 ± 0.2 E 01
05928	03/03/93	1.5 ± 0.2 E 01
07149	03/10/93	1.2 ± 0.2 E 01
07516	03/17/93	1.4 ± 0.2 E 01
08360	03/24/93	1.1 ± 0.2 E 01
08580	03/31/93	1.4 ± 0.2 E 01
10729	04/07/93	1.1 ± 0.2 E 01
10755	04/14/93	1.2 ± 0.2 E 01
11628	04/21/93	1.0 ± 0.2 E 01
12255	04/28/93	1.2 ± 0.2 E 01
12799	05/05/93	1.4 ± 0.2 E 01
13458	05/12/93	1.3 ± 0.2 E 01
14174	05/19/93	1.3 ± 0.2 E 01
15071	05/26/93	7.8 ± 1.4 E 00
15408	06/02/93	1.2 ± 0.2 E 01
16236	06/09/93	1.1 ± 0.1 E 01
16785	06/16/93	1.3 ± 0.2 E 01
17644	06/23/93	1.2 ± 0.2 E 01
17981	06/30/93	1.1 ± 0.2 E 01
18513	07/07/93	7.4 ± 1.0 E 00
19897	07/14/93	1.5 ± 0.2 E 01
20410	07/21/93	1.1 ± 0.2 E 01
21017	07/28/93	1.3 ± 0.2 E 01
21812	08/04/93	1.3 ± 0.2 E 01
22449	08/11/93	1.1 ± 0.2 E 01
23386	08/18/93	1.0 ± 0.2 E 01
23750	08/25/93	1.2 ± 0.2 E 01

GROSS ALPHA (Cont.)

TI #	Analysis Date	Activity (pCi/l)
24641	09/01/93	1.4 ± 0.2 E 01
25441	09/08/93	1.5 ± 0.2 E 01
26420	09/15/93	9.3 ± 1.6 E 00
26679	09/22/93	1.3 ± 0.2 E 01
27679	09/29/93	1.1 ± 0.2 E 01
28285	10/06/93	1.1 ± 0.2 E 01
29164	10/13/93	1.3 ± 0.2 E 01
30479	10/20/93	1.2 ± 0.2 E 01
31367	10/27/93	1.2 ± 0.2 E 01
31803	11/03/93	1.2 ± 0.2 E 01
32600	11/10/93	1.4 ± 0.2 E 01
33742	11/17/93	1.3 ± 0.2 E 01
34049	11/24/93	1.2 ± 0.2 E 01
34805	12/01/93	9.7 ± 1.5 E 00
35615	12/08/93	1.1 ± 0.2 E 01
36167	12/15/93	9.4 ± 1.5 E 00
36993	12/22/93	9.6 ± 1.5 E 00
37568	12/29/93	9.6 ± 1.5 E 00

GROSS BETA

TI #	Analysis Date	Activity (pCi/l)
00868	01/06/93	2.0 ± 0.1 E 01
01769	01/13/93	2.0 ± 0.2 E 01
02250	01/20/93	2.0 ± 0.2 E 01
02959	01/27/93	2.0 ± 0.1 E 01
03556	02/03/93	2.4 ± 0.2 E 01
04474	02/10/93	2.3 ± 0.2 E 01
04837	02/17/93	2.1 ± 0.2 E 01
05584	02/24/93	1.8 ± 0.1 E 01
05928	03/03/93	2.3 ± 0.2 E 01
07149	03/10/93	2.1 ± 0.2 E 01
07516	03/17/93	2.0 ± 0.1 E 01
08360	03/24/93	1.6 ± 0.1 E 01
08580	03/31/93	2.5 ± 0.2 E 01
10729	04/07/93	1.9 ± 0.1 E 01
10755	04/14/93	2.3 ± 0.2 E 01
11628	04/21/93	2.1 ± 0.2 E 01
12255	04/28/93	2.0 ± 0.1 E 01
12799	05/05/93	2.5 ± 0.2 E 01
13458	05/12/93	1.9 ± 0.1 E 01
14174	05/19/93	2.1 ± 0.2 E 01
15071	05/26/93	2.3 ± 0.2 E 01

GROSS BETA (Cont.)

TI #	Analysis Date	Activity (pCi/l)
15408	06/02/93	1.8 ± 0.1 E 01
16236	06/09/93	1.7 ± 0.1 E 01
16785	06/16/93	1.7 ± 0.1 E 01
17644	06/23/93	2.7 ± 0.2 E 01
17981	06/30/93	2.0 ± 0.2 E 01
18513	07/07/93	2.6 ± 0.1 E 01
19897	07/14/93	2.1 ± 0.2 E 01
20410	07/21/93	2.2 ± 0.2 E 01
21017	07/28/93	2.4 ± 0.2 E 01
21812	08/04/93	1.7 ± 0.1 E 01
22449	08/11/93	1.6 ± 0.1 E 01
23386	08/18/93	2.6 ± 0.2 E 01
23750	08/25/93	2.4 ± 0.2 E 01
24641	09/01/93	2.5 ± 0.2 E 01
25441	09/08/93	2.2 ± 0.2 E 01
26420	09/15/93	2.1 ± 0.2 E 01
26679	09/22/93	2.5 ± 0.2 E 01
27679	09/29/93	2.0 ± 0.1 E 01
28285	10/06/93	2.4 ± 0.2 E 01
29164	10/13/93	1.7 ± 0.1 E 01
30479	10/20/93	1.8 ± 0.1 E 01
31367	10/27/93	2.5 ± 0.2 E 01
31803	11/03/93	2.1 ± 0.1 E 01
32600	11/10/93	2.4 ± 0.2 E 01
33742	11/17/93	2.5 ± 0.2 E 01
34049	11/24/93	1.9 ± 0.1 E 01
34805	12/01/93	1.8 ± 0.1 E 01
35615	12/08/93	1.9 ± 0.1 E 01
36167	12/15/93	2.1 ± 0.2 E 01
36993	12/22/93	1.9 ± 0.1 E 01
37568	12/29/93	2.0 ± 0.1 E 01

GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
00873	01/06/93	2.24 ± 0.22 E 04
01774	01/13/93	2.02 ± 0.20 E 04
02255	01/20/93	2.26 ± 0.23 E 04
02964	01/27/93	2.07 ± 0.21 E 04
03561	02/03/93	2.16 ± 0.22 E 04
04479	02/10/93	2.26 ± 0.23 E 04
04842	02/17/93	2.26 ± 0.23 E 04
05589	02/24/93	2.21 ± 0.22 E 04
05933	03/03/93	2.23 ± 0.22 E 04

GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
07154	03/10/93	2.22 ± 0.22 E 04
08365	03/24/93	2.15 ± 0.22 E 04
08585	03/31/93	2.20 ± 0.22 E 04
10734	04/07/93	2.18 ± 0.22 E 04
10760	04/14/93	2.17 ± 0.22 E 04
11633	04/21/93	2.23 ± 0.22 E 04
12260	04/28/93	2.22 ± 0.22 E 04
12804	05/05/93	2.26 ± 0.23 E 04
03463	05/12/93	2.17 ± 0.22 E 04
14179	05/19/93	2.15 ± 0.22 E 04
15076	05/26/93	2.25 ± 0.23 E 04
15413	06/02/93	2.19 ± 0.22 E 04
16241	06/09/93	2.20 ± 0.22 E 04
16790	06/16/93	2.23 ± 0.22 E 04
17649	06/23/93	2.16 ± 0.22 E 04
17986	06/30/93	2.20 ± 0.22 E 04
18518	07/07/93	2.21 ± 0.22 E 04
19902	07/14/93	2.23 ± 0.22 E 04
20415	07/21/93	2.18 ± 0.22 E 04
21022	07/28/93	2.20 ± 0.22 E 04
21817	08/04/93	2.24 ± 0.22 E 04
22454	08/11/93	2.17 ± 0.22 E 04
23391	08/18/93	2.22 ± 0.22 E 04
23755	08/25/93	2.23 ± 0.22 E 04
24666	09/01/93	2.28 ± 0.23 E 04
25546	09/08/93	2.21 ± 0.22 E 04
26425	09/15/93	2.25 ± 0.23 E 04
26684	09/22/93	2.20 ± 0.22 E 04
27684	09/29/93	2.20 ± 0.22 E 04
28290	10/06/93	2.08 ± 0.21 E 04
29169	10/13/93	2.23 ± 0.22 E 04
30484	10/20/93	2.22 ± 0.22 E 04
31372	10/27/93	2.23 ± 0.22 E 04
31808	11/03/93	2.21 ± 0.22 E 04
32605	11/10/93	2.17 ± 0.22 E 04
33747	11/17/93	2.21 ± 0.22 E 04
34054	11/24/93	2.19 ± 0.22 E 04
34810	12/01/93	2.25 ± 0.23 E 04
35620	12/08/93	2.23 ± 0.22 E 04
36172	12/15/93	2.17 ± 0.22 E 04
36998	12/22/93	2.20 ± 0.22 E 04
37573	12/29/93	2.28 ± 0.23 E 04

TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
00870	01/06/93	1.4 ± 0.1 E 03
01771	01/13/93	1.3 ± 0.1 E 03
02252	01/20/93	1.4 ± 0.1 E 03
02961	01/27/93	1.5 ± 0.1 E 03
03558	02/03/93	1.3 ± 0.1 E 03
04476	02/10/93	1.5 ± 0.2 E 03
04839	02/17/93	1.4 ± 0.1 E 03
05586	02/24/93	1.3 ± 0.1 E 03
05930	03/03/93	1.4 ± 0.1 E 03
07151	03/10/93	1.2 ± 0.1 E 03
07518	03/17/93	1.6 ± 0.2 E 03
08362	03/24/93	1.2 ± 0.1 E 03
08582	03/31/93	1.3 ± 0.1 E 03
10731	04/07/93	1.3 ± 0.1 E 03
10757	04/14/93	1.2 ± 0.1 E 03
11630	04/21/93	1.2 ± 0.1 E 03
12257	04/28/93	1.3 ± 0.1 E 03
12801	05/05/93	1.2 ± 0.1 E 03
13460	05/12/93	1.2 ± 0.1 E 03
14176	05/19/93	1.3 ± 0.1 E 03
15073	05/26/93	1.3 ± 0.1 E 03
15410	06/02/93	1.5 ± 0.2 E 03
16238	06/09/93	1.3 ± 0.1 E 03
16787	06/16/93	1.2 ± 0.1 E 03
17466	06/23/93	1.3 ± 0.1 E 03
17983	06/30/93	1.3 ± 0.1 E 03
18515	07/07/93	1.4 ± 0.1 E 03
19899	07/14/93	1.4 ± 0.2 E 03
20412	07/21/93	1.5 ± 0.2 E 03
21019	07/28/93	1.4 ± 0.2 E 03
21814	08/04/93	1.4 ± 0.2 E 03
22451	08/11/93	1.4 ± 0.1 E 03
23388	08/18/93	1.4 ± 0.1 E 03
23752	08/25/93	1.3 ± 0.1 E 03
24643	09/01/93	1.4 ± 0.1 E 03
25543	09/08/93	1.4 ± 0.1 E 03
26422	09/15/93	1.4 ± 0.1 E 03
26681	09/22/93	1.4 ± 0.1 E 03
27681	09/29/93	1.3 ± 0.2 E 03
28287	10/06/93	1.4 ± 0.1 E 03
29166	10/13/93	1.5 ± 0.2 E 03
30481	10/20/93	1.2 ± 0.1 E 03
31369	10/27/93	1.4 ± 0.1 E 03

TRITIUM - (H-3) 10ml.

TI #	Analysis Date	Activity (pCi/l)
31805	11/03/93	1.4 ± 0.1 E 03
32602	11/10/93	1.4 ± 0.1 E 03
33744	11/17/93	1.2 ± 0.1 E 03
34051	11/24/93	1.3 ± 0.1 E 03
34807	12/01/93	1.3 ± 0.1 E 03
35617	12/08/93	1.4 ± 0.1 E 03
36169	12/15/93	1.3 ± 0.1 E 03
36995	12/22/93	1.4 ± 0.1 E 03
37570	12/29/93	1.2 ± 0.2 E 03

Teledyne Isotopes In-House Blanks Sample Results - 1993
Water

GROSS ALPHA-BLANKS

TI #	Analysis Date	Activity (pCi/l)
00867	01/06/93	L. T. 6. E-01
01768	01/13/93	L. T. 5. E-01
02249	01/20/93	L. T. 6. E-01
02958	01/27/93	L. T. 4. E-01
03555	02/03/93	L. T. 5. E-01
04473	02/10/93	L. T. 4. E-01
04836	02/17/93	L. T. 9. E-01
05583	02/24/93	L. T. 6. E-01
05927	03/03/93	L. T. 1. E 00
07148	03/10/93	L. T. 6. E-01
07515	03/17/93	L. T. 5. E-01
08359	03/24/93	L. T. 5. E-01
08579	03/31/93	L. T. 5. E-01
10728	04/07/93	L. T. 4. E-01
10754	04/14/93	L. T. 2. E 00
11627	04/21/93	L. T. 6. E-01
12254	04/28/93	L. T. 6. E-01
12798	05/05/93	L. T. 4. E-01
13457	05/12/93	L. T. 5. E-01
14173	05/19/93	L. T. 6. E-01
15070	05/26/93	L. T. 5. E-01
15407	06/02/93	L. T. 7. E-01
16235	06/09/93	L. T. 4. E-01
16784	06/16/93	L. T. 6. E-01
17643	06/23/93	L. T. 8. E-01
17980	06/30/93	L. T. 8. E-01
18512	07/07/93	L. T. 4. E-01
19896	07/14/93	L. T. 4. E-01
20409	07/21/93	L. T. 5. E-01
21016	07/28/93	L. T. 7. E-01
21811	08/04/93	L. T. 4. E-01
22448	08/11/93	L. T. 5. E-01
23385	08/18/93	L. T. 6. E-01
23749	08/25/93	L. T. 6. E-01
24640	09/01/93	L. T. 4. E-01
25540	09/08/93	L. T. 7. E-01
26419	09/15/93	L. T. 8. E-01
26678	09/22/93	L. T. 7. E-01
27678	09/29/93	L. T. 7. E-01
28284	10/06/93	L. T. 7. E-01
29163	10/13/93	L. T. 5. E-01
30478	10/20/93	L. T. 6. E-01

GROSS ALPHA-BLANKS (Cont.)

TI #	Analysis Date	Activity (pCi/l)
31366	10/27/93	L. T. 6. E-01
31802	11/03/93	L. T. 6. E-01
32599	11/10/93	L. T. 8. E-01
33741	11/17/93	L. T. 7. E-01
34048	11/24/93	L. T. 6. E-01
34804	12/01/93	L. T. 7. E-01
35614	12/08/93	L. T. 7. E-01
36166	12/15/93	L. T. 4. E-01
36992	12/22/93	L. T. 5. E-01
37567	12/29/93	L. T. 7. E-01

GROSS BETA-BLANKS

TI #	Analysis Date	Activity (pCi/l)
00867	01/06/93	L. T. 8. E-01
01768	01/13/93	L. T. 1. E 00
02249	01/20/93	L. T. 9. E-01
02958	01/27/93	L. T. 8. E-01
03555	02/03/93	L. T. 7. E-01
04473	02/10/93	L. T. 7. E-01
04836	02/17/93	L. T. 9. E-01
05583	02/24/93	L. T. 8. E-01
05927	03/03/93	1.3 ± 0.7E 00
07148	03/10/93	L. T. 9. E-01
07515	03/17/93	L. T. 9. E-01
08359	03/24/93	L. T. 1. E 00
08579	03/31/93	L. T. 8. E-01
10728	04/07/93	L. T. 5. E-01
10754	04/14/93	L. T. 9. E-01
11627	04/21/93	L. T. 1. E 00
12254	04/28/93	L. T. 7. E-01
12798	05/05/93	L. T. 7. E-01
13457	05/12/93	L. T. 8. E-01
14173	05/19/93	L. T. 8. E-01
15070	05/26/93	1.1 ±0.6 E 00
15407	06/02/93	L. T. 8. E-01
16235	06/09/93	L. T. 6. E-01
16784	06/16/93	L. T. 8. E-01
17643	06/23/93	L. T. 8. E-01
17980	06/30/93	L. T. 8. E-01
18512	07/07/93	L. T. 6. E-01
19896	07/14/93	L. T. 7. E-01
20409	07/21/93	L. T. 7. E-01
21016	07/28/93	L. T. 8. E-01

GROSS BETA -BLANKS (Cont.)

TI #	Analysis Date	Activity (pCi/l)
21811	08/04/93	L. T. 7. E-01
22448	08/11/93	L. T. 7. E-01
23385	08/18/93	L. T. 8. E-01
23749	08/25/93	L. T. 9. E-01
24640	09/01/93	L. T. 8. E-01
25540	09/08/93	L. T. 8. E-01
26419	09/15/93	L. T. 8. E-01
26678	09/22/93	L. T. 7. E-01
27678	09/29/93	L. T. 8. E-01
28284	10/06/93	L. T. 8. E-01
29163	10/13/93	L. T. 9. E-01
30478	10/20/93	L. T. 1. E 00
31366	10/27/93	L. T. 1. E 00
31802	11/03/93	L. T. 8. E-01
32599	11/10/93	L. T. 9. E-01
33741	11/17/93	L. T. 8. E-01
34048	11/24/93	L. T. 9. E-01
14804	12/01/93	L. T. 7. E-01
35614	12/08/93	L. T. 8. E-01
36166	12/15/93	L. T. 1. E 00
36992	12/22/93	L. T. 9. E-01
37567	12/29/93	L. T. 8. E-01

TRITIUM - (H-3) - BLANKS

TI #	Analysis Date	Activity (pCi/l)
00871	01/06/93	L. T. 1. E 02
01773	01/13/93	L. T. 1. E 02
02254	01/20/93	L. T. 2. E 02
02963	01/27/93	L. T. 1. E 02
03560	02/03/93	L. T. 1. E 02
04478	02/10/93	L. T. 1. E 02
04841	02/17/93	L. T. 2. E 02
05588	02/24/93	L. T. 1. E 02
05932	03/03/93	L. T. 2. E 02
07153	03/10/93	L. T. 1. E 02
07520	03/17/93	L. T. 2. E 02
08364	03/24/93	L. T. 1. E 02
08584	03/31/93	L. T. 1. E 02
10753	04/07/93	L. T. 1. E 02
10759	04/14/93	L. T. 1. E 02
11632	04/21/93	L. T. 1. E 02
12259	04/28/93	L. T. 1. E 02
12803	05/05/93	L. T. 1. E 02
13462	05/12/93	L. T. 1. E 02

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

TI #	Analysis Date	Activity (pCi/l)
14178	05/19/93	L. T. 1. E 02
15075	05/26/93	L. T. 1. E 02
15412	06/02/93	L. T. 2. E 02
16240	06/09/93	L. T. 1. E 02
16789	06/16/93	L. T. 1. E 02
16789	06/16/93	L. T. 1. E 02
17648	06/23/93	L. T. 1. E 02
17985	06/30/93	L. T. 1. E 02
17985	06/30/95	L. T. 1. E 02
18517	07/07/93	L. T. 1. E 02
19901	07/14/93	L. T. 2. E 02
20414	07/21/93	L. T. 2. E 02
21021	07/28/93	L. T. 2. E 02
21816	08/04/93	L. T. 2. E 02
22453	08/11/93	L. T. 2. E 02
23390	08/18/93	L. T. 2. E 02
23754	08/25/93	L. T. 2. E 02
24645	09/01/93	L. T. 1. E 02
25545	09/08/93	L. T. 2. E 02
26424	09/15/93	L. T. 2. E 02
26683	09/22/93	L. T. 1. E 02
27683	09/29/93	L. T. 2. E 02
28289	10/06/93	L. T. 2. E 02
29168	10/13/93	L. T. 1. E 02
30483	10/20/93	L. T. 2. E 02
31371	10/27/93	L. T. 1. E 02
31807	11/03/93	L. T. 1. E 02
32604	11/10/93	L. T. 2. E 02
33746	11/17/93	L. T. 2. E 02
34053	11/24/93	L. T. 2. E 02
34809	12/01/93	L. T. 2. E 02
35619	12/08/93	L. T. 2. E 02
36171	12/15/93	L. T. 2. E 02
36997	12/22/93	L. T. 1. E 02
37571	12/29/93	L. T. 2. E 02

APPENDIX J
TLD QUALITY CONTROL PROGRAM

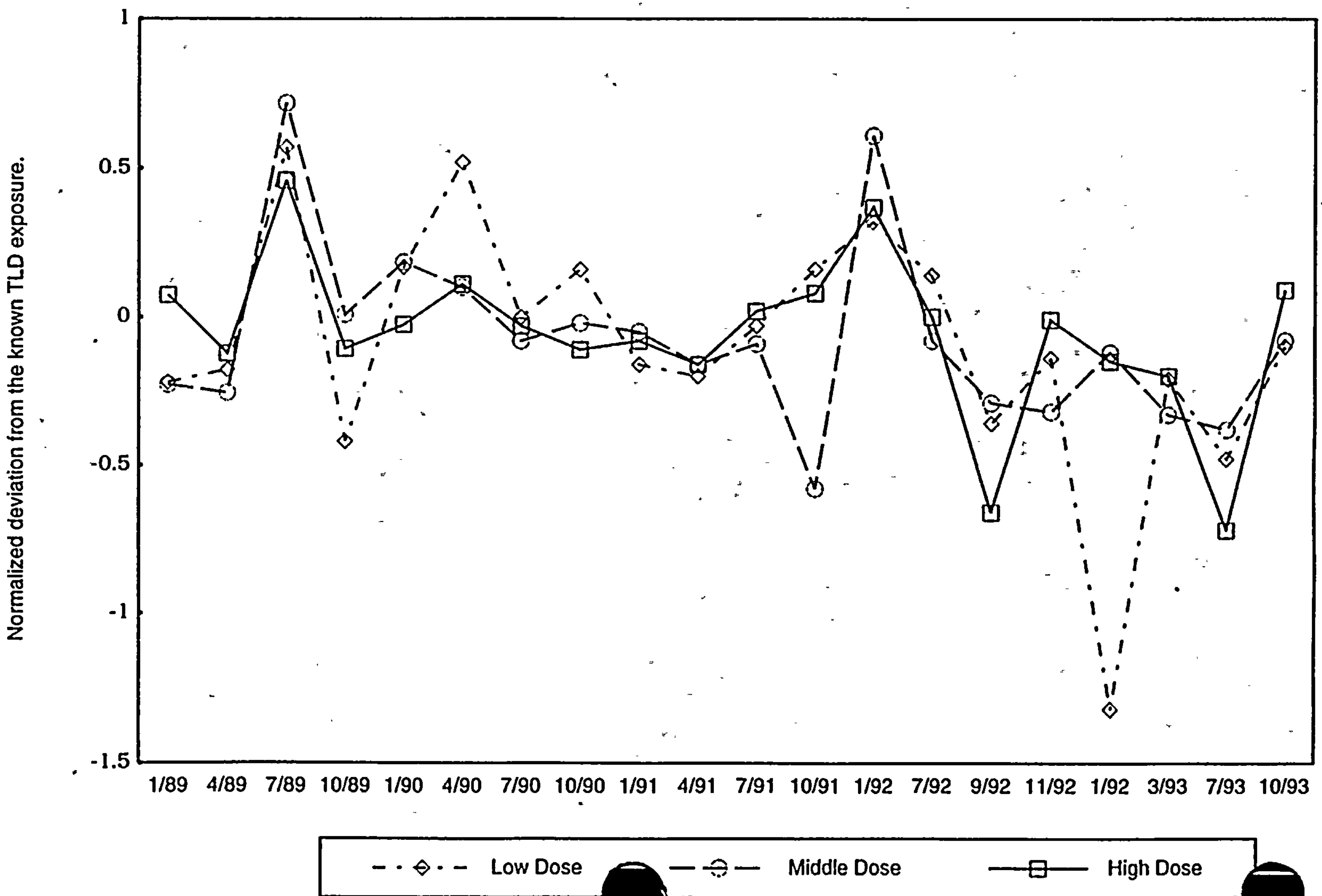
TLD QUALITY CONTROL PROGRAM

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

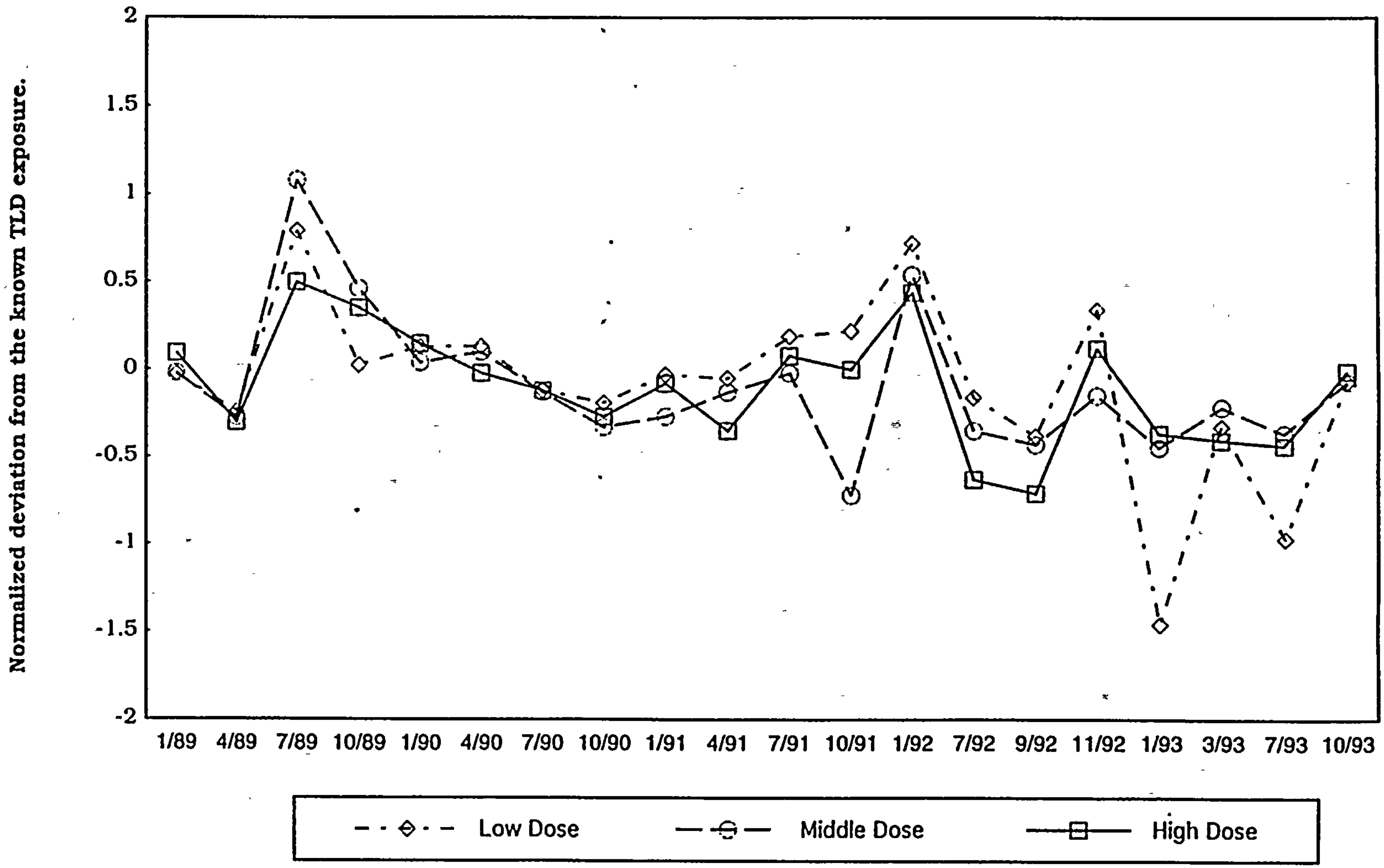
Typical exposures are between 20 and 80 mR. The TLDs are read on each of the three Model 8300 Readers in the environmental TLD laboratory and the calculated results are reported to the QA manager. The QA manager evaluates the results and writes a report discussing the performance of the labs.

For 1993 all results were within the requirements of Regulatory Guide 4.13, Section C. The standard deviations were less than 7.5% and the variations from the known were less than 30%. The accompanying graphs show the normalized deviations of the measured doses to the exposure doses for each of the three readers.

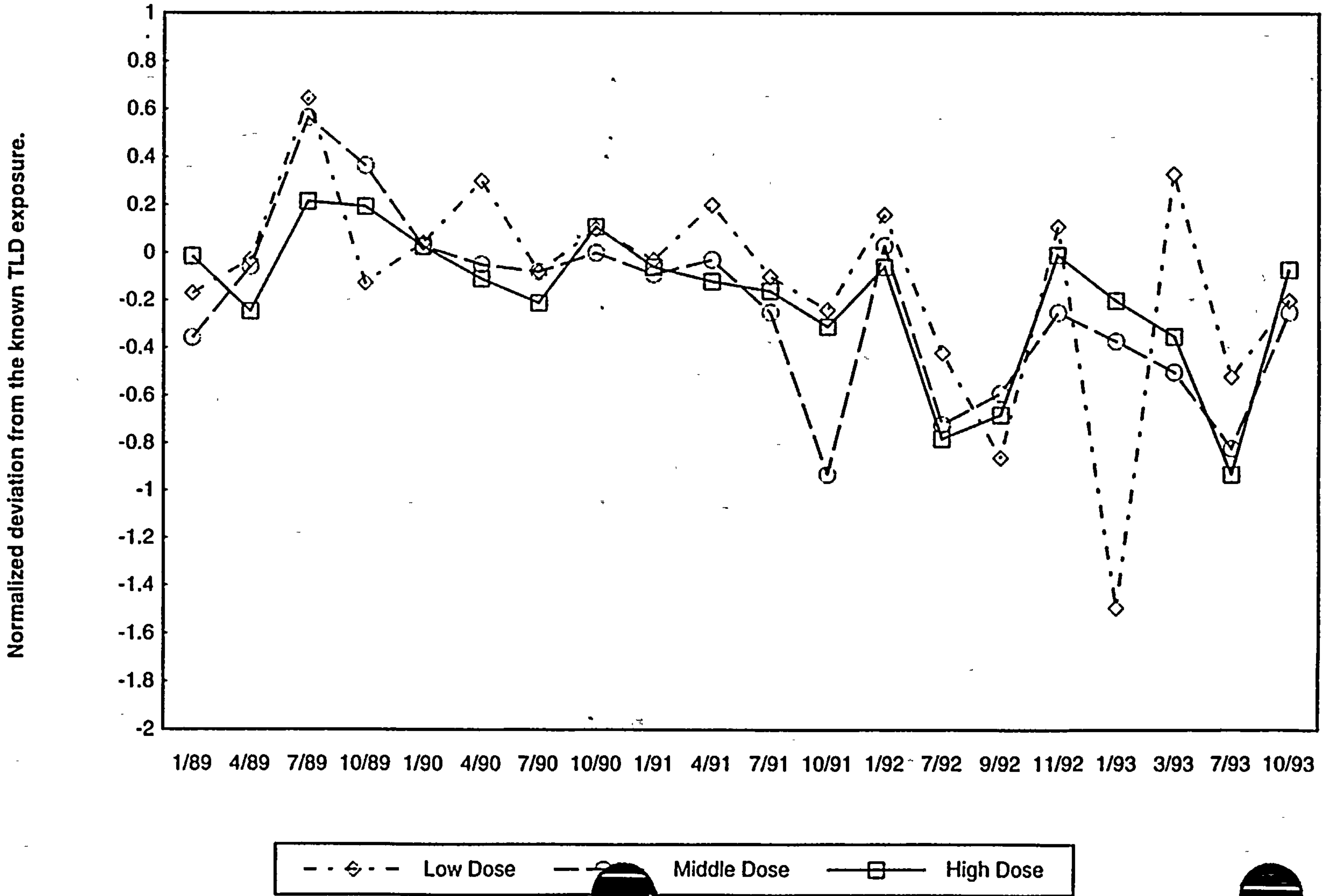
QUALITY CONTROL - TLDS
TLD READER 205



QUALITY CONTROL - TLDS
TLD READER 211

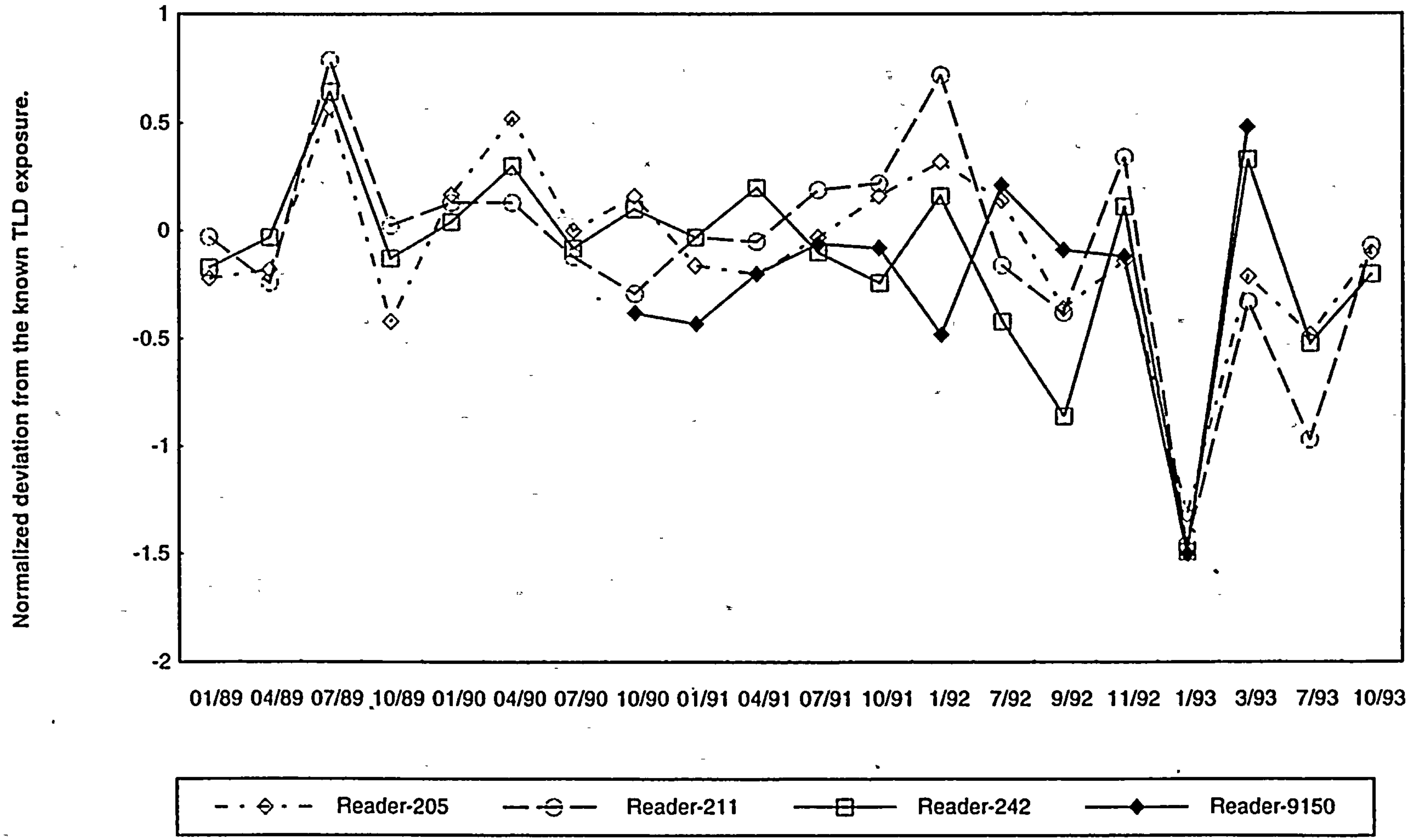


QUALITY CONTROL - TLDs
TLD READER 242



QUALITY CONTROL - TLDs

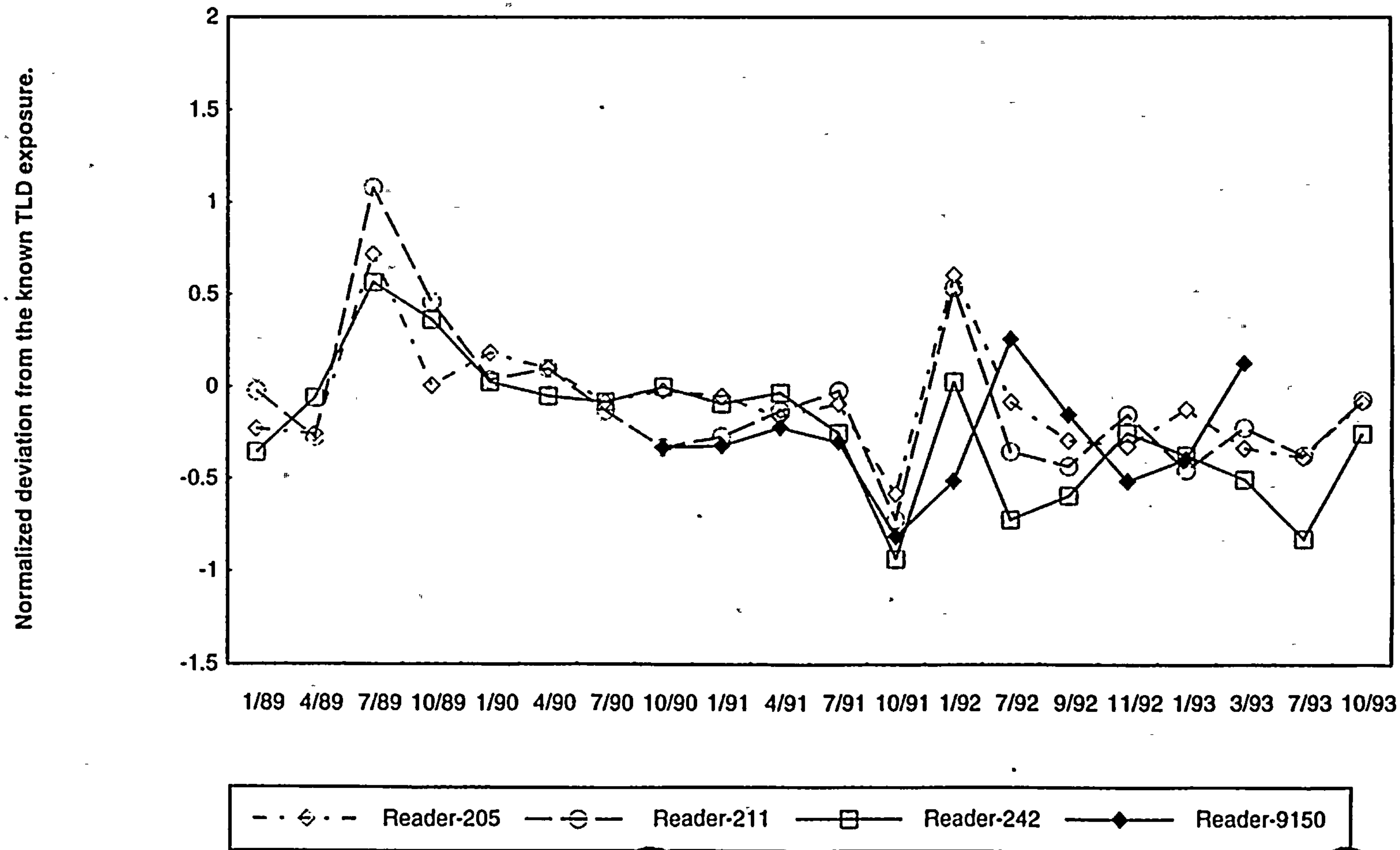
LOW DOSE



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

QUALITY CONTROL - TLDs

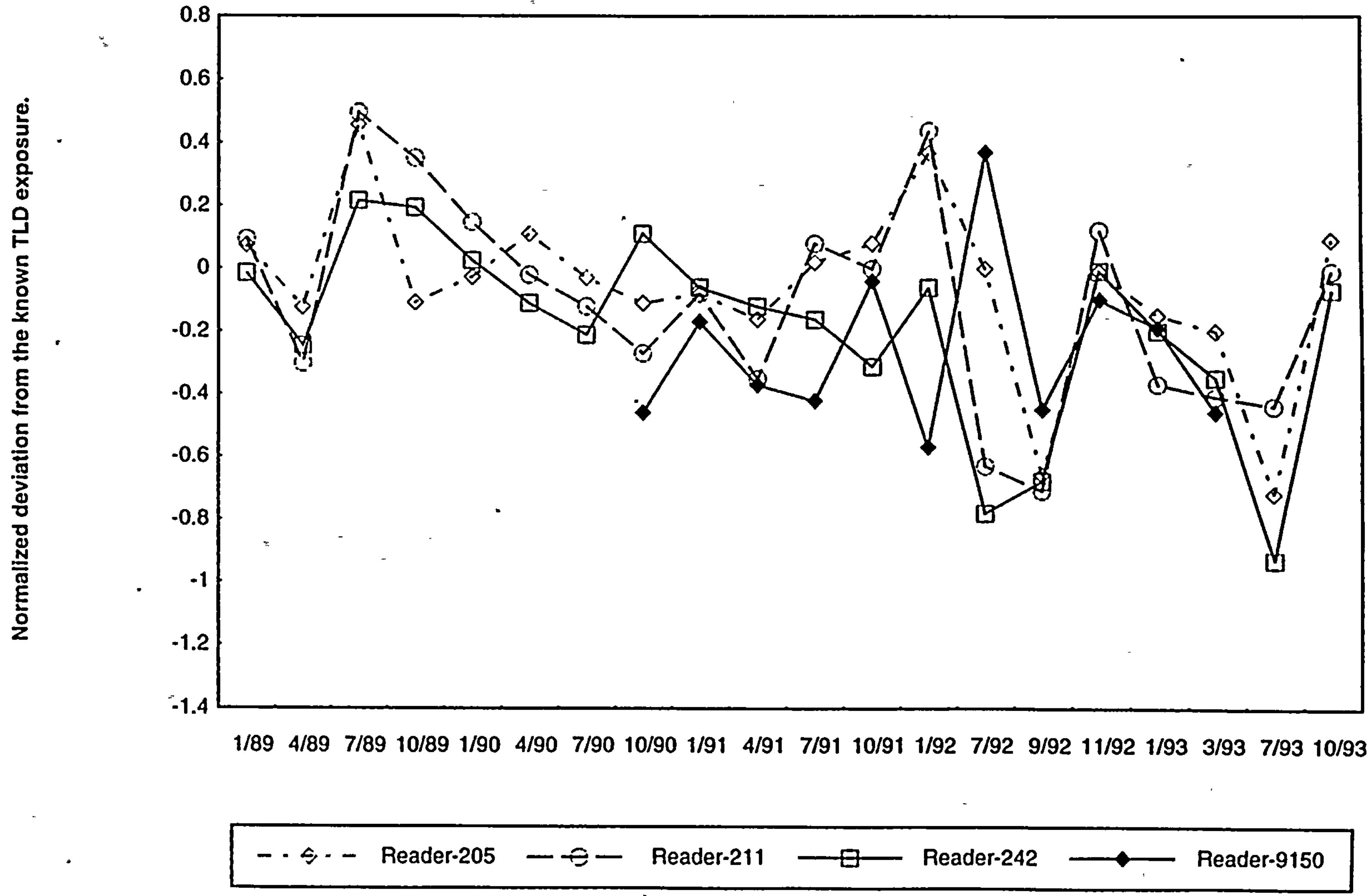
MIDDLE DOSE



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.