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April 24, 1995

AEP:NRC:08060

Docket Nos.: 50-315
50-316

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

Gentlemen:

Donald C. Cook Nuclear Plant Units 1 and 2
ANNUAL ENVIRONMENTAL OPERATING REPORT
JANUARY 1, 1994 TO DECEMBER 31, 1994

Attached herewith is the Donald C. Cook Nuclear Plant Annual Environmental Operating Report for the year 1994. This report was prepared in accordance with procedure 12 PMP 6010 OSD.001, "Offsite Dose Calculation Manual," section 4.8.1., and Technical Specification, Appendix B, Part 2, section 5.4.1.

Sincerely,

for E. E. Fitzpatrick
Vice President

blb

Attachment

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

IE25
11

Donald C. Cook Nuclear Plant • Units 1 & 2

Annual Environmental Operating Report

January 1, through December 31, 1994

Indiana Michigan Power Company
Bridgman, Michigan

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

9505030275

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I. INTRODUCTION

Procedure 12 PMP 6010 OSD.001, "Offsite Dose Calculation Manual," Section 4.8.1 and Technical Specification, Appendix B, Part 2, Section 5.4.1 require that an annual report, which details the results and findings of ongoing environmental radiological and non-radiological surveillance programs, be submitted to the Nuclear Regulatory Commission. This report serves to fulfill these requirements and represents the Annual Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1 through December 31, 1994.

During 1994, based on the monthly operating reports for Unit 1 and Unit 2, the annual gross electrical generation, average unit service factors, and capacity factors were:

Parameter	Unit 1	Unit 2
Gross Electrical Generation (MwH)	5,982,780	3,699,090
Unit Service Factor (%)	70.9	54.3
Unit Capacity Factor - MDC* Net (%)	65.7	38.0

* Maximum Dependable Capacity

II. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

There were no environmental Technical Specification changes in 1994.

III. NON-RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

A. Plant Design and Operation

During 1994, 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 fourteen environmental screenings during the reporting period. Copies of these screenings are located in Appendix II of this report. It was concluded that no environmental evaluations were required and that no unreviewed environmental questions existed.

B. Non-Routine Reports

A summary of the 1994 non-routine events is located in Appendix I of this report. No long-term, adverse environmental effects were noted.

C. Environmental Protection Plan

There were no instances of Environmental Protection Plan noncompliance in 1994.

D. Potentially Significant Unreviewed Environmental Issues

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

There were fourteen environmental screenings during the reporting period. Copies of these screenings are located in Appendix II of this report. The screenings determined that there were no unreviewed environmental questions.

E. Environmental Monitoring - Herbicide Application

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

Herbicide applications are the activities monitored in accordance with section 4.2. There were no preoperational herbicide studies to which comparisons could be made. Herbicide applications are controlled by plant procedure 12THP6020.ENV.104.

A summary of the 1994 herbicide applications is contained in Appendix III of this report. Based on observations, there were no negative impacts or evidence of trends toward irreversible change to the environment as a result of the herbicide applications. Based on our review of application records and field observations, the applications conformed with EPA and State requirements for the approved use of herbicides.

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

Macrofouler monitoring and control activities, and whole effluent toxicity testing during 1994 are discussed in Appendix IV of this report. Zebra Mussels remained under control in 1994. Whole effluent toxicity testing studies showed no adverse environmental impact.

IV. RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

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. Changes to the REMP

There were no changes to the REMP during 1994.

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

This report summarizes the collection and analysis of various environmental sample media in 1994 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.

Several measurememts of iodine-131 in charcoal filters and tritium measured at low levels in onsite wells, appear to be the only radionuclides attributable to the Donald C. Cook Nuclear Plant operation. However, the associated groundwater does not provide a direct dose pathway to man.

C. Land Use Census and Well Report

The Land Use Census is performed to ensure that significant changes in the immediate vicinity of the Donald C. Cook Nuclear Plant are identified. Any identified changes are evaluated to determine whether a modification must be made to the REMP or other related programs. No such changes were identified during the 1994 Land Use Census. A further discussion of the Land Use Census can be found in Appendix V of this report.

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

There were no changes in the solid, liquid, or gaseous radioactive waste treatment systems during 1994.

V. CONCLUSION

Based upon the results of the radiological environmental monitoring program and the radioactive effluent release reports for the 1994 reporting year, it can be concluded that there were no adverse affects to the environment or to the general public due to the operation of the Donald C. Cook Nuclear Plant.

APPENDIX I

NON-ROUTINE REPORTS

1994

1994 Non-Routine Events

February 22, 1994 - Plant personnel determined that the office building HVAC system was leaking water containing sodium nitrite. A notification was made to the Michigan Department of Natural Resources concerning the discharge of sodium nitrite (a closed loop corrosion additive) to Lake Michigan via the plant stormwater system. After identification of the leak, the corrosion additive chemical was not added to the system until the system was repaired. Repairs were made on March 7, 1994 and the system was placed back in service utilizing the corrosion additive.

June 6, 1994 - Plant personnel discovered sodium hypochlorite leaking through the floor grating above the forebay discharging to Lake Michigan. Analysis indicated a total residual chlorine value that exceeded our NPDES permit.

APPENDIX II

ENVIRONMENTAL SCREENINGS REPORTS

1994

AMERICAN ELECTRIC POWER

Date January 7, 1994

Subject Environmental Screening
Plant Modification 01-PM-1415
Modification of Steam Generator Blowdown Moisture Separator Piping

From G. P. Arent

To 01-PM-1415 Packet

Introduction

Plant Modification 01-PM-1415, Revision 0, proposes to modify the inlet piping to the steam generator blowdown startup flash tank (SUFT) moisture separators to ensure that the moisture separators receive equal flow. Additionally, the drain line from the moisture separators will be increased from two (2) inches to four (4) inches. The purpose of this modification is to minimize the water carry over currently being experienced from the Unit One steam generator startup flash tank moisture separators.

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 modifying the SUFT moisture separators.

As discussed previously, plant modification 01-PM-1415 proposes to modify the inlet piping configuration to the steam generator blowdown startup flash tank moisture separators and increase the size of the separator drain lines. The additional water entrained as a result of this configuration change will be drained via the turbine room sump overflow line to Lake Michigan.

The changes proposed by this modification do not impact the assumed steam generator blowdown effluent flow assumed in the NPDES permit, the FES or the plant offsite dose calculation manual. The assumed flowrate of 500 gpm is based on the amount of blowdown being admitted into the startup flash tank, therefore, the additional water being drained to the turbine room sump overflow line, as a result of the piping modification does not constitute an increase in the effluent released.

Based on the above review, it has been determined that the proposed modification of the blowdown startup flash tank moisture separator piping configuration will not result in a condition inconsistent with the existing environmental assumptions made for the Cook Nuclear Plant.

Intra-System

Conclusion

Based on this review of plant modification 01-PM-1415, 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) 01-PM-1415, Revision 0, Modification of Steam Generator Blowdown Moisture Separator Piping.
5) PMP 6010.OSD.001, Revision 6, Offsite Dose Calculation Manual.

Keywords

steam generator blowdown
startup flash tank
environmental

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

c: D. L. Eads
D. M. Fitzgerald/J. Carlson
J. P. Novotny
J. E. Trader
DC-N-6370.1

AMERICAN ELECTRIC POWER

Date February 15, 1994

Subject Environmental Screening
Use of Ethanolamine (ETA) for Plant Heating Boiler Corrosion/Erosion Control

From G. P. Arent

To D. M. Fitzgerald

Introduction

Revision One (1) to procedure 12 THP 6020.COP.301, "Heating Boiler", proposes the use of ethanolamine(ETA) also known as monoethanolamine at Cook Nuclear Plant for the purpose of pH control in the plant heating boiler. The use of ETA will improve the pH in the heating boiler and therefore, lower corrosion/erosion ratios and reduce corrosion transport. The use of ETA in the secondary system on both Units One and Two has previously been reviewed and approved. Additionally, notification of the proposed use of ETA in the heating boiler was provided to the Michigan Department of Natural Resources (MDNR) on February 9, 1994.

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 the use of ETA in the plant heating boiler.

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

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

No. The use of 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 for the plant heating boiler 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.

Draining of the plant heating boiler to the turbine room sump and ultimately to the absorption pond is generically included in the discussion of chemical effluent to the absorption pond in the FES.

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 heating boiler blowdown (equivalent to the steam generator blowdown) effluent. In the notification submitted to the MDNR, the release concentration of ETA was stated to be below the 20 mg/l limit stated in the FES.

A review of the NPDES Permit was also performed to determine if the additional effluent being discharged to the absorption pond, during draining of the plant heating boiler in preparation for startup, 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 use of ETA. The discharge of ETA via the turbine room sump was also discussed in the notification to the MDNR.

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 4) 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 plant heating boiler pH control at Cook Nuclear Plant does not result in a condition inconsistent with the existing environmental assumptions made for Cook Nuclear Plant.

Conclusion

Based on this review of the use of ETA for plant heating boiler 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, D. L. Baker to Mr. Fred Morley and Mr. Thomas Leep, "NPDES Permit No. MI0005827 Cook Nuclear Plant, Bridgman, Michigan", February 9, 1994.

Keywords

turbine room sump
plant heating boiler
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 February 21, 1994

Subject Environmental Screening
Addition of Automatic Air Release Vent to Sodium Hypochlorite System

From G. P. Arent

To J. J. Satin

Introduction

The proposed enhancement to the sodium hypochlorite injection system installs an automatic air release vent in the solution pump discharge header to the diffuser control valves. Effluent from the vent will be directed into a bermed, fifty-five (55) gallon drum, which will be located on the south side of the screen house next to the number twenty-one (21) circulating water pump. The purpose of this vent is to ensure that the discharge header remains full and that the sodium hypochlorite injection system can operate in the continuous chlorination mode, as designed.

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 an automatic air release vent on the sodium hypochlorite injection system.

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

No. The installation of an automatic air release vent will not result in an adverse environmental impact previously evaluated in the FES.

The FES recognizes the potential affects of circulating water system chlorination and requires the monitoring of such evolutions. The monitoring requirement is satisfied by the use of two in-line chlorine analyzers. In addition to monitoring, the analyzers also provide a system shutdown function (when the system is in automatic) which trips the system prior to the total residual chlorine level reaching the NPDES limit.

In the event that the automatic air release vent were to fail in the "full open" position, the afore mentioned trip function would prevent the level of total residual chlorine from exceeding the NPDES limit. Therefore, no increase in the effluent released or potential for significant adverse environmental impact is identified as a result of this change.

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

No. The chlorination of plant systems and the potential impact of this activity have been previously addressed in the FES.

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

No. As discussed in question one, the amount of effluent released to the environment will not be changed. The addition of the automatic air release vent is required to allow the system to function as designed and therefore does not represent an addition to the quantity of constituency of the system effluent. In the event that the automatic air release vent were to fail, the sodium hypochlorite system would automatically shutdown (when the system is in the automatic mode) prior to the total residual chlorine level exceeding the NPDES permit value.

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

No. The authorized power level of Unit One and Unit Two is unaffected by this change

Will a previously undisturbed area be impacted by this activity ?

No. This change is related to effluent releases via Outfalls 001 and 002 and does not impact site land areas.

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

No. In a memorandum from D. L. Baker to Messrs. Fred Morely and Tomas Leep of the Michigan Department of Natural Resources, dated March 15, 1993, the continuous chlorination of the essential and non-essential service water systems was addended to the Cook Nuclear Plant NPDES Permit.

Based on the above review, it has been determined that the proposed addition of an automatic air release vent in the sodium hypochlorite system will not result in a condition inconsistent with the existing environmental assumptions made for the Cook Nuclear Plant.

Open Items

While the addition of the automatic air release vent poses no significant environmental impact, as discussed previously, it does represent a potential personnel safety concern.

Based on discussions with J. Novotny of AEPSC Environmental Engineering, the following issues must be addressed as part of the installation of the automatic air release vent.

1. The design calls for the use of a bermed, fifty-five gallon drum to collect any vented sodium hypochlorite. This drum must be covered to reduce the release of fumes from the sodium hypochlorite.

2. A placard should be made and installed at the location of the fifty-five gallon drum which clearly identifies the potential content of the drum. This placard should be consistent with other chemical safety information placards used at the plant.

3. Consideration should be given to periodically inspecting the barrel and providing a means to drain the barrel of sodium hypochlorite and returning it back to the sodium hypochlorite storage tank should the need arise.

Conclusion

Based on this review of the proposed addition of an automatic air release vent, it is concluded that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

The issues raised in the "open items" section of this memo should be addressed to ensure a personnel safety concern 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-0801, Revision 1, Sodium Hypochlorite Injection Panel Enhancements

Keywords

sodium hypochlorite
zebra mussels
circulating water
environmental

Approved by: Doug Malin 2/21/94
D. H. Malin, Manager
Licensing and Fuels

c: D. L. Eads
D. M. Fitzgerald/J. Carlson
J. P. Novotny
DC-N-6370.1
Steve Brewer
Doug Malin

AMERICAN ELECTRIC POWER

Dato April 11, 1994

Subject Environmental Screening Memorandum, RFC-12-3110
Addition to the South Security Control Center

From G. P. Arent

To RFC-12-3110 Packet

Introduction

RFC-DC-12-3110, proposes the construction of an addition to the south security control center for the purpose of housing a new security computer system and other support equipment. The building will be a twenty five by forty foot (25' x 40') concrete structure located entirely within the protected area. Construction of the building will require the filling of one of five existing transformer catchbasin drywells with gravel.

Review Action Taken

The Final Environmental Statement (FES), the Updated Final Safety Analysis Report and Questions, the National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential impact of constructing the building.

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

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

No. The addition of the new building will not result in an increased adverse environmental impact as discussed in Section VII of the FES. The proposed location of the south security control center is within the protected area and will only affect ground which has been "previously disturbed".

Secondly, the elimination of one drywell (through filling) will not significantly reduce the drainage systems capability to handle stormwater runoff (resulting from assumed rainfall).

Intra-System

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

No. The construction of buildings on the site is discussed in the FES. Since this proposed building is located within the protected area and affects only previously disturbed ground, there is no adverse environmental impact not previously evaluated.

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

No. The proposed addition of a building at the south security control center will not effect site effluent.

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity ?

No. As stated earlier, the proposed building will be constructed within the existing protected area and on ground "previously disturbed". Trenches necessary to for support cabling will also be excavated within the protected area and on ground previously disturbed. Therefore, undisturbed areas will not be impacted.

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

No. None of the environmental permits at the site are affected by this proposed construction.

In support of this construction activity a Berrien County Soil Erosion and Sedimentation Control Permit and a Michigan Department of Natural Resources Critical Dune Permit have been requested and approved. No special limitations or restrictions were identified in these permits specific to the construction activity discussed above.

Based on the above screening, it has been determined that the construction of an addition to the south security control center at Cook Nuclear Plant does not result in a condition inconsistent with the existing environmental assumptions. The findings of the above screening were discussed with Messrs. J. P. Novotny of the Environmental Engineering Section, J. P. Carlson and R. D. Beem of the Environmental Safety and Health Department at Cook Nuclear Plant. Based on these discussions, the construction of the south security control center is considered acceptable.

Open Item(s)

During this review it was determined that a question exists concerning the adequacy of the transformer catchbasin drainage systems capacity during a transformer fire event. It is clear, based on the sizing of the existing system, that the operation of the transformer deluge during a fire event has the potential to overwhelm the existing system.

This issue does not impact the activity proposed by RFC-DC-12-3110.

The transformer catchbasin drainage capacity issue will be addressed as part of the upgrade of the catchbasin under PM-691.

Conclusion

Based on this review of the proposed construction of an addition to the south security control center, the Nuclear Licensing and Fuels Section concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973
4) Memo, R. D. Beem to G. P. Arent, RFC-3110 Environmental Information, April 8, 1994.
5) Memo, G. F. Zych to W. P. Modry et. al., Cook Nuclear Plant RFC-3110, File DC-C-0550, February 9, 1994.
6) Michigan Department of Natural Resources Critical Dune Permit, Dated April 6, 1994.
7) Berrien County Soil Erosion and Sedimentation Control Permit, Dated April 8, 1994.

Keywords

south security control center
construction permit

Approved by: Doug Malin 4/11/94
D. H. Malin, Manager
Nuclear Licensing and Fuels

c: S. J. Brewer
V. S. Craig
J. Pollack
D. M. Fitzgerald/J. Carlson/R. D. Beem
P. Stathakis
J. P. Novotny
DC-N-6370.1

AMERICAN ELECTRIC POWER

Date April 12, 1994

Subject Cook Nuclear Plant Environmental Screening Memorandum, Installation of Sulfuric Acid Tank for Reverse Osmosis Unit

From G. P. Arent

To R. D. Beem

Introduction

The installation of a temporary, 2000 gallon sulfuric acid storage tank has been proposed to support the processing of demineralized water via the reverse osmosis unit (RO unit). The installation of this tank will reduce the potential for safety and environmental risks associated with using sulfuric acid to reduce scaling of the RO unit membranes. Sulfuric acid is currently being provided through the use of fifty five gallon drums.

Review Action Taken

The Final Environmental Statement (FES), the Updated Final Safety Analysis Report and Questions, the National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential impact of installing a temporary 2000 gallon sulfuric acid tank.

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

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

No. The installation of a temporary, 2000 gallon sulfuric acid storage tank will not result in a significant increase in any adverse environmental impact previously evaluated in the FES. The storage of sulfuric acid in above ground tanks was not specifically discussed in the FES.

The use of a secondary containment tank design (the 2000 gallon tank sits within a 3000 gallon containment tank) in accordance with State of Michigan requirements will prohibit the release of sulfuric acid from a single failure event. It is therefore considered acceptable to provide above ground storage capability for sulfuric acid.

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

No. As discussed previously, the use of an above ground storage tank for sulfuric acid was not previously evaluated by the FES. It is concluded however, that the design of the tank (secondary containment) essentially eliminates the threat of a tank rupture resulting in the spillage of sulfuric acid. Therefore, the need for further evaluation of a potential sulfuric acid spill to the stormwater system is considered unwarranted.

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

No. The proposed installation of a sulfuric acid storage tank will have no effect on the constituency of ground, storm or surface water discharges currently evaluated for Cook Nuclear Plant.

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity ?

No. The temporary sulfuric acid tank will be set on an existing asphalt roadbed located on the west side of the plant within the protected area. Therefore, undisturbed areas will not be impacted.

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

No. Prior to the use of the reverse osmosis unit in the first quarter of 1993, a notification was made to the Michigan Department of Natural Resources in accordance with Part II.A.2 of the Cook Nuclear Plant NPDES permit. No additional notice is required to utilize a sulfuric acid storage tank in place of fifty five gallon drums to support the operation of the RO unit.

Based on the above screening, it has been determined that the proposed installation of a 2000 gallon sulfuric acid storage tank on the west side of the Cook Nuclear Plant will not result in a condition inconsistent with the existing environmental assumptions. In support of this determination, discussions were held with Messrs. W. J. Lentz of the Operations Department, J. P. Carlson and R. D. Beem of the Environmental Safety and Health Department at Cook Nuclear Plant on April 9, 11 and 12, 1994. Based on these discussions and the information provided therein, the installation of the temporary sulfuric acid storage tank is considered acceptable.

Open Item(s)

In discussions with R. D. Beem and W. J. Lentz, it was determined that a the hoses connecting the temporary sulfuric acid storage tank and the RO unit will be 3/8" plastic tubing. Consideration should be given to double wall tubing or some other type of chemically compatible hoses to ensure that failure of a single tube would not result in a spill of sulfuric acid.

Conclusion

Based on this review of the proposed installation of a temporary 2000 gallon sulfuric acid storage tank on the west side of the Cook Nuclear Plant, the Nuclear Licensing and Fuels Section concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973
4) Memo, R. D. Beem to G. P. Arent, Environmental Evaluation Request - RO Acid Tank, April 6, 1994.
5) Memo, D. L. Baker to Mr. Fred P. Morely, NPDES Permit No. MI0005827, Cook Nuclear Plant (Topic: Use of Reverse Osmosis Unit), January 22, 1993.

Keywords

reverse osmosis unit
sulfuric acid

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DC-N-6370.1

AMERICAN ELECTRIC POWER

Date April 13, 1994

Subject Cook Nuclear Plant, Environmental Screening Memorandum
Use of Carbohydrazide in Condensate/Feedwater System

From G. P. Arent

To J. P. Carlson

Introduction

The Cook Nuclear Plant proposes the use of carbohydrazide as an oxygen scavenger during condensate flushing. The use carbohydrazide in place of hydrazine enhances the effectiveness of oxygen scavenging and system surface protection at low condensate and feedwater system temperatures.

The product name for the carbohydrazide being used in this application is NALCO 1250 Oxygen Scavenger (12.1% by weight).

Review Action Taken

The Final Environmental Statement (FES), the Updated Final Safety Analysis Report and Questions, the National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential impact of using carbohydrazide in the condensate and feedwater systems.

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

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

No. The use of carbohydrazide as a water treatment additive was not identified as a contributor to an adverse environmental impact in the FES. A review of the Material Safety Data Sheet states that carbohydrazide does not contain hazardous ingredients under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Additionally, carbohydrazide is not an "Extremely Hazardous Substance" (as defined in 40CFR 355)" and does not contain ingredients listed on the Michigan Critical Materials Register.

Intra-System

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

No. While carbohydrazide was not originally identified as a water treatment additive in the FES, hydrazine (of which carbohydrazide is a breakdown product at high temperatures, greater than 275° Fahrenheit) was identified. Hydrazine was added as an oxygen scavenger, carbohydrazide will be utilized in the same manner and has been shown to perform in a superior manner at low temperatures.

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

No. The existing hydrazine concentration expected in the plant steam generators and the auxiliary heating boiler blowdown effluent is not defined in the current NPDES permit.

During the initial use of carbohydrazide the highest level expected in the effluent exiting the plant at outfall 001 is 0.34 ppb and outfall 002 is 0.005 ppb. These effluent values, do not pose a significant impact in the effluent constituent or quantity.

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity ?

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

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

No. The NPDES Permit will not be formally changed to allow for the use of carbohydrazide.

Notification of the use of carbohydrazide 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 breakdown products of carbohydrazide (nitrogen, carbon dioxide and water) and residual carbohydrazide would potentially released through our surface water outfalls. As stated previously, none of these constituents is expected to exceed the effluent limitations as specified in the NPDES Permit.

Based on the above screening, it has been determined that the use of carbohydrazide for oxygen scavenging and the protection of system surfaces at Cook Nuclear Plant does not result in a condition inconsistent with the existing environmental assumptions. In support of this determination, discussions were held with Messrs. M. J. O'Keefe of the Radiological and Chemical Support Section and J. P. Carlson of the Environmental Safety and Health Department at Cook Nuclear Plant on April 12 and 13, 1994. Based on these discussions and the information provided therein, the use of carbohydrazide in the condensate and feedwater systems is considered acceptable.

Open Item(s)

It was noted during this review, that the proposed usage date for carbohydrazide was April 15, 1994. Based on conversations with J. P. Carlson, the Michigan Department of Natural Resources has approved the use of carbohydrazide, therefore usage may start as desired (provided all other administrative requirements are satisfied).

Conclusion

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

References

1) Unit 1 and 2 Technical Specifications Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973
4) Memo, M. J. O'Keefe to J. B. Kingseed, Donald C. Cook Nuclear Plant Safety Review of Carbohydrazide as an Oxygen Scavenger During Condensate Flushing, April 13, 1994.
5) Memo, D. L. Baker to Mr. Fred Morley, Donald C. Cook Nuclear Plant NPDES Permit No. MI 0005827, (Topic: Use of Carbohydrazide), March 25, 1994.

Keywords

condensate
feedwater
carbohydrazide
npdes permit

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AMERICAN ELECTRIC POWER

Date May 20, 1994

Subject Environmental Screening
Installation of 12KV/600v Support Transformer per 12-PM-790

From G. P. Arent

To 12-PM-790 Packet

Introduction

Plant modification 12-PM-790 proposes to install a 12KV/600v oil filled, stepdown transformer in support of the operation of the sewage treatment plant. The identified location of this transformer is approximately 25 feet due east of the south sewage treatment building in a parking area at the foot of the dune which runs northeast to southwest (see drawing 12-13900 and 12-1397). In addition to the transformer and its associated bermed pad, a 12 KV cable run from the transformer to a manway west of the south sewage treatment building will be excavated.

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 the transformer and excavating the 12 KV cable run.

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

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

No. The installation of a 12KV/600v stepdown transformer and trenching in support of the 12KV cable run will not result in an increased adverse environmental impact as discussed in Section VII of the FES. The proposed location of the transformer and the cable run affect ground which has been "previously disturbed" (e.g., transformer will be placed in an existing parking area and cable run trenching will be preformed on the existing road bed). The placement of the transformer and the trench path were verified on site, on May 19, 1994 with Mr. M. R. Hurray of the Project Engineering Section.

Intra-System

Is the proposed activity a matter <u>not</u> previously evaluated in the Final Environmental Statement ?

No. The installation and construction of site support structures is discussed in the FES. Since the proposed transformer, bermed pad and trenching affects only previously disturbed ground, there is no adverse environmental impact not previously evaluated.

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

No. The proposed installation of the transformer and trenching activities in support of the 12KV cable run will not affect site effluent. Additionally, the bermed transformer pad is provided with a normally closed drain valve which will prevent any leakage from the transformer to the environment from being discharged without detection, sampling and treatment (if required).

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

No. The authorized power level of Unit One and Unit Two is unaffected by this change

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

No. As stated earlier, the proposed transformer, transformer pad and trenching activity related to the 12 KV cable run will affect only ground that has been "previously disturbed". Therefore, no previously undisturbed areas will be impacted.

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

No. None of the environmental permits at the site are affected by this proposed construction.

In support of this construction activity a Berrien County Soil Erosion and Sedimentation Control Permit and a Michigan Department of Natural Resources Critical Dune Permit will have to be requested and approved. If special limitations or restrictions are identified actions shall be taken satisfy these requirements during the installations and trenching proposed by this project.

<u>Open Items</u>

As discussed previously, a Berrien County Soil Erosion and Sedimentation Control Permit and a Michigan Department of Natural Resources Critical Dune Permit will have to be requested and approved prior to commencing any excavation associated with PM-790.

Based on the above screening, it has been determined that the installation of a 12KV/600v transformer, transformer pad and trenching activities associated with the 12KV cable run at Cook Nuclear Plant does not result in a condition inconsistent with the existing environmental assumptions. The findings of the above screening were discussed with Messrs. J. P. Novotny of the environmental engineering section, and J. P. Carlson of the environmental safety and health department at Cook Nuclear Plant. Based on these discussions, the implementation of the above portion of 12-PM-790 is considered acceptable.

Conclusion

Based on this review of the proposed installation of a 12KV/600v transformer and associated pad and 12 KV cable run, it is concluded that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

The issues raised in the "open items" section of this memo shall be addressed prior to excavation activities associated with this modification.

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) Drawings 12-13900, 12-1397 and 12-AEQS-162

Keywords

south sewage treatment plant
12KV/600v transformer

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AMERICAN ELECTRIC POWER

Date June 3, 1994

Subject Donald C. Cook Nuclear Plant
Environmental Screening
Review of Proposed Procedure 12-PMP 6010.RPP.700 Revision 0

From G. P. Arent

To 12-PMP 6010.RPP.700 Packet

Introduction

In response to INPO SOER 93-01, Diagnosis and Mitigation of Reactor Coolant System Leakage Including Steam Generator Tube Ruptures, Cook Nuclear Plant has developed a response procedure for processing contaminated secondary water. Procedure 12-PMP 6010.RPP.700 provides for the establishment of a water recovery task force who will determine the appropriate means of collecting and processing the waste water. The philosophy of this procedure is to collect and recycle any secondary waste water resulting from an event versus releasing the waste water as effluent.

The purpose of this environmental screening is twofold. First, the screening will determine whether or not the contingency actions provided in the procedure are consistent with the existing environmental regulations at Cook Nuclear Plant. Secondly, the screening will respond to a question raised by Mr. J. P. Carlson of Cook Nuclear Plant which stated: "...whether or not a notification to the Michigan Department of Natural Resources (MDNR) concerning a change to the NPDES permit would be necessary in the event of a steam generator tube rupture." This question is concerned with whether changes to the permit are necessary today or whether we would interface with the MDNR at the time of the event.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) Permit, Updated Final Safety Analysis (UFSAR) and Appendix B of Technical Specifications were reviewed in support of this screening to determine the potential environmental impact of implementing the contingency actions delineated in the procedure.

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

No. The philosophy of 12-PMP 6010.RPP.700 is to capture and process secondary waters contaminated as a result of a steam generator tube rupture or similar event prior to release. This is consistent with the FES which assumes that contaminated waste water (primary or secondary*) will be processed prior to release.

* Steam generator blowdown

Intra-System

The FES also assumes that the potential for plant accidents exist. The FES states: "The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. ...It was concluded from the results of the "realistic" analysis that the environmental risks due to postulated radiological accidents are exceedingly small." Included in this analysis was the probability of a steam generator tube rupture.

Additional discussions with the Nuclear Safety Section regarding the probabilistic risk assessment confirmed the fact that the probability of a steam generator at Cook Nuclear Plant was small (7.2×10^{-3}).

Based on the fact that contaminated water will be contained and processed prior to release and that the accident assumptions described in the FES are still valid, this event is not considered to result in a significant increase in any adverse environmental impact previously evaluated in the Final Environmental Statement.

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

No. Please see the response to question one.

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

No. As described in the response to question one, the FES addresses the potential for an accident condition to occur at Cook Nuclear Plant. Inferred in this assumption is the fact that waste waters resulting from an event will exist and be subsequently processed and released.

Additionally; the UFSAR (Section 14.2.4) indicates that, "The recovery and cleanup would be relatively long term due to the secondary side chemicals present, and might require installation of special resins in a demineralizer to remove these." Procedural guidance is provided to ensure the chemical profile of the proposed release effluent is compared to the limits prescribed by the NPDES Permit.

Attachment three of the proposed procedure provides guidelines for releasing liquid effluent. These guidelines include the sampling and analyzing of the effluent in accordance with the off-site dose calculation manual (ODCM) to ensure release constituents are maintained within the limits of 10CFR 20.

Therefore, the contingency actions identified in 12-PMP 6010.RPP.700 are consistent with the assumptions in the FES, UFSAR and ODCM concerning quantity and constituency of the effluent.

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

No. The proposed procedure has no affect on the Unit One or Two authorized power level.

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

No. The contingency actions identified in the proposed procedure will not result in an impact on undisturbed site areas.

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

No. The proposed contingency actions identified by this procedure do not require a change to the existing NPDES Permit. The basis for this determination follows:

1. The waste water generated as a result of this event will be contained, processed and sampled prior to release. According to procedural guidance, the effluent limits defined by the NPDES Permit and the off-site dose calculation manual will govern the release.

2. At this time, the constituency of the potential effluent is unknown. As a result, specific limits could not be readily developed for inclusion in the NPDES Permit.

3. The probability of a steam generator tube rupture event occurring a Cook Nuclear Plant is small (7.2×10^{-3}). This has been addressed by the FES and confirmed by the probabilistic risk assessment. Inclusion of limits in the NPDES Permit for a low probability event is unwarranted.

4. Based on discussions in both the FES and the UFSAR, it is assumed that chemical analysis will be performed to determine the most appropriate means of processing prior to release. Once the constituency of the potential effluent is identified, notification to the MDNR at the time of the event, could be made if sample results indicated chemical concentrations outside the limits of the NPDES Permit.

Conclusion

Based on this review of the proposed procedure 12-PMP 6010.RPP.700, Revision 0, it is concluded that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

Additionally, it is concluded that a change to the NPDES Permit is not required at this time.

References

1) Unit 1 and 2 Technical Specifications Appendix B
2) UFSAR Section 12.2.4
3) NPDES Permit No. MI0005827, September 20, 1990
4) Final Environmental Statement, August 1973
5) 12-PMP 6010.RPP.700, Revision 0, "Draft", The Processing of Contaminated Water Generated in the Secondary System.

Keywords

soer 93-01
secondary system contamination
environmental

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AMERICAN ELECTRIC POWER

Date June 17, 1994

Subject Cook Nuclear Plant, Environmental Screening of a Temporary Modification: Installation of Temporary Sodium Hypochlorite System

From G. P. Arent

To S. E. Lehrer

Introduction

The temporary modification proposes to install a vendor (Betz Industrial) supplied temporary sodium hypochlorite system to support zebra mussel control in the service water system. The proposed system would include, 1) a bermed tank truck (to be replaced by a temporary tank at a later date), 2) three pump skids containing two pumps each and associated valving, and 3) polyethylene tubing to connect the pump skids to the essential service water and non-essential service water systems. The tank truck will be located on the west side of the plant, slightly north of the existing reverse osmosis unit. A berm with a capacity of 150% of the contents of the tanker will be provided. The pump skids will be located in the screen house between number eleven and twelve circulating water pumps. The pump skids will be provided with barrel berms to capture potential leakage. Polyethylene tubing will be routed from the skid pumps to six service water system connection points. One line will run to each of the four essential service water pump chlorination diffusers, one line will also be directed to each units non-essential service water suction line. Sodium hypochlorite will be injected at these points "clean" meaning that no mixing water will be delivered and that the chemical will be trickled into the system at a predetermined rate.

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 temporary sodium hypochlorite injection system.

In addition to the above documents, a draft copy of the proposed temporary modification as well as information from the vendor were reviewed. A telecon was also conducted between Cook Nuclear Plant representatives from Plant Engineering, Chemistry and Environmental, Safety and Health Departments and AEPSC Nuclear Licensing and Fuels Section and the Mechanical Support System Section on June 17, 1994 at 1000 hours to discuss the proposed temporary modification.

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

No. The installation of a temporary sodium hypochlorite system will not result in an adverse environmental impact previously evaluated in the FES.

The FES recognizes the potential affects of circulating water system chlorination and requires the monitoring of such evolutions. The monitoring requirement is satisfied by the use of two in-line chlorine analyzers. In addition to monitoring, the temporary sodium hypochlorite system is provided with a system shutdown function which trips the system when a header pressure of less than five (5) pounds per square inch is sensed.

In the event of a system piping failure, the aforementioned trip function in conjunction with the chlorine analyzer alarm would aid in preventing the level of total residual chlorine from exceeding the NPDES limit. Therefore, no increase in the effluent released or potential for significant adverse environmental impact is identified as a result of this change.

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

No. The chlorination of plant systems and the potential impact of this activity have been previously addressed in the FES.

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

No. As discussed in question one, the amount of effluent released to the environment will not be changed. The installation of the temporary sodium hypochlorite system temporarily replaces the existing permanent system to allow for repairs and improvements. The existing system had originally been reviewed and approved for operation by the Michigan Department of Natural Resources. The temporary system will operate in a similar manner and with the same chemical effluent limitations as the existing system. As a result, the temporary system does not represent an addition to the quantity of constituency of the system effluent.

As stated previously, in the event that a system failure occurs, the temporary sodium hypochlorite system would be expected to automatically or be manually shutdown prior to the total residual chlorine level exceeding the NPDES permit value.

Finally, the tanker, future storage tank and pump skids will be provided with berms designed to accept 150% of the total volume in the respective components being support. This would preclude an unexpected release of sodium hypochlorite due to a catastrophic failure of the component.

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

No. The authorized power level of Unit One and Unit Two is unaffected by this change.

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

No. This change is related to effluent releases via Outfalls 001 and 002 and does not impact site land areas.

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

No. In a memorandum from D. L. Baker to Messrs. Fred Morely and Tomas Leep of the Michigan Department of Natural Resources, dated March 15, 1993, the continuous chlorination of the essential and non-essential service water systems was addended to the Cook Nuclear Plant NPDES Permit.

Based on the above review, it has been determined that the proposed installation of a temporary sodium hypochlorite system will not result in a condition inconsistent with the existing environmental assumptions made for the Cook Nuclear Plant.

<u>Open Items</u>

This environmental evaluation was performed based on the information available on June 17, 1994 and telecon information provided by Cook Nuclear Plant and Betz Industrial. Significant changes to the proposed design of the temporary system, or changes in the concentration of the chemical used which could result in a variance from the existing NPDES permit will require an additional evaluation.

Do to the chemical properties of sodium hypochlorite, a potential personnel safety concern does exist. To address this potential concern, the following actions are recommended:

1. Placards should be made and installed at the location of the tanker/temporary storage tank which clearly identifies the content. This placard should be consistent with other chemical safety information placards used at the plant.

2. Consideration should be given to labelling the temporary polyethylene hoses which will be installed in the screen house to identify that chemicals will be transported in the tubing and who should be notified if a leak develops.

Conclusion

Based on this review of the proposed installation of a temporary sodium hypochlorite system, it is concluded that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

The issues raised in the "open items" section of this memo should be addressed to ensure a personnel safety concern 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) Draft proposed Temporary Modification for the Installation of a Temporary Sodium Hypochlorite System.
5) Memo, Baker, Donald L. to Messrs. Fred Morely and Tomas Leep, March 15, 1993, RE: NPDES Permit No. MI 0005827.

Keywords

sodium hypochlorite
zebra mussels
nesw
esw
environmental

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AEP
AMERICAN ELECTRIC POWER

Date June 20, 1994

Subject Environmental Screening
Circulatory Water System Biocide Application

From D. L. Mazzitti *DLM*

To 12 THP 6020 CHM.318 Packet

Introduction

A new procedure (12 THP 6020 CHM.318) is being proposed to chemically treat the circulating water system for the control of Zebra Mussels through the use of vendor supplied biocide and to detoxify biocide residual in the effluent prior to discharge to Lake Michigan. The purpose of this new procedure will be to replace 12 THP 6020 ENV.109, which specifically calls for chemical treatment of the circulating water system for Zebra Mussel control through the use of "Clam-Trol" CT-1. This new procedure will serve to change the type of biocide used at Cook Nuclear Plant, not the scope of the ongoing treatment process itself.

Review Action Taken

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of the technical specifications were reviewed in support of this screening to determine the potential environmental impact of this new procedure.

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

No. This new procedure for application of biocide for Zebra Mussel control in the circulating water system will not result in an adverse environmental impact previously evaluated in the FES.

The FES recognizes the potential effects of circulating water system chlorination ("Mortality could potentially reach 100% during the daily... chlorination of the condenser cooling water," p. VII-2), and requires operational monitoring to detect adverse effects.

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

No. The chlorination of plant systems and the potential impact of this activity have been previously addressed in the FES.

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

No. As stated in the Wastewater Discharge Application for renewal of the Cook Plant NPDES Permit (March 31, 1994), the concentration of any of the proposed treatment chemicals will be brought to within the water quality based effluent limits as required. Therefore, the amount of effluent released to the environment will not be changed.

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

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

Will a previously undisturbed area be impacted by this activity?

No. This change is related to effluent releases via Outfalls 001 and 002 and does not impact site land areas.

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

No. In a memorandum from D. L. Baker to Messrs. Fred Morely and Tomas Leep of the Michigan Department of Natural Resources, dated March 15, 1993, the continuous chlorination of the essential and non-essential service water systems was addended to the Cook Nuclear Plant NPDES Permit.

It is important to note that the Cook Nuclear Plant safety evaluation screening of THP 6020 CHM.318 has determined that this procedure change "requires a change to NPDES permit due to change in biocide." This analysis does not necessarily concur with the Cook Nuclear Plant determination. In a memorandum transmitting application for renewal of the Cook Nuclear Plant NPDES Permit from D. L. Baker to Messr. William E. McCracken of the Michigan Department of Natural Resources, dated March 31, 1994, several permit modifications were specified in order to improve Cook Nuclear Plant operations. One of the modifications, Attachment 3, Zebra Mussel Control Strategy, states the following:

> "Should non-oxidizing biocides be required, we (Cook Nuclear Plant) plan to use either Betz CT-2, Betz CT-4, Calgon H-130M, or Nalco 9210. We request the flexibility to use any Federal Insecticide, Fungicide, and Rodenticide Agency (FIFRA) approved non-oxidizing biocide." (Procedure 12 THP 6020 ENV.109 calls for the exclusive use of Betz Clam-Trol CT-1)."

As such, this new procedure will enable use of the stated biocide improvements incorporated in the Cook Nuclear Plant NPDES permit, particularly by allowing for a generic application of biocides.

Based on the above, it has been determined that the implementation of procedure 12 THP 6020 CHM.318 poses no significant environmental impact, as previously discussed.

Open Items

Procedure 12 THP 6020 CHM.318 poses no significant environmental impact. An application for renewal of the Cook Plant NPDES Permit, encompassing Attachment 3, was submitted to MDNR on March 31, 1994. A formal response is anticipated in the near future. Procedure implementation can occur prior to application renewal, however, if the MDNR response identifies other suitable controls to serve on an interim basis. These interim controls will have to be incorporated into this new procedure.

Conclusion

Based on this review of a new procedure to chemically treat the circulating water system for the combat of Zebra Mussels through the use of biocide, Nuclear Licensing and Fuels concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications, Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973
4) Memo, D. L. Baker to William E. McCracken, "NPDES Permit Renewal Application, No. MI0005827, Cook Nuclear Plant, Bridgman, Michigan", March 31, 1994

Keywords

Zebra mussels
Circulating water
Environmental

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AMERICAN ELECTRIC POWER

Date July 14, 1994

Subject Cook Nuclear Plant Units 1 and 2
Environmental Screening of a Temporary Modification: Installation of Temporary Sodium Hypochlorite System in Support of Circulating Water System Treatment

From G. P. Arent

To S. E. Lehrer

Introduction

The temporary modification proposes to install a vendor supplied (Betz Industrial) temporary sodium hypochlorite system to support zebra mussel and slime control in the circulating water system (specifically the main and feedpump condensers). The proposed system would include, 1) a bermed tank truck (to be replaced by a temporary tank at a later date), 2) one pump skids containing three pumps and associated valving, and 3) polyethylene tubing to connect the pump skids to the circulating water system (via the forebay upstream of the travelling screens). The tank truck will be located on the west side of the plant, slightly north of the existing reverse osmosis unit. A berm with a capacity of 150% of the contents of the tanker will be provided. The pump skid will also be located on the west side of the plant, north of the screenhouse. The pump skid will be provided with a barrel berm to capture potential leakage. Polyethylene tubing will be routed from the skid pump to two locations in the forebay upstream of the travelling screens. Sodium hypochlorite will be injected at these points in the forebay for approximately 155 minutes per day.

Review Action Taken

The Nuclear Licensing and Fuels Section has previously performed two environmental evaluations related to the installation and use of the temporary sodium hypochlorite system. One evaluation (memo: G. P. Arent to S. E. Lehrer, dated June 17, 1994) addressed the temporary installation of a sodium hypochlorite system in support of the essential service water and non-essential service water systems. The second evaluation (memo: D. L. Mazzitti to 12-THP 6020 CHM.318 Packet, June 20, 1994) addressed the procedural changes necessary to utilize the temporary system in support of the circulating water system needs.

A review of these two evaluations concluded that they bound the installation of the proposed temporary modification in support of the circulating water systems and that an additional environmental evaluation is not warranted.

Intra-System

Open Items

The original environmental evaluation was performed based on the information available on June 17, 1994 and telecon information provided by Cook Nuclear Plant and Betz Industrial. A subsequent review of the proposed additional sodium hypochlorite system in support of the circulating water system was performed in support of the temporary modification package (memo: G. P. Arent to Temporary Modification File, July 14, 1994). Significant changes to the proposed design of the temporary systems (i.e., use of berms around sodium hypochlorite supply and pump skids) or changes in the concentration of the chemical used which could result in a variance from the existing NPDES permit will require an additional evaluation.

The potential safety concerns identified in the previous memo (G. P. Arent to S. E. Lehrer, June 17, 1994) are applicable to this temporary modification, therefore the following actions should be taken.

1. Placards should be made and installed at the location of the tanker/temporary storage tank which clearly identifies the content. This placard should be consistent with other chemical safety information placards used at the plant.

2. Consideration should be given to labelling the temporary polyethylene hoses which will be installed in the screen house to identify that chemicals will be transported in the tubing and who should be notified if a leak develops.

Conclusion

Based on this review of the proposed installation of a temporary sodium hypochlorite system, it is concluded that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

The issues raised in the "open items" section of this memo should be addressed to ensure a personnel safety concern 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) Draft proposed Temporary Modification for the Installation of a Temporary Sodium Hypochlorite System.
5) Memo, Baker, Donald L. to Messrs. Fred Morely and Tomas Leep, March 15, 1993, RE: NPDES Permit No. MI 0005827.
6) Updated Final Safety Analysis Report (UFSAR) Section 10.6.2
7) Memo: G. P. Arent to S. E. Lehrer, June 17, 1994, "Cook Nuclear Plant, Environmental Screening of a Temporary Modification: Installation of Temporary Sodium Hypochlorite System."
8) Memo: D. L. Mazzitti to 12-THP 6020 CHM.318 Packet, June 20, 1994, "Circulatory Water System Biocide Application."

Keywords

sodium hypochlorite
zebra mussels
circulating water
environmental

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AMERICAN ELECTRIC POWER

Date August 10, 1994

Subject Environmental Screening
12 Kv Backup Power Distribution Loop

From D. L. Mazzitti

To 12-PM-1439 Packet

Introduction

A proposed design change at the Cook Nuclear Plant involves installation of a backup power distribution feed from the Livingston Road 12 Kv circuit to various site facilities in the event of a failure on the existing 12 Kv feeder circuit. A failure of this circuit, presently with no backup power supply, would cause a major disruption in the office building, RPAC, site engineering support building, warehouse #6/fab shop and sewage treatment facility. This proposed tie-in will be installed from the Smith Beach Access Road to Transformer #12-TR-FSW, located north of Warehouse #6/Fab Shop Building. The installation will involve about 300 feet of underground cable, which will necessitate some trenching.

Review Action Taken

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

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

No. This proposed design change for installation of a 12 Kv backup power distribution feed will not result in an adverse environmental impact previously evaluated in the FES.

The FES recognizes the potential effects of the impact of plant construction activities - on land, water, and human resources. It states that about one-half of the site has been altered during construction by leveling the dune areas for building and roads. The proposed design change will occur in the previously disturbed area away from the slope or toe of the dune. Trenching to install a portion of the feed will be placed in the existing roadway.

Intra-System

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

No. The potential effects of the impact of plant construction activities on the topography at the 650 acre Cook Plant site has been evaluated in the FES. Because the site is well concealed from the surrounding land, the impact of construction is small. Changes in surface erosion arising from soil runoff has been evaluated.

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

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

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

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

Will a previously undisturbed area be impacted by this activity?

No. While this proposed change will occur on site land areas, the installation will be placed in and adjacent to an existing roadway which represents disturbed land.

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

No. The proposed design changes will not require modifications to existing permits, but will require two new permits.

Open Item

Proposed design change 12-PM-1439 poses no significant environmental impact. An application for a Critical Dunes permit was submitted to the Michigan Department of Natural Resources on August 2, 1994 and is expected to be received by Indiana-Michigan Power Co. within 60 days. A Berrien County Soil Erosion Permit application was also submitted on August 2, 1994, and this permit is expected to be received by September 2, 1994. Both of these permits will be required prior to any excavation on site.

Conclusion

Based on this review of the proposed design change to install a 12 Kv power distribution feed, Nuclear Licensing and Fuels concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

References

1) Unit 1 and 2 Technical Specifications, Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August 1973

Keywords

12 KV Circuit
Environmental

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AMERICAN ELECTRIC POWER

Date September 8, 1994

Subject Donald C. Cook Nuclear Plant, Environmental Screening
Use of Sulfur Hexafluoride for Condenser Leak Detection

From D. L. Mazzitti

To J. P. Carlson

INTRODUCTION

The Cook Nuclear Plant proposes the use of sulfur hexafluoride (SF6) for condenser leak detection. Any leaks between the secondary system and the circulating water will be detected as non-condensable gases are evacuated through the condenser air ejectors. The use of SF6 instead of a helium-based test system enhances operational effectiveness of the units by not requiring the condensers to be taken out of service.

REVIEW ACTION TAKEN

The Final Environmental Statement (FES), National Pollutant Discharge Elimination System (NPDES) Permit and Appendix B of the technical specifications were reviewed in support of this screening to determine the potential environmental impact of using SF6 for condenser leak detection.

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

No. Use of SF6 gas to detect condenser leaks was not identified as a contributor to an adverse environmental impact in the FES. A review of the Material Safety Data Sheet indicates that SF6, which is colorless and odorless, does not contain hazardous ingredients under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Additionally, the small amount of SF6 gas (1.3 - 10 ppm) used is negligibly soluble in water, according to the MSDS. The MSDS further indicates that no human health hazards are currently known and that no evidence exists of adverse effects of repeated (chronic) overexposure.

Is the proposed activity a matter previously evaluated in the FES?

No. While SF6 was not originally identified as a water treatment additive in the FES, dilute sulfite (5 - 10 ppm) is discussed. The FES recognizes that this dilute sulfite will be oxidized quickly in the lake, so there is no need to consider this discharge as being different from the stream generator blowdown.

Intra-System

Similarly, the small amount of SF6 gas will come from solution in the discharge vaults (located in the plant screenhouse) or escape to the atmosphere beyond the discharge tunnel outlets. As far as fluorine is concerned, no control parameter exists for it in the D. C. Cook Nuclear Plant Chemical Constituent Administrative Specifications (12 THP 6020 Lab.041); therefore, no T/S limitation exists for its usage.

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

No. The SF6 gas should escape to the atmosphere, as discussed above.

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity?

No. The proposed use of SF6 will not result in activities related to site grounds, therefore, undisturbed areas will not be impacted.

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

No. The NPDES permit will not have to be formally changed to allow for the use of SF6. Notification of the use of SF6 was provided to the Michigan Department of Natural Resources (MDNR) on May 31, 1994, in accordance with our existing permit. The use of SF6 is not expected to exceed effluent limitations as specified in the NPDES Permit. As such, the use of SF6 for condenser leak detection is considered acceptable.

OPEN ITEMS

The projected usage date for SF6 is September 15, 1994 (M. J. O'Keefe memo to the writer, August 30, 1994). The MDNR verbally approved on August 29, 1994 the use of SF6 in response to the company's notification of May 31, 1994. Therefore, usage may start as desired (provided all other administrative requirements are satisfied).

CONCLUSION

Based on the review of the proposed use of SF6 in the circulating water for condenser tube leak detection, the Nuclear Licensing and Fuels Section concludes that an environmental evaluation is not required and that an unreviewed environmental question does not exist.

REFERENCES

1) Unit 1 and 2 Technical Specifications Appendix B
2) NPDES Permit No. MI0005827, September 20, 1990
3) Final Environmental Statement, August, 1973
4) Memo, M. J. O'Keefe to D. L. Mazzitti, Use of Sulfur Hexafluoride for Condenser Leak Detection, August 20, 1994.
5) Memo, John Carlson to Ms. Sylvia Heaton, Donald C. Cook Nuclear Plant NPDES Permit No. MI0005827, (Topic: Use of SF6), May 30, 1994.
6) Material Safety Data Sheet, Sulfur Hexafluoride (SF6)
7) D. C. Cook Nuclear Plant Chemical Constituent Administrative Specifications

KEYWORDS

sulfur hexafluoride
NPDES permit
circulating water
condenser tubes

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Env Letters

AMERICAN ELECTRIC POWER

Date December 18, 1994

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

From G. P. Arent

To M. J. O'Keefe

Introduction

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

Review Action Taken

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

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

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

Intra-System

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

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

3) Ethanolamine (ETA): an environmental screening (see reference 11) performed in October of 1993 determined that the use of ETA for pH control at D. C. Cook would not result in a condition inconsistent with the existing environmental assumptions made in the Cook Nuclear Plant Final Environmental Statement. The MDNR was informed of the use of ETA in the March 15, 1993 correspondence which included the high concentration of hydrazine notification (see reference 6). The self-imposed limit for ETA in the secondary system in the March 1993 submittal was less than 20 mg/l (20 ppm). Communications with the MDNR in April of 1994 stated the estimated ETA concentrations at the plant outfalls would average less than 10 ppb and not exceed a 100 ppb maximum. The proposed concentration of ETA in heating boiler and steam generators as defined in the matrices is 75 ppm, this would correlate to an estimated 3.5 ppb level at the plant outfalls.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

No. Authorized power level will not be affected.

Will a previously undisturbed area be impacted by this activity ?

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

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

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

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

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

Open Item(s)

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

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

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

Conclusion

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

References

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

Keywords

condensate
feedwater
carbohydrazide
hydrazine
ethanolamine
ammonia
npdes permit
plant heating boiler

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DC-N-6370.1

APPENDIX III

HERBICIDE APPLICATION REPORT

1994

INDIANA MICHIGAN POWER

Date March 7, 1995

Subject **1994 Herbicide Spray Report - Cook Nuclear Plant**

From J.S. Lewis

To J.P. Carlson

The following herbicides were applied on Cook Nuclear Plant property in 1994:

- Trimec 899 Broadleaf Herbicide
- Riverdale Tri-Power Selective Herbicide
- Barricade 65 WG Herbicide
- Lesco Pre-M 3.3 EC Herbicide
- Oust Herbicide
- Roundup Herbicide

Plant areas that were treated with herbicides include the switchyards, inside the protected area, along the railroad tracks, near the training center and visitor center, around miscellaneous warehouses and out buildings, and around the sewage treatment ponds and buildings.

Based on our review of the application records and observations of the treated areas, the herbicides were applied in accordance with the manufacturer label recommendations and according to Federal and State requirements. A certified applicator was used as required. No signs of overspray or spillage were observed or noted. No adverse environmental effects occurred.

APPENDIX IV

MACROFOULER MONITORING CONTROL PROGRAM, AND WHOLE EFFLUENT TOXICITY TESTING

1994

Aquatic Issues - 1994 Zebra Mussel Monitoring and Control Report

The following reports detail the 1994 zebra mussel monitoring and control activities performed at the Cook Nuclear Plant. The reports that follow summarize the efforts of the American Electric Power Service Corporation, Indiana Michigan Power Company/Cook Nuclear Plant, LMS Engineers, RUST/Brand Utility Services Inc., ARD Environmental, Inc., Great Lakes Environmental Center, Betz Industrial and the Ashland Chemical Company.

Indiana Michigan Power Company

Cook Nuclear Plant
1994 Zebra Mussel Monitoring
and Control Report
March 20, 1995

INTRODUCTION

The Plant's Zebra Mussel Monitoring and Control Program is presented in the reports that follow. Chlorine, molluscicides, and mechanical cleaning remain the zebra mussel control strategy at the Cook Plant. Papers on a telerobotics evaluation to remove zebra mussels from the floor of the screenhouse intake forebay and a pilot study to evaluate the use of chlorine dioxide to prevent zebra mussel settlement are also included.

Monitoring efforts continue to assess the threat of zebra mussel infestation and determine the effectiveness of plant control techniques. In 1994, a special winter bio-monitoring study similar to the one performed in 1992 was duplicated. Reports on the bio-monitoring studies by LMS and diver reports of zebra mussel infestation and mortality assessment in the aftermath of the September 1994 Clam-trol treatments are included.

A vendor supplied chlorination system was used to chlorinate the circulating and service water systems in 1994.

ERADICATION AND CONTROL MEASURES

The 1994 control strategy consisted of the use of a proprietary molluscicide (Clam-trol CT-2), continuous and intermittent chlorination of the service and circulating water systems, and mechanical cleaning.

MECHANICAL CLEANING

Mechanical cleaning of the intake forebays and essential service water pump bays was performed by divers during both the Unit 1 and Unit 2 refueling outages in 1994. The Unit 1 Main Condenser inlet tunnel was inspected and cleaned during the Unit 1 refueling outage. A robotics evaluation to clean zebra mussels from the floor of the circ. water intake forebay was performed during the Unit 2 refueling outage and is included in the attached reports. Cleaning and flushing of small bore piping and strainers in the service water systems and low volume water systems was continued in 1994. 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 1994.

CLAM-TROL TREATMENT RESULTS

A treatment of the intake forebay and circulating water system and a targeted treatment of the South Intake pipeline using Betz Clam-trol CT-2 was performed in 1994. Because the service water systems, misc. seal & cooling, and screenwash pump systems draw from the treated intake forebay water, they also received benefit from the treatment. A report to the Michigan DNR describing these treatements and the results of the whole effluent toxicity testing is attached.

CHLORINATION TREATMENT RESULTS

Chlorine, in the form of 12.5% sodium hypochlorite, was applied continuously and intermittently at a target end of pipe residual concentration of 0.5-1.0 mg/l in the service water systems and intermittently at a target rate of 0.2 mg/l in the Circulating Water System. The service water systems were chlorinated continuously from 22 June thru 1 August 1994 and intermittently from 5 August thru 26 November 1994. The Circulating Water system was chlorinated from 2 August thru 2 December 1994. A summary of the chlorination schedule and concentrations is included in Appendix A of the LMS monitoring report. Continuous chlorination of the service water systems proved to be very effective in the prevention of zebra mussel settlement. Intermittent chlorination of the service water systems was less effective as indicated on test substrates.

FOULING FROM THE INTAKE PIPELINES

The intake pipelines have been treated in the past with Clam-trol as deemed necessary and plant conditions allow. The North and the Center Intake pipelines were treated with Clam-trol in 1992 and the South Intake pipeline in 1994. 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.

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. Continuous chlorination has shown to be effective for controlling zebra mussels in the service water systems. 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.

Robotic Removal of Zebra Mussel Accumulations in a Nuclear Power Plant Screenhouse

S.R. Kotler, ARD Environmental, Inc., E.C. Mallen, Indiana Michigan Power Co./Cook Nuclear Plant, and K.M. Tamms, American Electric Power Service Corporation

Abstract

Zebra mussel accumulations in the power plant intake system have increased over the last four years and have become a maintenance issue. Several treatment methods have been used in combination, including molluscicides, chlorination and mechanical cleaning by divers.

Mechanical cleaning by divers is limited to areas of relatively low flow velocity. Various sections of the screenhouse are not accessible except during an outage or when one of the intake tunnels can be otherwise be blocked and flow reduced. In addition, diver services are relatively costly. For the above reasons, the Indiana Micigan Power Co., Cook Nuclear Plant, contracted with ARD Environmental Inc. to develop and test a robotic system as an alternative to cleaning by divers.

The first phase of this project addressed the requirement to clean the screenhouse floor in all areas, including those with high flow velocity. Subsequent phases will address robotic cleaning of other areas of the intake and the screenhouse structures.

The objectives of the project were to:

1) Demonstrate the ability to deploy and retrieve a modified XT1000 vehicle in the inlet bay and screen bays.

2) Remove the accumulations of zebra mussels and possibly other pumpable material from the floor.

3) Reduce or eliminate the need for diver services and reduce overall cost of removing accumulations of zebra mussels.

4) Critique operations and develop recommendations for further enhancements to the robotic equipment and materials handling system.

Implementation of the operating plan commenced on September 8, 1994, and was completed on October 7,1994. The project demonstrated that robotic techniques are an efficient and cost effective alternative to diver operations for mechanical removal of zebra mussels. In particular, the robotic system was able to operate effectively in the high flow velocity areas including those at the intake tunnels. The ability to operate in the high flow

areas means that zebra mussel removal may take place at any time, without affecting normal plant operations.

1 Introduction

Initial discussions were held with Cook Nuclear Plant personnel in mid-july, 1994. The purpose of these discussions was to define to project requirements, and discuss the approach to be taken by ARD Environmental, Inc. (ARDE), in performing the project. Pursuant to these discussions, ARDE prepared an Operating Plan, which described, in detail, the proposed system and equipment, the methods and procedures to be used, plant support requirements, and safety considerations. The Operating Plan also included a detailed project schedule (figure 1).

The objectives of the project were to:

1) Demonstrate the ability to deploy and retrieve a modified XT1000 vehicle in the inlet bay and screen bays.

2) Remove the accumulations of zebra mussels and possibly other pumpable material from the floor.

3) Reduce or eliminate the need for diver services and reduce overall cost of removing accumulations of zebra mussels.

4) Critique operations and develop recommendations for further enhancements to the robotic equipment and materials handling system.

The first cleaning effort was performed by ARD Environmental (ARDE) personnel. Subsequent cleanings may also be performed by ARDE personnel, however the overall goal of the project is to develop equipment and a methodology that would permit Cook Nuclear Plant personnel to perform maintenance cleaning and removal of zebra mussel infestations in the inlet bay and screen bays on a routine basis, with minimum support from outside contractors.

This phase of the project consisted of a number of tasks. They included a detailed review of the engineering drawings of the screenhouse, a review of plant operational requirements, design modifications to ARD's XT1000 vehicle to permit insertion in the manways at the plant, design and fabrication of ancillary equipment to support the operation, and development of an operating plan that meshed with plant requirements and activities during a scheduled outage.

The specific cleaning tasks were to remove zebra mussel accumulations from the floor of the screenhouse, in the areas between the traveling screens and trash racks, and west of the trash racks, in the inlet bay and in the triangular trash traps in

the corners of the screenhouse (figure 3).

Operations were required to be conducted on a non-interference basis with other activities being conducted in and around the screenhouse. These included molluscicide treatment of the South Intake tunnel, diver activities in various portions of the screenhouse, and other activities associated with the Unit 2 outage and general operations in the plant.

The robotic system was able to operate in all conditions encountered, although there are improvements that would be incorporated in a production system. Mounds of mussels 8'-10' in height were encountered and successfully removed. Even where there was a large mound where the vehicle was introduced into the screen bay, it was capable of working its way through the mound to the bottom, and then maneuver to remove the remainder of the mound.

The next version of the system will incorporate the lessons learned during this project, both in equipment configuration and operating procedures.

2 Plant Description and Operating Environment

The Cook Nuclear Plant is shown in plan view in figure (2). Cooling water for the plant is brought into the screenhouse through three intake tunnels, 16' in diameter, which extend approximately 2300' into Lake Michigan. The screenhouse is a concrete chamber approximately 200' long by 108' wide by 45' deep. The screenhouse is divided into three major areas: The forebay, which is the area between the intake tunnels and the trash racks; the screen bays which are the areas between the trash racks and the traveling screens; and the pump bay, which is the area between the traveling screens and the circulating water pump inlets. There are also two trash traps, which are triangular areas on each end of the forebay, isolated by baffle walls. The screenhouse layout is shown in figure (3).

Zebra mussels accumulate on the inside of the intake tunnels and on the intake tunnel cribs and surrounding rip-rap. Inside the screenhouse, they accumulate on the walls, floors and trash racks, except in areas of high flow. Large piles of mussels, which slough off from other areas, accumulate on the screenhouse floor in areas of low flow, and against out-of-service traveling screens. These piles may reach heights in excess of 10'.

The plant was undergoing an outage, with Unit 2 down for refueling. Four circulating water pumps were shut down for most of the operation, reducing flow through the screenhouse by 57%. The unit 2 traveling screens were also shut down for maintenance. The south intake was closed off by a stop log and was undergoing treatment with molluscicide to kill the mussels lining the intake pipe.

Other operations in the screenhouse included traveling screen maintenance, routine operations, and diver operations to clean the screenhouse walls on both sides of the traveling screens.

Lake Michigan was generally calm, although there was a period of thermal inversion and rougher conditions which significantly reduced visibility in the screenhouse for a period of time. No extreme temperature or other weather conditions were experienced.

3 Equipment Description

The overall system is shown in the block diagram in figure (4). The prototype vehicle consists of a tracked, pneumatically-driven platform based on the ARDE XT1000. A four horsepower air motor and 60:1 gearbox are used to drive each track. The motors and gearboxes are modified for use underwater. The prototype vehicle was reduced in size and otherwise reconfigured to permit entry via the screenhouse access points in the Cook Nuclear Plant. In addition, the side plates were cut down to reduce hydrodynamic drag.
A suction head with raising and lowering capability was mounted on the front of the prototype vehicle, and an underwater camera and light assembly, with full pan and tilt, was mounted on a folding pedestal on the port side. This camera permitted the operator to navigate in the screen and inlet bays, and to monitor mussel removal. The vehicle is shown in several views in figure (5).

The umbilical assembly consisted of four supply and return air lines (two for each motor), four small diameter control tubes to raise and lower the suction head and camera, a high-strength buoyant tether, and the suction line from the pump to the prototype vehicle. In addition, a 2" closed hose was added to maintain the umbilical positively buoyant.

The handling equipment consisted of three mobile engine-hoist cranes modified to handle the prototype vehicle and associated equipment. One crane was equipped with an electrically-driven capstan and snatch blocks for handling the prototype vehicle. The second and third cranes were identically equipped with electric winches and snatch blocks to handle the auxiliary camera and to suspend the diver's submersible pump. Aluminum channels were used to span the manways and grates, permitting safe positioning of the cranes over the openings.

The auxiliary camera assembly consisted of a 2' square cage equipped with upper and lower rollers on the back side. An underwater camera, lights and pan and tilt unit was mounted on a plate on the bottom of the cage. The vehicle camera was a color unit, and the auxiliary camera was a black-and-white low light level unit. The purpose of the auxiliary camera was to provide the operator with a means of observing insertion of the prototype

vehicle. After the first deployment, the auxiliary camera was considered unnecessary and was not used thereafter.

The operator console consisted of a portable cabinet in which were mounted video monitors, pan and tilt control units, and VCRs for the vehicle and auxiliary cameras. An audio recorder was also installed to permit logging of commentary by the operator. High noise environment sound-powered phones were included to permit communications between the two operators.

The vehicle control console was a separate portable unit, normally used with the XT1000 vehicle, to permit the operator freedom of movement. This was found to be unnecessary for this operation, and the portable console was eventually mounted in front of the video monitors. All pneumatic control valves are electrically operated via the joysticks on the vehicle control console. The pneumatic control assembly contains all of the pneumatic valves, pressure regulators, and exhaust mufflers for the subsystem.

Initially, per a request from Cook Nuclear Plant personnel, ARDE used a pump supplied by the divers. This pump was a 4" electrically-powered ABS submersible. Difficulty in priming, and lack of sufficient 440 volt outlets required changing the pump. ARDE then rented a 6" diesel-powered Godwin self-priming pump for the remainder of the project.

4 Operations

Mobilization commenced on 9/8/94. Training and badging had been conducted previously at the plant, therefore no delays were experienced once ARDE staff arrived at the site. The equipment was unloaded and set up on 9/12 and 9/13, and operations commenced on 9/14, in accordance with the schedule in ARDE's Operating Plan.

All equipment with the exception of the air compressor and Godwin pump were located inside. The compressor and pump were placed against the west wall of the screenhouse, in temporary containments in the event of fuel spills. ARDE's truck was also parked outside the screenhouse.

Occasional delays were experienced during the project due to other, higher priority, activities associated with the outage. Some delays were also experienced when the divers were unable to retrieve their pump on request, due to other activities. These delays reduced the overall effectiveness of ARDE's operation in terms of total time on site versus total volume of mussels pumped. This would not be an issue for a future production system operated by plant personnel.

The Operating Plan initially addressed cleaning of all areas of the screen and inlet bays. Based on prior diver reconnaissance, the

plan was modified and only selected areas, with significant accumulation of mussels, were entered and cleaned. Table 1 summarizes performance in each area.

No safety or health incidents occurred during the operation, and no support was required from the divers or plant personnel, once the diver's pump was replaced. Operations were completed on 10/6/94, and the equipment was broken down and removed on 10/7, approximately 10 days ahead of the original schedule.

The Operating Plan described several techniques to be used for entering the various areas in the screen and inlet bays. In practice these methods were simplified considerably. Some of the equipment prepared for the project, such as the crane for the pump, was not required. Appendix (A) contains various photographs, taken during the project, showing the equipment and conditions in the screenhouse.

4.1 System Performance

Performance of the ARDE system was equivalent to diver performance when equivalent conditions existed. That is, where large mounds of mussels were encountered, and pumping capacity was the same, the rate at which mussels could be removed was equal to diver performance. Although clogging and inability to prime were problems encountered with the ABS submersible electric pump, when it operated properly it was very effective.

The centrifugal trash pump substituted by ARDE was at a disadvantage as it had to overcome a static suction head of about 16'. On the other hand, clogs could easily be cleared by injecting either air or water into the suction hose. Any future system would utilize a hydraulically-driven submersible pump. This would permit clearing of clogs by reversing the pump, as well as water or air injection. Moreover the advantage of reduced total equivalent head would be recovered.

Table (1) lists the area worked, pumping hours, total volume and pumping rate. The forebay areas are west of the trash racks, and the screen bay areas are west of the traveling screens. A memo with additional information and comments is included in the appendix. The bare numbers below do not reflect the advantages that a production system would enjoy, which include: Operation at any time and shift; operation in or transit of high flow areas; no confined space entry or other major safety related requirements; cleaning of screen bays with traveling screens in operation; and operation independent of plant status.

Note that the dumpsters used had a maximum capacity of about 24 cubic yards. Since the gravity drain reduced the usable overall height, the dumpsters were only filled to about 80% of maximum

capacity (about 20 cubic yards), to permit them to be tilted without spillage during removal.

4.2 Adversity Factors

4.2.1 ABS Submersible Pump

Although the ABS pump supplied by the divers had a high delivery rate, it was not the best choice for several reasons.

- Installing or removing the pump required the services of the divers, since it was their pump.
- The pump was electrically-driven by a 440 VAC 3-phase motor, thus it was not reversible, which made it more difficult to clear clogs.
- There was no provision for back flushing either with air or water, which also made it more difficult to clear clogs.
- Clearing a clog required the pump to be pulled from the water and the suction line (and possibly the discharge line) disconnected.
- This type of pump is not capable of clearing air from a loop in the suction line, making start up more difficult.

4.2.2 Visibility

Poor visibility, caused by thermal inversion in the Fall and Spring, or storms at any time, prevent the use of the prototype vehicle as it is presently configured. Visibility varied from 10 to 15 feet in clear conditions to less than 1 foot in poor conditions. Poor visibility would also hamper a diver if he had to locate a pile of mussels. However, if he knew where the mussels were, an experienced diver could readily locate and remove them by feel.

Even under ideal conditions, visibility is limited in the large open areas of the inlet bay. This limits direct point-to-point navigation in these areas. However, it does not prevent use of the vehicle as the mussels accumulate against the walls, and the vehicle can always be directed along a wall.

ARDE intends to test an ultrasonic imaging system to determine if this would be a useful adjunct to the video system. Note that although the vehicle is hampered by poor visibility at present, it can be used whenever convenient, thus times of poor visibility can be avoided. Note also, that only about 2 days of operation were affected by poor visibility.

4.2.3 High Flow Conditions

The prototype vehicle was operable in all locations, however the

effects of high currents were definitely felt in several areas. After initial entry into the traveling screen area of Unit 2, which was in a refueling outage, the vehicle was deployed into a number of high flow areas on the operating unit 1 side of the screenhouse to both remove material and demonstrate the ability of the system to be deployed and operate in these areas.

The first high flow deployment was in the forebay area directly across from the center intake. The deployment, initiated from behind the baffle wall, was successful. After removing the accumulations of materials from that area the vehicle was moved around the corner and toward the intake tunnel. After rounding the baffle the vehicle was oriented to face the inlet directly, using the baffle wall as a reference. The vehicle was then driven toward the intake. The actual vehicle path was a slow arc toward the north end of the forebay, due to the effects of the flow on the discharge and control hoses.

After orienting the vehicle again, a second, successful, attempt was made to reach the intake. As the vehicle approached the intake, flow velocities increased dramatically. The ability of the vehicle to turn and move decreased, as well as the ability of the operator to accurately determine the location of the vehicle, its proximity to structures, and its orientation within the forebay.

4.2.4 Conflicting Operations

Other priority operations, related to management of outage-related activities, resulted in some delays to ARD's activities. Early in the project, when diver support was required to move their pump, some delays were experienced because dive personnel were not always available. A production system, operable by plant personnel at convenient times, would not experience these delays.

4.2.5 Dumpster Configuration

The dumpsters used were standard 20'x8'x4' units with swing-open doors. The dumpsters are designed to handle solid waste material. Each time the dumpster is removed from the site and emptied it must be resealed to provide a proper waterproof seal. This requires approximately 12 tubes of silicone caulk and 30 to 45 minutes of time. The seals achieved by this method are marginal in their ability to keep water from leaking onto the ground.

The current method of material dewatering utilizes a single or dual 8" gravity decant. This system provides adequate flow volume to keep the water level inside of the dumpster. There are a number of disadvantages to this particular system. The 8" decant lines

are bulky and difficult to manage when full of water. The final decant of free water following filling of the dumpster is a slow process. A 2" clear tube is used as a siphon which takes approximately 1 hour to finish the decant to a level acceptable for transportation.

4.2.6 Piping and Dumpster Layout

Although there was enough space to lay out all the umbilicals and discharge lines, the presence of other equipment, and other activities made umbilical handling more time consuming and difficult. The placement of the dumpsters required the discharge hose to be disconnected and moved whenever dumpsters were brought in, or other equipment required access to the area.

4.2.7 Umbilical/Discharge Hose Weight

The weight of the hose/umbilical assembly made it difficult for two men to retrieve the system. Retrieval had to stop periodically so the hose/umbilical could be rearranged.

4.3 Equipment Malfunctions

Only two malfunctions were experienced during the operation. The first was the inability to lower the vehicle camera for vehicle retrieval. This was traced to a faulty air line connection which most likely occurred during assembly of the system. The air line feeding the retract side of the camera air cylinder was not fully seated in the connector. During operation, the air line pulled loose, preventing the cylinder from lowering the camera. The vehicle was raised as high as possible, and the line was connected by reaching into the manway.

The second malfunction was caused by leaking seals on the camera cylinder. The cylinders installed initially on the camera and suction head were not rated for underwater use. However, because of schedule, and the long lead time for rated cylinders, a decision was made to use off-the-shelf unrated units, and the underwater rated units were ordered at the same time. When the seals started to fail on the camera cylinder, the rated replacements were shipped and arrived the same day. It was installed the next morning with very little loss of operational time.

5 Observations and Lessons Learned

A) Mussels continue to accumulate in stagnant areas immediately after they have been cleaned. For any given set

of flow conditions these areas are well defined.

B) Accumulations at the base of the traveling screens can be caused by cleaning operations with the screens secured. Restarting the screens can result in significant carry-over of mussels, therefore the screens should be operated continuously while cleaning operations take place.

C) The trash racks tend to accumulate significant growth of mussels about halfway down, yet appear to be clear near the surface and the bottom. This is probably attributable to the vertical flow velocity profile. If necessary, the trash racks could be cleaned from the surface.

D) Routine cleaning of areas where large accumulations occur, particularly in the screen bays, would be effective in preventing carry-over and clogged traveling screens.

E) Operations could be made more efficient if the removal process were treated as routine maintenance, rather than a periodic problem to be solved.

F) Increasing vehicle weight, and modifying the attachment points for the umbilical and suction hose would improve handling in high flow areas. A flexible attachment point, which would allow the suction hose and umbilical to swivel around two axes would enable the vehicle to maneuver more freely as the suction hose and umbilical would be better able to align with the flow, regardless of the direction of motion of the vehicle.

G) Improved articulation of the suction head would allow the vehicle to drive straight into the piles of mussels and other debris.

H) Track redesign would aid in deployment by allowing the tracks to come into contact with the screenhouse floor with the vehicle in the vertical position.

I) The temporary and expedient nature of the shell removal piping, dumpster configuration, dumpster decant system, and dumpster staging slowed the overall removal rate of the mussels.

With the above improvements, the robotic system represents a cost-effective alternative to the use of divers for screen and inlet bay floors.

6 Recommendations

The complexity of the zebra mussel problem, coupled with the complexity of power plant operation, suggests that an analysis be

done to determine the optimum, cost-effective solution to the problem. It is clear that a combination of techniques are required, each to address a specific problem area. The ongoing nature of the problem suggests that some permanent installations are required, for example, piping and manifolds to carry the mussels to the container site.

Improvements to the vehicle would include reducing its width to permit the vehicle to access the trash traps via the 24"x24" openings, increasing vehicle weight and modifying the suction hose attachment point to reduce the effects of hydrodynamic drag on vehicle maneuverability. In addition, the pneumatic drive and actuation cylinders would be replaced by hydraulics, and the track profile would be modified to permit easier insertion of the vehicle. Articulation of the suction head would permit the vehicle to be driven straight into the piles of mussels.

Optimizing the equipment operationally would also require a purpose-designed handling system, controllable locally or from the operator's console. The handling system would incorporate power-assist for the umbilical, as well as an improved vehicle winch.

Since zebra mussel removal appears to be a long-term problem, operations in general would be simplified by installing a permanent piping and manifold system in the screenhouse for the pump discharge. Permanent outside piping, and a more convenient site for the dumpsters used to haul the mussels, would also facilitate operations, as would substitution of a decant pump for the gravity decant method currently in use.

7 Comparison of Vehicle and Diver Operations

Diver operations and the use of the robotic system were compared for cost and efficiency, and each technique has its merits. Based on experience at the Cook Nuclear Plant, the crew size needed to operate the robotic system under various scenarios is as follows:

Case A: Robotic system operated by contract diving personnel

One diver/vehicle operator
Two tenders/laborers

Case B: Robotic system operated by newly trained in-house personnel with contract labor support

Two maintenance mechanics/operators
Two laborers

Case C: Robotic system operated by experienced in-house personnel with contract labor support

Two maintenance mechanics/operators
One laborer

Case D: Optimized Robotic system operated by experienced in-house personnel with contract labor support

One maintenance mechanics/operator
One laborer

Case E: Diver removal of mussels by conventional pumping

One diver/supervisor
One diver
One tender
One laborer

Table (2) is a qualitative pro/con comparison of the techniques.

8 Conclusions

The project goals for this phase were met. The ARDE Robotic system can provide a cost effective alternative to diver operations for removal of zebra mussels from the screenhouse floor at the Cook Nuclear Plant. The prototype system, a modified ARDE XT1000, incorporating special features for the project, demonstrated the feasibility of the approach.

The experience gained on the project will enable a production system to be designed and built that will meet ongoing needs of the plant on a routine basis. For optimum operational efficiency, some piping and a dedicated hydraulic power unit should be permanently installed in the plant. In addition, the dumpsters and decanting method should be replaced with a more suitable approach.

While divers can be replaced for cleaning the screenhouse floor, they are still needed to clean the walls, and to perform other activities in the plant.

Acknowledgements

We thank Mr. William Hannah of the Indiana Michigan Power Company/Cook Nuclear Plant, and his dive crew from RUST Utility Services for their help in staging and retrieval of equipment needed to support this project. Also Messrs. James Ridgely, William Lewis, and Scott Carpenter, of ARD Environmental, Inc., for vehicle operations and suggestions for improved performance. And finally, the managements of the American Electric Power Service Corporation, Indiana Michigan Power Co./Cook Nuclear Plant and ARD Environmental, Inc., for the opportunity to demonstrate telerobotics technology for zebra mussel cleaning, and review of this paper.

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TABLE 1: PERFORMANCE SUMMARY			
AREA WORKED	PUMP HOURS	TOTAL VOLUME CU YDS	PUMPING RATE YDS/HR
2-6,7	3	12	4
2-6,7	3.5	8	2.3
2-2,3	1	2	2
2-2,3	4	8	2
Unit 2 Forebay	2	2	1
Unit 1 Forebay	2.5	5	2
Unit 1 Forebay	2	6	3
1-4,3	2	5	2.5
1-4,3	2	3	1.5
1-4,3	3.5	9	2.6
1-4,3	3.5	7	2
1-2,1	3.5	7	2
1-2,1	3	6	2

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TABLE 2: COMPARISON OF CLEANING TECHNIQUES		
TECHNIQUE	PRO	CON
DIVING	WIDE CHOICE OF TOOLS/MOST FLEXIBLE	LARGER CREW SIZE
	CLEAN FLOOR OR WALLS	NUMEROUS SAFETY ISSUES
	CAN OPERATE IN POOR VISIBILITY	SECOND DIVER MUST BE READY TO ASSIST IN CASE OF EMERGENCY
		LIMITED ENDURANCE
		CAN'T WORK IN HIGH FLOW
		MUST SECURE TRAVELING SCREENS FOR SAFETY
		BACKUP SYSTEMS REQUIRED
ARDE ROBOT	SMALLER CREW SIZE	LIMITED CHOICE OF TOOLS/NOT AS FLEXIBLE
	FEW SAFETY ISSUES	CLEAN FLOOR ONLY
	UNLIMITED ENDURANCE	POSSIBLY LIMITED BY POOR VISIBILITY
	TRAVELING SCREENS CONTINUE TO OPERATE	MAY REQUIRE DIVER RETRIEVAL IN CASE OF MALFUNCTION
	CAN WORK IN HIGH FLOW	
	EQUIPMENT CAN BE LEFT SUBMERGED INDEFINITELY	
	BACKUP SYSTEMS NOT REQUIRED	

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Appendix A: Photographs

The following photographs were taken primarily from video footage shot during the performance of the project. The resolution of the photos is limited by the resolution of the video equipment, thus the quality of the photos is not as good as 35 mm film.

1. Modified XT1000 vehicle on the loading dock at ARD Environmental, Inc.

2. Modified XT1000 vehicle in the screenhouse, showing a close up of the suction head and tracks.

3. View looking east in the screenhouse showing modified XT1000 vehicle being inserted through a manway. A traveling screen unit is immediately behind the vehicle.

4. Dumpster full of zebra mussels in the material handling area south of the screenhouse.

5. Trash rack showing accumulation of zebra mussels. This frame is from the auxiliary camera, which was black-and-white. The auxiliary camera was only used during the first insertion.

6. View of one of the traveling screens.

7. View of the vehicle suction head and accumulated mussels on the screenhouse floor.

8. Resident aquatic life in the screenhouse forebay. Numerous fish of various types were observed during the operation.

```
Schedule Name : D.C.Cook Phase I: Screen House Floor
Responsible   : Kotler
As-of Date    : 21-Jul-94  9:00a       Schedule File : COOK1


                                  94
                                  Jul           Aug                      Sep              Oct
Task Name                         11   18   25  1    8   15   22   29   6   12   19   26   3    11  17   24   31

 D.C.Cook Screen House Cleanup      .  ##################################################################   .
    Phase I: Screen House Floor     .  ##################################################################   .
       Project Management           .  ##############################################################   .   .
          Project Planning          .  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.    .    .    .    .    .    .    .   .
          Liaison with Plant Pe     .  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX   .   .
       Equipment Design and Mod     .  | .  ###############  .    .    .    .    .    .    .    .    .   .   .
          TT1000 Platform Mods.     .  | .    .XXXXXXX  .    .    .    .    .    .    .    .    .    .   .   .
          Umbilical/Material Ho     .  | .    .XXXXXXXXXX    .    .    .    .    .    .    .    .    .   .   .
          Pneumatic Drive Mods      .  | .    .XXXX.    .    .    .    .    .    .    .    .    .    .   .   .
          Vehicle Camera Instal     .  | .    .    . XXXXX  .    .    .    .    .    .    .    .    .   .   .
          Suction Nozzle Redesi     .  | .  XXX    .    .    .    .    .    .    .    .    .    .    .   .   .
          Auxiliary Camera Desi     .  | .    .   XXXXXXX   .    .    .    .    .    .    .    .    .   .   .
          Vehicle Handling Equi     .  | .    .    . XXXXXX  .    .    .    .    .    .    .    .    .   .   .
          Pump Handling Equipme     .  | .    .    .    XX   .    .    .    .    .    .    .    .    .   .   .
          Aux. Camera Handling      .  | .    .    .    .XX  .    .    .    .    .    .    .    .    .   .   .
          Operator Console          .  | .    .   XXXXXX    .    .    .    .    .    .    .    .    .   .   .
       Fabrication and Assembly     .  | .    .   ##################  .    .    .    .    .    .    .   .   .
          Vehicle                   .  | .    .   XXXXXXXXXXXX   .    .    .    .    .    .    .    .   .   .
          Camera Installation       .  | .    .    .    .   XXXX .    .    .    .    .    .    .    .   .   .
          Control Umbilical         .  | .    .    .    .   XXXX .    .    .    .    .    .    .    .   .   .
          Material Hose             .  | .    .    .    .    .   XX    .    .    .    .    .    .    .   .   .
          Operator Console          .  | .    .    .    XXXXXXXXX .    .    .    .    .    .    .    .   .   .
          Auxiliary Camera          .  | .    .    .    .    . XXXXX   .    .    .    .    .    .    .   .   .
          Vehicle Handling Equi     .  | .    .    .    . XXXXX  .    .    .    .    .    .    .    .   .   .
          Pump Handling Equipme     .  | .    .    .    .    XX  .    .    .    .    .    .    .    .   .   .
          Aux. Camera Handling      .  | .    .    .    .   .XX  .    .    .    .    .    .    .    .   .   .
          Spares                    .  | .    .    .    .    .   .XX   .    .    .    .    .    .    .   .   .
       System Checkout              .  | .    .    .    .    .    . XX .    .    .    .    .    .    .   .   .
       Mobilization                 .  | .    .    .    .    .    .    XXXX.    .    .    .    .    .   .   .
       Site Work: Floor Cleanou     .  ############################################################.    .   .
          Equipment Setup and C     .  | .    .    .    .    .    .    .   XX    .    .    .    .    .   .   .
          Forebay Cleanout          .  | .    .    .    .    .    .    .    . XXXXXXXX.    .    .    .   .   .
          Screen Bay Cleanout       .  | .    .    .    .    .    .    .    .    .   XXXXXXXXXXXXXX.   .   .
          Equipment Rental          .  M .    .    .    .    .    .    .    .    .    .    .    .    .   .   .
       Demobilization               .  | .    .    .    .    .    .    .    .    .    .    .    .   XXX  .   .
       Travel and Living            .  M .    .    .    .    .    .    .    .    .    .    .    .    .   .   .
       Equipment Refurbishment      .  | .    .    .    .    .    .    .    .    .    .    .    .    . XXX   .

------------------------------------------------------------------------------------------------------
XXXXX Detail Task       ##### Summary Task      ***** Baseline
xxXXX (Progress)        ==### (Progress)        >>>   Conflict
XXX-- (Slack)           ###-- (Slack)           ..XXX Resource delay
Progress shows Percent Achieved on Actual          M Milestone
----------------- Scale: 8 hours per character --------------------------------------------------------

TIME LINE Gantt Chart Report, Strip 1
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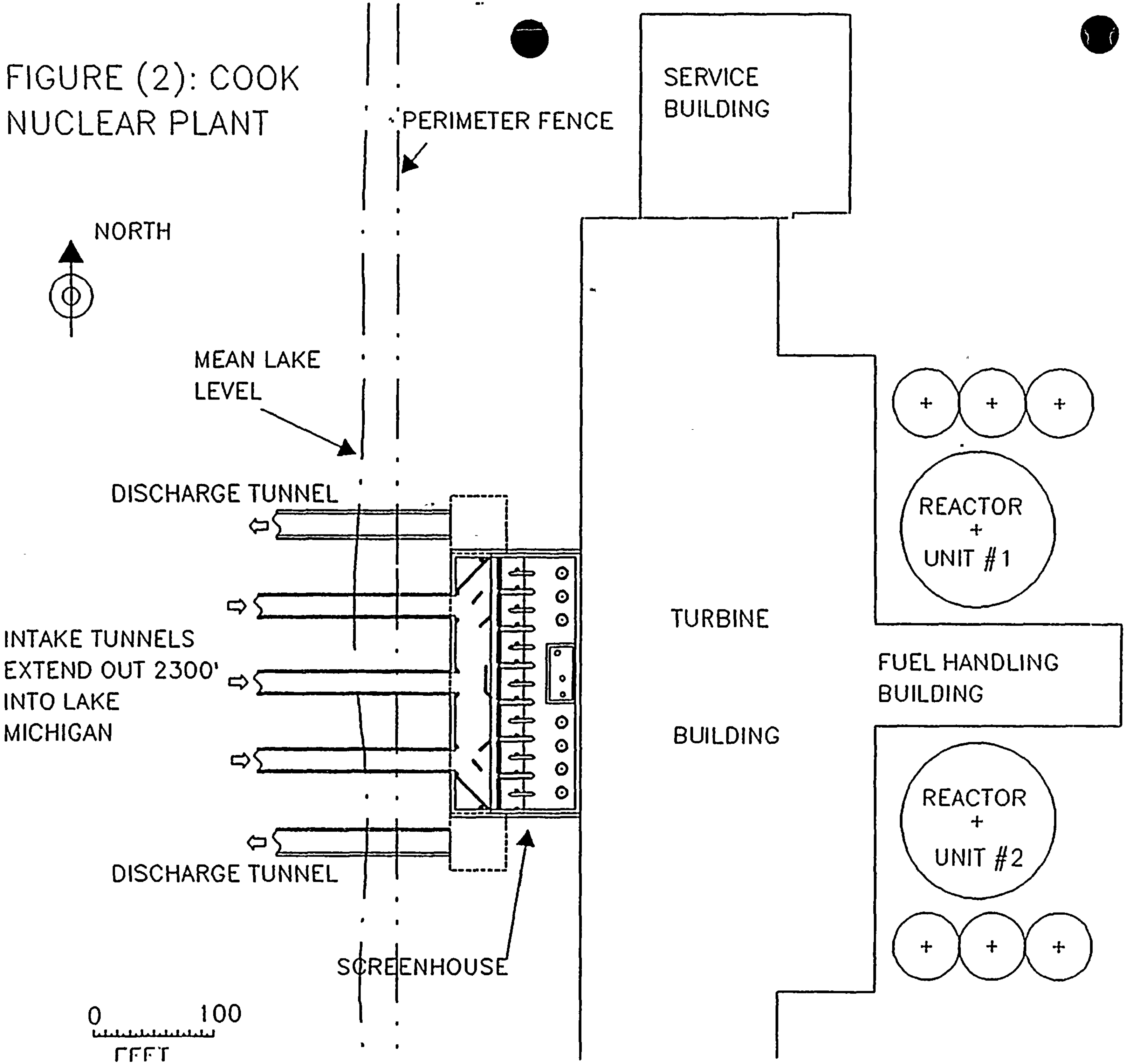
FIGURE (1) PROJECT PLAN

FIGURE (2): COOK NUCLEAR PLANT



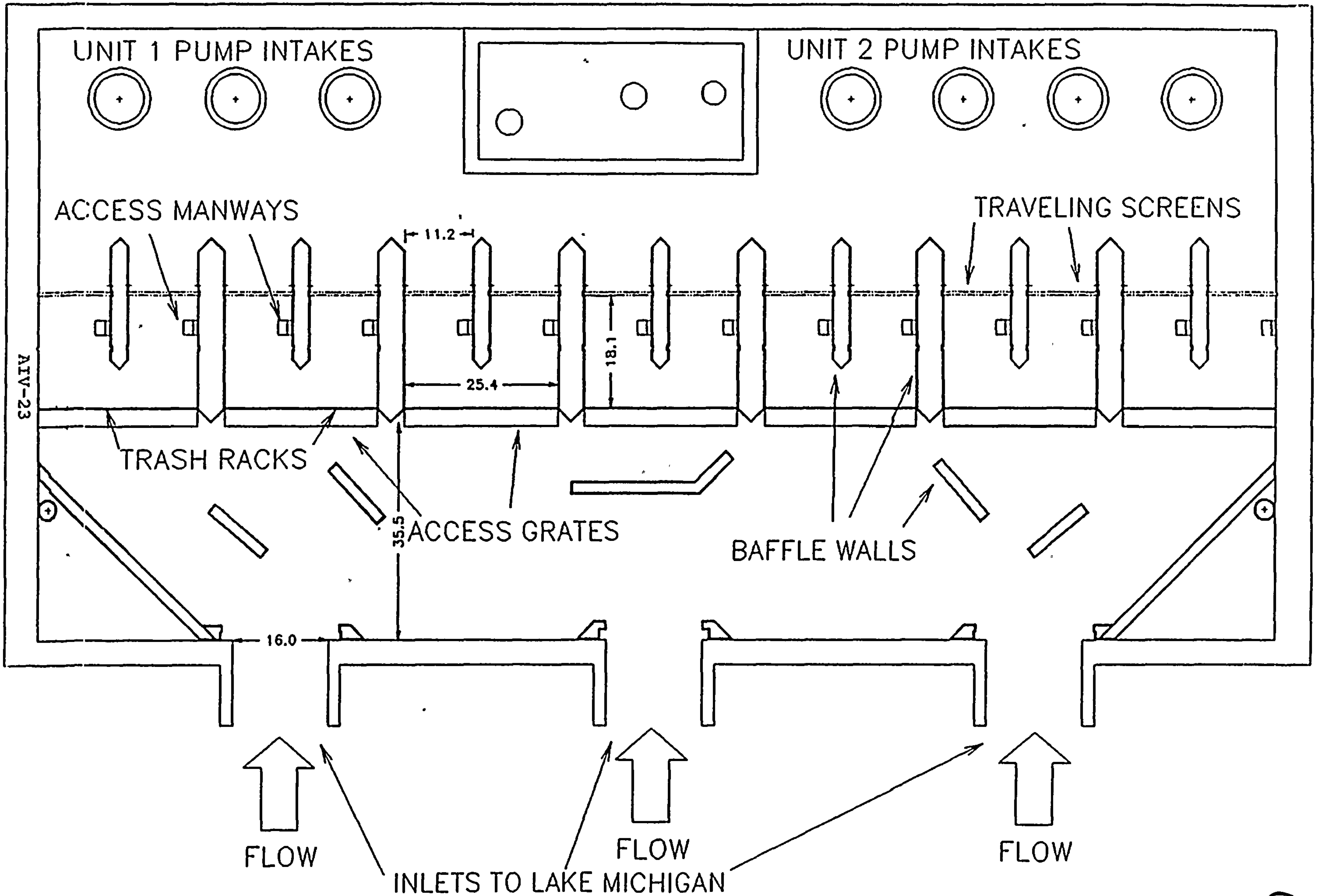


FIGURE (3): SCREENHOUSE LAYOUT, COOK NUCLEAR PLANT

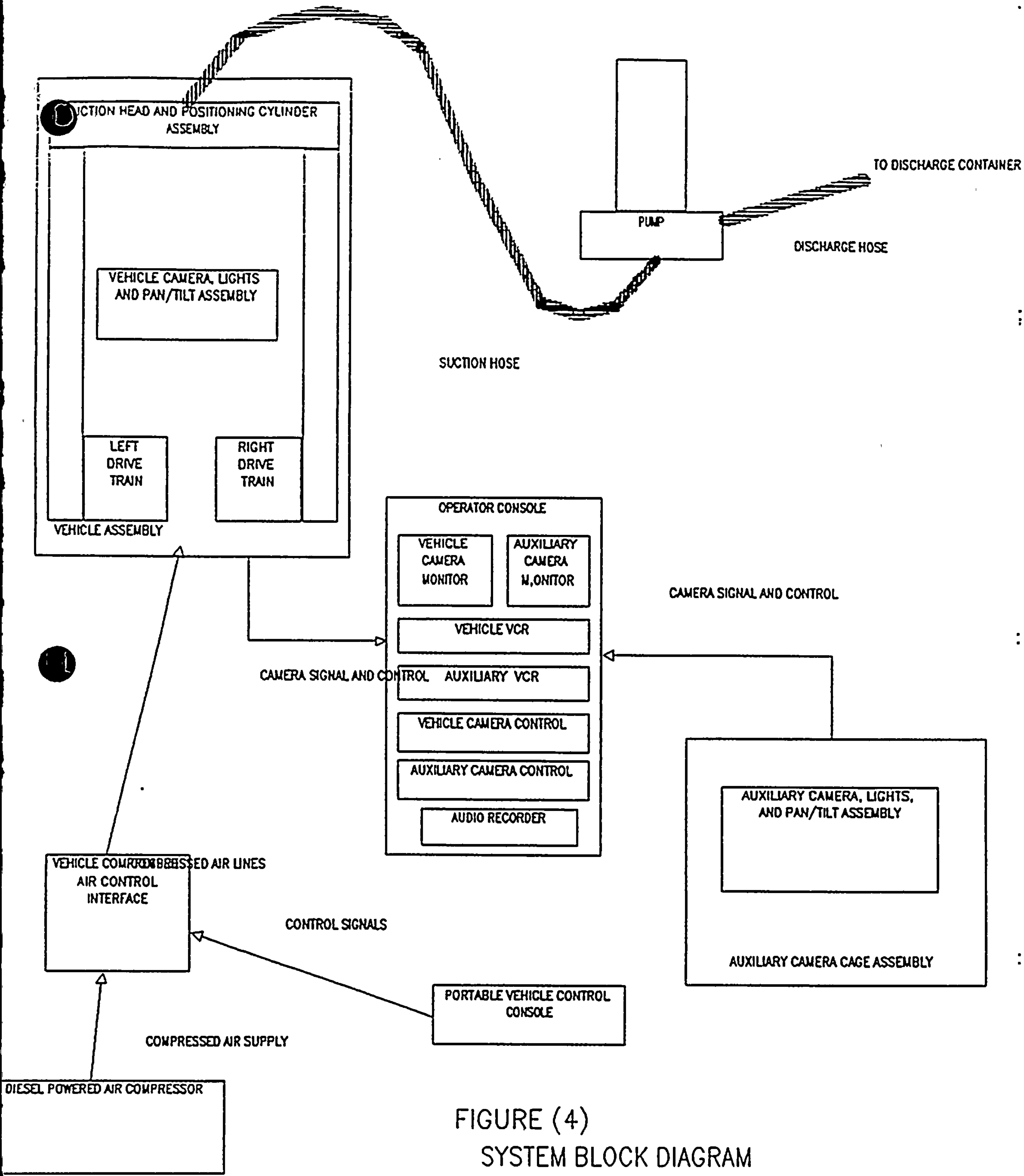
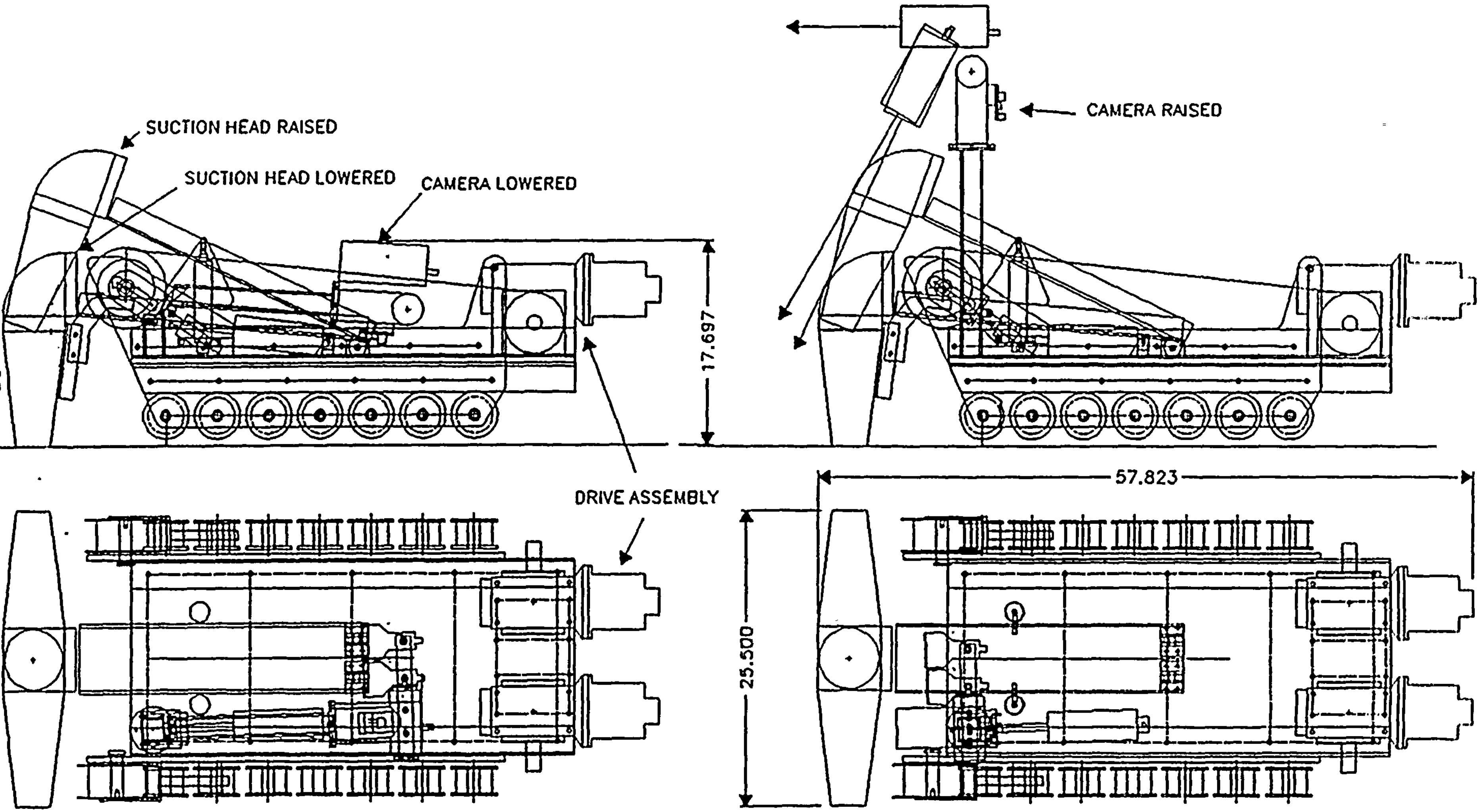
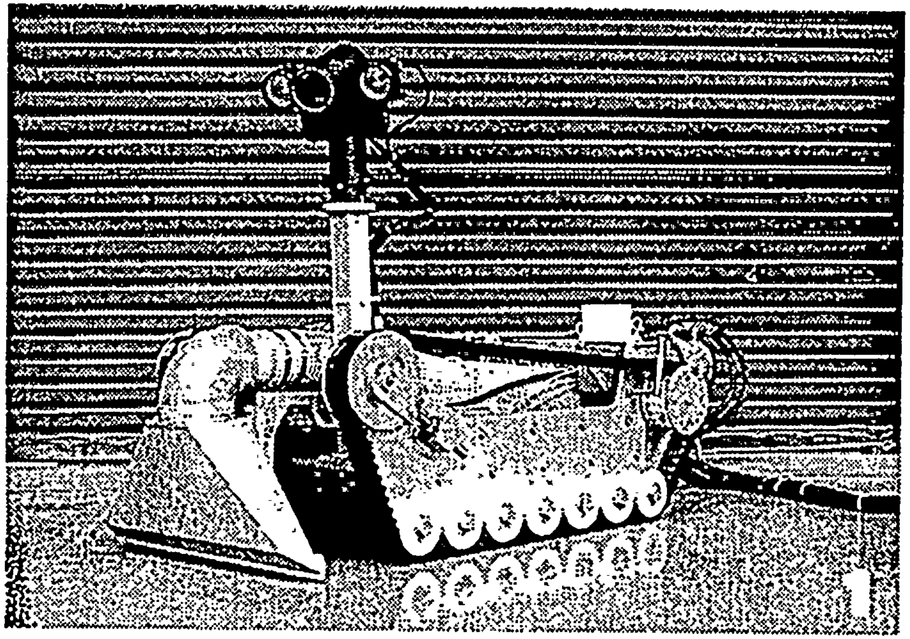


FIGURE (4)
SYSTEM BLOCK DIAGRAM
ZEBRA MUSSEL REMOVAL EQUIPMENT
COOK NUCLEAR PLANT

FIGURE (5): MODIFIED XT1000 FOR ZEBRA MUSSEL REMOVAL PROJECT

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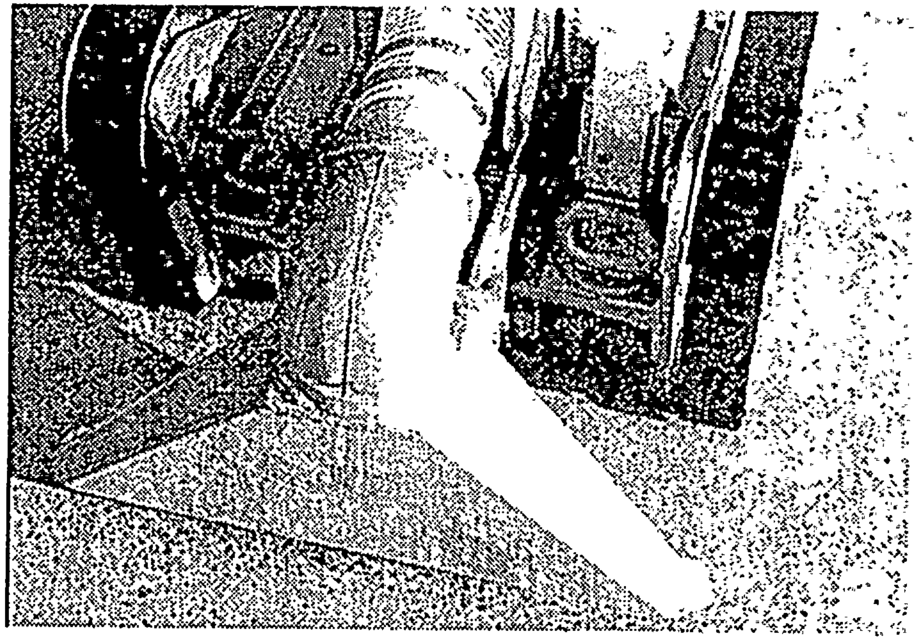

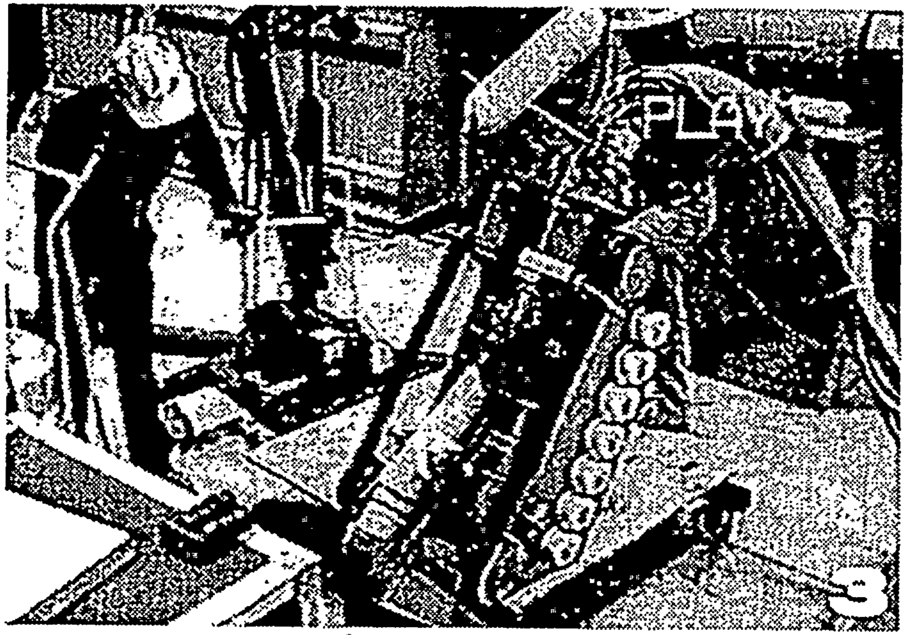
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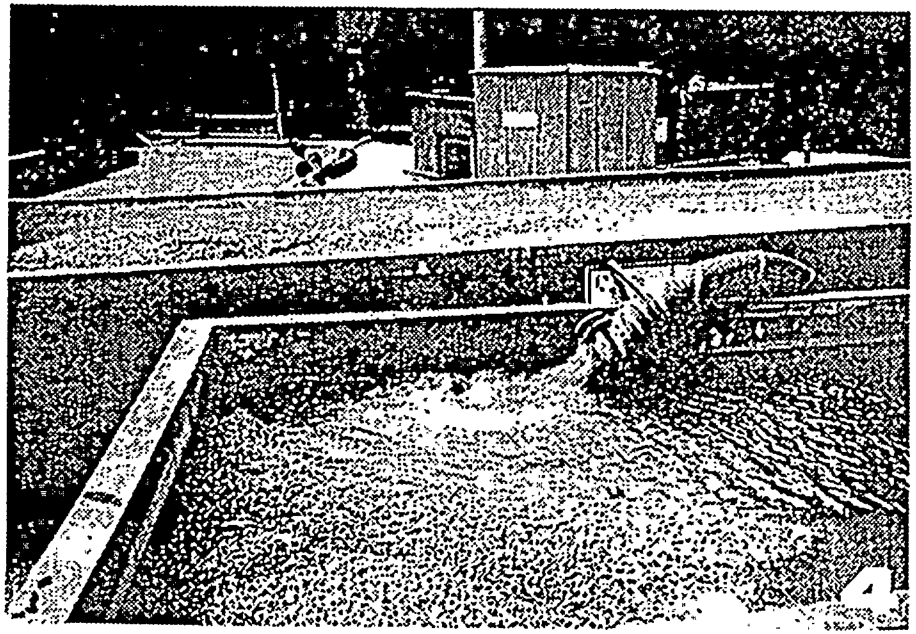
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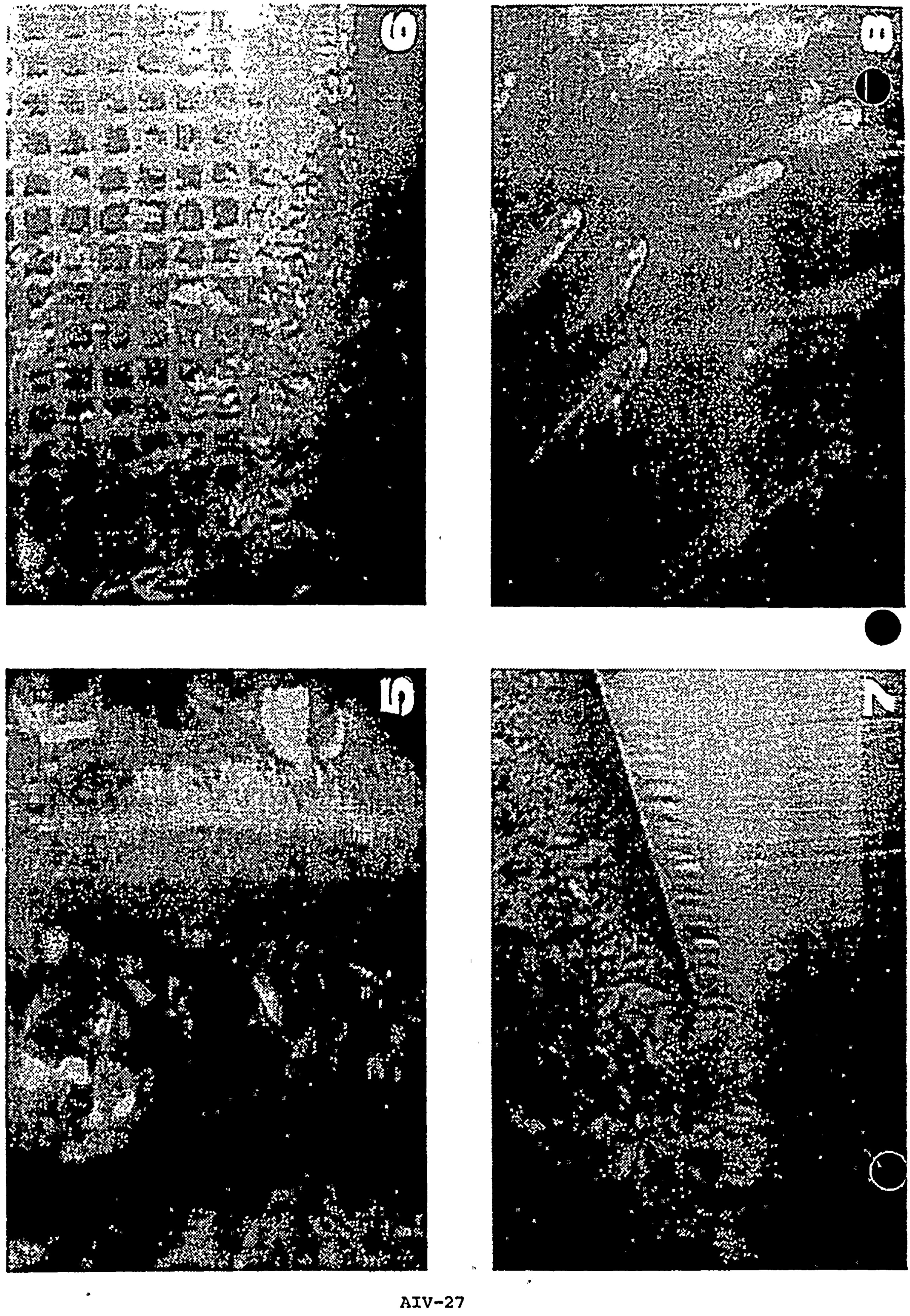
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Ashland Chemical

USE OF CHLORINE DIOXIDE TO PREVENT ZEBRA MUSSEL SETTLEMENT

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USE OF CHLORINE DIOXIDE TO PREVENT ZEBRA MUSSEL SETTLEMENT

ABSTRACT

A pilot scale study was conducted at the Cook Nuclear Plant to determine if an intermittent, low level feed of chlorine dioxide would be effective in controlling the settlement of zebra mussel veligers. Results of the study showed that the feed of chlorine dioxide at 0.25 mg/l for 15 minutes duration, four times daily, reduced settlement by 95% versus an untreated system and successfully controlled post-veliger mean densities to less than 600 individuals/ m^2.

BACKGROUND

The Indiana-Michigan Power Company, Cook Nuclear Plant, is a 2200 MW dual unit nuclear generating station located on the Eastern Shore of Lake Michigan. Once-through, non-contact cooling water is used in three major systems at the Cook Nuclear Plant. The Circulating Water System (1.6 million gpm) includes the Main Condenser Cooling Water, Miscellaneous Sealing and Cooling Water, and other minor, non-safety related cooling and water supply systems. The Essential Service Water (ESW) system (20,000 gpm) is a safety related system which supplies water to heat exchangers and components responsible for the safe shutdown of the nuclear reactors. The Non-Essential Service Water (NESW) system (13,500 gpm) supplies cooling water to non-safety related components in the plant.

Zebra mussels were first discovered sparsely distributed during routine diving inspections and cleaning of the plant's forebay in July of 1990. By 1991, densities of attached zebra mussels in untreated areas of the plant increased to 200,000 individuals/m^2. (1)

The discovery of zebra mussels prompted the plant to develop a control strategy using mechanical removal and chemical means. A quaternary amine-based non-oxidizing biocide coupled with clay detoxification has been used for periodic eradication and sodium hypochlorite is used for post-veliger control. Mechanical cleaning using divers and robots supplement the chemical treatment plan. Chlorine dioxide was considered for evaluation as a control agent to prevent settlement in the plant's search for alternative biocides.

Veliger densities entering the plant are monitored throughout the spawning season. In 1994, these densities ranged from 0 to 514,000 veligers/m^3 (see Table 1).

In 1994, chlorine, in the form of 12.5% sodium hypochlorite, was applied continuously and intermittently in the Service Water Systems, and intermittently in the Circulating Water System. The target end-of-pipe total residual chlorine concentration was 0.5 to 1.0 mg/l. When injected intermittently, the chlorine was applied for 155 minutes, once per day. Post-veliger settlement was monitored during the treatment period using bio-boxes that contained rows of glass microscope slides. Post-veliger settlement rates measured on the Unit 2 ESW return piping ranged from 0 to 10,000/m^2 (see Table 4). It has been determined that a target settlement rate of less than 500 post-veligers/m^2 will result in minimal problems to the plant systems from adult zebra mussels. Continuous chlorination was able to achieve this criterion; however, intermittent feed was not. A pilot study was designed to determine whether chlorine dioxide could meet this 500 post-veligers/m^2 goal when injected on an intermittent basis.

PROPERTIES AND BENEFITS OF CHLORINE DIOXIDE

Chlorine dioxide has been used commercially since 1944.(2) The City of Niagara Falls, New York used chlorine dioxide to oxidize phenols causing taste and odor problems in drinking water. Since chlorine dioxide has 2.5 times the oxidizing power of chlorine, it was hoped that it would

oxidize the malodorous compounds and create a more palatable water. It was soon discovered that chlorine dioxide had impressive biocidal properties as well.

Chlorine dioxide must be generated on site. The most common commercial route involves the use of sodium chlorite, sodium hypochlorite and a mineral acid:(3)

$NaOCl$	+	$2HCl$	+	$2NaClO_2$	→	$2ClO_2$	+	$3NaCl$	+	H_2O
Sodium Hypochlorite		Hydrochloric Acid		Sodium Chlorite		Chlorine Dioxide		Sodium Chloride		Water

As a dissolved gas, however, chlorine dioxide is fairly stable. It is easily generated in a water stream and piped to the point of use. Chlorine dioxide has been successfully used for:

- Cooling water, micro and macrobiocidal control
- Drinking water disinfection
- Drinking water taste and odor control
- Fats bleaching
- Wastewater pollutant oxidation
- Paper machine microbiological control
- Pulp bleaching

As an oxidant, chlorine dioxide tends to be selective. It has been used to oxidize phenol, sulfur compounds and amines, without producing halogenated by-products as other bromine- and chlorine- based biocides tend to do. As a disinfectant, chlorine dioxide has proven to control slime-forming bacteria, spores, viruses, fungi and algae without forming trihalomethanes such as chloroform.

The use of chlorine dioxide as a molluscicide is relatively recent. The mechanism of death is believed to be an oxidation of the respiratory and reproductive system.(5) Chlorine dioxide has been used successfully to eradicate adult zebra mussels in a two to four day period of time at a concentration of 0.6 to 1.2 mg/l.(4)

Chlorine dioxide has been used as a microbiocide in cooling systems for many years. The cause of death in microorganisms is believed to be an interruption of protein synthesis. It is effective at very low dosage, over a wide pH range and the kill is very rapid. In once-through cooling systems, chlorine dioxide has been effectively applied on an intermittent basis.(5)

POST-VELIGER SETTLEMENT EXPERIMENT

Chlorine dioxide has proven to be an excellent microbiocide and zebra mussel eradication agent in cooling water systems. Previous static testing has shown that an intermittent, low level feed of chlorine dioxide will not only control microbiological growth, but will also prevent the settlement of post-veligers.

A pilot scale study was designed in cooperation with the Indiana Michigan Power Company, Cook Nuclear Plant; Lawler, Matusky and Skelly Engineers; and Ashland Chemical Company, Drew Industrial Division. Its purpose was to evaluate the effectiveness of an intermittent feed of chlorine dioxide for control of post-veliger settlement in a dynamic system. The objective of the experiment was to control settlement to less than 500 veligers/m².

EXPERIMENTAL DESIGN

The study consisted of two tests, with each one including one control and one treatment bio-box. These bio-boxes each contained two rows of seven Plexiglas coupons measuring 4.5 x 4.5 inches. Water was pumped into the bio-boxes directly from the plant's intake forebay via a well pump. The sampling design for all tests was as follows:

- End of first week: Three randomly selected coupons were removed for analysis from both the control and treated bio-boxes. These were replaced with new coupons.
- End of second week: Three coupons from the remaining 11 original coupons were randomly selected for analysis from each of the bio-boxes. These were replaced with new coupons.
- End of third week: All coupons were removed from both bio-boxes for analysis.

This sampling design provided the following analysis for both control and treatment bio-boxes:

- Two sets of three coupons exposed to one week of treatment.
- Two sets of three coupons exposed to two weeks of treatment.
- One set of eight coupons exposed to three weeks of treatment.

The whole water veliger density (number of veligers per cubic meter) in the forebay was also analyzed on a weekly basis.

Figure 1 shows the layout of the test system. A fresh chlorine dioxide solution of approximately 100 mg/l concentration was prepared every two to three days and stored in an insulated cooler containing ice. A timer was set to pump the solution to the treated bio-box at approximately 0.25 mg/l for the designated duration and frequency dictated by the test protocol.

The two tests conducted were as follows:

Test 1: Chlorine dioxide was introduced for 15 minutes to the treatment bio-box at a dosage of approximately 0.25 mg/l at six hour intervals (four times daily).

Test 2: Chlorine dioxide was introduced for 30 minutes to the treatment bio-box at a dosage of approximately 0.25 mg/l at twelve hour intervals (twice daily).

The physical and chemical data collected during the tests are presented in Table 5.

SAMPLE ANALYSIS

One side (opposite the incoming flow) of each coupon was analyzed. The analysis included the count of settled zebra mussels and the measurement of shell size of these organisms. The concentration of chlorine dioxide was also measured approximately three times per week at the inlet and outlet of the treatment bio-boxes.

TEST RESULTS

The following summarizes the results of the above tests. The data are presented in Tables 2 and 3 (attached).

<u>Test 1</u>: Chlorine dioxide fed at 0.25 mg/l, 4 times per day, 15 minutes per application.

Average whole water veliger density = 27139 veligers per cubic meter
Average temperature during study = 55° F

Average Post Veliger Count
(Number/m²)

	Treatment	Control	% Reduction
Periodic Sampling (12.3 days average)	378	7032	95
Cumulative Sampling (3 week exposure)	1068	20851	95

<u>Test 2</u>: Chlorine dioxide fed at 0.25 mg/l, twice daily, 30 minutes per application.

Average whole water veliger density = 300 veligers per cubic meter
Average temperature during study = 49° F

Average Post Veliger Count
(Number/m²)

	Treatment	Control	% Reduction
Periodic Sampling (Mean of 0.4, 1 and 2 week exposures)	1059	1626	35
Cumulative Sampling (3 week exposure)	2524	3535	29

POST-VELIGER SIZE DATA

Post-veliger shell sizes were measured throughout the test period. The data collected are shown on Tables 2 and 3 and mean shell sizes were:

Test 1: Treated sample = 311 μm; Control sample = 314 μm.

Test 2: Treated sample = 751 μm; Control sample = 795 μm.

The above results indicate that the majority of the veligers treated in Test 2 were translocators. The whole water veliger density was very low during this testing period (the mean was 300 veligers/m³), indicating that very few newly spawned veligers were available for settlement.

The problem that exists for data interpretation in Test 2 is that:

1. Fewer available post-veligers were available as compared to Test 1.
2. Water temperature was lower than in the previous test.

These differences do not allow us to reach any firm conclusions regarding the efficacy of chlorine dioxide in either the treatment of translocators or when fed in two rather than four daily treatment introductions. This may be a subject of future studies.

CONCLUSIONS

Pilot testing conducted at the Cook Nuclear Plant provided some very promising results regarding the use of chlorine dioxide as a control agent for the prevention of post-veliger settlement. The testing also provided some results which indicated that additional testing is required to separate and identify the variables responsible for those results which were not as promising.

Data generated during Test 1 indicate that an intermittent, low level feed of chlorine dioxide will effectively control the settlement of post-veligers in a dynamic system. The treatment regime feeding chlorine dioxide at 0.25 mg/l for 15 minutes duration, four times daily, showed excellent results, reducing settlement by 95% and controlling post-veliger settlement densities to a mean of 551/m².

In Test 2, the data were less promising for the feed of chlorine dioxide, twice daily for 30 minutes each period at a concentration of 0.25 mg/l. While an overall reduction of 33% was achieved, the effects of cooler water temperatures, fewer test organisms, and possible resistance of translocator-sized mussels to the low level dosage could not be separated from the treatment duration variable that was being tested.

Further testing will need to be conducted to determine the effects of these variables and to confirm all results on a full-scale plant system.

ACKNOWLEDGMENTS

We thank Messrs. E. Scott Rose, Virenkumar Shah and Dean Warlin of the Indiana Michigan Power Company, Cook Nuclear Plant, for their efforts in equipment staging, chemical solution preparation and performing the chemical residual analyses for this experiment. We thank Mr. Jeff Mensinger of Lawler, Matusky and Skelly Engineers for collection and analysis of the samples. Finally, we thank the managements of the American Electric Power Service Corporation, Indiana Michigan Power Company, Cook Nuclear Plant; Ashland Chemical Company, Drew Industrial Division; and

Lawler, Matusky and Skelly Engineers; for their support and review of this paper.

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Table 1 — Whole Water Veliger Sampling

Date	Veligers m
April 28	1900
May 12	0
May 26	5600
June 2	500
June 9	3700
June 16	4300
June 23	1950
June 30	513500
July 7	300375
July 14	57250
July 21	25400
July 28	17250
August 4	10500
August 11	42750
August 18	85500
August 25	5700
September 1	9300
September 8	79650
September 15	77167
September 22	13700
September 29	28500
October 6	5250
October 13	1750
October 20	53250
October 27	11667
November 3	16500
November 10	200
November 17	700
November 23	0
December 14	0

Table 2— Test 1 Results

Chlorine Dioxide introduced at 0.25 mg/l residual for 15 minutes, 4 times daily.

Average Post-Veliger Count (Number/m²)

Weeks Exposed	Treatment	Control	% Reduction
1*	403	4587	91
2	227	11846	98
2	504	4663	89
3	1068	20851	95
MEAN	551	7032	95

Average Post-Veliger Size (μm)

Weeks Exposed	Treatment	Control
1*	283	309
2	367	376
2	283	271
3	312	298
MEAN	311	314

* Only one set of samples were taken during the first week of treatment.

Table 3 — Test 2 Results

Chlorine dioxide introduced at 0.25 mg/l residual 30 minutes, 2 times daily

Average Post-Veliger Count (Number/m²)

Weeks Exposed	Treatment	Control	% Reduction
0.4*	25	302	92
1	807	1815	56
2	1638	2067	21
2	1764	2319	24
3	2524	3535	29
MEAN	1352	2008	33

Average Post-Veliger Size (μm)

Weeks Exposed	Treatment	Control
0.4*	475	550
1	723	841
2	843	801
2	964	988
3	952	1055
MEAN	751	795

* The sampling period deviated from the experimental design due to start-up scheduling difficulties.

Table 4— 1994 Chlorination Program

Sampling of Unit 2 ESW Return Water

Date	Periodic Sample Count (#/m²)	Periodic Sample Size Range (μm)	Cumulative Sample Count (#/m²)	Cumulative Sample Size Range (μm)	Chlorination Frequency
May 12	747	400-650	-	-	None
June 2	711	300-800	-	-	None
June 16	853	475-1500	1067	650-1800	None
June 30	0	-	-	-	Continuous
July 14	6401*	100-375	746*	125-250	Continuous
July 21	2773*	125-175	-	-	Continuous
July 28	1173*	125-250	-	-	Continuous
Aug. 11	2347	125-375	10000	125-325	Intermittent
Aug. 25	1600	150-450	-	-	Intermittent
Sept. 8	1653	125-500	1973	125-275	Intermittent
Sept. 22	6400	125-275	-	-	Intermittent
Oct. 6	891	200-275	1173	225-775	Intermittent
Oct. 20	6133	225-350	-	-	Intermittent
Nov. 3	2560	250-1150	3520	275-875	Intermittent
Nov. 23	2027	200-625	-	-	Intermittent
Dec. 14	640	350-600	426	350-675	None

* Post-veligers believed to be dead as there was clumping on the slides. - Sampling not scheduled.

AIV-33

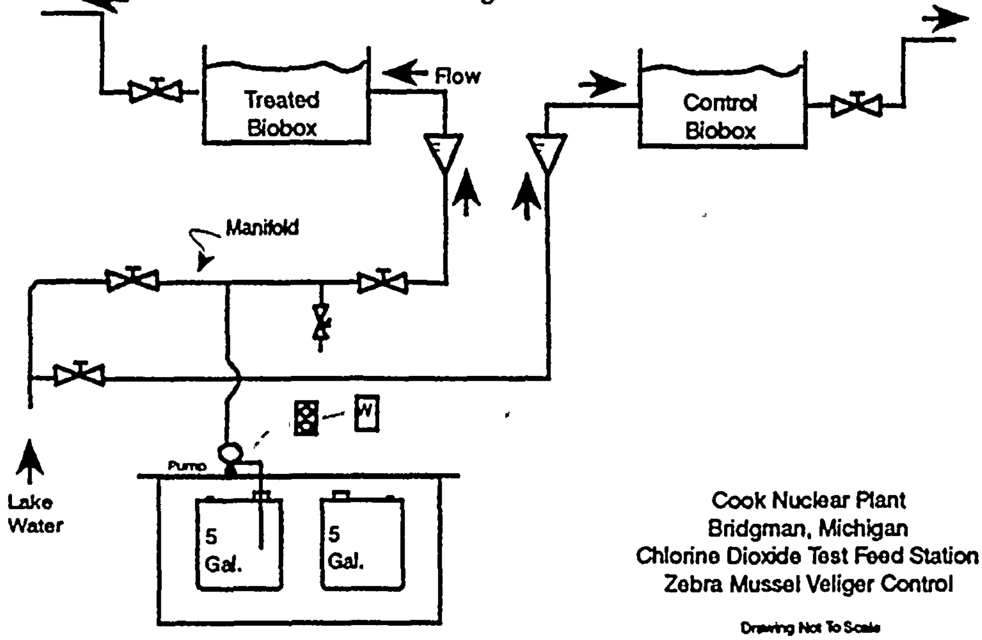
Table 5 —Physical and Chemical Data Collected During Test

Day of Test	ClO_2 Solution Strength (mg/liter)[a]	Inlet Concentration (mg/liter)[a]	Outlet Concentration (mg/liter)[a]	Temperature (°F)
TEST 1				
1	106	0.22	0.16	57
4	110	0.24	0.18	57
10		0.20	0.19	53
11	103	0.26	0.15	53
12		0.28	0.18	53
13		0.23	0.15	54
14	116	0.21	0.22*	54
17	110	0.23	0.18	51
Test 1 Mean	109	0.23	0.18	54
TEST 2				
1	102	0.22	0.15	52
2	106	0.23	0.16	52
3		0.25	0.15	52
5	91	0.23	0.15	47
7		0.22	0.11	48
8	112	0.23	0.14	48
10		0.26	0.17	49
11	108	0.25	0.19	49
12	104	0.23	0.13	49
14		0.23	0.12	48
Test 2 Mean	104	0.24	0.15	49

* Outlet concentration essentially the same as inlet. Deviation is due to testing error.

Note: Chlorine dioxide concentrations in and out of the control box was 0 mg/l for all times sampled.

Figure 1



Cook Nuclear Plant
Bridgman, Michigan
Chlorine Dioxide Test Feed Station
Zebra Mussel Veliger Control

Drawing Not To Scale

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April 20, 1994
File No. 673-001

Mr. Eric Mallen
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Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106

Re: Additional Winter Sampling for Zebra Mussels

Dear Mr. Mallen:

At your request, LMS continued a reduced zebra mussel monitoring program at D.C. Cook plant during the winter of 1994. Artificial substrates were set at one location each on the NESW and ESW service water systems and at two locations in the forebay. The initial set was made on 22 January 1994, with collections and resets with clean slides being made on 24 February and 22 March. The final set was collected on 8 April to allow sufficient time for laboratory analysis before the contract expired on 15 April 1994.

Counts expressed as No. per meter^2, average size (μ), and min-max size ranges (μ) information is presented in the attached Table. Several interesting observations were made.

- Zebra mussels continue to move in the forebay and into the service water system during the winter months.
- Concentrations ranged from 160 to 3,093 per m^2 in the service water systems. Most samples revealed low concentrations in these systems.
- Settlement occurred in low concentrations (*less than 1,000/m^2 on all dates in the forebay sampling locations*).

- Mean size and size ranges indicate that these individuals were translocators and that most of them may have been from the same cohort.

These results show that low numbers of translocating zebra mussels continue to move into the Cook plant service water systems throughout the winter when the chlorination system is not used. These have the potential to become established in the systems and to reproduce in the pipes during the following season. These results and this potential need to be factored into the treatment strategy being developed for the D.C. Cook plant.

We are not aware of other winter data being developed at power plants on Lake Michigan at this time. Most utilities discontinue both sampling and treatment in either November or December. These programs are then reactivated in either April or May. We will continue to search for other winter data to pass along to you.

If you have any questions, please contact me.

Very truly yours,

Bruce L. Lippincott

Bruce L. Lippincott, PhD
Manager, Midwest Office

BLL/pat

673-001.ltr

D.C. COOK WINTER ZEBRA MUSSEL SETTLEMENT
February - April 1994

DATE	NESW	ESW	FOREBAY 1	FOREBAY 2
24 Feb 1994				
#/m^2	1599	213	267	328
ave size (μ)	460	500	440	328
min - max (μ)	225-625	250-950	250-600	250-450
22 March 1994				
#/m^2	427	3093	746	853
ave size (μ)	380	541	453	397
min - max (μ)	300-450	300-1100	350-625	300-600
08 April 1994				
#/m^2	160	373	426	320
ave size (μ)	383	539	418	400
min - max (μ)	350-400	450-700	325-500	300-550

Prepared for

INDIANA MICHIGAN POWER COMPANY
One Cook Place
Bridgman, Michigan

MOLLUSC BIOFOULING MONITORING DURING 1994

Donald C. Cook Nuclear Plant

April 1995

LMSE-95/0171&673/002

Prepared by:

LAWLER, MATUSKY & SKELLY ENGINEERS
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EXECUTIVE SUMMARY

The Indiana Michigan Power Company has been conducting biofouling studies at the Donald C. Cook Nuclear Plant since 1983. In 1991, monitoring of zebra mussels in the circulating water, essential service water (ESW), and nonessential service water (NESW) systems was added to the program. The objectives of this monitoring are to detect the presence and density of zebra mussel veligers in the circulating water system and postveliger settlement in the forebay and service water systems.

Veligers were present in the forebay from 26 May through 17 November 1994. Peak densities occurred on 30 June and 7 July 1994, with the major peak occurring on the June date (513,500/m^3). Secondary peaks were observed on 18 August, 8 and 15 September, and 20 October, 1994. The June peak was atypical for the lower Great Lakes which normally experience peak densities during the September-October period.

Settlement occurred in the forebay on all periodic sampling dates in 1994. Size information indicates that settlement during the 12 May to 30 June and the 3 November to 14 December periods was composed primarily of translocators. First evidence of 1994 spawned postveliger settlement was observed on 30 June. Heaviest settlement occurred between 8 September and 3 November with the peak occurring during the 22 September to 6 October period. This is typical for the lower Great Lakes and is similar to results reported for the 1992 and 1993 monitoring programs.

Cumulative settlement was monitored in the forebay using two six inch PVC pipes (ID 2 in.). These were set near the end of April and retrieved in December. One sampler was exposed to the Clamtrol treatment and the other was placed in non-treated water during the Clamtrol treatment period. The objective was to compare post-treatment settlement with that of the entire monitoring period. The treatment sampler was inspected before being reset in the forebay on 15 September and was void of mussels at that time. Analysis following retrieval in December showed the density on the treated sampler was approximately 76% of the density on the sampler that was not exposed to Clamtrol. Size ranges and mean sizes of zebra mussels observed on

the two samplers were similar suggesting that many translocators settled on the treated sampler during this three month period. Those findings emphasize the need for effective chlorination in the service water systems during the September to December period.

Settlement of live postveligers first appeared on the artificial substrates set in the service water systems on 11 August. Size data indicated that settlement reported for the period 12 May through 16 June was composed of translocators that had spawned prior to 1994. Observation of location of individuals on slides, number of half shells, and size data indicated that results recorded for the month of July reflected the effects of the continuous chlorination, i.e. primarily dead veligers that were entrained on the slides during their removal. The disappearance of translocators from the service water artificial substrates between 16 and 30 June reflects the effectiveness of continuous chlorination for a period of five days. Continuous chlorination for the service water systems ended on 1 August and these systems received no chlorination until 11 August. Inspection of slides collected on that date showed live postveligers randomly located and no half shells; both are signs of live veligers. Intermittent chlorination was scheduled from 11 August to 1 December. However, this schedule was increasingly interrupted from September through November, mostly the result of equipment failure. Consequently, chlorination was not very effective during this period, as reflected by both periodic and cumulative settlement densities.

Settlement of postveligers at the miscellaneous sealing and cooling system location first appeared on 28 July based on size information. This system was not chlorinated during the continuous chlorination phase and provided a reasonable data set for comparison with those of the chlorinated service water systems for that period. Water pumped to the miscellaneous sealing and cooling water system was drawn from the chlorinated circulatory water system during the intermittent chlorination phase. Other factors, such as variable flow, heated water, and heavy sediment loading confounded the comparison. Cumulative artificial substrate density comparisons suggest that continuous chlorination was effective.

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 1994 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, NESW, and miscellaneous sealing and cooling systems for periodic and cumulative post-veliger settlement.

1.2 OBJECTIVES

Specific objectives for the 1994 biofouling monitoring program were as follows:

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

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

CHAPTER 2

METHODS

2.1 WHOLE-WATER SAMPLING

Whole-water sampling of the circulating water system was conducted from 28 April to 14 December 1994. 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 Myers Model 2JF51-8 well pump, rated to deliver 8 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 return side of both service water systems and on the miscellaneous sealing and cooling system. Monitors were equipped with modified test-tube racks designed to hold slides for periodic and cumulative sampling. (*Periodic settlement* is defined as short-term monitoring, either two- or three-week periods, depending on the month. *Cumulative settlement* is long-term monitoring that extends from initial deployment [28 April] to the end of the sampling season.) A sufficient number of substrates were initially placed in the samplers to allow 10 slides to be removed once per month at the service water and miscellaneous sealing and cooling water locations. Cumulative settlement was monitored in the forebay using two pieces of PVC pipe that were each six inches long and had an inside diameter of two inches. Each pipe was cut in half lengthwise, rejoined using hose clamps, and attached to a rope at intervals of about three feet. One sampler was exposed to ClamTrol CT-2 and the other was not exposed to the toxicant during the September 10-11, 1994 Clamtrol treatment. 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 28 April was retrieved from each location once per month 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 that were designed to measure periodic settlement were placed in the intake forebay and consisted of cinderblocks with test-tube racks secured inside the openings. Periodic samplers were deployed by rope in the central location approximately one meter from the bottom.

Cumulative settlement artificial substrates were also deployed by rope at the central location in a vertical orientation at mid-depth in the forebay. Initially, two of these samplers were also deployed near the bottom of the forebay. However, these lower units were buried in debris during the season and did not yield any information.

Sidestream monitors were placed on the return side of the service water systems (ESW and NESW) and the miscellaneous sealing and cooling water system. Each monitor contained two modified test-tube racks that held all slides above the monitor base. This allowed silt and sediment to fall out before they could influence 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.)

Cumulative settlement in the forebay was determined by scraping an approximate two square inch section of one half of the PVC pipe sampler. The section of pipe selected for analysis was approximately in the middle of the sampler. This avoided either over or under estimating densities by analyzing the more heavily infested bottom end or the more lightly infested upper

end of the sampler. The raw number counted was then converted and extrapolated from numbers per square inch to the conventional numbers per square meter.

Shell diameters were measured on up to 50 selected and random individuals to obtain maximum, minimum, and average sizes. A total of 100 shells were measured on each of the cumulative artificial substrate samplers that were placed in the forebay. 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 28 April 1994 and completed on 14 December 1994. Sixty samples were taken (two per sampling date) from the station's intake forebay. The monitoring system performed up to expectations. The continued use of an electronic flowmeter provided data comparable to those of the 1993 monitoring program. As a result, direct comparisons with 1993 data can be made.

Results of sampling are presented in Figure 3-1 and Table 3-1. With the exception of the 12 May, 23 November, and 14 December sampling dates, veligers were present in all samples collected. The major density peak was observed on 30 June (513,500/m^3). Lesser peaks of abundance occurred on 18 August (85,500/m^3), 8 September (79,650/m^3), and 20 October (53,250/m^3).

As was also observed in 1993, veliger presence throughout the monitoring program (except for December) suggests that substantial densities of veligers are in the water column for more than six months of the year. Heaviest spawning activity occurred during the late June - early July period. During the seven weeks from early September through the third week of October, mean veliger densities were approximately 37,000/m^3, which was approximately 50,000/m^3 less than the same period in 1993. This June peak of abundance differed markedly from the 1993 peak, both in magnitude and season. In 1993, the peak abundance was recorded during the first two weeks of October at a density of about 109,000/m^3. The October 1993 period of peak abundance is more typical for the lower Great Lakes (O'Neil, personal communication). It is thought that the June 1994 peak was more the result of unusually hot weather that occurred during the first two weeks of June than environmental differences between the early fall periods of the two years. However, the expected fall peak failed to materialize in 1994.

FIGURE 3-1
WHOLE-WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER, D.C. COOK, 1994

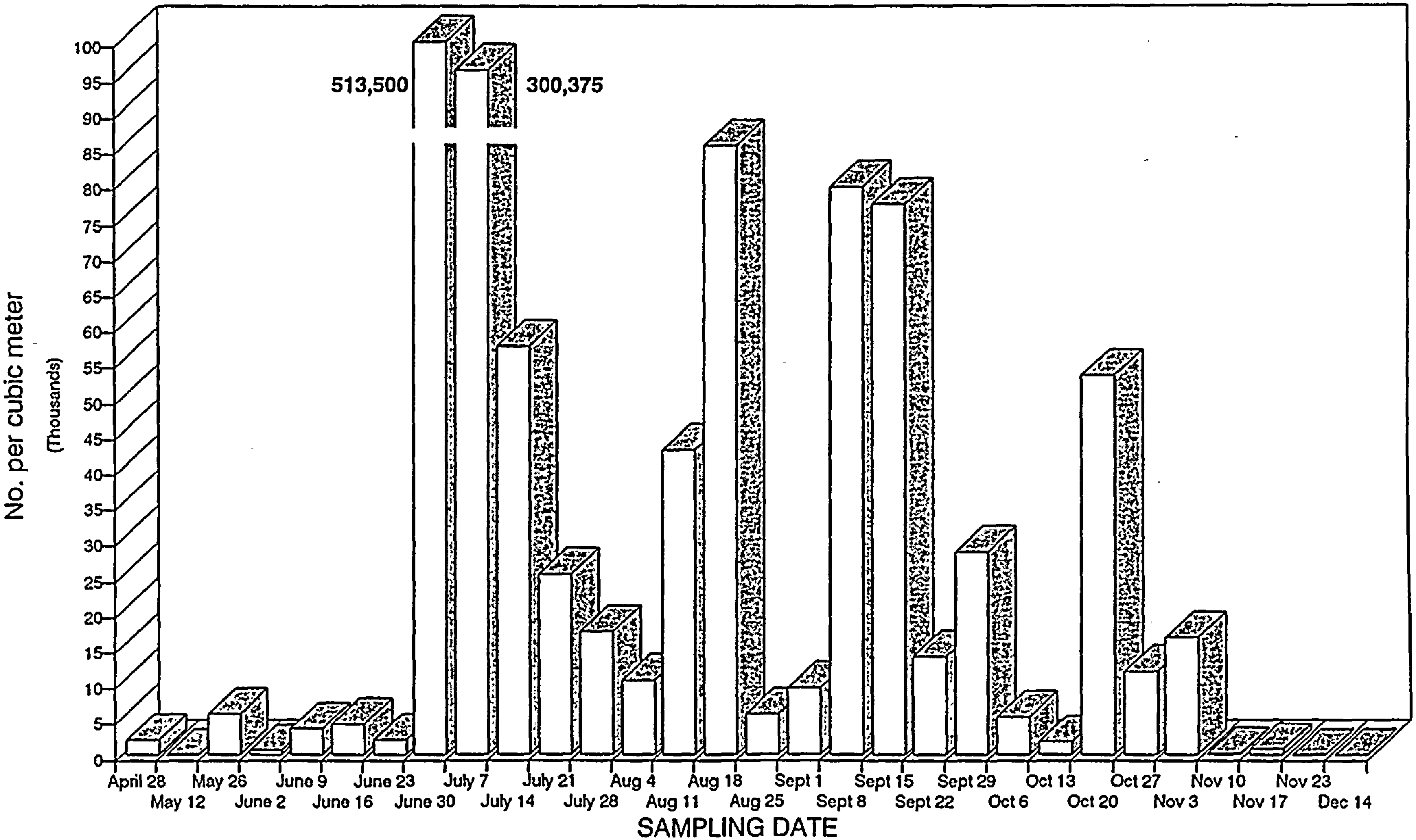

TABLE 3-1

WHOLE WATER SAMPLING PROGRAM
VELIGERS PER CUBIC METER, D.C. COOK, 1994

DATE	DENSITY (No./m³)	SIZE RANGE (μm)	MEAN SIZE (μm)
4/28/94	1,900	600 - 1,000	700
5/12/94	0	-	-
5/26/94	5,600	175 - 350	210
6/02/94	500	100 - 550	260
6/09/94	3,700	100 - 650	254
6/16/94	4,300	<175	175
6/23/94	1,950	<150	150
6/30/94	513,500	100 - 150	125
7/07/94	300,375	100 - 225	142.5
7/14/94	57,250	150 - 220	177
7/21/94	25,400	125 - 275	175
7/28/94	17,250	75 - 250	154
8/04/94	10,500	125 - 225	169
8/11/94	42,750	100 - 225	163
8/18/94	85,500	100 - 200	133
8/25/94	5,700	125 - 225	164
9/01/94	9,300	100 - 250	165
9/08/94	79,650	125 - 200	150
9/15/94	77,167	125 - 200	172
9/22/94	13,700	100 - 250	175
9/29/94	28,500	125 - 225	170
10/06/94	5,250	75 - 250	154
10/13/94	1,750	175 - 300	229
10/20/94	53,250	100 - 175	144
10/27/94	11,667	100 - 400	157
11/03/94	16,500	150 - 225	173
11/10/94	200	200 - 225	213
11/17/94	700	175 - 250	214
11/23/94	0	-	-
12/14/94	0	-	-

Size data for the 1994 sampling season shows that translocators were active in the forebay on 28 April but that spawning had not yet begun. Spawning commenced between 12 and 26 May and continued through the first half of November as indicated by the lower portion of the size range data. Size range data also shows that translocators were present in the water column from 26 May through 9 June but then were absent from the samples for the remainder of the sampling season. On most other dates, the upper end of the size range was near or less than the size of settlement (200-225μm).

In summary, zebra mussel veligers were present in the water column on all sampling dates except 12 May, 23 November, and 14 December. Translocators comprised all of the 28 April sample and were present through 9 June. Spawning commenced between 12 and 26 May and continued through early November. Peak veliger densities occurred during the 30 June - 7 July period. Secondary peaks were observed on 18 August, 8 and 15 September, and 20 October. The June peak for veliger density was atypical for the lower Great Lakes which normally experience peak densities during the September - October period.

3.2 ARTIFICIAL SUBSTRATE SAMPLING

3.2.1 Circulating Water System

Artificial substrate monitoring was conducted from 28 April to 14 December 1994. Periodic settlement rates for the circulating water system (forebay) are shown in Figure 3-2. Table 3-2 provides density and size information for settled postveligers. Samples were collected at the center forebay location which is protected by a deflector wall.

Settlement in the forebay occurred on all periodic sampling dates in 1994. Size information presented in Table 3-2 indicates that settlement during the early portion of the program (12 May to 30 June) was composed primarily of translocators that were re-settling in relatively low densities (2000-7000/m^2). Translocators continued to appear in low numbers on the periodic artificial substrates throughout the sampling period. First evidence of 1994 spawned zebra mussel settlement was observed on 30 June. Heaviest settlement occurred between 8 September

FIGURE 3-2
ARTIFICIAL SUBSTRATE SETTLEMENT-FOREBAY NUMBERS PER SQUARE METER, D.C. COOK, 1994

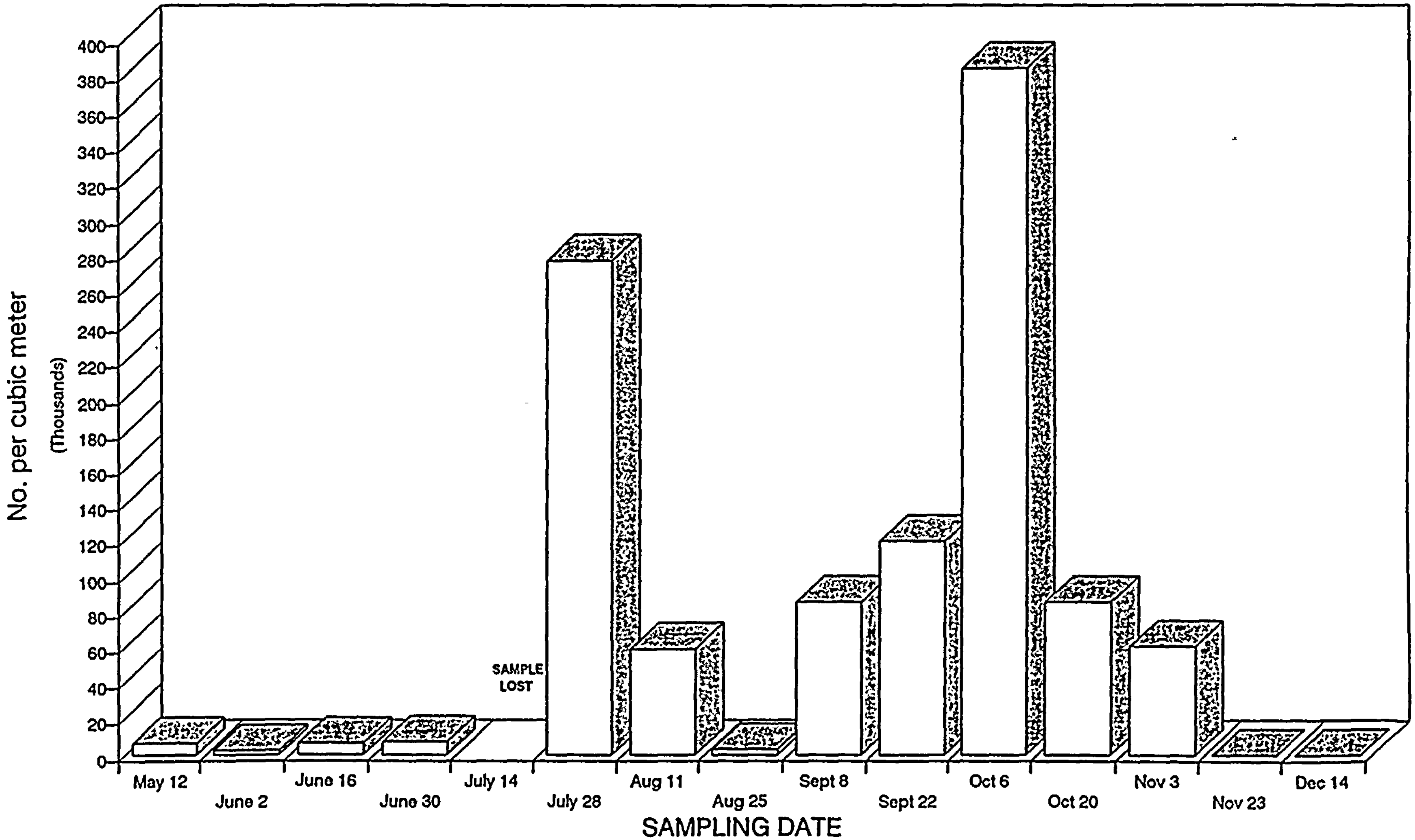

TABLE 3-2

ARTIFICIAL SUBSTRATE SETTLEMENT-FOREBAY *PERIODIC* POSTVELIGER DENSITY, SIZE RANGE, AND MEAN SIZE, D.C. COOK, 1994

DATE	DENSITY (No./m^2)	SIZE RANGE (μm)	MEAN SIZE (μm)
5/12/94	5,867	550 - 3,200	662
6/02/94	2,363	300 - 2,200	695
6/16/94	6,224	400 - 1,800	-
6/30/94	6,933	150 - 2,100	877
7/14/94	a	a	a
7/28/94	276,270	200 - 425	263
8/11/94	59,379	175 - 1,200	353
8/25/94	3,093	150 - 2,500	514
9/08/94	85,468	150 - 375	287
9/22/94	119,325	175 - 750	281
10/06/94	383,500	175 - 1,175	351
10/20/94	85,868	200 - 450	282
11/03/94	60,623	300 - 500	423
11/17/94	2,987	350 - 3550	811
12/14/94	1,493	450 - 2350	910

[a]Sample lost.

and 3 November with the peak occurring during the 22 September to 6 October period. This is typical for the lower Great Lakes and consistent with results reported for the 1992 and 1993 monitoring programs (LMS 1993, 1994). A second, lesser peak was observed during the 14 July to 28 July period following the peak spawning period (30 June to 7 July). The 6 October peak included translocators, as indicated by the size range and mean size data (Table 3-2). This partially explains why peak settlement did not follow peak spawning as expected. Unlike the 1993 results, very little settlement occurred between 3 November and 14 December. Based on size data, the majority of those individuals settling during this period were translocators rather than recently spawned postveligers.

Cumulative settlement was monitored using two six inch long pieces of PVC (ID 2 in.). These were suspended from a rope at mid-depth in the forebay. Both pipes were set in April and retrieved in December. One of the pipes was exposed to the ClamTrol treatment while the other was placed in a biobox which was not exposed to the chemical. The objective was to compare post-ClamTrol settlement to that of the entire sampling period. Information gathered during previous years suggested that much of the annual settlement occurs within a short period following the ClamTrol treatment. Density on the post treatment artificial substrate was $231,697/m^2$. The individual sizes ranged from 650 to 4500 μm, and the mean size of 98 randomly selected individuals plus the largest and smallest individuals was 1931 μm. Data collected from the artificial substrate that was not exposed to the treatment included a density of $303,562/m^2$. The size of these individuals ranged from 700 to 5200 μm and averaged 2153 μm. Review of these results indicates that settlement occurred rapidly on the artificial substrate that was exposed to treatment and that the size range and mean size were similar to those of the control substrate monitor. This was unexpected because the treatment substrate was void of mussels when reset in the forebay. (All mussels were deemed as dead in the treatment biobox in which the substrate was stored during the ClamTrol treatment.) Therefore, settlement occurred rapidly on the "clean" surface to occupy available space. This phenomenon had been qualitatively observed in other years by divers in the forebay and was expected. Based on size data, it is reasonable to conclude that many of these mussels that settled between 15 September and 14 December were translocators, which was expected. This indicates that a substantial number of zebra mussels of all sizes are available to colonize the "clean" surfaces of recently

treated systems each autumn. It underscores the need for effective preventative treatment in the service water systems during the September-November period each year. Although densities of veligers in the water column tend to decrease to zero by the end of November, densities of translocators are sufficient to warrant continuing treatment until 1 December.

3.2.2 Service and Miscellaneous Sealing and Cooling Water Systems

Unlike 1993 when both the supply and return side of the ESW and NESW of Unit 2 were sampled, only the return side of the ESW and NESW systems were monitored during 1994. The ESW systems of both Units 1 and 2 were monitored throughout the sampling period; and, initially, only the Unit 2 NESW system was sampled. However, flow to the Unit 2 NESW system monitoring biobox was shut off during the 8-22 September period. The NESW monitoring location was then moved to Unit 1 where it remained until the end of the study period. A sidestream biobox monitor was placed on the miscellaneous sealing and cooling water system for the first time in 1994. This system draws its water from a source separate from that of the service water systems. Field observations made at this monitoring location indicated considerable variance in flows to the biobox, heavy accumulation of sediment in the biobox, and very warm temperatures in the water flowing through this biobox . This system did not receive any chlorination during the period of continuous chlorination but was chlorinated during the period of intermittent chlorination. The ESW and NESW systems were scheduled for chlorination from the end of June to the first week of December.

Periodic settlement densities for the service water systems and the miscellaneous sealing and cooling water system are shown in Table 3-3 and Figure 3-3. Settlement occurred at ESW R-2 and NESW R-2 on the first retrieval date (12 May 1994), but did not appear on artificial substrates set at ESW R-1 and miscellaneous sealing and cooling water locations until 16 June and 30 June, respectively. Artificial substrates were set at the latter two locations after 12 May and most likely had not acquired a sufficient biofilm to support the translocators that were settling on artificial substrates which had been in place at the other locations since late January as part of the winter monitoring program. (Results of that program have been submitted separately and are not included in this report.) Size information (Table 3-4) shows that

FIGURE 3-3

ARTIFICIAL SUBSTRATE SETTLEMENT-PERIODIC SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER DENSITY PER SQUARE METER, D.C. COOK 1994

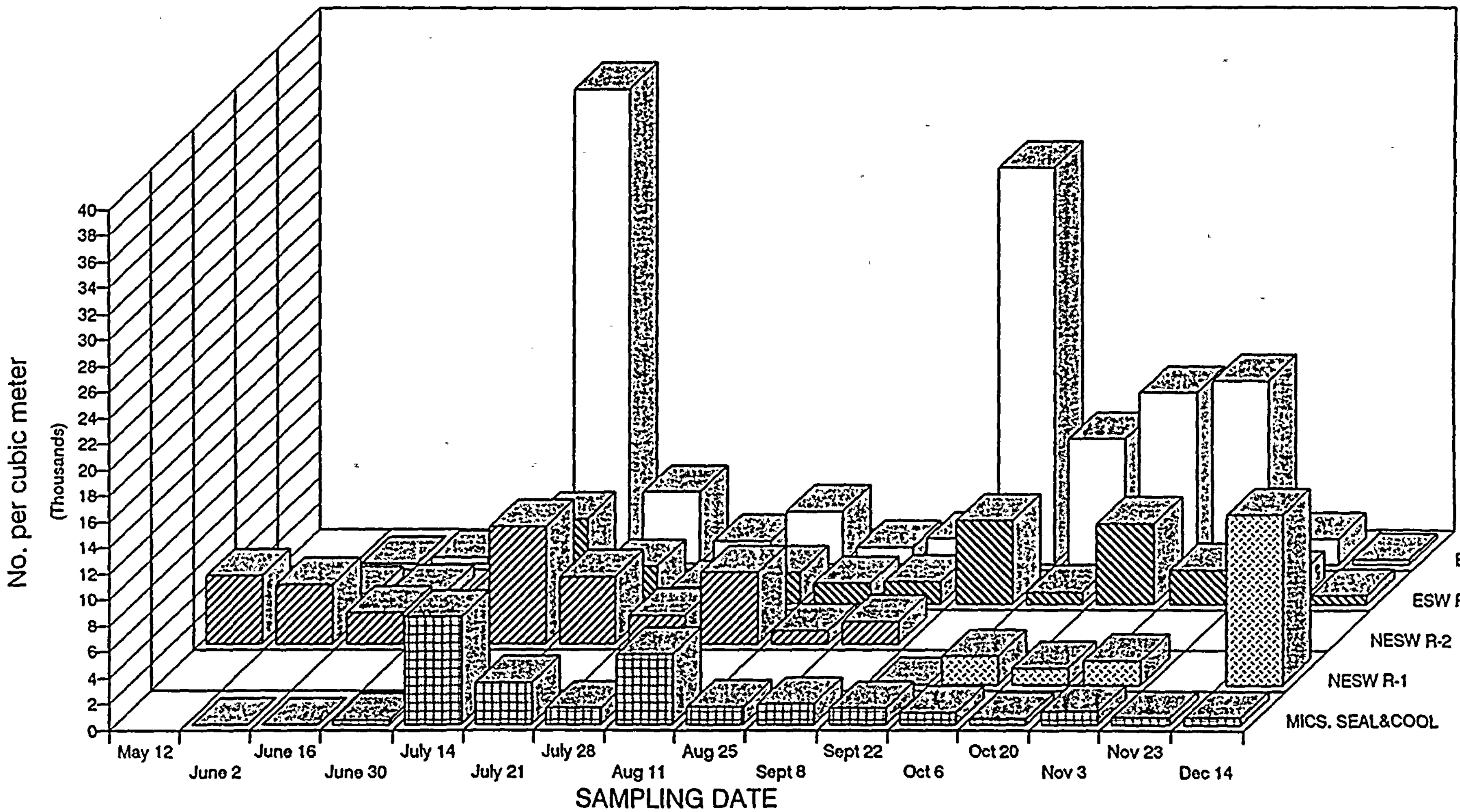

TABLE 3-3

ARTIFICIAL SUBSTRATE SETTLEMENT-*PERIODIC* SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER DENSITY PER SQUARE METER, D.C. COOK, 1994

DATE	ESW R-1	ESW R-2	NESW R-2	NESW R-1	MISC. COOLING
5/12/94	NS[a]	747	5,245	NS	NS
6/02/94	0	711	4,480	NS	0
6/16/94	427	853	2,347	NS	0
6/30/94	0	0	427	NS	320
7/14/94	36,356	6,401	8,960	NS	8,213
7/21/94	5,467	2,773	5,067	NS	3,200
7/28/94	1,707	1,173	2,133	NS	1,173
8/11/94	3,947	2,347	5,440	NS	5,333
8/25/94	1,200	1,600	933	NS	1,333
9/08/94	1,867	1,653	1,707	NS	1,546
9/22/94	30,294	6,400	NS	0	1,244
10/06/94	9,600	891	NS	2,133	853
10/20/94	13,067	6,133	NS	1,244	400
11/03/94	14,045	2,560	NS	1,733	933
11/23/94	1,920	2,027	NS	NS[b]	533
12/14/94	320	640	NS	12,978	533

[a]NS=Not sampled.
[b]No flow.

TABLE 3-4

ARTIFICIAL SUBSTRATE SETTLEMENT-*PERIODIC* SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER SIZE DATA (μm), D.C. COOK, 1994

	ESW R-1		ESW R-2		NESW R-2		NESW R-1		MISC. COOLING	
DATE	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
5/12/94	NS[a]	NS	400-650	450	475-900	621	NS	NS	NS	NS
6/02/94	0	0	300-800	548	250-700	370	NS	NS	0	0
6/16/94	550-800	675	475-1500	766	450-3400	978	NS	NS	0	0
6/30/94	0	0	0	0	100-125	113	NS	NS	100-125	108
7/14/94	125-225	164	100-375	178	125-200	171	NS	NS	100-200	156
7/21/94	125-225	163	125-175	153	125-200	156	NS	NS	100-225	152
7/28/94	125-200	154	125-250	191	125-200	163	NS	NS	125-175	155
8/11/94	150-350	235	125-375	233	150-550	278	NS	NS	175-300	244
8/25/94	125-225	175	150-450	244	175-350	255	NS	NS	225-325	279
9/08/94	125-325	186	125-500	205	125-400	191	NS	NS	200-350	237
9/22/94	200-275	232	125-275	214	NS	NS	0	0	125-250	184
10/06/94	125-325	250	200-275	242	NS	NS	175-450	307	200-375	281
10/20/94	250-625	325	225-350	265	NS	NS	200-625	347	250-375	325
11/03/94	225-825	425	250-1150	506	NS	NS	275-800	435	375-1750	552
11/23/94	250-1100	544	200-625	419	NS	NS	NS[b]	NS[b]	275-750	465
12/14/94	350-650	475	350-600	442	NS	NS	250-2550	819	350-650	465

[a]NS=Not sampled.
[b]No flow.

settlement was composed mostly of translocators during the 12 May through 16 June period. The very warm water passing through the biomonitor at the miscellaneous sealing and cooling water location most likely contributed to the lack of settlement during this same time period.

Continuous chlorination of the service water systems was initiated during the last week of June (Appendix A) and continued through 1 August. On 5 and 11 August, chlorination was changed to an intermittent basis (one 155 minute treatment per day) in the circulating and service water systems, respectively. This schedule was followed until the first week of December with several interruptions. These included no scheduled chlorination in the Unit 2 nonessential service water systems from 9 September to 17 November (ClamTrol treatment and Unit 2 Outage) and no scheduled chlorination in Unit 1 service water systems 9 September to 16 September (ClamTrol Treatment). Figures 3-4 and 3-5 combine the percent availability of the chlorination system in two week increments and periodic settlement recorded at Units 1 and 2, respectively. Both service water systems were chlorinated for equal amounts of time until the 22 September to 6 October period. Differences in chlorination system availability between the service water systems were recorded from that period to the end of the monitoring season. These differences are included in Figures 3-4 and 3-5. Other unscheduled interruptions occurred primarily during the period of intermittent chlorination. Days without chlorination or with no TRC data for the ESW and NESW of both Units 1 and 2 are summarized in Table 3-5. (The full data set is presented in Appendix A.) This table indicates that the chlorination system operated well only in July. The other months contained periods of no chlorination or no data. The effectiveness of the chlorination system can not be evaluated with "no data" entries.

The data (30 June) indicate that settlement was completely prevented at ESWR-1 and ESWR-2 following the initiation of continuous chlorination during the last week of June. The low density combined with the size data for NESWR-2 on 30 June strongly suggests that settlement did not occur at this location either because the size range (100-125 μm) is well below the minimal size range associated with post veliger settlement (200-225 μm). Comparison of size range data for NESWR-2 to that of the veligers in the wholewater samples taken on the same date indicates that veligers were incidentally entrained on the artificial substrates when they

FIGURE 3-4

POSTVELIGER SETTLEMENT UNIT 1 ESSENTIAL AND NONESSENTIAL SERVICE WATER SYSTEMS, D.C. COOK, 1994

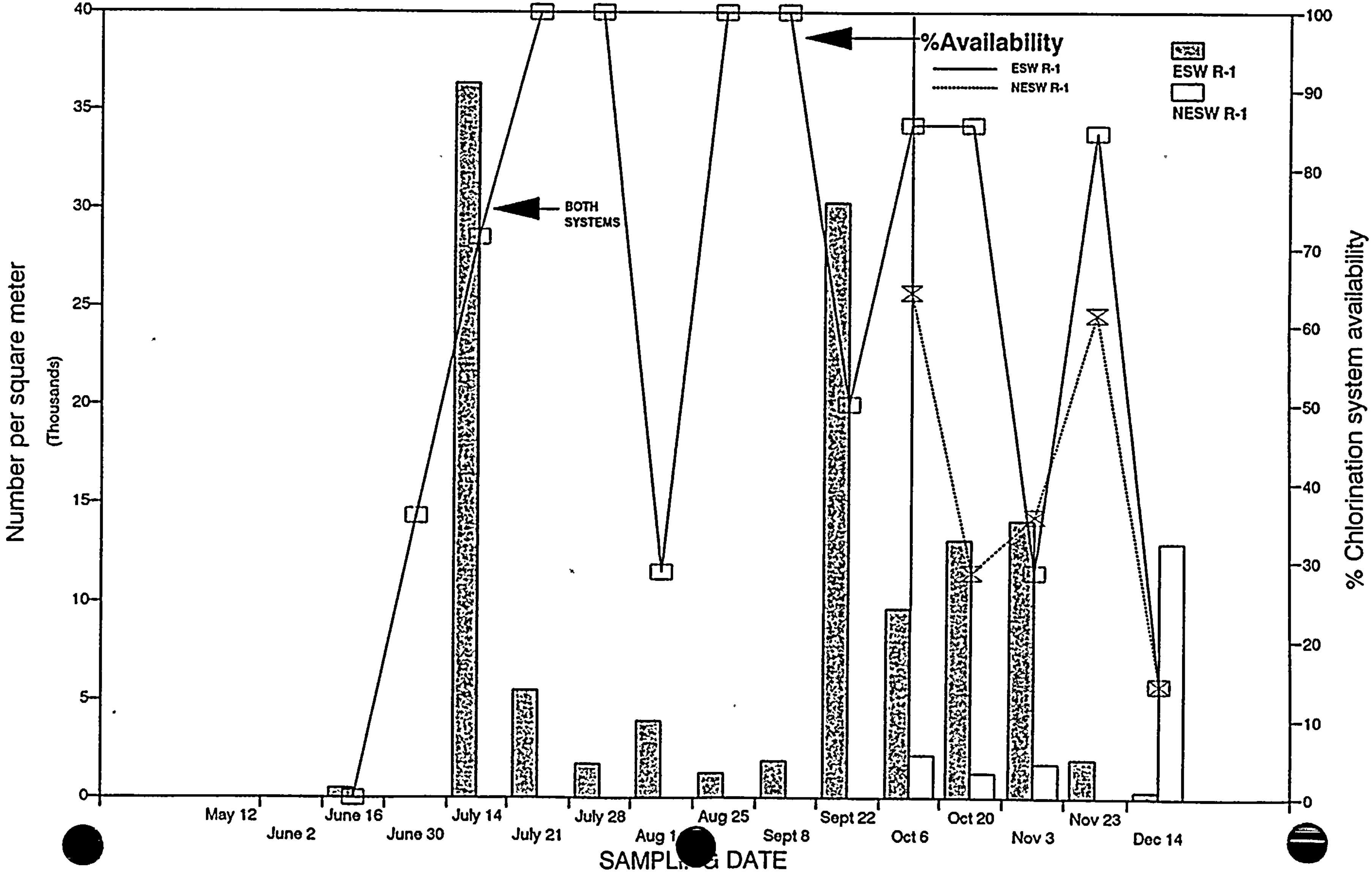

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FIGURE 3-5

POSTVELIGER SETTLEMENT UNIT 2 ESSENTIAL AND NONESSENTIAL SERVICE WATER SYSTEMS, D.C. COOK, 1994

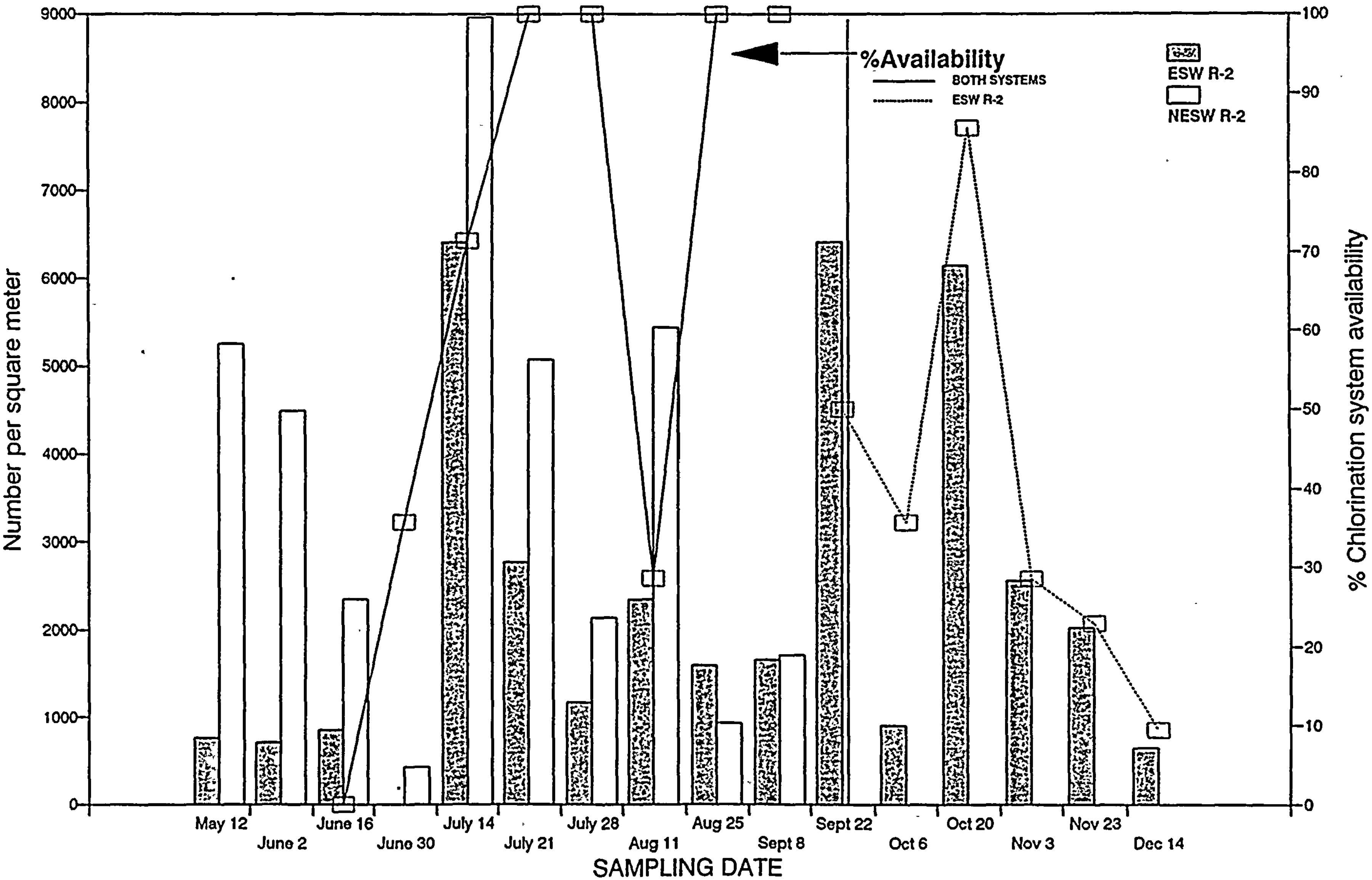

TABLE 3-5 (Page 1 of 3)

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

DATE	UNIT 1		UNIT 2	
	ESW	NESW	ESW	NESW
May				
1-31	NC	NC	NC	NC
June				
1-24	NC	NC	NC	NC
30	NC	NC	NC	NC
July				
1	NC	NC	NC	NC
2	NC	NC	NC	NC
10	NC	NC	NC	NC
11	NC	NC	NC	NC
24	ND[1]	ND	ND	ND
August				
2-10	NC[2]	NC	NC	NC
13	ND	ND	ND	ND
19	ND	ND	ND	ND
21-25	ND	ND	ND	ND
September				
9-15	NC[a]	NC[a]	NC[a]	NC[a]
16	ND	ND	ND	ND
17	ND	ND	ND	NC
18	ND	ND	ND	ND
19	ND	ND	ND	ND
20	ND	ND	ND	ND
22	ND	ND		NC
23			ND	ND
24	NC	NC	NC	NC
25	NC	NC	NC	NC
26			NC	NC
27			NC	NC
28			NC	NC
29			NC	NC
30			NC	NC

[1]ND – No TRC data, but chlorination occurred.
[2]NC – No chlorination.
[a]Clamtrol treatment.

TABLE 3-5 (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
October				
1			NC	NC
2			NC	NC
3				NC
4	ND	ND	ND	ND
5	ND	NC	ND	NC
6	ND	NC	ND	NC
7		NC		NC
8		NC		NC
9		NC		NC
10	ND	ND	ND	NC
11				NC
12				NC
13		NC		NC
14		NC	NC	NC
15		NC		NC
16		NC		NC
17		NC		NC
18				NC
19	NC	NC		NC
20	NC	NC	NC	NC
21			NC	NC
22	ND	ND	ND	ND
23	ND	ND	ND	ND
24	NC		NC	NC
25	NC	NC	NC	NC
26	NC	NC	NC	NC
27	NC	NC	NC	NC
28				NC
29	NC	NC	NC	NC
30	NC	NC		NC
31	NC	NC	NC	NC

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

TABLE 3-5 (Page 3 of 3)

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

	UNIT 1		UNIT 2	
DATE	ESW	NESW	ESW	NESW
November				
1	NC	NC	NC	NC
2	NC	NC	NC	NC
3	NC	NC	NC	NC
4	NC	NC	NC	NC
5	NC	NC	NC	NC
6		NC		NC
7	NC	NC	NC	NC
8		NC	NC	NC
9		NC	NC	
10			NC	NC
11			NC	NC
12	NC	NC	NC	NC
13	NC	NC	NC	NC
14	NC	NC	NC	NC
15				NC
16				NC
17	NC	NC	NC	NC
18	NC	NC	NC	NC
19	NC	NC	NC	NC
20			NC	NC
21			NC	NC
22			NC	NC
23			NC	NC
24			NC	NC
27	NC	NC	NC	NC
28	NC	NC	NC	NC
29	NC	NC	NC	NC
30	NC	NC	NC	NC

[1]NC – No chlorination.

were removed from the biobox. The same explanation holds true for the results reported on 30 June for the miscellaneous sealing and cooling water sampling location.

Density data recorded for 14, 21, and 28 July are misleading. Size data shows that, although some individuals were of settleable size, mean sizes for all locations on those dates were below the minimum threshold for settlement. Laboratory analysis of the slides from the service water systems also revealed that approximately 90% of these individuals were clumped in silt or sand and that large numbers of half shells were present. These observations strongly suggest that the individuals counted were dead, further indicating that the continuous chlorination schedule was very effective during the critical settlement period which followed the peak spawn of the season.

Chlorination was changed from a continuous to an intermittent mode on 5 August in the circulating water system. The pump supplying the miscellaneous sealing and cooling water system withdrew water from the chlorinated circulating water system. Consequently, the miscellaneous sealing and cooling water was chlorinated from 5 August to 3 December. Furthermore, elevated water temperature enhances the efficacy of the chlorine reaching the monitoring location. However, chlorine was not delivered to the service water systems between 2 and 11 August. Analysis of the artificial substrates collected on 11 August showed that densities increased; but more importantly, size ranges and particularly mean sizes of individuals increased beyond the threshold for postveliger settlement. Equally important were the observations that individuals were randomly distributed on the substrates, were no longer clumped with silt or sand, were beginning to orient in typical fashion, and were definitely attached to the substrates. All of these observations indicated that the postveligers were alive. Densities declined and remained relatively stable between 11 August and 22 September. Settlement of live organisms peaked for the year in the essential service water systems of both units on 22 September, one week following the ClamTrol Treatment. From 22 September to the end of the sampling season, densities in the ESW systems fluctuated between 320 and 14,045 postveligers/m^2 with higher concentrations generally being recorded at ESWR-1. During this same period, densities typically ranged between 1000 and 2000/m^2 at NESWR-2, except for 14 December when a concentration of 12,978/m^2 was recorded. Size data suggest

that many of these individuals were translocators. Size ranges and means for the other locations and dates were expected for this period of the year. However, they were not expected in the service water systems that were being treated with chlorine. It is apparent that the chlorination system was either not delivering the product or one 155 minute dose of 0.5 to 1.0 mg/l per day is insufficient to prevent settlement. The spargers became at least partially clogged with mineral deposits early in October; therefore, delivery of chlorine was seriously impeded from October to December. Chlorination data presented in Appendix A indicates that the service water systems were chlorinated on a sporadic basis between 18 October and 26 November. This sporadic treatment contributed to the periodic artificial substrate results recorded during this period.

Another method of presenting the problems encountered by the chlorination system is to assess it in terms of percent availability for each month. Table 3-6 presents 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. All systems operated at 87.1% in July, but steadily declined from August through November as the result of Unit 2 outage and failures of the chlorine delivery systems. With the exception of Unit 1 ESW in October, the percent availability of the systems with measured TRC values was at or below 50% for the August to November period. This coupled with heated, chlorinated water being delivered to the miscellaneous sealing and cooling water system during the period of intermittent chlorination explains why there is little difference between the results recorded in the service water systems and those recorded in the miscellaneous sealing and cooling water system during most of the monitoring season.

A second set of data was collected at each of the service water systems and miscellaneous sealing and cooling water system for the purpose of determining the effectiveness of chlorination during the entire sampling season. These cumulative densities are presented in Table 3-7 and associated size information can be found in Table 3-8. Artificial substrates used for cumulative analyses were set on 12 May and sets of 10 slides were retrieved from each location at monthly intervals throughout the sampling season. Results were evaluated in conjunction with periodic data to better understand postveliger settlement in the systems.

TABLE 3-6

PERCENT AVAILABILITY OF CHLORINATION SYSTEM FOR SERVICE WATER SYSTEMS

May-November 1994

	UNIT 1		UNIT 2	
MONTH	ESW	NESW	ESW	NESW
May	0	0	0	0
June	16.7	16.7	16.7	16.7
July	87.1 (83.9)	87.1 (83.9)	87.1 (83.9)	87.1 (83.9)
August	71.0 (45.2)	71.0 (45.2)	71.0 (45.2)	71.0 (45.2)
September	70.0 (50.0)	70.0 (50.0)	53.3 (33.3)	46.7 (30.0)
October	70.0 (51.6)	41.9 (30.0)	64.5 (45.2)	9.7 (0.0)
November	46.7 (46.7)	36.7 (36.7)	16.7 (16.7)	10.0 (10.0)

( ) percent availability with known TRC concentrations.

TABLE 3-7

ARTIFICIAL SUBSTRATE SETTLEMENT-*CUMULATIVE* SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER DENSITY PER SQUARE METER, D.C. COOK, 1994

DATE	ESW R-1	ESW R-2	NESW R-2	NESW R-1	MISC. COOLING
6/16/94	640	1,067	3,307	NS[a]	0
7/14/94	320	746	5,227	NS	201,603
8/11/94	3,200	10,000	7,253	NS	25,733
9/08/94	1,707	1,973	3,307	NS	10,560
10/06/94	22,186	1,173	NS	2,667	1,920
11/03/94	9,493	3,520	NS	1,600	8,267
12/14/94	8,000	426	NS	1,422	1,386

[a]NS=Not sampled.
[b]No flow.

TABLE 3-8

ARTIFICIAL SUBSTRATE SETTLEMENT-*CUMULATIVE* SERVICE WATER AND MISCELLANEOUS COOLING WATER SYSTEMS POSTVELIGER SIZE DATA (μm), D.C. COOK, 1994

DATE	ESW R-1		ESW R-2		NESW R-2		NESW R-1		MISC. COOLING	
	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
6/16/94	550-950	783	650-1800	766	400-2800	978	NS[a]	NS	0	0
7/14/94	125-175	145	125-250	161	125-425	184	NS	NS	100-250	148
8/11/94	125-325	197	125-325	211	150-2200	358	NS	NS	125-350	246
9/08/94	125-750	209	125-275	211	125-400	216	NS	NS	150-500	293
10/06/94	200-475	314	225-775	339	NS	NS	125-525	307	225-425	313
11/03/94	275-700	420	275-875	447	NS	NS	200-475	364	200-475	308
12/14/94	750-2000	1105	350-675	450	NS	NS	475-750	610	400-550	442

[a]NS=Not sampled.

Because chlorine was not injected into the systems between 12 May and 16 June, the 16 June results reflect movement through and settlement by translocators. Size data presented in Table 3-8 are the basis for this observation.

Continuous chlorination was initiated during the last week of June and the 14 July data show the effectiveness of this treatment. Densities were reduced at ESWR-1 and ESWR-2 but increased at NESWR-2. Size ranges and means indicate that the translocators which were observed on 16 June had either been killed or moved through the systems. Size data also indicates that most of the individuals were veligers that had not yet reached settleable size and were most likely incidentally entrained on the slides as they were removed from the bioboxes. This is consistent with information reported for the periodic substrates that were retrieved on the same date.

Continuous chlorination of the service water systems was discontinued on 1 August. No chlorination occurred in the service water systems between 2 and 11 August. This nine day period of no chlorination appears to be responsible for increases in densities in the service water systems (increases of one order of magnitude at ESWR-1, two orders of magnitude at ESWR-2, and 39% at NESWR-2). Mean size data for this date at these locations shows that, on average, these individuals were of settleable size. Observations made during laboratory analysis indicated that individuals were randomly distributed and attached to the substrates, an observation which was also made for the periodic substrates on this date.

For the period from 11 August to 14 December, densities fluctuated in the essential service water systems with the peak density of the year at ESWR-1 being recorded on 6 October. This is consistent with periodic substrate data which show that peak settlement of live organisms at ESWR-1 occurred between 8 and 22 September (Table 3-3), the period included within the period of the 6 October cumulative sample. The change of the NESW sampling location from Unit 2 to Unit 1 between 8 September and 6 October does not permit long term analysis at either location. However, density and size data suggest that settlement occurred at the Unit 1 location from the time sampling began until the end of the program and that growth occurred on the slides during this period.

The progressive increase in the lower end of the postveliger size range as well as the progressive increase in their mean size in the essential service water systems of both units indicate that settled postveligers were remaining attached and growing during the period from 8 September to 14 December. The lower end of the size ranges at ESWR-1, ESWR-2, and NESWR-1 indicates that new settlement continued through 3 November. The 14 December size data show no new settlement, which is consistent with wholewater sampling results (0/m^3 on both 23 November and 14 December) (Table 3-1) and periodic settlement recorded for this date (Table 3-4).

Analysis of cumulative artificial substrate samples collected at the miscellaneous sealing and cooling water location shows that the highest density (several orders of magnitude greater than those recorded at the service water locations) occurred on 14 July and that the mean size of those individuals was 148 μm. This is substantially less than the threshold size for settlement. As with artificial substrates retrieved at other locations on this date, it has been concluded that many veligers were incidentally entrained on the slides during the retrieval process. There were many more veligers available to be entrained in the miscellaneous sealing and cooling water than in the chlorinated water, suggesting that chlorination was having the intended effect during this period. As expected, densities varied after 14 July and generally trended downward. However, these densities were generally one order of magnitude greater than those observed in the service water systems through August and September. This further suggests that chlorination of the service water systems was effective early in the monitoring program; but between September and December, it was not very effective. Size data show that the size range maxima remained fairly constant after 14 July but that the minima of the size range increased steadily during the period. This resulted in a steadily increasing mean size that can be interpreted as representing growth through the period. The fairly constant upper end of the size range maxima throughout the period was unexpected and suggests that translocation of organisms greater than 500-600 μm in size may have been occurring in this system during most of the sampling season. This explanation is not entirely confirmed by periodic data. However, translocators were responsible for size range maxima on periodic artificial substrates retrieved from the miscellaneous sealing and cooling water system on several dates (3 and 23 November; 14 December).

CHAPTER 4

SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

Whole-water and artificial substrate sampling was initiated on 28 April 1994 and continued to 14 December 1994. The major spawning peak occurred during the last week of June with lesser peaks occurring on 18 August, 8 September, and 20 October. The magnitude of the June peak was approximately four times greater than that of the 1993 peak veliger abundance.

Peak postveliger settlement in the forebay occurred during the 22 September to 6 October period. A secondary peak in settlement was observed for the 14 to 28 July period that followed the major spawning peak. The fall settlement peak occurred during the period in which several secondary peak spawns were observed. Fall spawning and settlement peaks are typical for the lower Great Lakes. Cumulative settlement observations that included reinfestation following ClamTrol treatment indicated rapid settlement occurred after the treatment.

Postveliger settlement in the service water depended more on mode of chlorination and its frequency than on availability of postveligers. Periods of heaviest settlement (September to November) in the ESW systems corresponded to periods of interrupted, intermittent chlorination. When the chlorination system was in the continuous mode, settlement in the service water systems was prevented. Specifically, the second heaviest period of settlement in the forebay (which is not chlorinated) occurred between 14 July and 28 July 1994. During this same period, the continuous chlorination schedule was maintained and settlement in the service water systems was eliminated (individuals on the substrates were found to be dead veligers). During the peak period of settlement in the forebay (September-October), chlorine was being administered intermittently (one 155 min dose per day) and spargers were clogged during October. Consequently, settlement in the essential service water systems of both units also peaked during this period indicating that chlorination delivery was not very effective.

Cumulative settlement in the service water systems also reflected the chlorination program as administered during 1994. In June, densities varied and were composed of translocators. Following the initiation of continuous chlorination, July samples were comprised mostly of dead veligers. The translocators had disappeared, having either been killed or having moved from this hostile environment. Densities varied among locations from August to December; however, these individuals were live postveligers that continued to grow throughout the period. This growth reflected the reduced level of effectiveness of the chlorination program during the period; growth was expected to occur as the result of the failure of maintaining the target level of chlorine delivery. Availability of chlorination systems to the service water systems decreased from 71% in August to less than 50% in November.

4.2 RECOMMENDATIONS

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

- Whole-water sampling should continue to be initiated in April to determine the presence of veligers in the water column.
- Studies of postveliger settlement substrates should continue to be conducted from May (substrate set in April) through December.
- The chlorination system should be maintained (reduce formation of lime scale on spargers) to ensure appropriate intermittent or continuous delivery of chlorine to control postveliger settlement (1 May-1 December).
- Based on settlement data from the early part of the program (May-June), chlorine should be delivered to the service water systems beginning on or about 1 May. This should reduce/eliminate the translocators from establishing residency in the critical service water systems.
- A minimum target of availability of the chlorination systems to the service water systems should be set at 70% with a goal of 90% for each month.

APPENDIX A

JUNE CHLORINATION - UNIT 1

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
6/1/94	-	-	-
6/2/94	-	-	-
6/3/94	-	-	-
6/4/94	-	-	-
6/5/94	-	-	-
6/6/94	-	-	-
6/7/94	-	-	-
6/8/94	0.09	-	-
6/9/94	0.06	-	-
6/10/94	0.05	-	-
6/11/94	0.023	-	-
6/12/94	-	-	-
6/13/94	-	-	-
6/14/94	-	-	-
6/15/94	-	-	-
6/16/94	-	-	-
6/17/94	-	-	-
6/18/94	0.02	-	-
6/19/94	-	-	-
6/20/94	-	-	-
6/21/94	-	-	-
6/22/94	0.02	-	-
6/23/94	0.03	-	-
6/24/94	0.01	-	-
6/25/94	<0.001	0.51[a]	0.14[a]
6/26/94	<0.001	0.54	0.02
6/27/94	<0.01	0.47	0..93
6/28/94	<0.01	2.05	0.04
6/29/94	<0.01	1.85	0.00
6/30/94	<0.01	-	-

Comments: - No chlorination

[a] Continuous chlorination initiated; continue to 2 August

JUNE CHLORINATION - UNIT 2

Date	End of Pipe Average TRC - 155 min/day Circ (ave) ppm	ESW ppm	NESW ppm
6/1/94	-	-	-
6/2/94	-	-	-
6/3/94	-	-	-
6/4/94	-	-	-
6/5/94	-	-	-
6/6/94	-	-	-
6/7/94	-	-	-
6/8/94	0.08	-	-
6/9/94	0.08	-	-
6/10/94	0.06	-	-
6/11/94	0.033	-	-
6/12/94	-	-	-
6/13/94	-	-	-
6/14/94	-	-	-
6/15/94	-	-	-
6/16/94	-	-	-
6/17/94	-	-	-
6/18/94	0.02	-	-
6/19/94	-	-	-
6/20/94	-	-	-
6/21/94	-	-	-
6/22/94	0.02	-	-
6/23/94	0.03	-	-
6/24/94	0.02	-	-
6/25/94	0.006	0.42[a]	0.36[a]
6/26/94	<0.001	0.52	0.03
6/27/94	<0.01	0.50	0.81
6/28/94	<0.01	0.54	0.82
6/29/94	<0.01	0.27	0.53
6/30/94	<0.01	-	-

Comments: - No chlorination

[a] Continuous chlorination initiated; continued to 2 August

JULY CHLORINATION - UNIT 1

	End of Pipe Average TRC		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
7/1/94	<0.01	-	-
7/2/94	0.001	-	-
7/3/94	0.001	.15	0.62
7/4/94	0.001	0.30	0.58
7/5/94	0.011	0.32	0.52
7/6/94	0.001	0.36	0.57
7/7/94	<0.001	0.56	0.63
7/8/94	0.01	0.62	0.84
7/9/94	0.017	0.47	0.56
7/10/94	0.01	-	-
7/11/94	0.006	-	-
7/12/94	<0.001	0.40	0.59
7/13/94	0.001	0.53	0.56
7/14/94	0.001	0.47	0.49
7/15/94	0.001	0.45	0.85
7/16/94	0.001	0.55	0.89
7/17/94	0.001	0.56	0.53
7/18/94	0.009	0.28	0.35
7/19/94	0.008	0.66	0.64
7/20/94	0.006	0.60	.060
7/21/94	0.017	0.52	0.64
7/22/94	0.015	0.47	0.56
7/23/94	0.011	0.42	0.37
7/24/94	0.010	*	*
7/25/94	0.01	0.72	0.69
7/26/94	0.01	0.62	0.73
7/27/94	0.009	0.51	0.02
7/28/94	0.008	0.66	0.82
7/29/94	0.003	0.61	0.81
7/30/94	0.002	0.77	0.82
7/31/94	0.002	0.72	0.79

Comments: - No chlorination

* Chlorination performed - data not available

JULY CHLORINATION - UNIT 2

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
7/1/94	<0.01	-	-
7/2/94	<0.01	-	-
7/3/94	0.001	0.42	0.78
7/4/94	0.001	0.38	0.66
7/5/94	0.011	0.47	0.64
7/6/94	0.002	0.47	0.63
7/7/94	0.001	0.64	0.66
7/8/94	0.01	0.66	0.41
7/9/94	0.013	0.46	0.61
7/10/94	0.013	-	-
7/11/94	0.008	-	-
7/12/94	<0.001	0.33	0.12
7/13/94	0.001	0.40	0.79
7/14/94	0.002	0.37	0.76
7/15/94	0.002	0.35	0.48
7/16/94	0.002	0.37	0.48
7/17/94	0.002	0.46	0.97
7/18/94	0.003	0.30	0.67
7/19/94	0.002	0.70	1.16
7/20/94	0.003	0.60	1.12
7/21/94	0.003	0.58	1.05
7/22/94	0.006	0.53	1.00
7/23/94	0.002	0.32	0.56
7/24/94	0.002	*	*
7/25/94	0.001	0.60	0.97
7/26/94	0.001	0.68	1.05
7/27/94	0.007	0.02	0.02
7/28/94	0.017	0.77	0.98
7/29/94	0.019	0.66	1.11
7/30/94	0.003	0.89	0.97
7/31/94	0.003	0.80	0.93

Comments: - No chlorination

* Chlorination performed - data not available

AUGUST CHLORINATION - UNIT 1

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
8/1/94	0.002	0.68	0.63
8/2/94	0.06	-	-
8/3/94	0.11	-	-
8/4/94	0.16	-	-
8/5/94	0.13	-	-
8/6/94	0.17	-	-
8/7/94	0.13	-	-
8/8/94	0.15	-	-
8/9/94	0.08	-	-
8/10/94	0.12	-	-
8/11/94	0.16	1.15	1.62[a]
8/12/94	0.15	0.92	0.84
8/13/94	0.14	*	*
8/14/94	0.13	0.93	1.07
8/15/94	0.12	1.04	0.99
8/16/94	0.11	0.99	1.22
8/17/94	0.12	0.66	0.85
8/18/94	0.10	0.77	0.95
8/19/94	0.12	*	*
8/20/94	0.12	0.71	0.91
8/21/94	0.10	*	*
8/22/94	0.11	*	*
8/23/94	0.12	*	*
8/24/94	0.10	*	*
8/25/94	0.11	*	*
8/26/94	0.10	0.69	1.05
8/27/94	0.08	0.08	0.91
8/28/94	0.09	1.09	0.88
8/29/94	0.09	0.46	0.48
8/30/94	0.11	0.48	0.57
8/31/94	0.10	0.50	0.45

Comments: - No chlorination

* Chlorination performed - data not available

[a] Intermittent chlorination of service water systems initiated; continued to end of season

AUGUST CHLORINATION - UNIT 2

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
8/1/94	0.003	0.66	0.84
8/2/94	0.024	-	-
8/3/94	0.082	-	-
8/4/94	0.13	-	-
8/5/94	0.13	-	-
8/6/94	0.15	-	-
8/7/94	0.11	-	-
8/8/94	0.10	-	-
8/9/94	0.08	-	-
8/10/94	0.11	-	-
8/11/94	0.11	1.14	1.18[a]
8/12/94	0.12	0.84	1.27
8/13/94	0.11	*	*
8/14/94	0.11	0.99	1.42
8/15/94	0.12	0.68	1.25
8/16/94	0.19	1.11	1.41
8/17/94	0.17	0.69	1.41
8/18/94	0.11	0.92	1.54
8/19/94	0.12	*	*
8/20/94	0.12	1.00	1.38
8/21/94	0.10	*	*
8/22/94	0.10	*	*
8/23/94	0.11	*	*
8/24/94	0.11	*	*
8/25/94	0.15	*	*
8/26/94	0.11	0.77	1.42
8/27/94	0.10	0.00	1.18
8/28/94	0.11	0.80	1.17
8/29/94	0.11	0.47	0.79
8/30/94	0.13	0.46	0.84
8/31/94	0.11	0.39	0.72

Comments: - No chlorination

* Chlorination performed - data not available

[a] Intermittent chlorination of service water systems initiated; continued to end of season

SEPTEMBER CHLORINATION - UNIT 1

	End of Pipe Average TRC		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
9/1/94	0.10	0.62	0.69
9/2/94	0.15	0.15	0.30
9/3/94	0.10	1.07	0.73
9/4/94	0.11	1.19	0.89
9/5/94	0.09	1.19	0.78
9/6/94	0.09	0.98	0.77
9/7/94	0.15	0.85	1.12
9/8/94	0.14	1.10	1.35
9/9/94	a	-	-
9/10/94	a	-	-
9/11/94	a	-	-
9/12/94	a	-	-
9/13/94	a	-	-
9/14/94	a	-	-
9/15/94	a	-	-
9/16/94	0.08	*	*
9/17/94	0.08	*	*
9/18/94	0.06	*	*
9/19/94	0.12	*	*
9/20/94	0.10	*	*
9/21/94	0.11	0.07	0.85
9/22/94	0.10	*	*
9/23/94	0.15	0.33	0.77
9/24/94	0.09	-	-
9/25/94	0.11	-	-
9/26/94	0.14	0.13	0.60
9/27/94	0.15	0.92	1.39
9/28/94	0.10	0.49	1.70
9/29/94	0.14	0.61	2.04
9/30/94	0.15	0.68	1.65

Comments: [a] Clamtrol treatment

- No chlorination

* Chlorination performed - data not available

SEPTEMBER CHLORINATION - UNIT 2

Date	End of Pipe Average TRC		
	Circ (ave) ppm	ESW ppm	NESW ppm
9/1/94	0.11	0.70	1.28
9/2/94	0.14	0.10	0.27
9/3/94	0.13	1.08	1.85
9/4/94	0.15	1.04	1.89
9/5/94	0.14	0.95	1.70
9/6/94	0.17	0.77	2.13
9/7/94	0.17	0.76	1.63
9/8/94	0.11	0.09	1.63
9/9/94	a	-	-
9/10/94	a	-	-
9/11/94	a	-	-
9/12/94	a	-	-
9/13/94	a	-	-
9/14/94	a	-	-
9/15/94	a	-	-
9/16/94	a	*	*
9/17/94	a	*	-
9/18/94	a	*	*
9/19/94	a	*	*
9/20/94	a	*	*
9/21/94	a	0.84	0.82
9/22/94	a	0.72	-
9/23/94	a	*	*
9/24/94	a	-	-
9/25/94	a	-	-
9/26/94	a	-	-
9/27/94	a	-	-
9/28/94	a	-	-
9/29/94	a	-	-
9/30/94	a	-	-

Comments: [a] Unit 2 Outage (no discharge)

[-] No chlorination

[*] Chlorination performed - data not available

OCTOBER CHLORINATION - UNIT 1

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
10/1/94	0.09	0.14	1.50
10/2/94	0.09	0.06	2.14
10/3/94	0.10	0.04	0.55
10/4/94	0.08	-	*
10/5/94	0.12	-	-
10/6/94	0.12	-	-
10/7/94	0.17	0.10	-
10/8/94	0.05	0.02	-
10/9/94	0.03	0.02	-
10/10/94	0.12	*	*
10/11/94	0.15	0.17	2.20
10/12/94	0.10	0.10	0.75
10/13/94	0.12	0.08	-
10/14/94	0.15	0.015	-
10/15/94	0.11	0.01	-
10/16/94	0.11	0.01	-
10/17/94	0.10	0.24	-
10/18/94	0.12	0.005	1.66
10/19/94	0.11	-	-
10/20/94	0.12	-	-
10/21/94	0.14	0.08	1.42
10/22/94	0.10	*	*
10/23/94	0.11	*	*
10/24/94	0.07	-	1.36
10/25/94	0.11	-	-
10/26/94	0.11	-	-
10/27/94	0.10	-	-
10/28/94	0.09	0.11	0.09
10/29/94	0.11	-	-
10/30/94	0.14	-	-
10/31/94	0.11	-	-

Comments: -.No chlorination

* Chlorination performed - data not available

OCTOBER CHLORINATION - UNIT 2

	End of Pipe Average TRC		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
10/1/94	a	-	-
10/2/94	a	-	-
10/3/94	a	0.19	-
10/4/94	a	*	*
10/5/94	a	*	-
10/6/94	a	*	-
10/7/94	a	0.11	-
10/8/94	a	0.01	-
10/9/94	a	0.01	-
10/10/94	a	*	-
10/11/94	a	0.02	-
10/12/94	a	2.16	-
10/13/94	a	0.03	-
10/14/94	a	-	-
10/15/94	a	0.02	-
10/16/94	a	0.01	-
10/17/94	a	0.03	-
10/18/94	a	0.04	-
10/19/94	a	2.03	-
10/20/94	a	-	-
10/21/94	a	-	-
10/22/94	a	*	*
10/23/94	a	*	*
10/24/94	a	-	-
10/25/94	a	-	-
10/26/94	a	-	-
10/27/94	a	-	-
10/28/94	a	0.05	-
10/29/94	a	-	-
10/30/94	a	0.04	-
10/31/94	a	-	-

Comments: [a] Unit 2 Outage (no discharge)

- No chlorination

* Chlorination performed - data not available

NOVEMBER CHLORINATION - UNIT 1

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
11/1/94	0.11	-	-
11/2/94	0.11	-	-
11/3/94	0.11	-	-
11/4/94	0.11	-	-
11/5/94	0.10	-	-
11/6/94	0.11	0.92	-
11/7/94	0.10	-	-
11/8/94	0.10	0.85	-
11/9/94	0.09	0.89	-
11/10/94	0.13	0.76	0.98
11/11/94	0.10	0.36	0.37
11/12/94	0.08	-	-
11/13/94	-	-	-
11/14/94	-	-	-
11/15/94	0.14	0.76	0.82
11/16/94	0.14	0.45	0.12
11/17/94	0.13	-	-
11/18/94	0.12	-	-
11/19/94	0.12	-	-
11/20/94	0.11	1.11	0.28
11/21/94	0.13	1.20	0.96
11/22/94	0.16	0.49	2.19
11/23/94	0.16	0.55	1.50
11/24/94	0.13	0.56	1.01
11/25/94	0.11	1.72	1.04
11/26/94	0.12	0.85	1.85
11/27/94	0.16	-	-
11/28/94	0.17	-	-
11/29/94	0.08	-	-
11/30/94	0.06	-	-

Comments: - No chlorination

NOVEMBER CHLORINATION - UNIT 2

	End of Pipe Average TRC		
Date	Circ (ave) ppm	ESW ppm	NESW ppm
11/1/94	a	-	-
11/2/94	a	-	-
11/3/94	a	-	-
11/4/94	a	-	-
11/5/94	a	-	-
11/6/94	a	0.27	-
11/7/94	a	-	-
11/8/94	a	-	-
11/9/94	a	-	0.89
11/10/94	a	-	-
11/11/94	a	-	-
11/12/94	a	-	-
11/13/94	a	-	-
11/14/94	a	-	-
11/15/94	a	0.76	-
11/16/94	a	0.48	-
11/17/94	<0.01	-	-
11/18/94	0.02	-	-
11/19/94	0.03	-	-
11/20/94	0.05	-	-
11/21/94	0.09	-	-
11/22/94	0.09	-	-
11/23/94	0.12	-	-
11/24/94	0.11	-	-
11/25/94	0.07	1.35	1.82
11/26/94	0.09	0.72	1.72
11/27/94	0.11	-	-
11/28/94	0.12	-	-
11/29/94	0.05	-	-
11/30/94	0.05	-	-

Comments: [a] Unit 2 Outage

\- No chlorination

DECEMBER CHLORINATION - UNIT 1

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
12/1/94	0.07	-	-
12/2/94	0.01	-	-
12/3/94	a	a	a
12/4/94	a	a	a
12/5/94	a	a	a
12/6/94	a	a	a
12/7/94	a	a	a
12/8/94	a	a	a
12/9/94	a	a	a
12/10/94	a	a	a
12/11/94	a	a	a
12/12/94	a	a	a
12/13/94	a	a	a
12/14/94	a	a	a
12/15/94	a	a	a
12/16/94	a	a	a
12/17/94	a	a	a
12/18/94	a	a	a
12/19/94	a	a	a
12/20/94	a	a	a
12/21/94	a	a	a
12/22/94	a	a	a
12/23/94	a	a	a
12/24/94	a	a	a
12/25/94	a	a	a
12/26/94	a	a	a
12/27/94	a	a	a
12/28/94	a	a	a
12/29/94	a	a	a
12/30/94	a	a	a
12/31/94	a	a	a

Comments: - No chlorination

a Chlorination system shutdown for the season

DECEMBER CHLORINATION - UNIT 2

Date	End of Pipe Average TRC Circ (ave) ppm	ESW ppm	NESW ppm
12/1/94	0.08	-	-
12/2/94	0.01	-	-
12/3/94	a	a	a
12/4/94	a	a	a
12/5/94	a	a	a
12/6/94	a	a	a
12/7/94	a	a	a
12/8/94	a	a	a
12/9/94	a	a	a
12/10/94	a	a	a
12/11/94	a	a	a
12/12/94	a	a	a
12/13/94	a	a	a
12/14/94	a	a	a
12/15/94	a	a	a
12/16/94	a	a	a
12/17/94	a	a	a
12/18/94	a	a	a
12/19/94	a	a	a
12/20/94	a	a	a
12/21/94	a	a	a
12/22/94	a	a	a
12/23/94	a	a	a
12/24/94	a	a	a
12/25/94	a	a	a
12/26/94	a	a	a
12/27/94	a	a	a
12/28/94	a	a	a
12/29/94	a	a	a
12/30/94	a	a	a
12/31/94	a	a	a

Comments: - No chlorination

[a] Chlorination system shutdown for the season

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BRAND
Brand Utility Services, Inc.

Quality Results from Quality People

28 February 1994
Bill Hannah, General Supervisor
Indiana Michigan Power Company
D.C. Cook Nuclear Power Station
One Cook Place
[illegible]

Subject: Unit 1 Condenser Zebra Mussel Infestation Report
I&M/AEP Contract # 9304 BUSI Job # 80021

The attached report represents the completion of the underwater Zebra Mussel inspection performed on 24 Feb 94, within the Unit 1 Condenser inlet tunnels, also WMO Valves 11, 12, 13, North East and South East inlet valves in A, B, and C Condenser. If you have any questions or comments with respect to this report, please contact me at your convenience.

Sincerely,

Douglas T. Weaver
Screenhouse Foreman
Underwater Construction Division

cc:	J. Carlson	I&M
	K. Tamms	AEP
	D. Weaver	BUSI
	Job File	80021

DTW/teo

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

Indiana and Michigan Power Company
D.C. Cook Nuclear Plant
Unit 1 Condenser Zebra Mussel Infestation Report

28 February 1994

Indiana and Michigan Power Company/A.E.P. Contract Number C-9304
Brand Utility Services, Inc. Job Number 80021

Site Coordinator: Thomas E. Owczarzak

Shift Foreman: Doug Weaver

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Indiana and Michigan Power Company
D.C. Cook Nuclear Power Station
Units 1 Condenser Zebra Mussel Infestation Report
28 February 1994

1.0 WMO Valves

1.1.1 1-WMO-11

Upon inspection of this valve it was found to be open approx: 6 inches with the position indicator reading closed. Due to the valve being partially open the north side seal and segment/bolts where not inspected. The south section of the seal appeared to be in good condition and all segments/bolts were in place and tight with no visable wear. The valve body support pins are in and appear to be tight. Since the valve was Red Tagged we were unable to operate valve to check the valve stop and baffles on the pump side. There was no mussel growth on the valve or in the valve tunnel section on the condenser side.

1.1.2 1-WMO-12

WMO-12 was found approx: 1 inch open with the position indicator reading closed. The seal is in good condition, with the segment/bolts in place and tight. There is some slight visable wear on the heads of the segment bolts that are in the 7 o'clock position. The valve was tagged and we were again unable to inspect the valve stop and baffles on the pump side. No mussel growth was found in the section of tunnel or on the valve itself. The valve body support pins are in place and appear tight.

1.1.3 1-WMO-13

WMO-13 was approx: 5 inches open and the indicator reading closed. Since the valve was partially open it was not possible to inspect the entire valve seal nor the segment/bolts on the north side of the valve. The seal on the south side is in good shape with no apparent deformation. The segment/bolts along this side have no visable wear and are inplace and tight. Valve body support pins are tight. Again the valve was tagged so we were unable to inspect the valve stop and baffles.

2.0 T.P.S. Penetrations

2.1.1 TPS-5

The 18 inch penetration TPS-5 has no mussel growth or any deformations visable of the concrete to report.

2.1.2 TPS-17

The 24 inch penetration TPS-17 has no mussel growth in the area. There is a deformation in the concrete along the lip of the pipe from the 5 o'clock position running to the 7 o'clock position approx: 1 inch wide.

2.1.3 TPS-192

The 30 inch penetration TPS-192 has no mussel growth and no deformations in the concrete or the surrounding area.

3.0 Condenser Inlet Valves

3.1.1 Condenser "C" N/E and S/E Inlet valves

Inspection of both valves of condenser "C" revealed that none of the segment/bolts had any visable wear, were inplace and appeared to be tight. Both seals and valve stops appeared to be in good condition and in place. The valve body support pins are inplace and tight.In the bottom of both individual valve tunnels there was a small build-up of debris approx: 1 inch deep. No mussel growth was found in or around the valves.

3.1.2 Condenser "B" N/E and S/E Inlet valves

The inspection of both valves of condenser "B" revealed that all of the segment/bolts showed no wear and were in place and appeared tight. The valve body support pins are inplace and tight. Valve seals and stops appear in good order. The bottom of the valve tunnels had a small amount of debris approx: 1 inch in depth and some loose debris (wood/rope). No mussel growth was found. In both tunnels there is rebar approx: 24 inches protruding out of the west wall. It does not come in contact with the valve's or appear to effect the operation.

3.1.3 Condenser "A" N/E and S/E Inlet Valves

Inspection of both valves revealed that all segment/bolts have no visible wear, are inplace and appeared to be tight. Both valve stops, seals, and valve body support pins are in good condition. No mussel growth was found. There is a approx: 24 inch of rebar protruding from the east wall of the S/E tunnel and does not appear to have any effect on the valve or its operation. Minor debris was in the bottom of each tunnel.

4.0 Mussel Growth and Concrete Abnormalities

4.1.1 Deflector Walls "A", "B", "C", "D".

All the deflector walls have no visible deformation and are clear of any mussel growth except for the north ends of deflector wall "A" and "B" (see attachment #1) The coverage is 100% and approx: 1 inch thick.

4.1.2 Inlet Tunnel Wall's, Floor, and Ceiling.

The only reportable mussel growth was found on the north west wall across from "C" condenser (see attachment #1). The area has a 65% coverage, 10% being dead mussels, and 55% live mussels. The mussels are one single layer and are approx: 1/2 inch in size. All other area's (floor, ceiling, walls) have no mussel growth. There are three area's of deformation to report, #1 is approx: 20 feet east of 1-WMO-12 on the south wall and 6 feet off of the bottom. This area is approx: 3 feet long and 10 inches wide, this appears to be an irregular finish and not a spalding or errosion problem. The other two areas were last reported in a inspection on 10 August 1992, the first is located east of 1-WMO-13 atthe transition point from the pipe to the concrete at the 12 o'clock position and is approx: 12 inches by 6 inches by 2 inches, which there is no change since last reported. The other area has some scouring taking place on the floor, south side of condenser "A" and "B" this also has not changed since last reported.

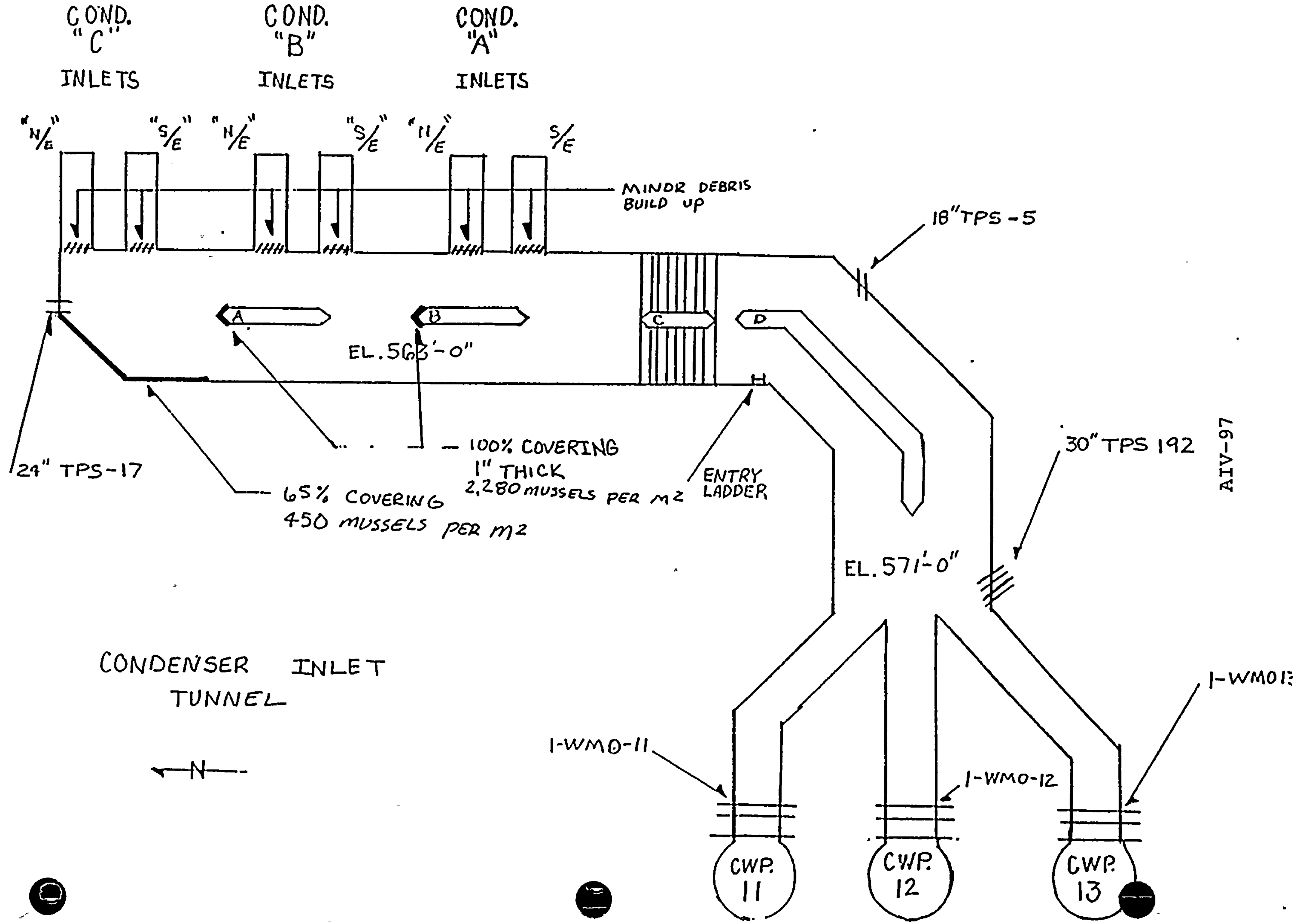
5.0 Recommendation

5.1.1 Deformation Areas

All the areas mentioned in this report with concrete deformations should be water-blasted to remove any loose material, debris, and possible marine growth. Then a concret, grout, or epoxy material should be applied to fill the voids to prevent any possible further erosion or deterioration.

5.1.2 Debris, Mussel Areas

All debris and mussels are scheduled for removal. Total amount of debris is approx: 1.5 cubic yards.


COND. "C" INLETS
COND. "B" INLETS
COND. "A" INLETS
"N/E"
"S/E"
"N/E"
"S/E"
"N/E"
S/E
MINOR DEBRIS BUILD UP
18" TPS-5
A
B
C
D
EL. 563'-0"
24" TPS-17
65% COVERING
450 MUSSELS PER M2
100% COVERING
1" THICK
2,280 MUSSELS PER M2
ENTRY LADDER
30" TPS 192
EL. 571'-0"
CONDENSER INLET TUNNEL
N
1-WMO-11
1-WMO-12
1-WMO13
CWP. 11
CWP. 12
CWP. 13

AIV-97

BRAND
Brand Utility Services, Inc.

Quality Results from Quality People

3 March 1994
Bill Hannah, General Supervisor
Indiana Michigan Power Company
D.C. Cook Nuclear Plant
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 Unit 1. If you have any questions or comments with respect to this report, please feel free to contact either Bob Drews or myself at your convenience.

Sincerely,

Thomas E. Owczarzak
BUSI Site Coordinator
Underwater Construction Division

cc:	J. Carlson	I&M
	K. Tamms	AEP
	C. Tirrell	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 Plant
Unit 1 Zebra Mussel Infestation Report

3 March 1994

Indiana and Michigan Power Company Contract Number C-9304
Brand Utility Services, Inc. Job Number 80021

Site Coordinator: Thomas E. Owczarzak
Production Supervisor: Bob Drews

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Indiana and Michigan Power Company
D.C. Cook Nuclear Plant
Unit 1 Zebra Mussel Infestation Report
3 March 1994

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)

Some sections of this report are documented on video tape, which is being submitted.

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

Water Temperature:

TWS Bays	-	38 degrees +/-
Trashracks	-	38 degrees +/-
Keyways	-	38 degrees +/-
Deflector Walls	-	38 degrees +/-

Operating Status:

TWS Bays	-	Unit 2 generating power
Trashracks	-	Unit 2 generating power
Keyways	-	Unit 2 generating power
Deflector Walls	-	Unit 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
1 - Radio Man

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 (PLEASE REFER TO THE ATTACHED DRAWING)

4.1 T.W.S. Bays:

1-1 From the bottom of the bay (elevation 546) up approx: 10 ft. the walls have 100% coverage. In this area the mussels are approx: 1/8 to 1/4 inch thick, there is an estimated 600 mussels per square meter. From the 10 ft. mark up to the surface mussel coverage decreases to approx: 20-30% and continues to thin out until there is no apparent mussel growth. The floor in this bay has 100% coverage approx: 6 inches deep with the top 2 inches being live mussels.

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: 20 ft. the walls have 100% coverage. This area the mussels are approx: 1/4 inch thick, and approx: 600 mussels per square meter. Continuing up to the surface the mussel coverage is 50% and the floor is clean due to higher flow.

1-4 Same condition exsists as in TWS bay 1-3.

1-5 From the bottom of the bay (elevation 546) up to the surface the coverage of mussels is approx: 60% and has 400 mussels per square meter. The floor has approx: 15 inches of debris 50% mussels and 50% sand.

1-6 Same as TWS bay 1-5.

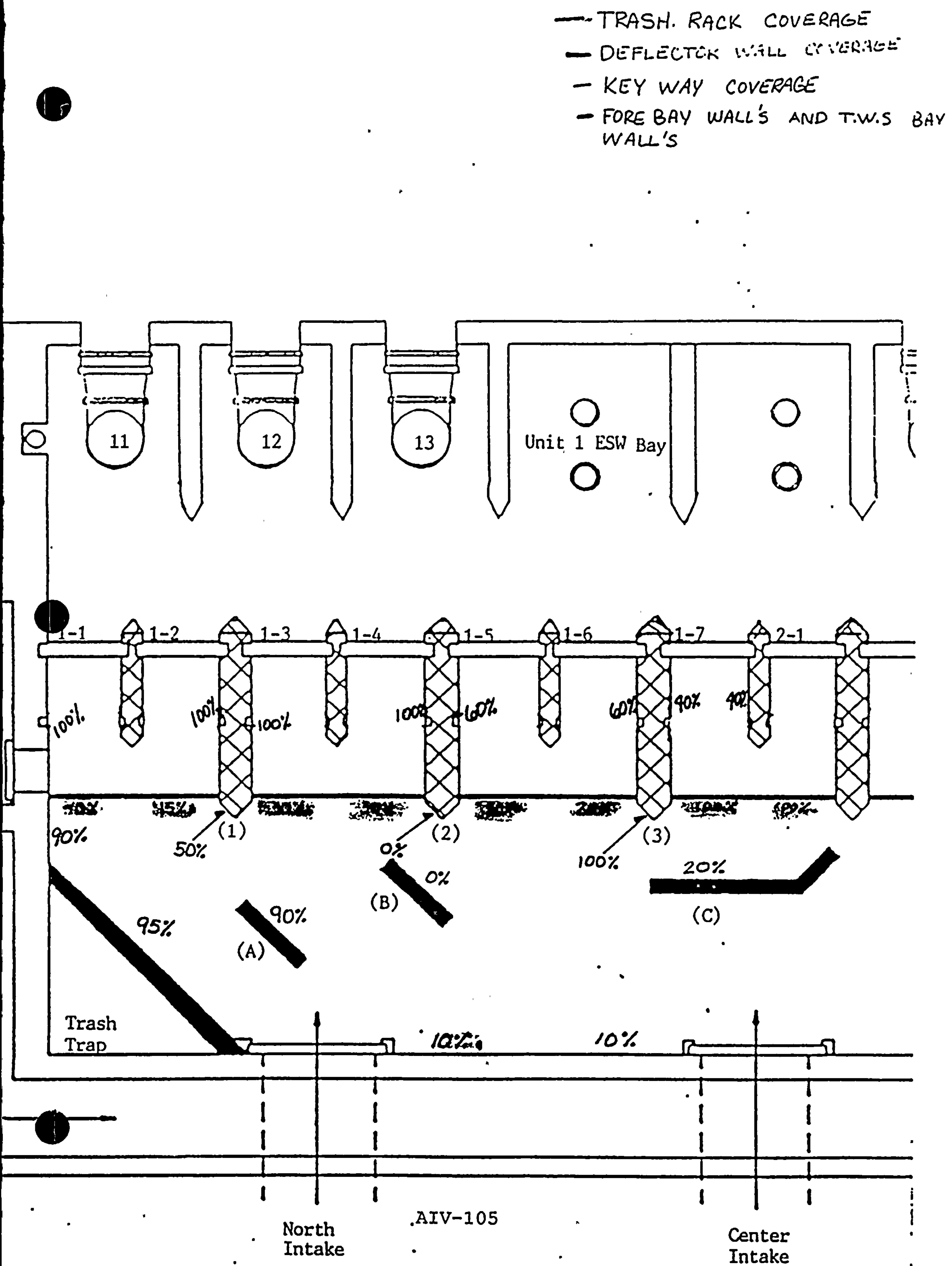
1-7 All the areas in this bay had 40% coverage, approx: 350 mussles per square meter. The floor has 1 foot of debris with the bottom 50% being sand and the rest mussels.

4.2 Trashracks:

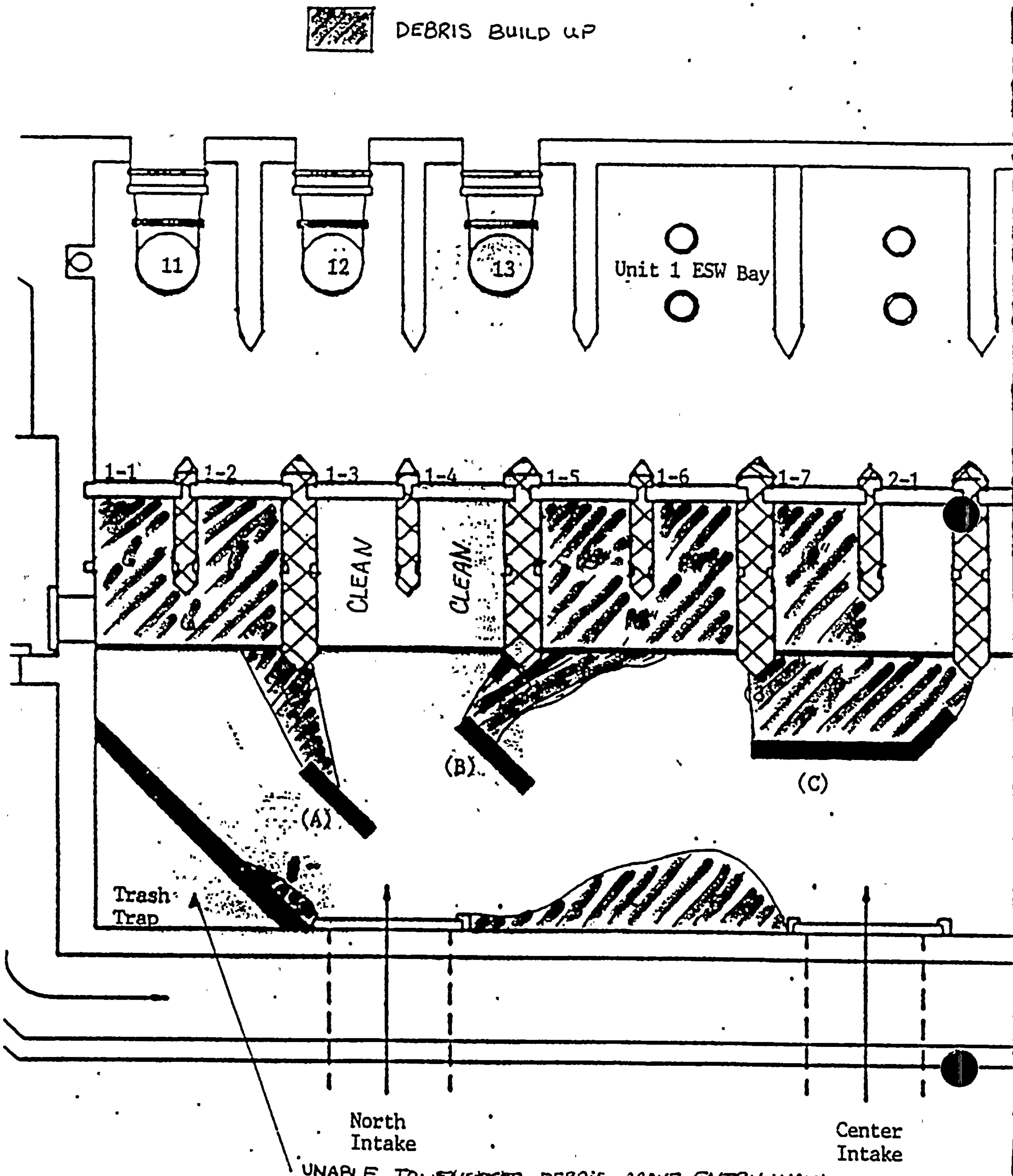
The trashracks extend from the bottom elevation 546' level up to their top elevation of 591'throughout the entire forebay. All the racks had moderate mussel growth, ranging from as high as 30% and to as low as 10% with the exception of the racks across TWS 1-7 which had 100% mussel coverage 1 inch thick. The concentration of mussels were found between the bottom (546 elev.) up 20' to the (566 elev.) and were also governed by the flow patterns. Extremely high flow areas had patchy and sparse growth. While in the low flow areas the mussel density greatly increased.

4.3 Keyways: (See Attachment #1)

Keyway # 1 has mussel coverage of approx: 50% and of that there is a 50/50 ratio of live to dead mussels. There is approx: 350 mussels per square meter. Keyway #2 has no apparent mussel growth. Keyway #3 has 100% mussel coverage 1/4 inch thick and increasing up to 1/2 inch thick at the mid-way point of the keyway. Keyway #3 has an estimated 1440 mussels per square meter. All other areas on the keyways not covered by mussels was covered by 1/8 inch coating of algea and silt. Flow patterns play a part in mussel buildup.


TRASH. RACK COVERAGE
DEFLECTOR WALL COVERAGE
KEY WAY COVERAGE
FORE BAY WALL'S AND T.W.S BAY WALL'S
11
12
13
Unit 1 ESW Bay
1-1
1-2
1-3
1-4
1-5
1-6
1-7
2-1
100%
100%
100%
100%
60%
60%
90%
90%
45%
90%
(1)
50%
(2)
0%
(3)
100%
0%
(B)
20%
(C)
95%
90%
(A)
Trash Trap
10%
North Intake
Center Intake

AIV-105


DEBRIS BUILD UP
11
12
13
Unit 1 ESW Bay
1-1
1-2
1-3
1-4
1-5
1-6
1-7
2-1
CLEAN
CLEAN
(A)
(B)
(C)
Trash Trap
North Intake
Center Intake
UNABLE TO ENSPECT, DEBRIS ABOVE ENTRY WAY'S

BRAND
Brand Utility Services, Inc.

Quality Results from Quality People

17 March 1994
Bill Hannah, General Supervisor
Indiana Michigan Power Company
D.C. Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106

Subject: Unit 1 ESW Pump Bay Report

The attached report represents the completion of the underwater inspections performed on Unit 1 ESW pump bay. If you have any questions or comments with respect to this report, please feel free to contact either Bob Drews or myself at your convenience.

AREAS OF CONCERN: Unit 1 ESW pump bay, east of TWS 1-5/1-6.

Sincerely,

Thomas E. Owczarzak
BUSI Site Coordinator
Underwater Construction Division

cc:	J. Carlson	I&M
	K. Tamms	AEP
	C. Tirrell	BUSI
	Job File	80021

AIV-107

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

Indiana and Michigan Power Company
D.C. Cook Nuclear Plant
Unit 1 ESW Pump Bay Report

17 March 1994

Indiana and Michigan Power Company Contract Number C-9304
Brand Utility Services, Inc. Job Number 80021

Site Coordinator: Thomas E. Owczarzak
Production Supervisor: Bob Drews
Shift Foreman: Todd Miller

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Indiana and Michigan Power Company
D.C. Cook Nuclear Plant
Unit 1 ESW Bay Report
17 March 1994

1.0 Purpose

The specific areas of concern were as follows:

ESW Bay
- -Mussel coverage
- -Debris buildup
- -Visible damage

East TWS 1-5/1-6
- -Mussel coverage
- -Debris buildup
- -Visible damage

2.0 Findings

2.1 ESW Bay

ESW bay inspections revealed that along the west face of the east wall the mussel coverage was approx: 80% with 600-700 mussels per square meter. The north and south walls along with the ESW pumps had 100% mussel coverage approx: 1 inch thick. The mussels were 1/2-3/4 inches in size, single layer with algae and silt in the mix. Debris that was found in the bay composed of 95% sand and 5% mussels. The mussels and silt on top and sand till bottom. Along the east wall the debris was 4 feet deep and increasing to 6 feet deep in the south east corner. There was 6 feet of debris along the entire south wall. Debris along the north wall starting in the north east corner there was 4 feet and tapering down to 3 feet at the keyway. The area around the pumps was clear with the cleanest area being on the south side of the pumps. No damage was found in the pump bay or with the sparger system and the ESW pumps. The ceiling had 50% mussel coverage and the west face of the ceiling wall had 30% coverage.

2.0 Continued

2.2 East TWS 1-5/1-6

The underwater inspections revealed that there is approx: 3 feet of debris behind the TWS 1-5/1-6 composing of sand and mussels. The mixture being 75% sand and 25% mussels. The debris was in layers, algae silt and mussels, then sand, and over and over again till reaching bottom. Moving east the debris increased to 4 feet in depth then tapering down to 1 foot where the cross currents are stronger. The mussel coverage on the keyways is approx: 100% with about 900 mussels per square meter. There was no damage found.

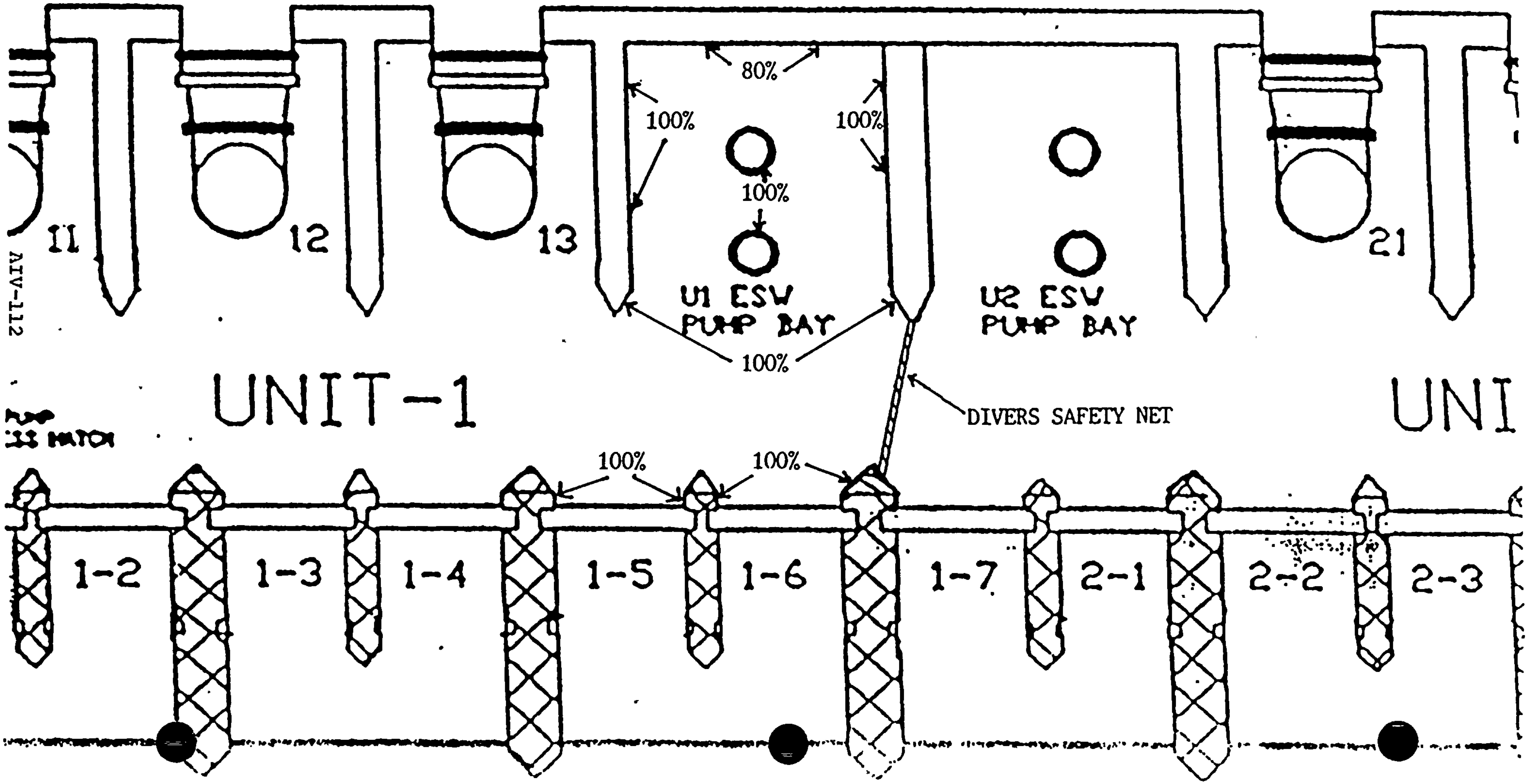
(SEE ATTACHMENTS 1 AND 2)

3.0 Comments and Recommendations

It is recommended that the chemical treatments continue, physical removal of mussels/debris by divers from all components and to dispose of the mussels into dumpsters. We welcome the opportunity to discuss any aspect of this report.

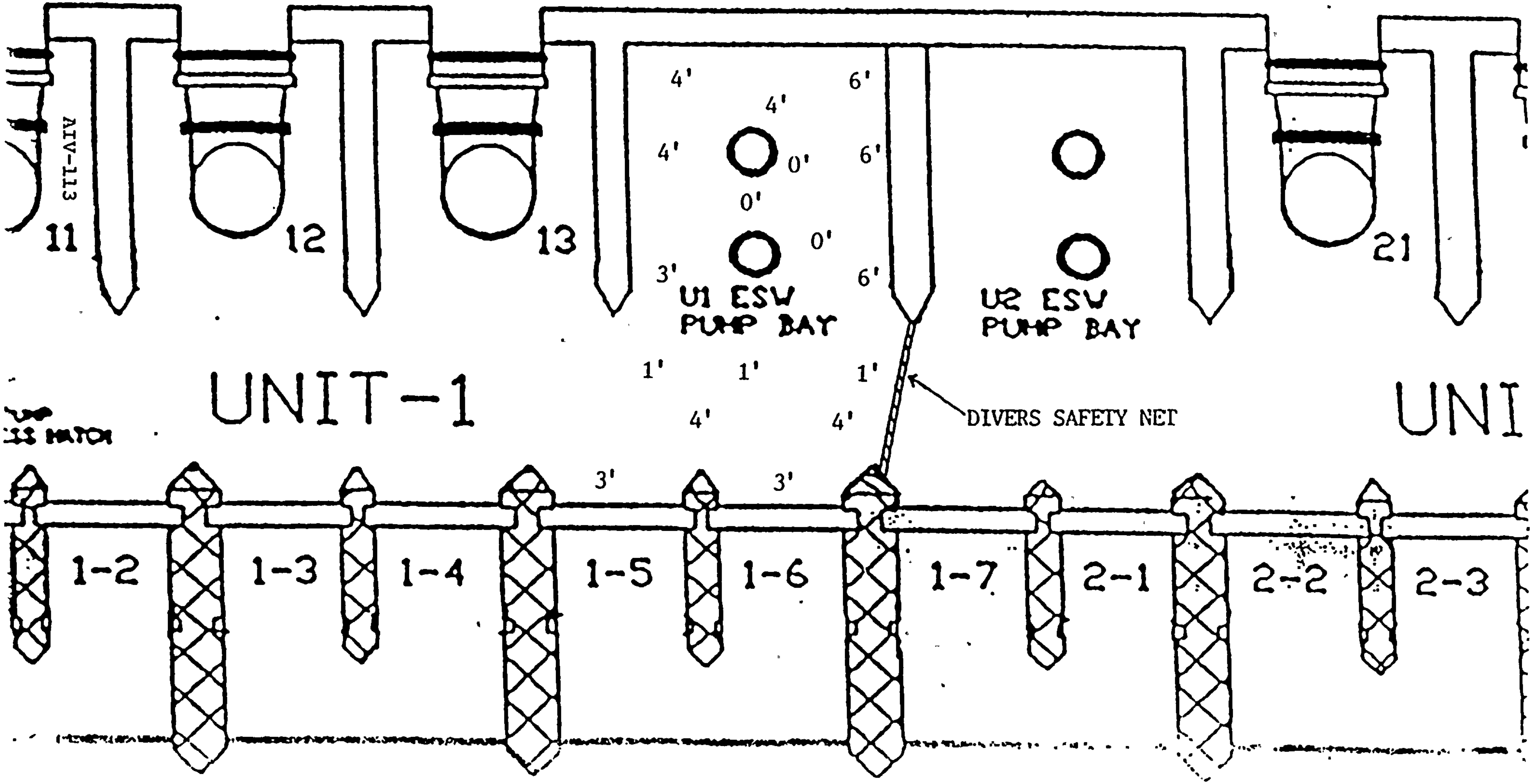
ATTACHMENT #1 MUSSEL COVERAGE

NOTE: THE CEILING HAD 50% MUSSEL COVERAGE.
THE WEST FACE OF THE CEILING WALL HAD 30% MUSSEL COVERAGE.
WHERE THERE WAS 100% MUSSEL COVERAGE, THE MUSSELS WERE SINGLE LAYER
APPROX: 1 INCH THICK AND 1/2-3/4 INCH IN SIZE WITH ALGEA AND SILT IN THE MIX.



ATTACHMENT #2 DEBRIS BUILDUP

NOTE: THE DEBRIS IN THE ESW BAY WAS APPROX: 95% SAND 5% MUSSELS
THE DEBRIS BETWEEN THE TWS AND THE ESW BAY WAS APPROX: 75% SAND 25% MUSSELS,
THIS DEBRIS WAS IN LAYERS MUSSELS, ALGEA, SILT, THEN SAND, AND OVER AGAIN TILL BOTTOM.



RUST

26 October 1994
Bill Hannah, General Supervisor
Indiana Michigan Power Company
D.C. Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106

Subject: South Intake Tunnel Mussel Kill Assessment Report

The attached report represents the completion of the underwater inspection performed on the South Intake Tunnel. If you have any questions or comments with respect to this report, please feel free to contact either Bob Drews or myself at your convenience.

AREAS OF CONCERN: South Intake Tunnel (mussel kill assessment, and corrosion areas).

Sincerely,

Thomas E. Owczarzak
RUSI Site Coordinator
Underwater Construction Division

cc:	E. Mallen	I&M
	K. Tamms	AEP
	B. Feeley	RUSI
	Job File	80021

RUST

Indiana and Michigan Power Company
D.C. Cook Nuclear Power Station
South Intake Tunnel Mussel Kill Assessment Report

28 September 1994

Indiana and Michigan Power Company Contract Number C-9403
Rust Utility Services, Job Number 80021

Site Coordinator: Thomas E. Owczarzak
Foreman/Shift Supervisor: Robert Perando

South Intake Tunnel Report

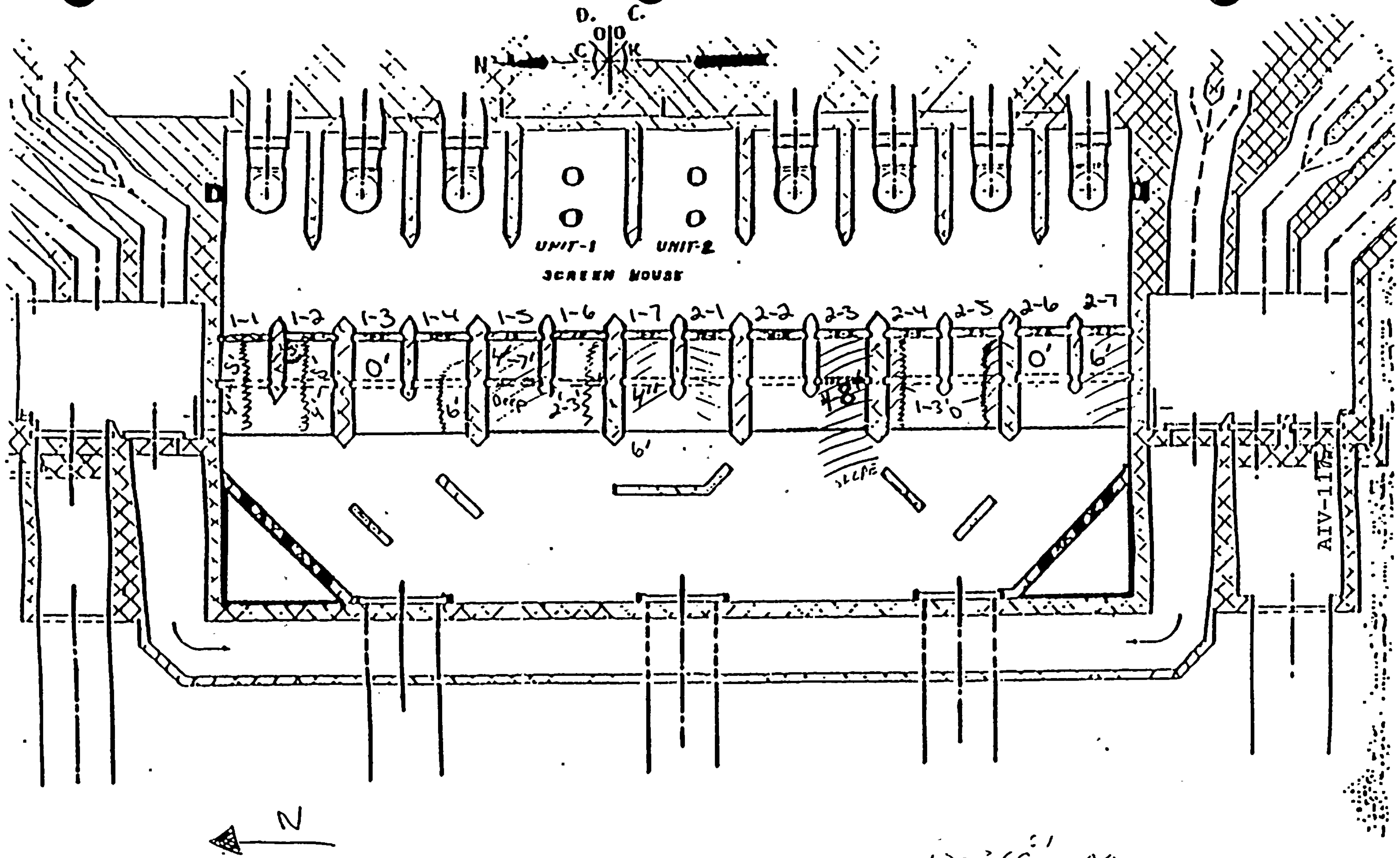
The underwater inspection started at the plant side and west of the stop-log that was set to control flow in the tunnel during the Clam-trol treatment. At the bottom of the stop-log there were signs of Zebra mussels, a layer was present 3-3.5 inches thick but not a build-up like what was expected in front of the stop-log.

The inspection continued with the Diver traveling in a west direction to approx: 100 ft. mark the inspection revealed that the Zebra mussels measured 3-3.5 inches thick, and the mussels that were present there are in the open state, meaning that the treatment was effective and that there is an approx: 99% kill ratio.

Then the inspection continued west to the 200' mark, here the mussels measured the same as the 100' mark and the kill ratio was again approx: 99%. Also at this location the Diver checked the tunnel for any wall corrosion and rust pockets. As noted on the video there were rust spots present when the Diver cleaned off the mussels. The areas do not appear to actually show any rust on the tunnel walls, when the bubbles of what appears to be rust are cleared off there is a shiny surface underneath the bubbled-up area and the wall appeared to be clean galvanized metal. There did not seem to be a pattern of the rust area's and to determine if there is a pattern the Diver would have to clean and perform a detailed inspection thru-out the tunnel.

The underwater inspection continued to the 300 ft., 400 ft., and 500 ft. mark where the same mussel data as before was collected. The Diver also removed mussels to look for any sign of corrosion and again the tunnel wall seems to be in good condition as noted on the video.

In general the Clam-trol treatment was very effective and based on the Divers previous experience the mussel kill ratio was 99%, again please review the video inspection in conjunction with this report.



12·3682' NRM
62

Date: 6/8/94

Foreman Mark White
Diver Jeff Weaver

1-1 North wall 4'-5' by T.R. slopes down to T.W.S

Flow is by South wall

2-7 ~~South Wall~~ - 6' Deep From T.W.S. to Trash Rack, the whole bay

2-6 Ø'

2-5 South Wall - 1' deep 3' Wide From T.W.S to T.R.
* High Flow bay

2-4 North Wall - Same as 2-5

2-3 South Wall - 4'-5' Deep & going to the North Wall is About 8' Deep. Goes From T.W.S. to Deflector Wall
* Flow - A little heavy

2-2 8' From Ladder is about 4' deep From T.W.S. To T.R.
* High Flow

2-1 4' by T.R. & 1' by T.W.S. (Silt & Sand).
South Wall by ladder 4-5' Deep

1-7 4" Silt on bottom - 6' Deep on outside of T.R.

-6 South wall - 2'-3' Deep - ~~2-3~~ From T.W.S. 6' Away
* High Flow BAY

-5 South Wall - 4'-5' Deep across to N.W. up to 7' Deep From T.W.S. - 2' Short From T.R.

-4 By T.R. 6' by S.W. Corner to 8' From T.W.S.
Nothing by North Wall

-3 Clean 0'
* High Flow Bay

AIV-118

-2 4' Deep From T.R. Go 4'-5' up to T.W.S. - Cover's 1/2 the [illegible]

BLANK = .005

Circ Discharge
Sample Location

9/14/95
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1912	86°F	—	—	<.05	SM
2100	87.1	—	—	<.05	PK
2300	83.9	—	—	<.05	PK
0100	82.7	—	—	<.05	PK
0300	85.1	—	—	<.05	PK
0446	85.1	—	—	<.05	PK
0610	84.7	—	—	<.05	SM
~~0715~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~.04~~	SM
0740	84.6	—	—	<.05	SM

* INT... SA... (LOGGE... ON W... SHEE...)

U-1 Main Condenser
Sample Location

Date: 1/14/94

Reviewed By: [signature]

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0310	93.5	—	—	2.05	PK

Attachment 3

GLEC

September 21, 1994

Great
Lakes
Environmental
Center

Applied
Water
Quality &
Environmental
Science

Traverse City
Operations
739 Hastings St.
Traverse City
MI 49686

616 941-2230
616 941-2240 fax

Columbus
Operations
1030 King Ave.
Columbus
OH 43212

614 297-8801
614 297-8866 fax

Mr. Eric Mallen
Indiana Michigan Power Company
Cook Nuclear Power Plant
Bridgeman, MI 49106

RE: BIOMONITORING REPORT FOR SAMPLES COLLECTED SEPTEMBER 10/11 AND 14/15, 1994

Dear Eric:

We have completed our analyses of the 48-hour *Daphnia magna* static acute toxicity tests performed on 30 ppm Clay/lake water samples, Unit 1/2 circulation discharge composite, and Unit 1 circulation discharge composite samples collected by Cook Nuclear Personnel on September 11 and 14, 1994. The samples were picked-up and delivered to the laboratory on those same days (September 11 and 14) by GLEC staff, and the tests were initiated that day.

The water samples were not acutely toxic to *Daphnia magna*. The NPDES Acute Biomonitoring Report form is enclosed for your review, and 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 Pam Lea at (616) 941-2230.

Thank you for the opportunity to provide this service to Indiana Michigan Power Company. We look forward to continuing to provide environmental services to Indiana Michigan Power Company in the future.

Sincerely,

Dennis J. McCauley
Environmental Research Scientist/
Co-Manager of Operations

DJM:kla
Enclosures

GLEC

Great Lakes Environmental Center

NPDES ACUTE BIOMONITORING REPORT FORM

GENERAL INFORMATION

1. Facility Name: Cook Nuclear Power Plant Reporting Date: September 19, 1994
2. Address: Indiana Michigan Power Co., Cook Nuclear Plant, Bridgeman, MI 49106
3. NPDES Permit Number: __________
4. Facility Contact: Eric Mallen 5. Phone No.: (616) 465-5901 ext 1540
6. Consultant/Lab Name: Great Lakes Environmental Center, Inc.
7. GLEC Contact: Dennis J. McCauley 8. Phone No.: (616) 941-2230
9. Receiving Water(s) of Discharge: Lake Michigan
10. Outfall(s) Tested: Unit 1/2 Circulation Discharge Composite, Unit 1 Circulation Discharge Composite and 30 ppm Clay/lake Water
11. Methods: GLEC in-house Standard Operating Procedures, which are based on U.S. EPA procedures (Peltier and Weber, 1991, "Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms," EPA/600/4-90/027

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate, and complete.

Dennis J McCauley
Signature

21 Sept 94
Date

Dennis J. McCauley
Name (typed or printed)

Environmental Research Scientist/
Co-Manager of Operations
Title

ACUTE TOXICITY TEST SAMPLING DATA

TABLE 1a

Sampling Summary for Acute Toxicity Tests

Sampling Location and Description	Sample Collection: Beginning mm/dd/yr (Time)	Sample Collection: Ending mm/dd/yr (Time)	Total Residual Chlorine (mg/L)
Final Effluent: Unit 1/2 Circulation Discharge Effluent Composite Outfall No.: Type (Grab/Composite): 24 hour composite Volume Collected: 1 gallon	09/10/94 *	09/11/94 0730 hrs.	
Water Sample: 30 ppm Clay/lake water sample Waterbody: Station No.: Type (Grab/Composite): Grab Volume Collected: 1 gallon	Prepared by Cook Nuclear Plant Staff	09/10/94 1600 hrs.	
Downstream Station (Near-field): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected:			
Additional Stations (if needed): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA			

* = Collection initiation time not indicated by Cook Nuclear personnel.
NA = Not Available

Michigan Indiana Power Company
Permit No. ____________

ACUTE TOXICITY TEST SAMPLING DATA

TABLE 1b

Sampling Summary for Acute Toxicity Tests

Sampling Location and Description	Sample Collection: Beginning mm/dd/yr (Time)	Sample Collection: Ending mm/dd/yr (Time)	Total Residual Chlorine (mg/L)
Final Effluent: Unit 1 Circulation Discharge Effluent Composite Outfall No.: Type (Grab/Composite): 24 hour composite Volume Collected: 1 gallon	09/14/94 *	09/15/94	
Water Sample: 30 ppm Clay/Lake Water Sample Waterbody: Station No.: Type (Grab/Composite): Grab Volume Collected: 1 gallon	Prepared by Cook Nuclear Plant Staff	09/14/94	
Downstream Station (Near-field): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected:			
Additional Stations (if needed): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA			

* = Collection initiation time not indicated by Cook Nuclear personnel.
NA = Not Available

TOXICITY TEST CONDITIONS

TABLE 2

Summary of Toxicity Test Conditions	
1. Test Species and Age:	*Daphnia magna*, <24 hours old
2. Test Type and Duration:	Static, 48 hours
3. Test Dates:	September 11-13, 1994 and September 15-17, 1994
4. Test Temperature (°C):	25 ± 1
5. Light Quality:	Ambient Laboratory, 10-20 $\mu E/m^2/s$
6. Photoperiod:	16 h light, 8 h darkness
7. Feeding Regime:	None
8. Size of Test Vessel:	100 mL beaker
9. Volume and Depth of Test Solutions:	80 mL
10. No. of Test Organisms per Test Vessel:	5
11. No. of Test Vessels per Test Solution:	4
12. Total No. of Test Organisms per Test Solution:	20
13. Test Concentrations (as % by volume effluent):	100, 50, 25, 12.5, and 6.25
14. Renewal of Test Solutions:	None
15. Dilution and Primary Control Water:	Circulation Water (filtered)
16. Secondary Control Water:	None
17. Aeration:	None
18. Endpoints Measured:	Immobility and Mortality

ACUTE TOXICITY TEST RESULTS

TABLE 3a

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/11/94 (mm/dd/yy) - 09/13/94 (mm/dd/yy) Using Effluent from Outfall Unit 1/2 Circulation Discharge Effluent Composite.

Test Solutions	Cumulative Percent Mortality				LC_{50} Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
25% Effluent	0	0			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3b

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/11/94 (mm/dd/yy) - 09/13/94 (mm/dd/yy) Using 30 ppm Clay/lake water solution.

Test Solutions	Cumulative Percent Mortality				LC_{50} Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	10			24-Hr	48-Hr	72-Hr	96-Hr
25% Effluent	0	10			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	5			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3c

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/15/94 (mm/dd/yy) - 09/17/94 (mm/dd/yy) Using Effluent from Unit 1 Circulation Discharge Composite.

Test Solutions	Cumulative Percent Mortality 24-Hr	48-Hr	72-Hr	96-Hr	LC_{50} Values 24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
[illegible]% Effluent	0	0			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3d

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/15/94 (mm/dd/yy) - 09/17/94 (mm/dd/yy) Using 30 ppm Clay/lake water solution.

Test Solutions	Cumulative Percent Mortality 24-Hr	Cumulative Percent Mortality 48-Hr	Cumulative Percent Mortality 72-Hr	Cumulative Percent Mortality 96-Hr	LC_{50} Values 24-Hr	LC_{50} Values 48-Hr	LC_{50} Values 72-Hr	LC_{50} Values 96-Hr
Primary Control/ Dilution Water	0	0			> 100 %	> 100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
25% Effluent	0	5			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ADDITIONAL TOXICITY TEST INFORMATION

Copies of sample collection forms, sample receipt forms, data sheets containing the biological and physical/chemical information measured during the test(s), and statistical calculations/printouts obtained during the test(s) are attached to the report in Appendix A.

CONCLUSIONS/COMMENTS

The Unit 1/2 circulation discharge composite, Unit 1 circulation discharge composite, and the 30 ppm Clay/lake water solution (Lake Michigan) samples were not acutely toxic.

Daphnia magna 48-hour TU_a value was ≤ 1.0 for all samples.

Reference Toxicant Results are attached in Appendix B.

APPENDIX A

RAW DATA SHEETS

GLEC

Great Lakes Environmental Center
Phone: (616) 941-2230
Fax: (616) 941-2240

CHAIN OF CUSTODY RECORD

(TO BE COMPLETED ONSITE AND SUBMITTED WITH SAMPLES)

Facility: Cook Plant - Indiana Michigan Power
Location: 1 Cook Place Bridgman Michigan 49106
Contact Person: Blair Zordell Eric Mallen
Phone Number: 616 465 5901 ext 2006 or 1540

Collector: DEAN WARLIN
Date: 9-11-94
Witness: JOHN CARLSON
Date: 9-11-94

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SAMPLE ID	DATE/TIME OF SAMPLE	VOLUME COLLECTED	SAMPLE COLLECTOR	SAMPLE CONTAINER	DESCRIPTION (Type of sample, source, physical characteristics)	PRESERVATION	ANALYSES REQUIRED
CIRC H_2O (FILT)	9-10-94/1600	1 GAL	SCOTT ROSE	GALLON BAG	LAKE WATER (FILTERED)	ICE	TOXICITY TEST
30 PPM CLAY/WATER	9-10-94/1600	1 GAL	SCOTT ROSE	GALLON BAG	CLAY + LAKE WATER MIXTURE (FILTERED H_2O)	ICE	TOXICITY TEST
UNIT 1/2 EFF. COMPOSITE	9-11-94/0730	1 GAL	DEAN WARLIN	GALLON BAG	4 COMPOSITES FROM EACH UNIT EVERY 4 HRS	ICE	TOXICITY TEST

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

	SHIPPER	RECEIVER	DATE	TIME
1.	Dean L Warlin			
2.	[signature]	→	9/10/94	8:20
		J W Brackenbury	9/11/94	17 30 p

Condition of Sample Upon Receipt:

Good
LakeWater – 7.4°C
Claywater – 7.5°C
Eff. 8.0°C

EFFLUENT AND RECEIVING WATER
CHECK-IN FORM

Client: Cook Nuclear Project No.: N078-00

Investigators: ______________________

INITIAL WATER CHEMISTRY (UPON RECEIPT)

Date: 9-11-94	Initials JB	Circ H_2O (Lake Water)	Clay Water	Unit 1/2 Effluent
GLC No.	JB	1976	1977	1978
Collection Date (time interval)	JB	9/10/94 1600	9/10/94 1600	9/11/94 0730
Temperature	JB	7.4°C	7.5°C	8.0°C

WATER CHEMISTRY AT TEST TEMPERATURES

Date: 9-11-94	Initials JB	(Circ H_2O) Lake Water	Clay Water	Unit 1/2 Effluent
GLC No.	JB	1976	1977	1978
Temperature	JB	25.0	25.0	25.0
pH	JB	8.09	8.14	8.15
Dissolved Oxygen (mg/L)	JB	9.0	9.6	9.9
Conductivity (umhos's/cm)	JB	291	300	305
Hardness (mg/L)	JB	~~108~~ 128	~~106~~ 136	128
Alkalinity (mg/L)	JB	108	106	108
Total Chlorine (mg/L)*		—	—	—
Total Ammonia (mg/L)*		—	—	—

* Check with project manager to see if necessary

Clay/Water: ~~Co~~ Twater 30 ppm

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear	Type of Test: Clay-water	Dilution Water: Lake Michigan 1976
Project No.: N078-00	No. Daphnids/Chamber: 5	GLC and/or Batch No.: 1977
Test Species: D. Magna	No. of Chambers: 4 (~~#s for chems~~)	Test Temperature: 25 ± 1
Investigators: PL/JB	Age of Daphnids: < 24 hrs	Incubator #: 1 Photoperiod: 16:8

Date / Time	Test Day	Tech. Init.	Treatment Level / Replicate Number	Lake Michigan Control 1	2	3	4	A 6.25% 1	2	3	4	B 12.5% 1	2	3	4	C 25% 1	2	3	4	D 50% 1	2	3	4	E 100% 1	2	3	4
9-11-94 4:35 P	0	JB	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.07				8.08				8.12				8.12				8.19				8.20			
			DO (mg/L)	8.6				8.5				8.6				8.4				8.3				8.5			
			Sp.Cond.(umhos/cm)	280				287				292				292				298				300			
9.12.94	1	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	~~5~~ 4	5	5	5	5	5	5	5	5	5
			Observations						4F	2F				3F				1 DOB				5F	2F				1F
			pH	8.16				8.24				8.26				8.29				8.30				8.31			
			DO (mg/L)	7.4				7.4				7.2				7.2				7.3				7.2			
			Temperature (°C)	25.1				25.3				25.9				25.9				25.9				25.9			
9.13.94 3:30 P	2	PL	No. Live	5	5	5	5	5	5	5	5	5	5	3	5	4	5	4	5	5	5	5	5	5	5	5	4
			Observations	1F										1F							1F		1F				
			pH	8.12				8.17				8.18				8.20				8.21				8.21			
			DO (mg/L)	7.6				7.7				7.6				7.7				7.9				7.9			
			Sp.Cond.(umhos/cm)	273				280				301				275				301				299			
			Temperature (°C)	25.4				25.8				25.8				25.8				25.8				25.8			

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

Reviewed by: Ram Lee
Date: 9/19/94

~~Chemtrol~~ + Benonite

Unit 1/2 Effluent

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook-Nuclear

Project No.: N078-00

Test Species: D Magna

Investigators: PL + JB

Type of Test: Unit 1/2 Eff

No. Daphnids/Chamber: 5

No. of Chambers: 4 (H5 for Chems)

Age of Daphnids: < 24 hrs.

Dilution Water: Lake Michigan 1976

GLC and/or Batch No.: 1978

Test Temperature: 25° ±1

Incubator #: 1

Photoperiod: 16:8

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Michigan Control 1	2	3	4	A 6.25% 1	2	3	4	B 12.5% 1	2	3	4	C 25% 1	2	3	4	D 50% 1	2	3	4	E 100% 1	2	3	4
9-11-94 4:15p	0	JB	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.10				8.15				8.18				8.22				8.23				8.27			
			DO (mg/L)	8.5				8.3				8.3				8.4				8.6				8.6			
			Sp.Cond.(umhos/cm)	283				300				303				287				294				304			
9.12.94	1	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations	1F	4F	2F								2F			1F					1F	1F				1F
			pH	8.18				8.24				8.26				8.29				8.31				8.30			
			DO (mg/L)	7.3				7.4				7.3				7.3				7.4				7.4			
			Temperature (°C)	25.0				25.0				25.0				25.1				25.1				25.1			
9.13.94 3:25 pm	2	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations	2F			2F			1F									1F			1F				1F	
			pH	8.28				8.27				8.28				8.29				8.32				8.31			
			DO (mg/L)	7.8				7.7				7.8				7.8				8.0				7.9			
			Sp.Cond.(umhos/cm)	242				264				264				263				291				290			
			Temperature (°C)	25.3				25.3				25.3				25.3				25.2				25.2			

AIV-150

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

Reviewed by: Pam Lea

Date: 9/19/94

GLEC

Great Lakes Environmental Center
Phone: (616) 941-2230
Fax: (616) 941-2240

CHAIN OF CUSTODY RECORD

(TO BE COMPLETED ONSITE AND SUBMITTED WITH SAMPLES)

AIV-151

Facility: D.C. Cook Nuclear Plant
Location: One Cook Place Bridgman MI 49106
Contact Person: ERRIC MALLEN
Phone Number: 616-465-5901 Ext. 1540

Collector: Viren. Shah
Date: 9-14-94 & 9-15-94
Witness: [illegible]
Date: 9/15/94

SAMPLE ID	DATE/TIME OF SAMPLE	VOLUME COLLECTED	SAMPLE COLLECTOR	SAMPLE CONTAINER	DESCRIPTION (Type of sample, source, physical characteristics)	PRESERVATION	ANALYSES REQUIRED
Lake Water	9-14-94	2 gallons	V. Shah	2, 1 gallon plastic	Dilution water	None	~~Wet Test~~ None
Lake water w/30 ppm Clay	9-14-94	1 gallon	V. Shah	1 gallon plastic	Clay 30 ppm water	Nones	WET TEST.
U-1 Circ discharge Composite	9-14-94 9-15-94	1 gallon	V Shah	1 gallon plastic	Composit water	None	WET TEST

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

	SHIPPER	RECEIVER	DATE	TIME
1.	V. Shah		9-15-94	@0827
2.		Aly [illegible]	9-15-94	8:40 AM
... of Sample Upon Receipt:		[illegible] Brackenbury	9-15-94	1:00 PM

Unit 1 Discharge 10.4°C
Clay - 7.0°C
Lakewater - 7.8°C

EFFLUENT AND RECEIVING WATER
CHECK-IN FORM

Client: Cook Nuclear Project No.: N078-00

Investigators:

INITIAL WATER CHEMISTRY (UPON RECEIPT)

Date: 9-15-94	Initials JB	U-1 Circ discharge	Lake water w/Clay	Lake Water
GLC No.	JB	1989	1990	1991
Collection Date (time interval)		9-14-94 9-15-94	9-14-94	9-14-94
Temperature	JB	10.4 °C	9.0 °C	7.8 °C

WATER CHEMISTRY AT TEST TEMPERATURES

Date: 9-15-94	Initials JB	U-1 Circ Discharge	Lakewater w/30ppm Clay	Lake Water
GLC No.	JB	1989	1990	1991
Temperature	JB	25.0	25.0	25.0
pH	JB	8.20	8.07	8.0
Dissolved Oxygen (mg/L)	JB	8.7	8.2	8.18
Conductivity (umhos's/cm)	JB	288	276	273
Hardness (mg/L)	JB	124	128	124
Alkalinity (mg/L)	JB	106	106	100
Total Chlorine (mg/L)*				
Total Ammonia (mg/L)*				

* Check with project manager to see if necessary

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: N078-00
Test Species: D. Magna
Investigators:

Type of Test: Clay-Water
No. Daphnids/Chamber: 5
No. of Chambers: 4 (~~#5 for chems~~)
Age of Daphnids: ≤24hrs

Dilution Water: Lake Michigan #1991
GLC and/or Batch No.: #1998
Test Temperature: 25±1°C
Incubator #: 6
Photoperiod: 16:8

AIV-153

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Michigan Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-15-94 3:05	0	JJ	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.13				8.14				8.14				8.16				8.17				8.18			
			DO (mg/L)	8.2				8.4				8.4				8.4				8.4				8.4			
			Sp.Cond.(umhos/cm)	273				289				291				291				293				296			
9.16.94 3:20	1	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations		1F	2F																1F	1F				
			pH	8.16				8.21				8.24				8.26				8.27				8.28			
			DO (mg/L)	7.2				7.4				7.4				7.4				7.4				7.4			
			Temperature (°C)	24.8				24.8				25.0				25.0				25.0				25.0			
9-17-94 3:30 pm	2	Dun	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5
			Observations			1F													1F								
			pH	8.29				8.33				8.36				8.38				8.38				8.41			
			DO (mg/L)	7.6				7.8				7.7				7.7				7.7				7.8			
			Sp.Cond.(umhos/cm)	285				295				302				304				304				316			
			Temperature (°C)	24.8				24.6				24.5				24.5				24.5				24.5			

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

Reviewed by: Pam Lea
Date: 9/19/94

U-1
Circ discharge

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: N078-00
Test Species: D. Magna
Investigators:

Type of Test: U-1 CIRC DISCHARGE
No. Daphnids/Chamber: 5
No. of Chambers: 4 (#5 for chem)
Age of Daphnids: ≤ 24 hrs

Dilution Water: Lake Michigan #1991
GLC and/or Batch No.: #1989
Test Temperature: 25±1
Incubator #: 6
Photoperiod: 16:8

AIV-154

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Mich Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-15-94 3:30 pm	0	[illegible]	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.17				8.19				8.20				8.21				8.24				8.31			
			DO (mg/L)	8.4				8.4				8.3				8.5				8.4				8.5			
			Sp.Cond.(umhos/cm)	273				281				285				283				281				289			
9.16.94 3:20 pm	1	Pf	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations						2F				1F										2F				1F
			pH	8.19				8.23				8.24				8.26				8.28				8.30			
			DO (mg/L)	7.3				7.2				7.3				7.4				7.1				7.4			
			Temperature (°C)	25.0				25.0				25.1				25.1				25.1				25.0			
9-17-94 3:15 pm	2	Dm	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations																1F								1F
			pH	8.24				8.32				8.33				836				840				8.40			
			DO (mg/L)	7.7				7.7				7.7				7.7				7.9				7.8			
			Sp.Cond.(umhos/cm)	283				286				288				288				285				297			
			Temperature (°C)	24.8				24.8				24.9				25.0				25.0				24.9			

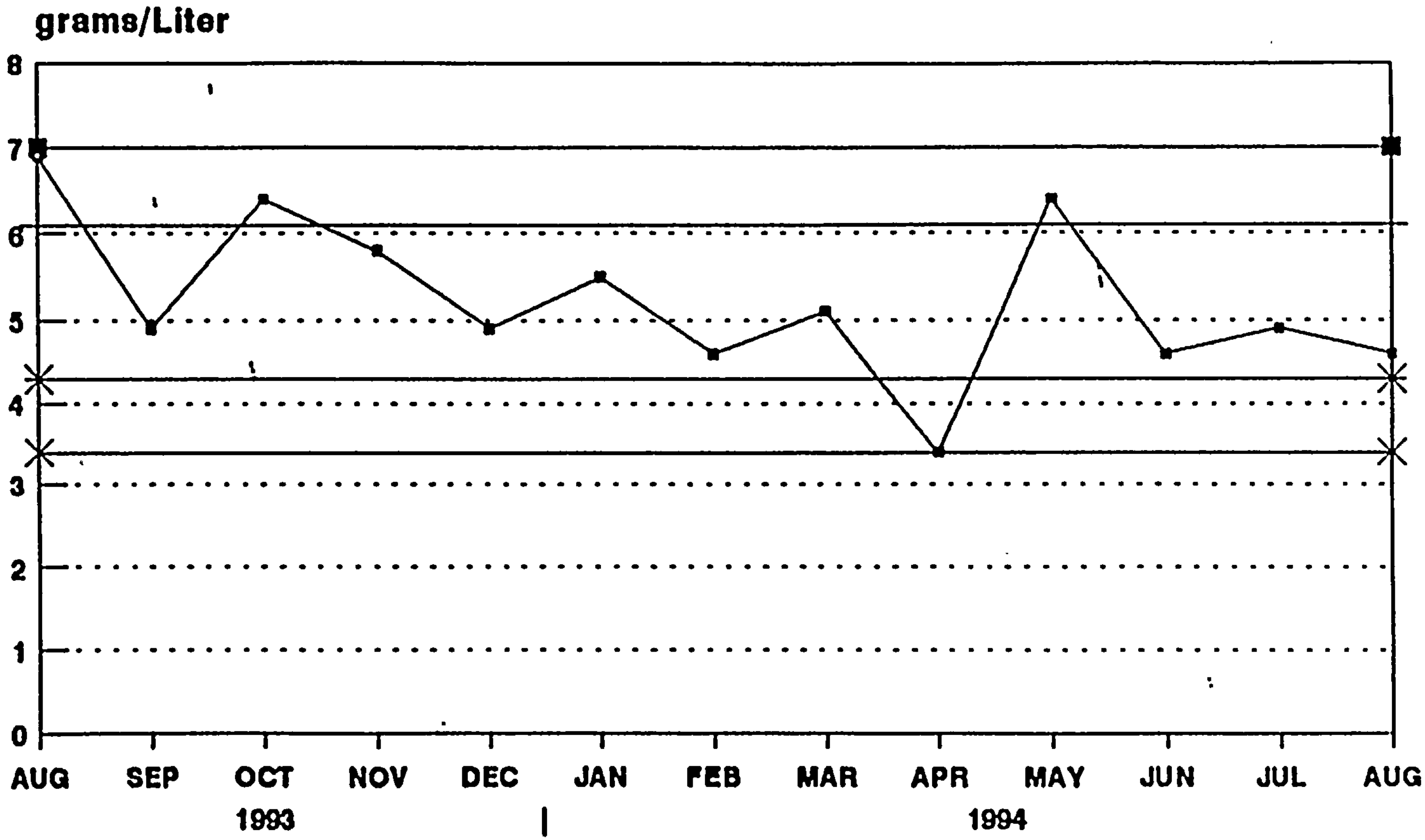
Observation Key:
DOB - Dried Out on Beaker
ERR - Erratic Swimming
F - Floater
PM - Particulate Matter
FS - Film on Surface
IMM - Immobile

Reviewed by: Pam Lee
Date: 9/19/94

APPENDIX B

REFERENCE TOXICANT DATA

GREAT LAKES ENVIRONMENTAL CENTER
Sodium Chloride (NaCl) Toxicity Data
1993 - 1994



Daphnia magna Survival

AIV-156

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

INDIANA
MICHIGAN
POWER

Mr. Greg Danneffel
District Supervisor
Michigan Department of Natural Resources
621 North Tenth Street
P.O. Box 355
Plainwell, MI 49080

October 12, 1994

Dear Mr. Danneffel:

The 1994 zebra mussel control program, utilizing Clam-trol CT-2 treatments, has been completed and the results evaluated. This letter is in reponse to Attachment 1 paragraph c included in Ms. Sylvia Heaton's letter to you of September 7, 1994 to submit the results of toxicity testing and Clam-trol CT-2 discharge concentrations following the Clam-trol applications at the Cook Nuclear Plant.

Compliance With Effluent Limits

Two Clam-trol CT-2 applications were performed in 1994. The first application was on the Plant's circulating water intake forebay on the evening of Sept. 10-11, 1994. The second followed on the evening of Sept. 14-15, 1994 on the Plant's South Intake tunnel.

For both treatments, Clam-trol CT-2 was fed at a target rate of 4 mg/l for a period of 12 hrs. Bentonite clay was fed and adjusted as necessary to maintain a rate of at least 7.5:1 clay/Clam-trol for detoxification of the active Clam-trol CT-2. Clam-trol CT-2 concentrations measured at the Unit 1 and 2 Main Condenser Outlets for the forebay treatment, and at the South Intake tunnel manway for the South Intake tunnel treatment, were used to provide feedback for the proper Clam-trol feedrate. The Clam-trol Methyl Orange Analytical Method was used as required by the MDNR. On both occasions, the Plainwell District Supervisor was notified a week in advance of the treatments.

Three thousand five hundred gallons (3,500 gal.) or 27,937 lbs. (7.982 lbs./gal. @90 degrees F) of Clam-trol CT-2 detoxified by 227,660 lbs. of bentonite clay were used for the intake forebay treatment. All samples taken from Outfalls 001 (Unit 1 Discharge) and 002 (Unit 2 Discharge) were less than detectable, 0.05 mg/l. The results of the lab analyses are presented in Attachment 1.

Two hundred eighty-two gallons (282 gal.) or 2,250 lbs. of Clam-trol CT-2 detoxified by 18,000 lbs. of bentonite clay were used for the South Intake tunnel treatment. All discharges were directed through Outfall 001 and CT-2 concentrations were less than detectable, 0.05 mg/l. The results of the lab analyses are presented in Attachment 2.

Effectiveness of Zebra Mussel Control

The effectiveness of the zebra mussel control was measured by diver inspections of the underwater structures and by sidestream biobox monitors connected to the circulating water, service water systems, and miscellaneous sealing & cooling water system. Diver inspections revealed intake forebay mortality rates of greater than 90% with the exception of a small stagnant area in the middle of the bay where zebra mussel mortality was assessed at 5-10%. Diver inspections of the South Intake tunnel revealed mortality rates of greater than 90%. Bio-box motality rates ranged from 70-100%. Based upon these results, the treatment program was rated at producing 95% or higher mortality to zebra mussels settled within the plant.

WET Testing Results

The WET testing study results are presented in detail in Attachment 3. Acute 48-hr. toxicity tests were conducted with Daphnia magna on 100%, 50%, 25%, 12.5%, 6.25%, and 0% effluents. The plant discharges consisting of Clam-trol/lake water detoxified by bentonite clay, as well as 30 ppm clay/lake water samples for both treatments were determined to be non-toxic. The Daphnia magna 48-hour TUA was <1.0 for all samples.

Other Significant Events

On the evening of September 10, 1994, during the intake forebay treatment, the Unit 1 Discharge clay feeder plugged causing an interruption of the clay detoxification feed to the discharge water. The Clam-trol CT-2 feed was stopped within seconds after the feeder plugged. A redundant feeder was placed in service which also plugged due to alignment problems. These alignment problems were corrected by blocking the eductor funnels in place to prevent movement. The Clam-trol CT-2 feed was resumed a half hour after the plug in the clay feeder was removed. No adverse environmental effects were noted as a result of the interruption in the clay feed. The plant is evaluating means of providing a redundant clay feed system should the clay feed be interrupted for future applications.

On the morning of Sept. 11, 1994 during the intake forebay Clam-trol treatment, discharge Outfalls 001 and 002 were sampled for turbidity. A visual observation of the samples revealed turbidity in the water caused by the bentonite clay. The turbidity subsided

as soon as the clay feed was terminated at the end of the treatment. This event was reported in the September Monthly Operating Report.

Conclusion

The special conditions stated in Attachment 1 of Ms. Heaton's memo authorizing the plant to use Clam-trol CT-2 were met. The brief interruption of the clay feed resulted in no adverse environmental effects. The results of the whole effluent studies demonstrated that the plant discharges were non-toxic.

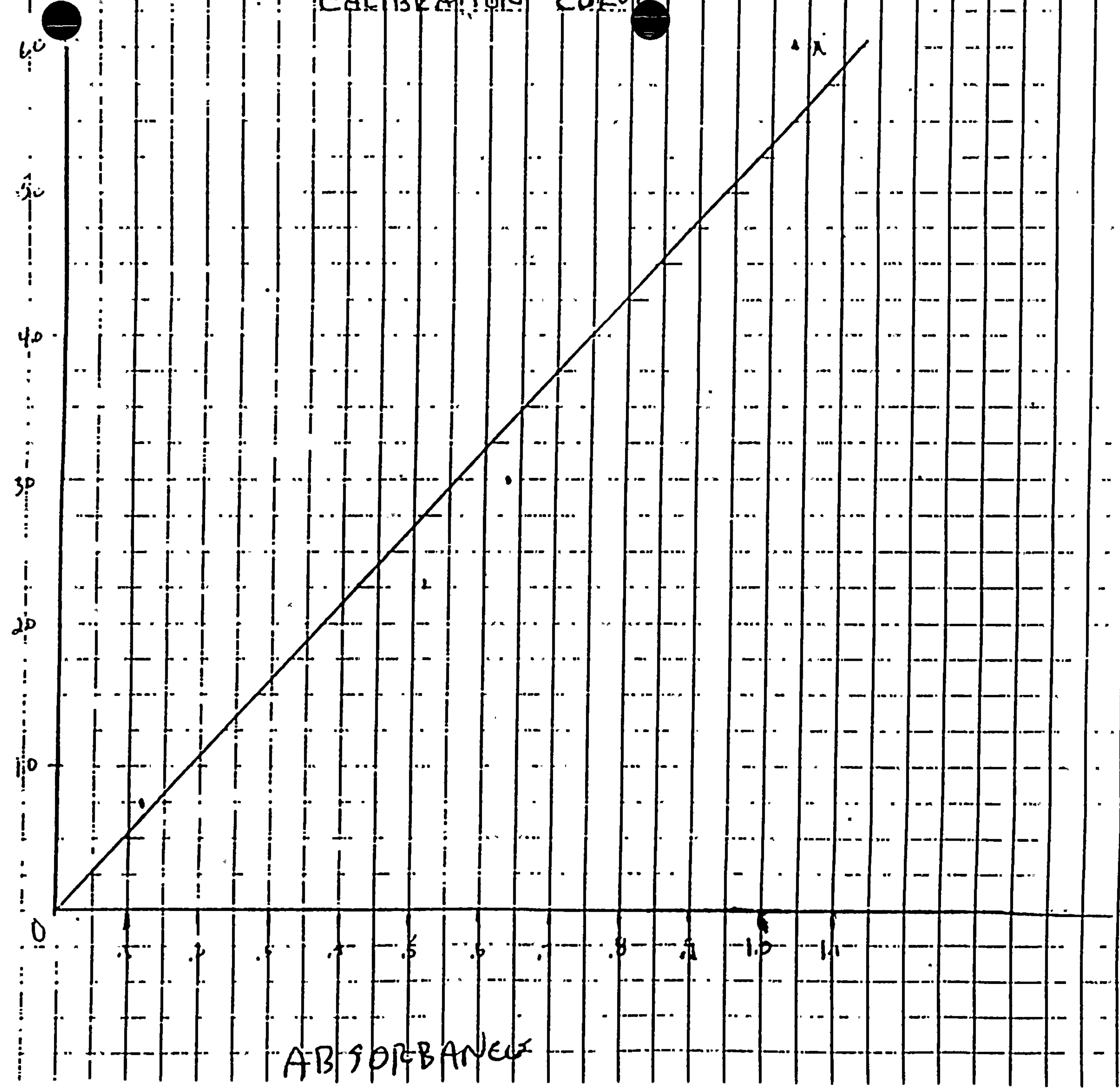
We look forward to your review of the requested data and permission to continue the use of Clam-trol CT-2 as designated in the September 7, 1994 memo.

Sincerely,

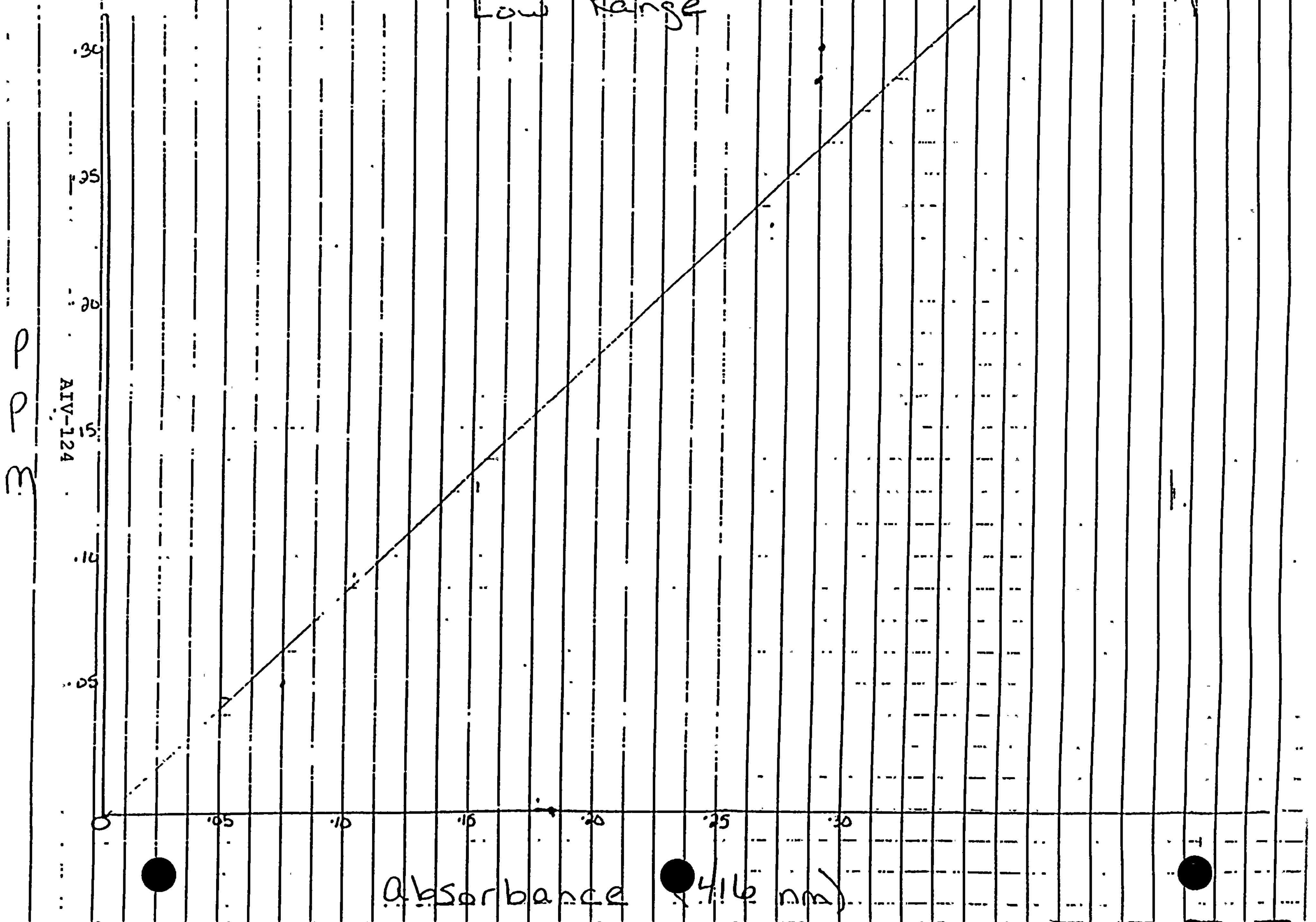
John P. Carlson
Environmental Supervisor

Attachment 1

CALIBRATION CURVE



CT-2 Calibration Curve
Low Range



12kon R - ~ ' U

Unit One Circ Discharge
Sample Location

9/10-11/94
Date

[signature] 9/11/94
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1935	77.3	—	—	<.05	PK
2130	79.5	—	—	<.05	PK
2330	77.6	—	—	<.05	PK
0130	76.8	—	—	<.05	PK
0330	76.9	—	—	<.05	DW
0530	76.1	—	—	<.05	DW
0730	77.4	—	—	<.05	PK

Blank = .070 < 0.05

Unit Two Circ Discharge
Sample Location

9/10-11/94
Date

[signature] 9/11/94
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1935	71.0	—	—	<.05	PK
2130	71.3	—	—	<.05	PK
2330	70.8	—	—	<.05	PK
0130	70.8	—	—	<.05	PK
0330	70.6	—	—	<.05	DW
0530	70.0	—	—	<.05	DW
0730	70.1	—	—	<.05	PK

Blank = .010

U-1 Condenser Outlet
Sample Location

9/10-11/94
Date

[signature] 9/11/94
Reviewed By

	Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
AS	1920	67.3	—	—	>6ppm	PK
AS	2025	81.2	.488	.418	2.2ppm	PK
BS	2026	80.8	.464	.394	2.1ppm	PK
CN	2027	76.9	.706	.636	3.5ppm	PK
AS	2135	81.3	.636	.566	3.0ppm	PK
BS	2305	82.5	.650	.580	3.2ppm	PK
CN	0040	81.2	.994	.924	5.0ppm	PK
CN	0230	79.5	—	—	>[illegible]ppm	PK
CN	0330	78.0	.582	.512	2.9ppm	DW
CN	0530	79.5	1.200	1.13	5.9ppm	DW

U-2 Condenser Outlet
Sample Location

9/10-11/94
Date

E.W. 9/11/94
Reviewed By

	Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
2AS	1920	67.3	—	—	>6 ppm	PK
~~2AN~~	~~2030~~	~~68.0~~	~~.488~~	~~.418~~	~~2.2 ppm~~	~~PK~~
2AN	2036	68.0	.618	.548	2.9 ppm	PK
2BN	2030	67.9	.820	.750	4.0 ppm	PK
2CN	2030	68.0	.680	.610	3.3 ppm	PK
2AN	2135	67.7	1.024	.954	5.1 ppm	PK
2BN	2200	68.5	.686	.616	3.3 ppm	PK
2CN	0040	67.5	1.156	1.086	5.8 ppm	P.K
2CN	0230	68.2	—	—	>6 ppm	PK
2CN	0330	62.0	.640	.570	3.2 ppm	DW
2BN	0530	66.5	.888	.818	4.3 ppm	DW

Miscellaneous
Sample Location

Date: 9/10-11/94

Reviewed By: C.W. 9/11/94

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
2310	72.5	.590	.520	2.9 ppm	PK
2312	71.7	.798	.728	3.9 ppm	PK
0050	75.8	1.076	1.006	5.3 ppm	PK
0055	69.3	1.260	1.190	5.9 ppm	PK
0230	70.5	1.078	1.008	5.3 ppm	DW
0230	70.5	1.180	1.110	5.9 ppm	DW
		~~1.078~~ DW	~~1.008~~ DW		
0545	68.4	—	—	76.0	DW
0545	67.8	.626	.556	3.0	DW
0550	67.5	1.128	1.058	5.8 ppm	DW

Attachment 2

South Intake
Sample Location

Date: 7/14/94

Reviewed By: [signature]

	Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
	1824	70.8	—	—	<.05	PK
	835	70.8	—	—	<.05	PK
	1845	70.4	.216	.166	.14	PK
	1855	70.3	.124	.074	.06	PK
	1946	70.5	~~[illegible]~~	—	<.05	BM
	2000	70.3	—	—	<.05	PK
ANDPIPE)	2025	71.5	.494	.444	2.5	PK
ANDPIPE)	2034	70.5	.814	.764	4.0	PK
	2125	70.6	.988	.938	5.0	PK
Arse)	2210	71.7	—	—	<.05	PK
Diffuser)	2210	72.0	—	—	>6.0	PK
Bott)	2210	70.9	—	—	>6.0	PK
mid)	2217	70.4	.780	.730	3.8	PK
(Top)	2223	64.6	1.040	.990	5.3	PK
	2340	69.2	.790	.740	4.0	BM
	0103	69.7	.708	.658	3.5	PK
	0305	70.1	.960	.910	4.9	PK
	0330	70.9	.710	.660	3.5	PK
	0440	70.2	.842	.842	4.5	PK
nSTREAM Diffuser	0430	71.0	—	—	>6.0	PK
REAM of Diffuser	0436	70.8	—	—	<.05	PK
	0615	69.8	—	—	>6.0	PK
	0625	70.1	.266	.216	.180	PK
	0655	70.4	.184	.134	.111	PK
STOPLOCK OPENED	0710	70.3	1.000	.950	5.0	PK
	0715	84.7	.122	.072	.06	BM

South Intake
Sample Location

9/15/94
Date

Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0725	84.3	.168	.118	.05	BM
0745	70.1	—	—	<.05	BM

BLANK = .050

**12 THP 6020 CHM. ~~318~~ 317 [initials] 9/21/94
ATTACHMENT 1

Circ Discharge
Sample Location

9/14/94
Date

[signature]
Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
1912	86 °F	—	—	<.05	SM
2100	87.1	—	—	<.05	PK
2300	83.9	—	—	<.05	PK
0100	82.7	—	—	<.05	PK
0300	85.1	—	—	<.05	PK
0445	85.1	—	—	<.05	PK
0610	84.7	—	—	<.05	SM
~~0715~~	~~[illegible]~~	~~[illegible]~~	~~.072~~	~~[illegible]~~	SM
0740	84.6	—	—	<.05	SM

* INT... SAF... (LOGGED ON W... SHEE...)

U-1 Main Condensate
Sample Location

4/14/94
Date

Reviewed By

Sample Time	Water Temp	Measured Absorbance	Corrected Absorbance	Conc. Biocide ppm	Initials
0310	93.3	—	—	L.05	PK

Attachment 3

GLEC

Great Lakes Environmental Center

Applied Water Quality & Environmental Science

Traverse City Operations
739 Hastings St.
Traverse City
MI 49686

616 941-2230
616 9[illegible]240 fax

Columbus Operations
1030 King Ave.
Columbus
OH 43212

614 297-8801
614 297-8866 fax

September 21, 1994

Mr. Eric Mallen
Indiana Michigan Power Company
Cook Nuclear Power Plant
Bridgeman, MI 49106

RE: BIOMONITORING REPORT FOR SAMPLES COLLECTED SEPTEMBER 10/11 AND 14/15, 1994

Dear Eric:

We have completed our analyses of the 48-hour *Daphnia magna* static acute toxicity tests performed on 30 ppm Clay/lake water samples, Unit 1/2 circulation discharge composite, and Unit 1 circulation discharge composite samples collected by Cook Nuclear Personnel on September 11 and 14, 1994. The samples were picked-up and delivered to the laboratory on those same days (September 11 and 14) by GLEC staff, and the tests were initiated that day.

The water samples were not acutely toxic to *Daphnia magna*. The NPDES Acute Biomonitoring Report form is enclosed for your review, and 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 Pam Lea at (616) 941-2230.

Thank you for the opportunity to provide this service to Indiana Michigan Power Company. We look forward to continuing to provide environmental services to Indiana Michigan Power Company in the future.

Sincerely,

Dennis J. McCauley
Environmental Research Scientist/
Co-Manager of Operations

DJM:kla
Enclosures

AIV-136

GLEC

Great Lakes Environmental Center

NPDES ACUTE BIOMONITORING REPORT FORM

GENERAL INFORMATION

1. Facility Name: Cook Nuclear Power Plant Reporting Date: September 19, 1994
2. Address: Indiana Michigan Power Co., Cook Nuclear Plant, Bridgeman, MI 49106
3. NPDES Permit Number: ______________
4. Facility Contact: Eric Mallen 5. Phone No.: (616) 465-5901 ext 1540
6. Consultant/Lab Name: Great Lakes Environmental Center, Inc.
7. GLEC Contact: Dennis J. McCauley 8. Phone No.: (616) 941-2230
9. Receiving Water(s) of Discharge: Lake Michigan
10. Outfall(s) Tested: Unit 1/2 Circulation Discharge Composite, Unit 1 Circulation Discharge Composite and 30 ppm Clay/lake Water
11. Methods: GLEC in-house Standard Operating Procedures, which are based on U.S. EPA procedures (Peltier and Weber, 1991, "Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms," EPA/600/4-90/027

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate, and complete.

Dennis J McCauley
Signature

21 Sept 94
Date

Dennis J. McCauley
Name (typed or printed)

Environmental Research Scientist/ Co-Manager of Operations
Title

ACUTE TOXICITY TEST SAMPLING DATA

TABLE 1a

Sampling Summary for Acute Toxicity Tests

Sampling Location and Description	Sample Collection: Beginning mm/dd/yr (Time)	Sample Collection: Ending mm/dd/yr (Time)	Total Residual Chlorine (mg/L)
Final Effluent: Unit 1/2 Circulation Discharge Effluent Composite Outfall No.: Type (Grab/Composite): 24 hour composite Volume Collected: 1 gallon	09/10/94 *	09/11/94 0730 hrs.	
Water Sample: 30 ppm Clay/lake water sample Waterbody: Station No.: Type (Grab/Composite): Grab Volume Collected: 1 gallon	Prepared by Cook Nuclear Plant Staff	09/10/94 1600 hrs.	
Downstream Station (Near-field): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected:			
Additional Stations (if needed): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA			

* = Collection initiation time not indicated by Cook Nuclear personnel.
NA = Not Available

ACUTE TOXICITY TEST SAMPLING DATA

TABLE 1b

Sampling Summary for Acute Toxicity Tests

Sampling Location and Description	Sample Collection		Total Residual Chlorine (mg/L)
	Beginning mm/dd/yr (Time)	Ending mm/dd/yr (Time)	
Final Effluent: Unit 1 Circulation Discharge Effluent Composite Outfall No.: Type (Grab/Composite): 24 hour composite Volume Collected: 1 gallon	09/14/94 *	09/15/94	
Water Sample: 30 ppm Clay/Lake Water Sample Waterbody: Station No.: Type (Grab/Composite): Grab Volume Collected: 1 gallon	Prepared by Cook Nuclear Plant Staff	09/14/94	
Downstream Station (Near-field): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected:			
Additional Stations (if needed): Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA Waterbody: NA Station No.: NA Type (Grab/Composite): NA Volume Collected: NA			

* = Collection initiation time not indicated by Cook Nuclear personnel.
NA = Not Available

TOXICITY TEST CONDITIONS

TABLE 2

Summary of Toxicity Test Conditions	
1. Test Species and Age:	*Daphnia magna*, <24 hours old
2. Test Type and Duration:	Static, 48 hours
3. Test Dates:	September 11-13, 1994 and September 15-17, 1994
4. Test Temperature (°C):	25 ± 1
5. Light Quality:	Ambient Laboratory, 10-20 $\mu E/m^2/s$
6. Photoperiod:	16 h light, 8 h darkness
7. Feeding Regime:	None
8. Size of Test Vessel:	100 mL beaker
9. Volume and Depth of Test Solutions:	80 mL
10. No. of Test Organisms per Test Vessel:	5
11. No. of Test Vessels per Test Solution:	4
12. Total No. of Test Organisms per Test Solution:	20
13. Test Concentrations (as % by volume effluent):	100, 50, 25, 12.5, and 6.25
14. Renewal of Test Solutions:	None
15. Dilution and Primary Control Water:	Circulation Water (filtered)
16. Secondary Control Water:	None
17. Aeration:	None
18. Endpoints Measured:	Immobility and Mortality

ACUTE TOXICITY TEST RESULTS

TABLE 3a

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/11/94 (mm/dd/yy) - 09/13/94 (mm/dd/yy) Using Effluent from Outfall Unit 1/2 Circulation Discharge Effluent Composite.

Test Solutions	Cumulative Percent Mortality				LC_{50} Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
25% Effluent	0	0			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3b

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/11/94 (mm/dd/yy) - 09/13/94 (mm/dd/yy) Using 30 ppm Clay/lake water solution.

Test Solutions	Cumulative Percent Mortality				LC$_{50}$ Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	10			24-Hr	48-Hr	72-Hr	96-Hr
[illegible]% Effluent	0	10			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	5			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC$_{50}$ and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3c

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/15/94 (mm/dd/yy) - 09/17/94 (mm/dd/yy) Using Effluent from Unit 1 Circulation Discharge Composite.

Test Solutions	Cumulative Percent Mortality				LC_{50} Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			>100 %	>100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
25% Effluent	0	0			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ACUTE TOXICITY TEST RESULTS

TABLE 3d

Results of a Daphnia (genus) magna (species) 48-Hour Static Acute Toxicity Test

Conducted 09/15/94 (mm/dd/yy) - 09/17/94 (mm/dd/yy) Using 30 ppm Clay/lake water solution.

Test Solutions	Cumulative Percent Mortality				LC_{50} Values			
	24-Hr	48-Hr	72-Hr	96-Hr	24-Hr	48-Hr	72-Hr	96-Hr
Primary Control/ Dilution Water	0	0			> 100 %	> 100 %		
Secondary Control								
6.25% Effluent	0	0						
12.5% Effluent	0	0			24-Hr	48-Hr	72-Hr	96-Hr
[illegible]% Effluent	0	5			[LL] NC			
50% Effluent	0	0			[UL] NC			
100% Effluent	0	0			LL = Lower Limit UL = Upper Limit			
Near-Field Sample					Method(s) Used to Determine LC_{50} and Confidence Limit Values: Trimmed Spearman-Karber			

NC = Not Calculable.

ADDITIONAL TOXICITY TEST INFORMATION

Copies of sample collection forms, sample receipt forms, data sheets containing the biological and physical/chemical information measured during the test(s), and statistical calculations/printouts obtained during the test(s) are attached to the report in Appendix A.

CONCLUSIONS/COMMENTS

The Unit 1/2 circulation discharge composite, Unit 1 circulation discharge composite, and the 30 ppm Clay/lake water solution (Lake Michigan) samples were not acutely toxic.

Daphnia magna 48-hour TU_a value was ≤ 1.0 for all samples.

Reference Toxicant Results are attached in Appendix B.

APPENDIX A

RAW DATA SHEETS

GLEC

Great Lakes Environmental Center
Phone: (616) 941-2230
Fax: (616) 941-2240

CHAIN OF CUSTODY RECORD

(TO BE COMPLETED ONSITE AND SUBMITTED WITH SAMPLES)

Facility: Cook Plant - Indiana Michigan Power
Location: 1 Cook Place Bridgman Michigan 49106
Contact Person: Blair Zordell Eric Mallen
Phone Number: 616 465 5901 ext 2006 or 1540

Collector: DEAN WARLIN
Date: 9-11-94
Witness: JOHN CARLSON
Date: 9-11-94

SAMPLE ID	DATE/TIME OF SAMPLE	VOLUME COLLECTED	SAMPLE COLLECTOR	SAMPLE CONTAINER	DESCRIPTION (Type of sample, source, physical characteristics)	PRESERVATION	ANALYSES REQUIRED
CIRC H_2O (FILT)	9-10-94/1600	1 GAL	SCOTT ROSE	GALLON BAG	LAKE WATER (FILTERED)	ICE	TOXICITY TEST
30 PPM CLAY/WATER	9-10-94/1600	1 GAL	SCOTT ROSE	GALLON BAG	CLAY + LAKE WATER MIXTURE (FILTERED H_2O)	ICE	TOXICITY TEST
UNIT 1/2 EFF. COMPOSITE	9-11-94/0730	1 GAL	DEAN WARLIN	GALLON BAG	4 COMPOSITES FROM EACH UNIT EVERY 4 HRS	ICE	TOXICITY TEST

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

	SHIPPER	RECEIVER	DATE	TIME
1.	Dean L Warlin			
2.	[signature] →	[signature]	9/10/94	8:20

Condition of Sample Upon Receipt: Good
Lake Water - 7.4°C
Claywater - 7.5°C
Eff. - 8.0°C

EFFLUENT AND RECEIVING WATER CHECK-IN FORM

Client: Cook Nuclear Project No.: N078-00

Investigators: ___

INITIAL WATER CHEMISTRY (UPON RECEIPT)

Date: 9-11-94	Initials JB	Circ H_2O (Lake Water)	Clay Water	Unit 1/2 Effluent
GLC No.		1976	1977	1978
Collection Date (time interval)	JB	9/10/94 1600	9/10/94 1600	9/11/94 0730
Temperature	JB	7.4°C	7.5°C	8.0°C

WATER CHEMISTRY AT TEST TEMPERATURES

Date: 9-11-94	Initials JB	(Circ H_2O) Lake Water	Clay Water	Unit 1/2 Effluent
GLC No.	JB	1976	1977	1978
Temperature	JB	25.0	25.0	25.0
pH	JB	8.09	8.14	8.15
Dissolved Oxygen (mg/L)	JB	9.0	9.6	9.9
Conductivity (umhos's/cm)	JB	291	300	305
Hardness (mg/L)	JB	~~108~~ 128	~~106~~ 136	128
Alkalinity (mg/L)	JB	108	106	108
Total Chlorine (mg/L)*				
Total Ammonia (mg/L)*				

* Check with project manager to see if necessary

Clay/Water: ~~Clay/Water~~ 30 ppm

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: N078-00
Test Species: D Magna
Investigators: PL/JB

Type of Test: Clay-water
No. Daphnids/Chamber: 5
No. of Chambers: 4 (~~H5 for chems~~)
Age of Daphnids: < 24 hrs

Dilution Water: Lake Michigan 1976
GLC and/or Batch No.: 1977
Test Temperature: 25 ± 1
Incubator #: 1   Photoperiod: 16:8

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Michigan Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-11-94 430P	0	JB	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.07				8.08				8.12				8.12				8.19				8.20			
			DO (mg/L)	8.6				8.5				8.6				8.4				8.3				8.5			
			Sp.Cond.(umhos/cm)	280				287				292				292				298				300			
9.12.94	1	pl	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5/4	5	5	5	5	5	5	5	5	5
			Observations						4F	2F				3F				1DOB				5F	2F				1F
			pH	8.16				8.24				8.26				8.29				8.30				8.31			
			DO (mg/L)	7.4				7.4				7.2				7.2				7.3				7.2			
			Temperature (°C)	25.1				25.3				25.9				25.9				25.9				25.9			
9.13.94 330 3p	2	pl	No. Live	5	5	5	5	5	5	5	5	5	5	3	5	4	5	4	5	5	5	5	5	5	5	5	4
			Observations	1F										1F							1F		1F				
			pH	8.12				8.17				8.18				8.20				8.21				8.21			
			DO (mg/L)	7.6				7.7				7.6				7.7				7.9				7.9			
			Sp.Cond.(umhos/cm)	273				280				301				275				301				299			
			Temperature (°C)	25.4				25.8				25.8				25.8				25.8				25.8			

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

Reviewed by: Ram Lee
Date: 9/19/94

~~Clam tox~~ ~~+ Bromide~~

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook - Nuclear
Project No.: N678-00
Test Species: D. Magna
Investigators: PL + JB

Type of Test: Unit 1/2 Eff
No. Daphnids/Chamber: 5
No. of Chambers: 4 (#5 for Clams)
Age of Daphnids: < 24 hrs.

Dilution Water: Lake Michigan 1976
GLC and/or Batch No.: 1978
Test Temperature: 25° ± 1
Incubator #: 1
Photoperiod: 16:8

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Michigan Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-11-94 4:15p	0	JB	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.10				8.15				8.18				8.22				8.23				8.27			
			DO (mg/L)	8.5				8.3				8.3				8.4				8.6				8.6			
			Sp.Cond.(umhos/cm)	283				300				303				287				294				304			
9.12.94	1	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations	1F	4F	2F								2F			1F					1F	1F				1F
			pH	8.18				8.24				8.26				8.29				8.31				8.30			
			DO (mg/L)	7.3				7.4				7.3				7.3				7.4				7.4			
			Temperature (°C)	25.0				25.0				25.0				25.1				25.1				25.1			
9.13.94 25 3pm	2	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations	2F			2F			1F									1F			1F				1F	
			pH	8.28				8.27				8.28				8.29				8.32				8.31			
			DO (mg/L)	7.8				7.7				7.8				7.8				8.0				7.9			
			Sp.Cond.(umhos/cm)	242				264				264				263				291				290			
			Temperature (°C)	25.3				25.3				25.3				25.3				25.2				25.2			

ATV-150

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

Reviewed by: Pam Lea
Date: 9/19/94

GLEC
Great Lakes Environmental Center
Phone: (616) 941-2230
Fax: (616) 941-2240

CHAIN OF CUSTODY RECORD

(TO BE COMPLETED ONSITE AND SUBMITTED WITH SAMPLES)

Facility: D.C. Cook Nuclear Plant
Location: One Cook Place Bridgman MI 49106
Contact Person: ERRIC MALLEN
Phone Number: 616-465-5901 Ext. 1540

Collector: Viren Shah
Date: 9-14-94 & 9-15-94
Witness: [signature]
Date: 9/15/94

SAMPLE ID	DATE/TIME OF SAMPLE	VOLUME COLLECTED	SAMPLE COLLECTOR	SAMPLE CONTAINER	DESCRIPTION (Type of sample, source, physical characteristics)	PRESERVATION	ANALYSES REQUIRED
Lake Water	9-14-94	2 gallons	V. Shah	2, 1 gallon plastic	Dilution water	None	~~Wet Test~~ None
Lake water w/30ppm Clay	9-14-94	1 gallon	V. Shah	1 gallon plastic	Clay 30ppm water	None	WET TEST.
U-1 Circ discharge Composite	9-14-94 / 9-15-94	1 gallon	V. Shah	1 gallon plastic	Composit water	None	WET TEST

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

	SHIPPER	RECEIVER	DATE	TIME	
1.	V. Shah		9-15-94	@0827	
2.		Aly Cooper	9-15-94	8:40 AM	Unit 1 Discharge 0.4°C; Clay 7.0°C

EFFLUENT AND RECEIVING WATER
CHECK-IN FORM

Client: Cook Nuclear Project No.: N078-00

Investigators:

INITIAL WATER CHEMISTRY (UPON RECEIPT)

Date: 9-15-94	Initials JB	U-1 Circ discharge	Lake Water w/Clay	Lake Water
GLC No.	JB	1989	1990	1991
Collection Date (time interval)	JB	9-14-94 9-15-94	9-14-94	9-14-94
Temperature	JB	10.4 °C	9.0 °C	7.8 °C

WATER CHEMISTRY AT TEST TEMPERATURES

Date: 9-15-94	Initials JB	U-1 Circ Discharge	Lake water w/30ppm Clay	Lake Water
GLC No.	JB	1989	1990	1991
Temperature	JB	25.0	25.0	25.0
pH	JB	8.20	8.07	8.0
Dissolved Oxygen (mg/L)	JB	8.7	8.2	8.18
Conductivity (umhos's/cm)	JB	288	276	273
Hardness (mg/L)	JB	124	128	124
Alkalinity (mg/L)	JB	106	106	100
Total Chlorine (mg/L)*				
Total Ammonia (mg/L)*				

* Check with project manager to see if necessary

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: NO78-00
Test Species: D. Magna
Investigators:

Type of Test: Clay-Water
No. Daphnids/Chamber: 5
No. of Chambers: 4 (~~#5 for chems~~)
Age of Daphnids: ≤24 hrs

Dilution Water: Lake Michigan #1991
GLC and/or Batch No.: #1998
Test Temperature: 25±1°C
Incubator #: 6 Photoperiod: 16:8

LIV-153

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Michigan Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-15-94 3:15	0	JJ	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.13				8.14				8.14				8.16				8.17				8.18			
			DO (mg/L)	8.2				8.4				8.4				8.4				8.4				8.4			
			Sp.Cond.(umhos/cm)	273				289				291				291				293				296			
9.16.94 3 20	1	PL	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations		1F	2F																1F	1F				
			pH	8.16				8.21				8.24				8.26				8.27				8.28			
			DO (mg/L)	7.2				7.4				7.4				7.4				7.4				7.4			
			Temperature (°C)	24.8				24.8				25.0				25.0				25.0				25.0			
9-17-94 3:30 pm	2	Dw	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5
			Observations			1F													1F								
			pH	8.29				8.33				8.36				8.38				8.38				8.41			
			DO (mg/L)	7.6				7.8				7.7				7.7				7.7				7.8			
			Sp.Cond.(umhos/cm)	285				295				302				304				304				316			
			Temperature (°C)	24.8				24.6				24.5				24.5				24.5				24.5			

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

Reviewed by: Pam Leai
Date: 9/19/94

U-1
Circ discharge

DAPHNID 48-HOUR STATIC ACUTE TOXICITY TEST

Test Material: Cook Nuclear
Project No.: N078-00
Test Species: D. Magna
Investigators:

Type of Test: U-1 CIRC DISCHARGE
No. Daphnids/Chamber: 5
No. of Chambers: 4 (#5 ~~for chems~~)
Age of Daphnids: ≤ 24hrs

Dilution Water: Lake Michigan #1991
GLC and/or Batch No.: #1989
Test Temperature: 25±1
Incubator #: 6
Photoperiod: 16:8

ATV-154

Date / Time	Test Day	Tech. Init.	Treatment Level	Lake Mich Control				A 6.25%				B 12.5%				C 25%				D 50%				E 100%			
			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
9-15-94 3:30 p	0	[illegible]	Temperature	25.0				25.0				25.0				25.0				25.0				25.0			
			pH	8.17				8.19				8.20				8.21				8.24				8.31			
			DO (mg/L)	8.4				8.4				8.3				8.5				8.4				8.5			
			Sp.Cond.(umhos/cm)	273				281				285				283				281				289			
9.16.94 3:20 pm	1	pf	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations						2F				1F										2F				1F
			pH	8.19				8.23				8.24				8.26				8.28				8.30			
			DO (mg/L)	7.3				7.2				7.3				7.4				7.1				7.4			
			Temperature (°C)	25.0				25.0				25.1				25.1				25.1				25.0			
9-17-94 3:15 pm	2	Dm	No. Live	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
			Observations																1F								1F
			pH	8.24				8.32				8.33				836				840				8.40			
			DO (mg/L)	7.7				7.7				7.7				7.7				7.9				7.8			
			Sp.Cond.(umhos/cm)	283				286				288				288				285				297			
			Temperature (°C)	24.8				24.8				24.9				25.0				250				24.9			

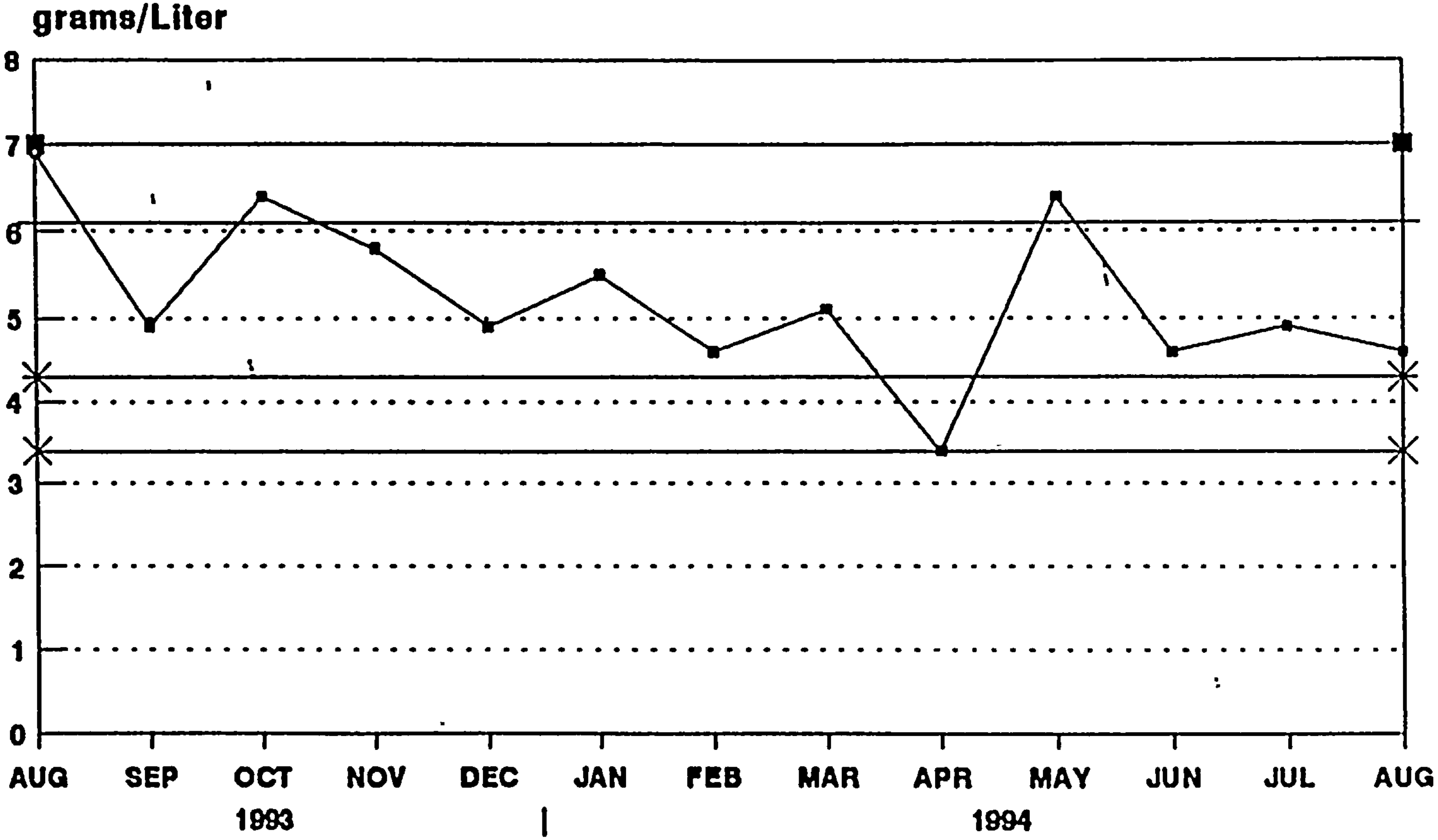
Observation Key:
DOB - Dried Out on Beaker
ERR - Erratic Swimming
F - Floater
PM - Particulate Matter
FS - Film on Surface
IMM - Immobile

Reviewed by: [signature]
Date: 9/19/94

APPENDIX B

REFERENCE TOXICANT DATA

GREAT LAKES ENVIRONMENTAL CENTER
Sodium Chloride (NaCl) Toxicity Data
1993 - 1994



Daphnia magna Survival

48-hour LC50 | Mean plus 1 S.D. | Mean minus 1 S.D.
Mean plus 2 S.D. | Mean minus 2 S.D.

AIV-156

APPENDIX V

ANNUAL REPORT: RADIOLOGICAL ENVIRONMENTAL

MONITORING PROGRAM

1994

DONALD C. COOK NUCLEAR PLANT

UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1994 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1994

Prepared by

Indiana Michigan Power Company

and

Teledyne Brown Engineering

April 15, 1995

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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 1994 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 Donald C. Cook Nuclear Plant on the environment. The analysis of air particulate filters, charcoal cartridges, direct radiation by thermoluminescent dosimeters, fish, water, milk and sediments from Lake Michigan, drinking water, and food products, either did not detect any radioactivity or measured only naturally occurring radionuclides at normal background levels.

Several measurements of iodine-131 in charcoal filters and tritium measured at low levels in on-site wells, appears to be the only radionuclide attributable to the Donald C. Cook Nuclear Plant operations. However, the associated groundwater does not provide a direct dose pathway to man.

I. INTRODUCTION

I. INTRODUCTION

The Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program (REMP) is conducted in compliance with NRC Regulatory Guide 1.21 and 4.1, licensing commitments, and Technical Specifications. The REMP was developed in accordance with the NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, November 1979. A synopsis of the sampling program and maps can be found in Section II, Sampling and Analysis Program. This report represents the Annual Radiological Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1, 1994 through December 31, 1994.

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 1994. For each sample medium, the table lists the sample locations, including distance and direction from the center of the two units, and the station identification. The station identifications for the sampling locations are shown on Figures 1 and 2. Also for each sample medium the sample collection frequency, type of analysis, and frequency of analysis are listed.

TABLE 1

DONALD C. COOK NUCLEAR PLANT- 1994

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 [illegible]nt.)

DONALD C. COOK NUCLEAR PLANT- 1994

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	(SG-1)	0.8 mi		95°		
Steam Generator Storage Facility	(SG-2)	0.7 mi		92°		Gross Beta/Quarterly
Steam Generator Storage Facility	(SG-4)	0.7 mi		93°	Quarterly	Gross Alpha/Quarterly
Steam Generator Storage Facility	(SG-5)	0.7 mi		92°		Gamma Isotopic/Quarterly

TABLE 1 (Cont.)
DONALD C. COOK NUCLEAR PLANT- 1994
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 (a)	0.3 mi	S		Daily	Gamma Isotopic/Monthly
Lake Michigan Shoreline		L-3 (a)	0.2 mi	N			Composite
Lake Michigan Shoreline		L-4 (b)	500 ft	S			Tritium/Quarterly Composite
Lake Michigan Shoreline		L-5 (b)	500 ft	N			
Sediment							
Lake Michigan Shoreline		L-2 (c)	0.3 mi	S			
Lake Michigan Shoreline		L-3 (c)	0.2 mi	N		Semi-annually	Gamma Isotopic/Semi-
Lake Michigan Shoreline		L-4 (b)	500 ft	S			Annually
Lake Michigan Shoreline		L-5 (b)	500 ft	N			
Milk-Indicator							
Totzke Farm	Baroda	Totzke	5.1 mi	ENE		14 Days	Gamma Isotopic/Sample
Schuler Farm	Baroda	Schuler	4.1 mi	SE			I-131/Sample
Warmbien Farm	Three Oaks	Warmbien	7.7 mi	S			
Freehling Farm	Buchanan	Freehling	7.0 mi	SE			
Schutze Farm	Buchanan	Schutze	7.0 mi	SE			
Milk-Background							
Wyant Farm	Dowagaic	Wyant	20.7 mi	E		14 Days	Gamma Isotopic/Sample
Livinghouse Farm	La Porte	Livinghouse	20.0 mi	S			I-131/ Sample

(a) After Marc . distance was changed to 500 feet.
(b) Locations nd L-5 were discontinued due to a program change.
(c) After April . distance was changed to 500 feet.

TABLE (cont.)
DONALD C. COOK NUCLEAR PLANT- 1994
RADIOLOGICAL SAMPLING STATIONS
DISTANCE AND DIRECTION FROM PLANT AXIS

Location	Station	Distance	Direction	Degrees	Collection Frequency	Analysis/Frequency
Fish						
Lake Michigan	ONS-N	.3 mi	N		2/year	Gamma Isotopic
Lake Michigan	ONS-S	.4 mi	S			2/year
Lake Michigan	OFS-N	3 .5mi	N			
Lake Michigan	OFS-S	5.0 mi	S			
Grapes/Broadleaf						
Nearest sample to Plant in highest D/Q land sector			Sector A & B		At time of harvest	Gamma Isotopic at time of harvest.
Grapes						
In a land sector containing grapes approximately 20 miles from the Plant and 180° from the sector with the highest D/Q.			Sector K		At time of harvest	Gamma Isotopic at time of harvest.

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

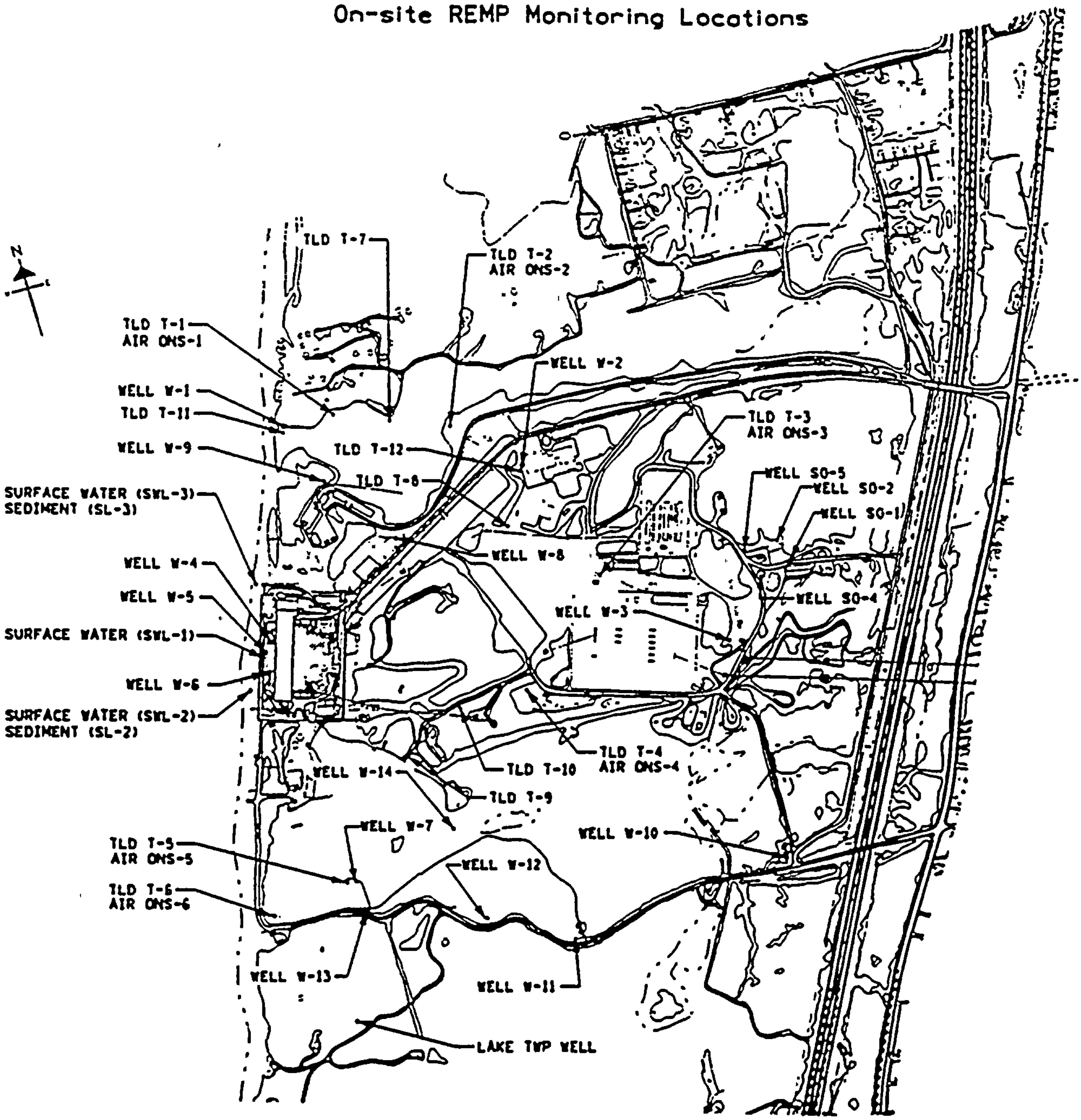
Please note the following defenitions:

Weekly	-	at least once every seven (7) days
Monthly	-	at least once every (31) days
Quarterly	-	at least once every ninety-two (92) days
Semi-annually	-	at least once every one hundred eighty-four (184) days

(a) After March 94, distance was changed to 500 feet.
(b) Locations L-4 and L-5 were discontinued due to a program change.
(c) After April 94, distance was changed to 500 feet.

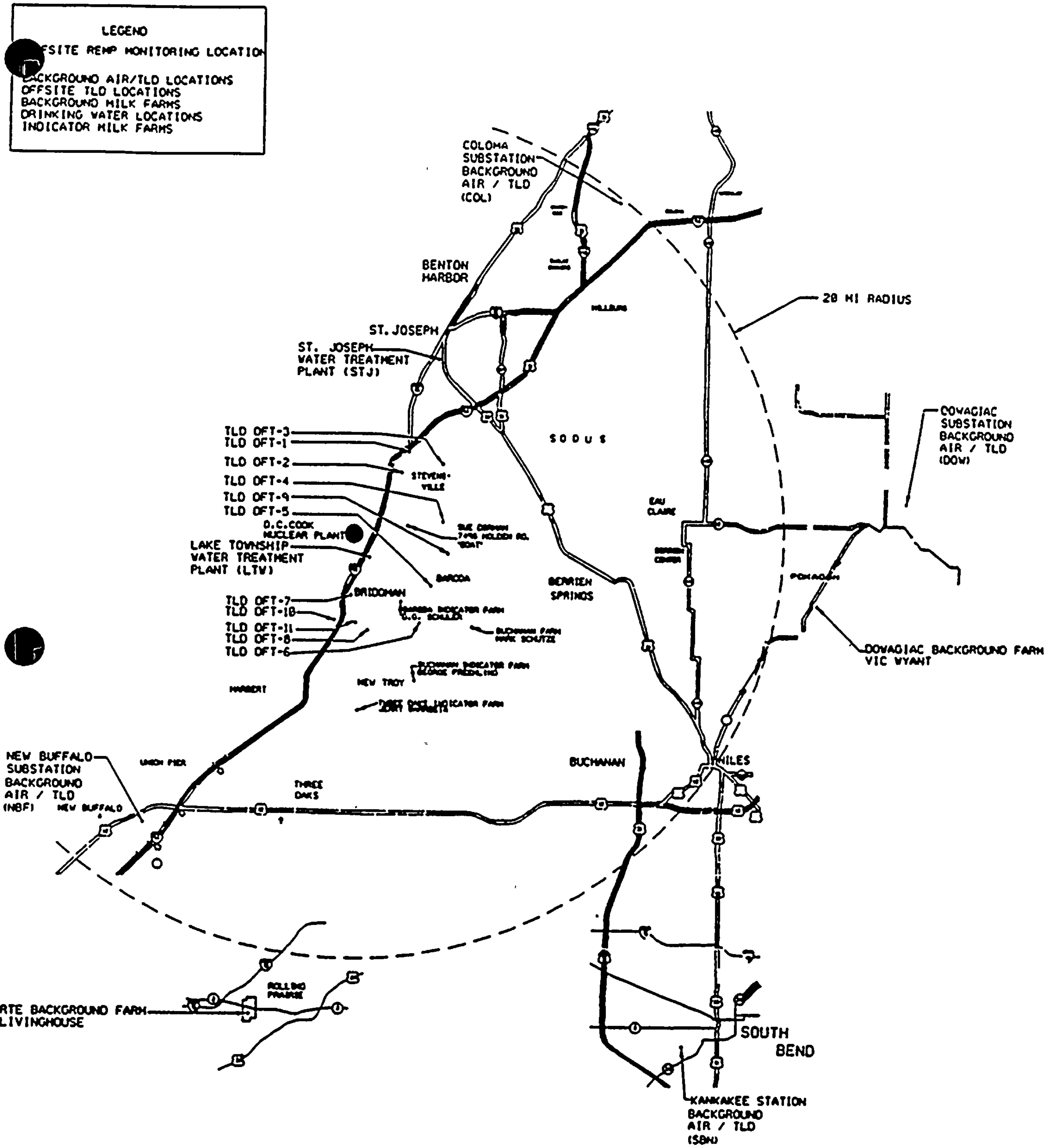
FIGURE 1

On-site REMP Monitoring Locations



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

FIGURE 2

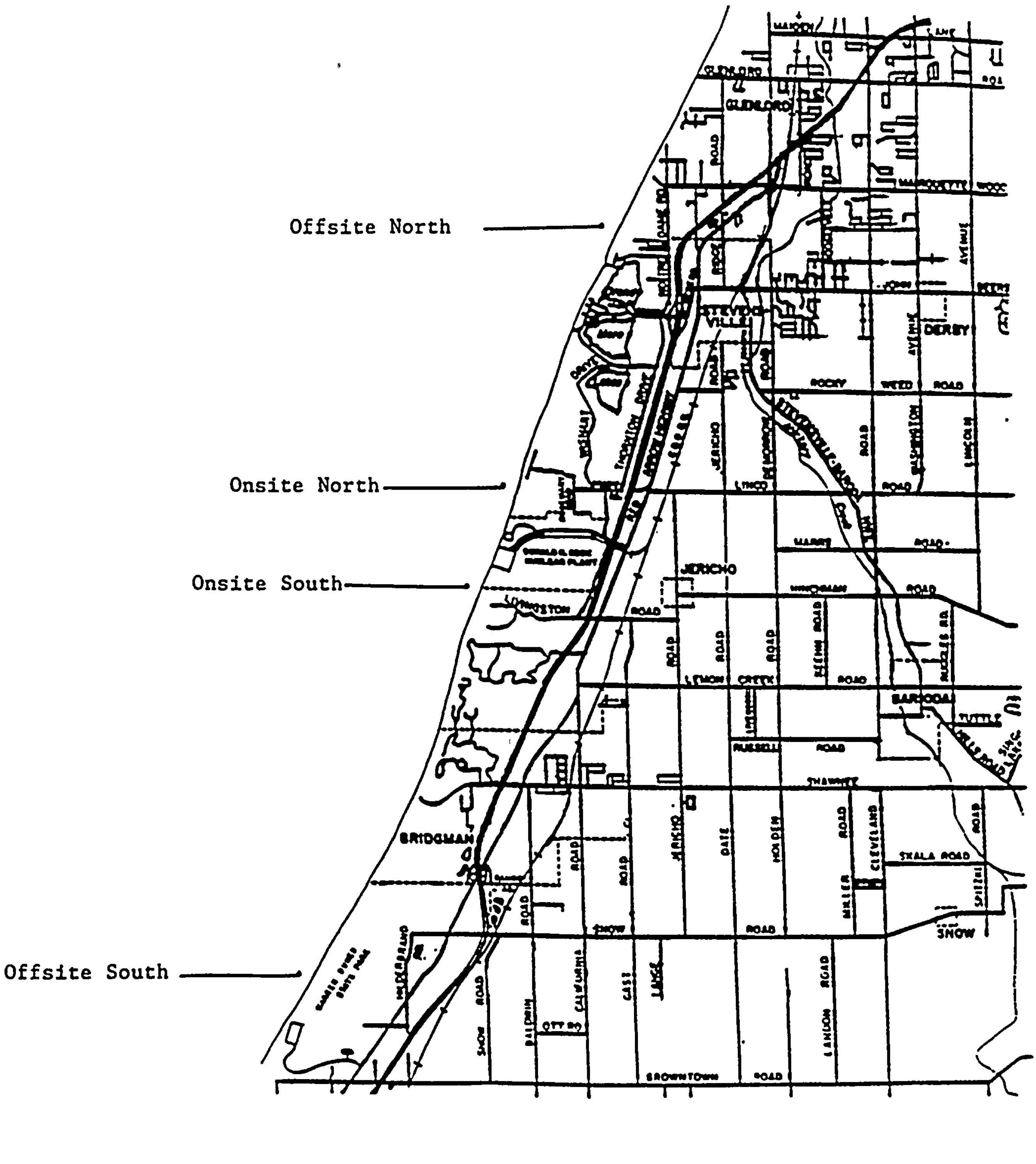


/cook/u12 sitemaps/wetmap.181
8-2-94 dls/rfz

FIGURE 3

SAMPLING LOCATIONS

FISH COLLECTED FOR RADIOLOGICAL ANALYSIS



III. SUMMARY AND DISCUSSION OF 1994 ANALYTICAL RESULTS

III. SUMMARY AND DISCUSSION OF 1994 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 1994 were analyzed by Teledyne Brown Engineering, Inc. (TI) in Westwood, New Jersey. The procedures and specifications followed at Teledyne Brown Engineering are in accordance with the Teledyne Brown Engineering Quality Assurance Manual and are explained in the Teledyne Brown Engineering Analytical Procedures. A synopsis of analytical procedures used for the environmental samples are proved in Appendix C. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Appendix D.

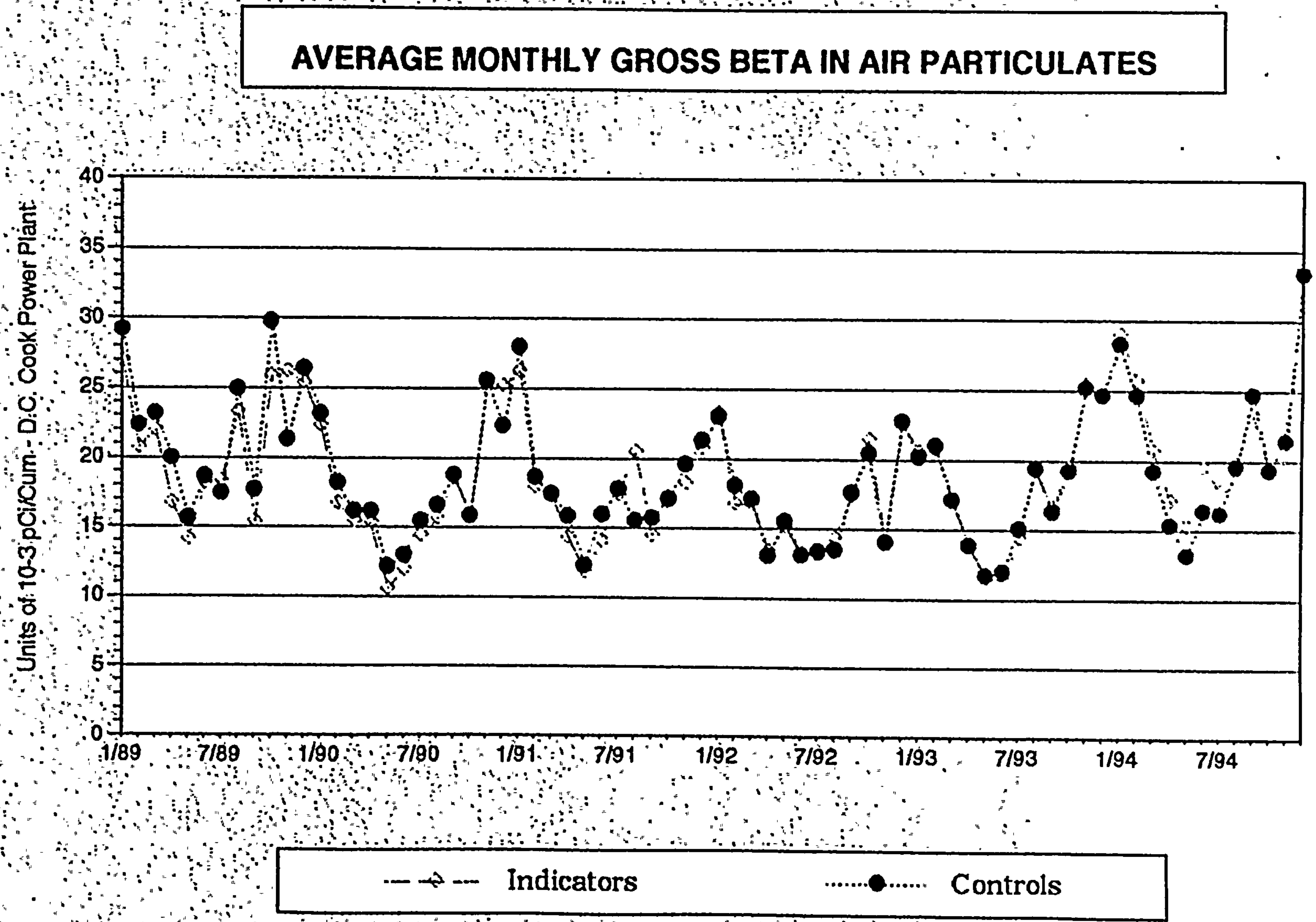
Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. Teledyne Brown Engineering analytical methods meet or exceed the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring, Revision 1, November 1979.

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

A. Airborne Particulates

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

Trending Graph - 1



gross beta activities are presented in Table B-1. The measurement of the gross beta activity on the weekly air particulate filters is a good indication of the levels of natural and or manmade radioactivity in the environment. The average gross beta concentration of the six indicator locations was 0.022 pCi/m^3 with a range of individual values between 0.003 and 0.057 pCi/m^3. The average gross beta concentration of the four control locations was 0.021 pCi/m^3 with a range between 0.007 and 0.052 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 1994 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 0.152 pCi/m^3 and the values ranged from 0.126 to 0.216 pCi/m^3. The average concentration for the indicator locations was 0.157 pCi/m^3 with a range of 0.107 to 0.210 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 three of the twenty-four indicator quarterly composites with an average concentration of 0.007 pCi/m^3 and a range of 0.004 to 0.011 pCi/m^3. Potassium-40 was measured in two of the sixteen control quarterly composites with a concentration of 0.007 pCi/m^3 and a range of 0.004 to 0.010 pCi/m^3. No other gamma emitting radioactivity was detected.

B. <u>Airborne Iodine</u>

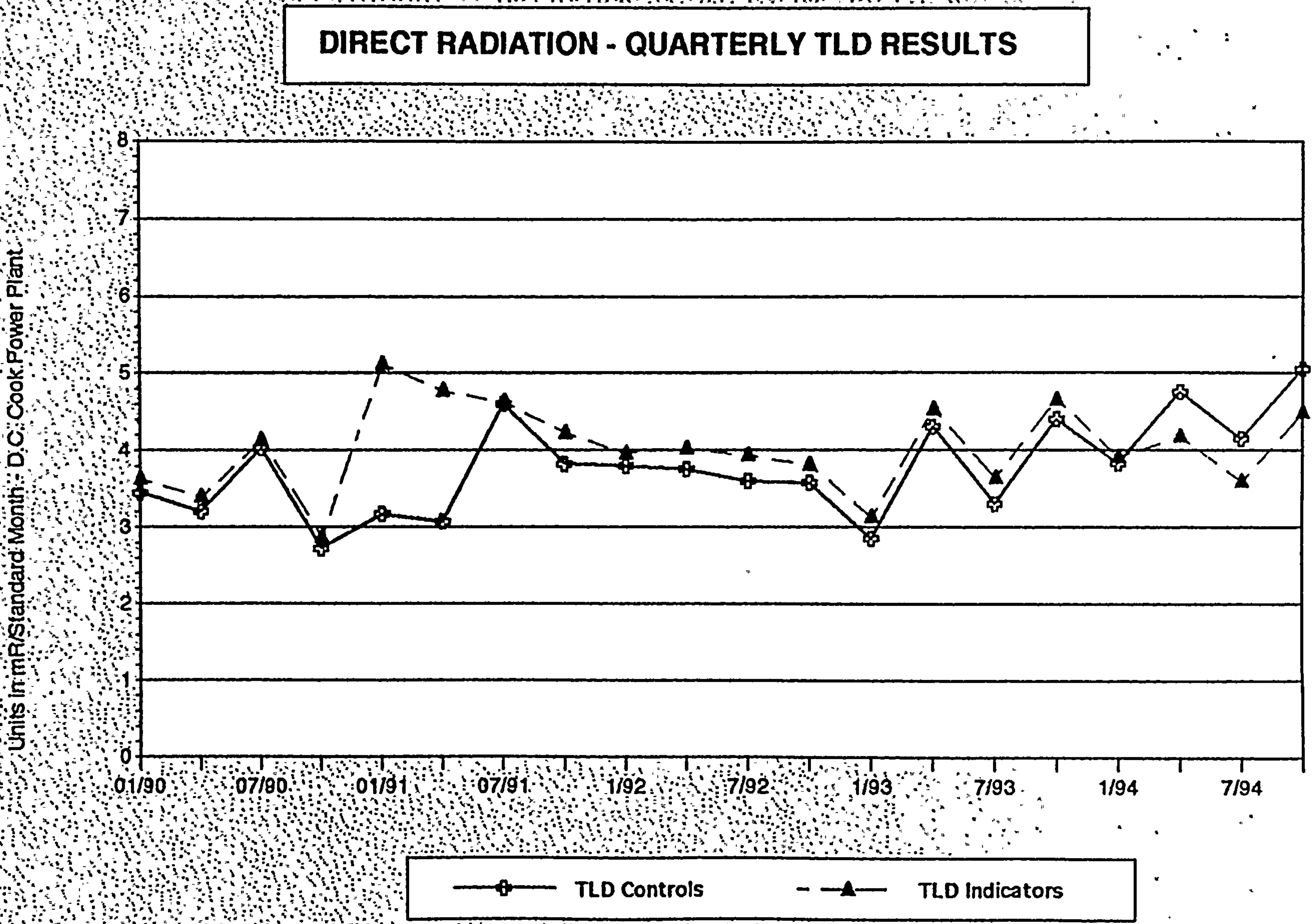
Airborne particulate samples are collected with a constant flow oil less pump at 56 LPM using a 47 mm particulate filter. Teda-3B charcoal cartridges are installed downstream of the particulate filters and are used to collect airborne radioiodine. The results of the weekly

analysis of the charcoal cartridges are presented in Table B-3. During the three week period from February 21 through March14, there were five positive measurements of iodine-131, all from on-site sampling locations. This can be attributed to both units being shut down within ten days of each other and significant amounts of iodine-131 being released from the unit vent stacks. The curies of iodine-131 released during late February and early March were within a usual range considering both units had shut down within ten days of each other. The ability to quantify this small amount of iodine-131 was attributed to relatively benign meteorological conditions following the shut down, and more efficient monitoring capabilities. The average concentration was 0.0156 pCi/m^3 and the range was 0.0088 to 0.0267 pCi/m^3. All of the five positive results were below the required detection limit of 0.07 pCi/m^3.

C. Direct Radiation - Thermoluminescent Dosimeters

Thermoluminescent dosimeters (TLDs) measure external radiation exposure from several sources including naturally occurring radionuclides in the air and soil, radiation from cosmic origin, fallout from atomic weapons testing, potential radioactive airborne releases from the power station and direct radiation from the power station. The TLDs record exposure from all of these potential sources. The TLDs are deployed quarterly at 27 locations in the environs surrounding the D. C. Cook Nuclear Plant. The average value of the four areas of each dosimeter (calibrated individually after each field exposure period for response to a known exposure and for transit exposure) are presented in Table B-4. Those exposure rates are quite typical of observed rates at many other locations in the country. The average annual measurement for the control samples was 4.44 mR/standard month with a range of 3.3 to 7.3 mR/standard month. The annual accumulation of indicator samples had a measurement of 4.05 mR/standard month with a range of 2.9 to 5.6 mR/standard month. The 1994 annual average in the environs of the Donald C. Cook Nuclear Plant is at the low range of the exposure rates (1.0 to 2.0 mR/week) measured during the preoperational period. The results of

Trending Graph - 2



the indicator and control TLDs are in good agreement and are plotted in Trending Graph 2.

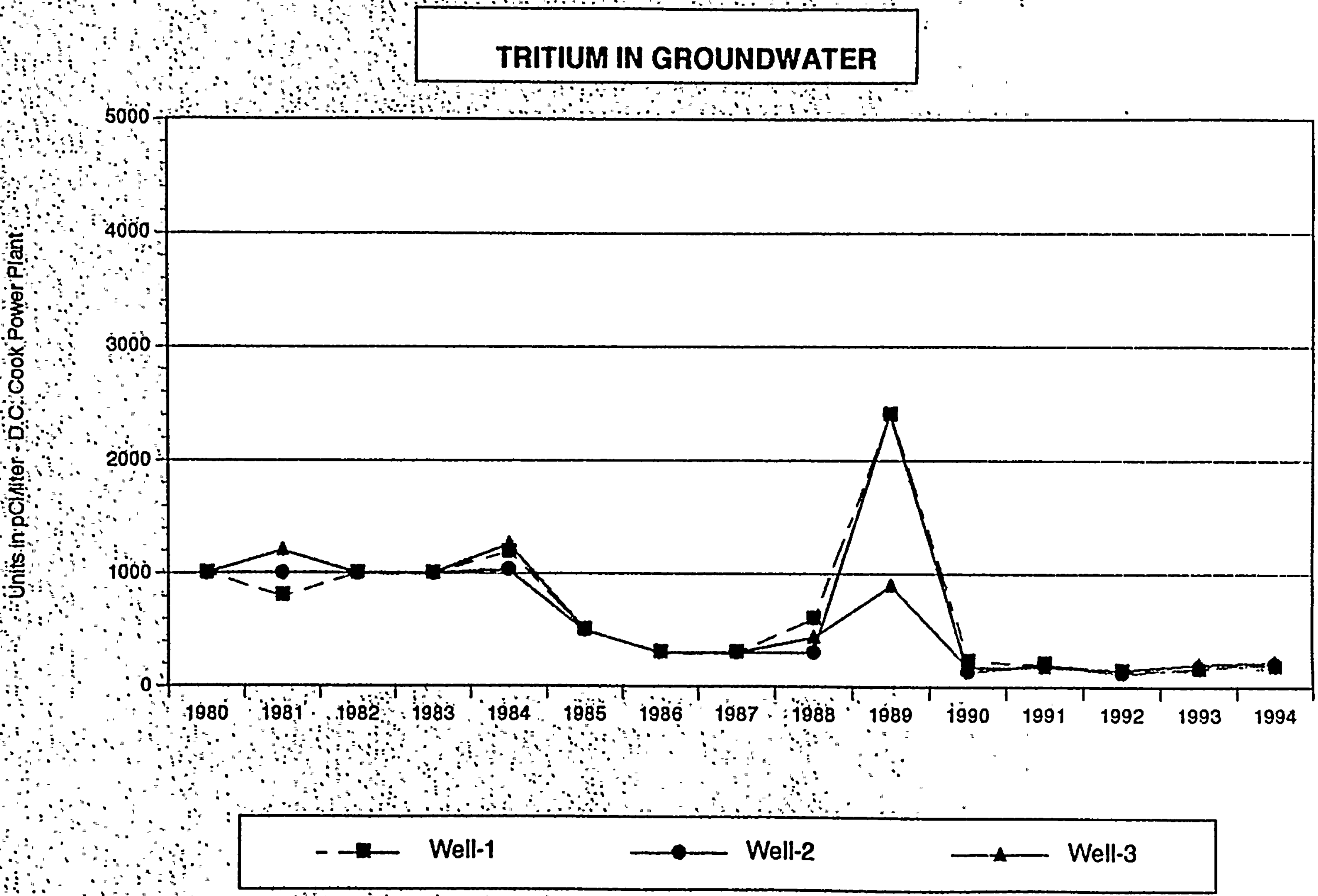
D. Surface Water

A 125 milliliter surface water sample is collected from the intake forebay and from four shoreline locations, all within 0.3 mile of the two reactors and were composited daily over a monthly period. However, due to a program change, locations L4 and L5 were dropped from the program in March 1994. The fourteen samples were analyzed for iodine-131 by the radiochemical technique described on page 71. No iodine-131 was detected. The quarterly composite was analyzed for tritium by liquid scintillation method described on page 70. Naturally occurring potassium-40 and cesium-137 were not measured during 1994. Tritium was detected in 2 of the 14 samples analyzed with an average concentration of 185 pCi/liter and a range of 150 to 220 pCi/liter. This is slightly higher than the 7 measurements in 1993 which had an average concentration of 166 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.

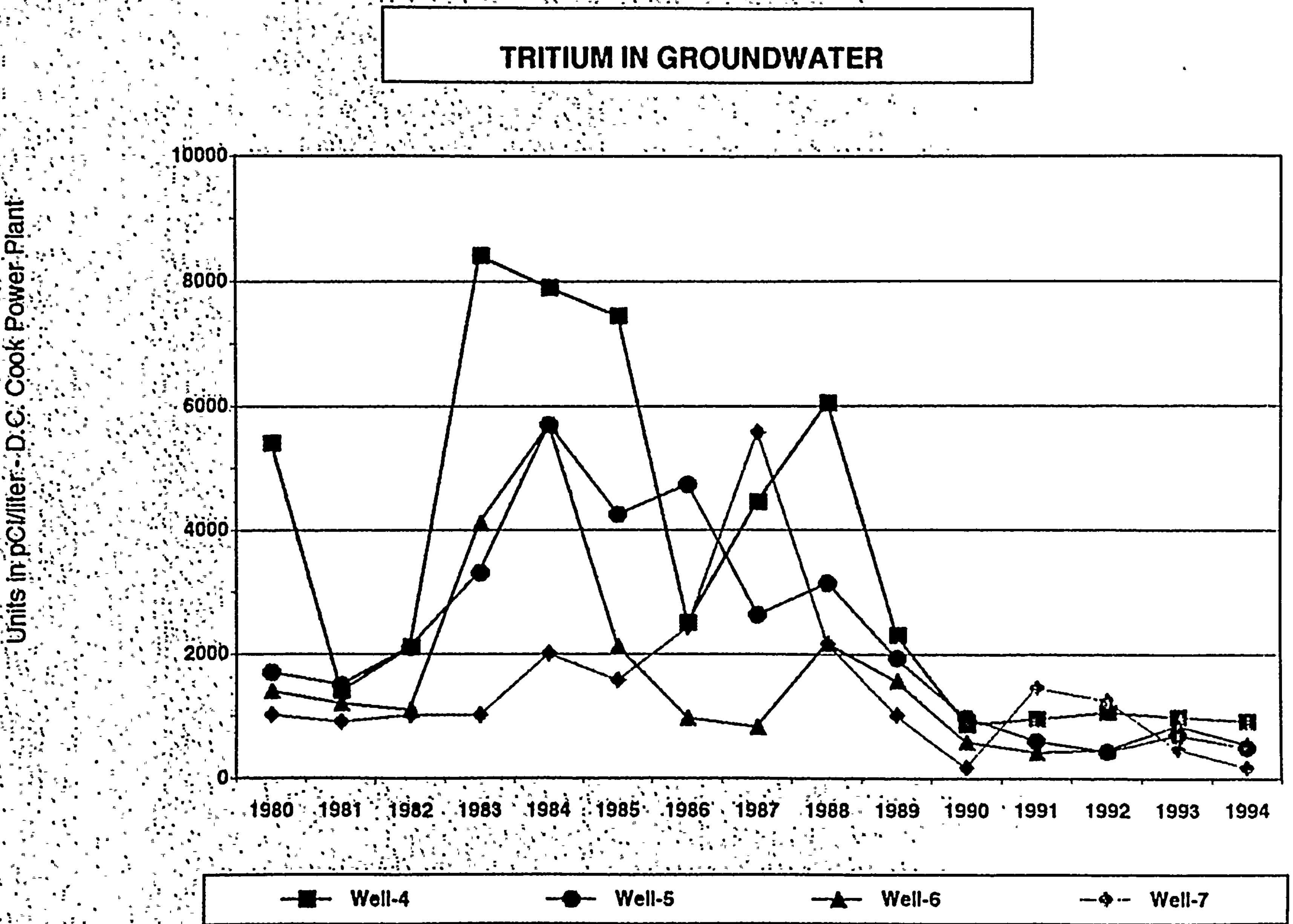
E. Groundwater

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, or equivalent. A two liter sample is then obtained. The samples are analyzed for gamma emitters and tritium. The results are presented in Table B-6. Naturally occurring potassium-40 was not measured during 1994 nor were any other gamma emitting isotopes. The groundwater wells W-4, W-5, W-6, W-8, and W-14 had measurable tritium activity throughout 1994. Tritium was measured in 17 of the 55 samples at the locations with an average concentration of 701 pCi/liter and a range of 170 to 1700 pCi/liter.

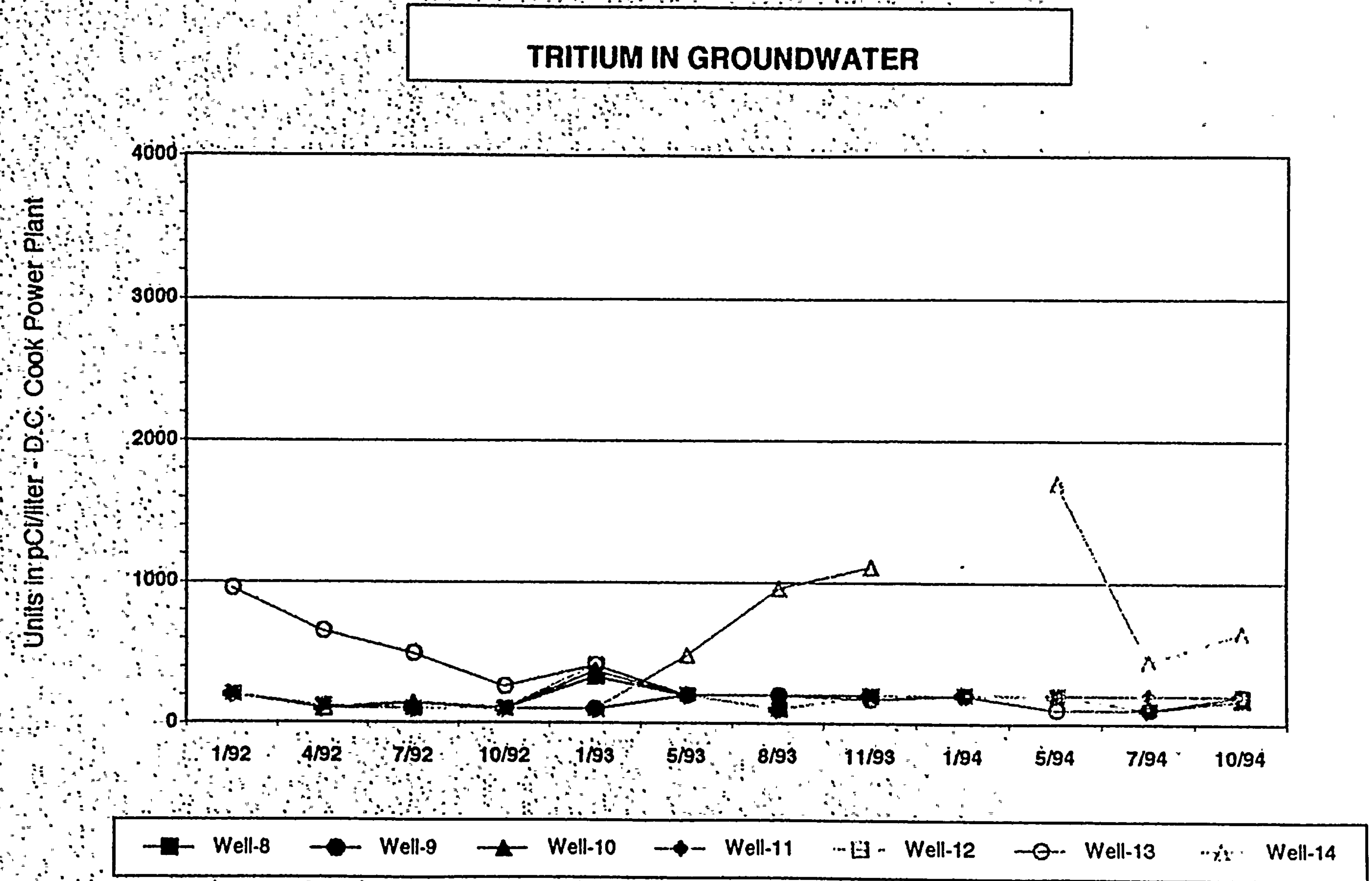
Trending Graph - 3



Trending Graph - 3 (Cont.)



Trending Graph - 3 (Cont.)



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

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 1994 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 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.

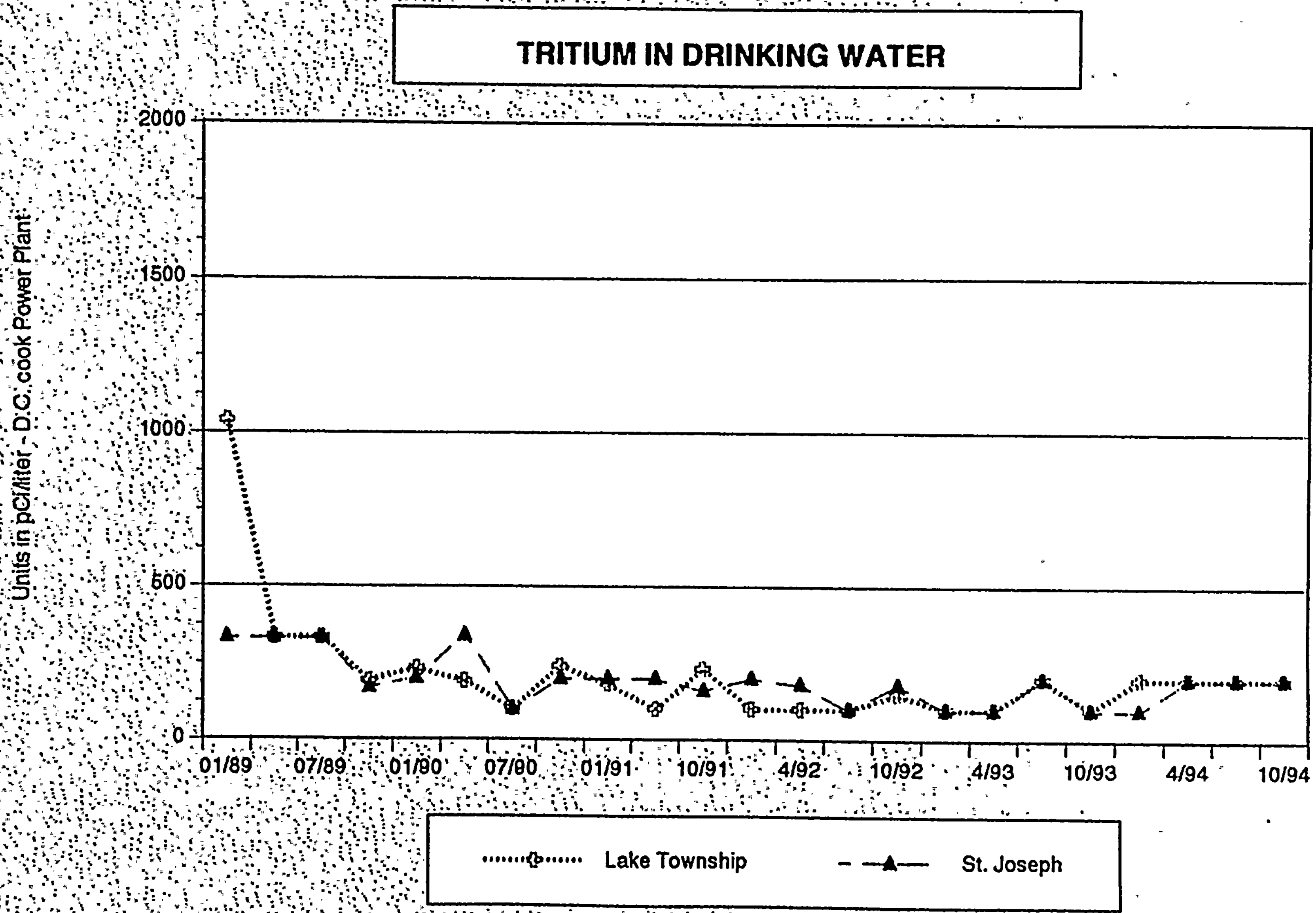
Gross beta activity was measured in all twenty-six samples from the Lake Township intake with an average concentration of 3.8 pCi/liter and a range from 1.6 to 5.1 pCi/liter. Gross beta activity was measured in all twenty-six samples from the St. Joseph intake with an average concentration of 3.6 pCi/liter and a range from 2.1 to 5.0 pCi/liter. No gamma emitting isotopes or iodine-131 were detected. Tritium was not measured in any of the four samples from either location. Tritium (or LLD values) in drinking water are plotted in Trending Graph 4.

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

G. Sediment

Sediment samples are collected semiannually along the shoreline of Lake Michigan at the same 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

Trending Graph - 4



are shown in Table B-8. In April one sample was collected from each location L2, L3, L4 and L5. In October sediment samples were collected from L2 and L3. Locations L4 and L5 were discontinued due to a program change. Gamma ray spectroscopy detected naturally occurring potassium-40 in all samples. The average potassium-40 concentration was 6063 pCi/kg (dry weight) with a range from 4840 to 9010 pCi/kg (dry weight). Thorium-228, also naturally occurring was measured in all samples with an average concentration of 137 pCi/kg (dry weight) with a range from 90.3 to 206 pCi/kg (dry weight). Radium-226 was measured in one sample with an activity of 691 pCi/kg. All other gamma emitters were below the lower limits of detection.

H. <u>Milk</u>

Milk samples of one gallon are collected from a bulk tank (e.g. 500 gallons) every fourteen days from six farms located between 4.1 miles and 20.7 miles from the site. Milk samples are preserved by adding 40 grams per gallon of sodium bisulfite when the samples are collected. The samples are analyzed for iodine-131 and other gamma emitters. The results are shown in Table B-9. Iodine-131 was not measured in any of the 153 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 1994 the average potassium-40 concentration for the control locations was 1363 pCi/liter with a range of 1030 to 1530 pCi/liter. The indicator locations had an average concentration of 1382 pCi/liter and a range of 1060 to 1800. There were no detections of iodine-131 during 1994. Cesium-137 was also not detected during 1994.

I. Fish

Using gill nets in approximately twenty feet of water in Lake Michigan, 4.5 pounds of fish are collected 2 times/year from each of four locations. One sample was unavailable at the offsite south location in October 1994. Nets were deployed, however fish were not caught. A reasonable effort was exerted, however attempts were hampered by inclement weather. The samples were then analyzed by gamma ray spectroscopy. Naturally occurring potassium-40 was measured in all samples with an average concentration of 3039 pCi/kg (wet weight) and a range of 2490 to 3500 pCi/kg (wet weight). Cesium-137 was measured in four of the seven fish samples with an average concentration of 47.0 pCi/kg (wet weight) and a range of 19.5 to 80.1 pCi/kg (wet weight).

J. Food Products

Food samples are collected annually at harvest, as near the site boundary as possible, and approximately twenty miles from the plant. Each sample consists of 3 pounds of grapes and 3 pounds of broadleaves. Naturally occurring potassium-40 was measured in all four samples with an average concentration of 2818 pCi/kg (wet weight) and a range of 2280 to 3850 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in all samples with an average concentration of 1365 pCi/kg (wet weight) and a range of 56.9 to 3840 pCi/kg (wet weight).

IV. CONCLUSIONS

IV. CONCLUSIONS

The results of the 1994 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 1994 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 1994. Five measurements of iodine-131 were detected in charcoal filters in 1994. This can be attributed to both units being shut down within ten days of each other and significant amounts of iodine-131 being released from the unit vent stacks. The curies of iodine-131 released during late February and early March were within a usual and expected range considering both units had shut down within ten days of each other. All of the five positive results were below the required detection limit of 0.07 pCi/m^3.

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. In March 1994 locations L4 and L5 were discontinued due to a program change. The samples are analyzed quarterly

for tritium, and monthly for gamma emitting isotopes. No gamma emitters were detected during 1994. 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 had measurable tritium which is attributed to the operation of the plant. The tritium levels in 1994 compare well with those measured in 1993. The highest concentration measured in 1994 was 1700 pCi/liter while the highest concentration measured during 1993 was 1200 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 not observed during 1994. No other gamma emitting isotopes were detected.

Samples are collected daily at the intakes of the drinking purification plants for St. Joseph and Lake Township. Samples composited daily over a two week period are analyzed for iodine-131, gross beta, and measured for gamma emitting isotopes. Samples are also analyzed quarterly for tritium. No iodine-131 or gamma emitting isotopes were detected. Gross beta was measured in all fifty-two samples at normal background concentrations. Tritium was not measured in any of the eight quarterly composite samples collected during 1994.

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. Due to a program change, locations L4 and L5 were dropped from the program. 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 1994, 1993, 1992 or 1991. Potassium-40 was measured in all milk samples at normal background levels. Cesium-137 was not detected in 1994.

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 four samples.

Food products, consisting of grapes, and broadleaf vegetation were collected and analyzed by gamma ray spectroscopy. No gamma emitting isotopes were measured during 1994.

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. Iodine-131 in five charcoal filters and tritium in five on-site wells appears to be the only radionuclides 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

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

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

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

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

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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, 1994

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Iodine (pCi/m^3)	I-131	526	15.6(5/314) (8.8-26.7)	A-5 Onsite 1895 ft.	26.7(1/53) -	-(0/212) -	0
Airborne Particulates ($1E-03\ pCi/m^3$)	Gross Beta (Weekly)	526	22.1(313/314) (2.5-57)	A-1 Onsite 1945 ft.	23.8(53/53) (12-46)	21.0(212/212) (7.0-52)	0
	Gamma	40					
	Be-7	40	157(24/24) (107-210)	A-6 Onsite 1917 ft.	172(4/4) (167-180)	152(16/16) (125-216)	0
	K-40	40	6.97(3/24) (3.89-10.7)	A-1 Onsite 1945 ft.	10.7(1/4) -	7.32(2/16) (4.44-10.2)	0
Direct Radiation (mR/Standard Month)	Gamma Dose Quarterly	107	4.05(91/91) (2.9-5.6)	SBN 26.2 mi SE	6.08(4/4) (4.2-7.3)	4.44(16/16) (3.3-7.3)	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, 1994

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		ALL INDICATOR LOCATIONS MEAN (a/b) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	LOCATION WITH HIGHEST MEAN MEAN RANGE	CONTROL LOCATION MEAN RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/liter)	Gamma	37	(0/47) -	N/A		(0/0) -	0
	H-3	14	185(2/14) (150-220)	L-1 Intake	220(1/4) -	-(0/0) -	0
Groundwater (pCi/liter)	Gamma	55					
	K-40	55	(0/55) -	N/A		-(0/0) -	0
	Th-228	55	(0/55) -	N/A		-(0/0) -	0
	H-3	55	701(17/55) (170-1700)	Well 14 1780 ft.	995(4/4) (440-1700)	-(0/0) -	0
Drinking Water (pCi/liter)	Gross Beta	52	3.70(52/52) (1.6-8.8)	LTW 0.4 mi S	3.79(26/26) (1.6-8.8)	-(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, 1994

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	6					
	K-40	6	6063(6/6) (4840-9010)	L-5 500 ft. N	9010(1/1) -	-(0/0) -	0
	Ra-226	6	691(1/6) -	L-5 500 ft. N	691(1/6) -	-(0/0) -	0
	Th-228	6	137(6/6) (90.3-206)	L-5 500 ft. N	206(1/1) -	-(0/0) -	0
Milk (pCi/liter)	Gamma	153					
	K-40	153	1382(101/101) (1060-1800)	Totzke 5.1 mi ENE	1436(14/14) (1300-1560)	1363(52/52) (1030-1530)	0
	I-131	153	-(0/101) -	N/A	N/A	-(0/52) -	0
	Cs-137	153	-(0/101) -	N/A	N/A	-(0/52) -	0

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

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1994

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	7					
	K-40	7	3039(7/7) (2490-3500)	ONS-North 0.3 mi N	3235(2/2) (2970-3500)	-(0/0) -	0
	Cs-137	7	47.0(4/7) (19.5-80.1)	ONS-North 0.3 mi N	80.1(1/2) -	-(0/0) -	0
Food/Vegetation (pCi/kg wet)	Gamma	4					
	Be-7	4	1365(4/4) (56.9-3840)	Sector A & B Variable	1977(2/2) (114-3840)	-(0/0) -	0
	K-40	4	2818(4/4) (2280-3850)	Sector A & B Variable	3260(2/2) (2670-3850)	-(0/0) -	0
	Cs-137	4	-(0/0) -	N/A	N/A	-(0/0) -	0

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

APPENDIX B
DATA TABLES

TABLE 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	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
	STATION CODES										
JANUARY 94											
01/03/94	23 ± 2	19 ± 2	23 ± 2	22 ± 2	23 ± 2	23 ± 2	22 ± 2	21 ± 2	24 ± 2	22 ± 2	22 ± 3
01/10/94	28 ± 2	19 ± 2	20 ± 2	23 ± 2	27 ± 2	26 ± 2	22 ± 2	24 ± 2	25 ± 2	25 ± 2	24 ± 6
01/17/94	43 ± 3	27 ± 3	30 ± 2	31 ± 3	28 ± 3	36 ± 3	29 ± 3	33 ± 3	28 ± 3	24 ± 2	33 ± 11
01/24/94	37 ± 3	36 ± 3	34 ± 3	41 ± 3	41 ± 3	45 ± 3	39 ± 3	42 ± 3	47 ± 3	37 ± 3	39 ± 8
01/31/94	30 ± 3	26 ± 2	23 ± 2	25 ± 2	29 ± 2	31 ± 3	27 ± 2	27 ± 2	26 ± 2	21 ± 2	27 ± 6
FEBRUARY											
02/07/94	28 ± 3	24 ± 2	25 ± 2	25 ± 2	29 ± 3	29 ± 3	25 ± 2	39 ± 3	24 ± 2	24 ± 2	27 ± 9
02/14/94	29 ± 2	2.1 ± 0.6(a)	23 ± 2	23 ± 2	31 ± 2	32 ± 2	27 ± 2	24 ± 2	25 ± 2	24 ± 2	28 ± 7
02/21/94	30 ± 2	1.0 ± 0.6(a)	23 ± 2	24 ± 2	28 ± 2	28 ± 2	27 ± 2	22 ± 2	28 ± 2	23 ± 2	27 ± 6
02/28/94	25 ± 2	< 2 (a)	21 ± 2	16 ± 2	23 ± 2	23 ± 2	21 ± 2	19 ± 2	22 ± 2	19 ± 2	22 ± 5
MARCH											
03/07/94	32 ± 3	22 ± 2	22 ± 2	27 ± 2	28 ± 2	25 ± 2	25 ± 2	25 ± 2	30 ± 3	23 ± 2	26 ± 7
03/14/94	22 ± 2	19 ± 2	19 ± 2	22 ± 2	21 ± 2	22 ± 2	24 ± 2	20 ± 2	18 ± 2	19 ± 2	21 ± 4
03/21/94	24 ± 2	18 ± 2	14 ± 2	20 ± 2	20 ± 2	20 ± 2	19 ± 2	16 ± 2	17 ± 2	18 ± 2	19 ± 5
03/28/94	18 ± 2	15 ± 2	13 ± 2	19 ± 2	17 ± 5(b)	16 ± 2	15 ± 2	12 ± 2	13 ± 2	12 ± 2	16 ± 5
Quarter Avg.	28 ± 13	23 ± 12	22 ± 11	24 ± 12	27 ± 12	27 ± 15	25 ± 11	25 ± 17	25 ± 16	22 ± 11	25 ± 14

(a) No measureable volume. Results in total pCi and not included in averages.
(b) Equipment malfunction; low sample volume and not included in averages.

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											
04/04/94	26 ± 2	17 ± 2	18 ± 2	(a)	21 ± 2	23 ± 2	18 ± 2	17 ± 2	11 ± 2	31 ± 3 (b)	20 ± 12
04/11/94	22 ± 2	17 ± 2	15 ± 2	23 ± 2	15 ± 2	19 ± 2	17 ± 2	16 ± 2	18 ± 2	19 ± 2	18 ± 6
04/18/94	18 ± 2	12 ± 2	19 ± 2	17 ± 2	12 ± 2	17 ± 2	13 ± 2	10 ± 2	16 ± 2	17 ± 2	15 ± 6
04/25/94	26 ± 2	20 ± 2	20 ± 2	23 ± 2	16 ± 2	19 ± 2	18 ± 2	17 ± 2	17 ± 2	21 ± 2	20 ± 6
05/02/94	12 ± 2	8.5 ± 1.6	9.7 ± 1.7	11 ± 2	7.9 ± 1.6	11 ± 2	8.0 ± 1.7	7.0 ± 1.6	7.9 ± 1.6	7.2 ± 1.6	9 ± 4
MAY											
05/09/94	20 ± 2	15 ± 2	16 ± 2	21 ± 2	15 ± 2	15 ± 2	14 ± 2	13 ± 2	14 ± 2	14 ± 2	16 ± 5
05/16/94	13 ± 2	11 ± 2	12 ± 2	15 ± 2	9.8 ± 1.7	14 ± 2	10 ± 2	11 ± 2	11 ± 2	12 ± 2	12 ± 3
05/23/94	14 ± 2	11 ± 2	12 ± 2	13 ± 2	11 ± 2	11 ± 2	10 ± 2	10 ± 2	9.4 ± 1.9 (b)	12 ± 2	11 ± 3
05/30/94	21 ± 2	16 ± 2	17 ± 2	26 ± 3	18 ± 2	19 ± 2	18 ± 2	18 ± 2	15 ± 2	19 ± 2	19 ± 6
JUNE											
06/06/94	20 ± 2	16 ± 2	15 ± 2	21 ± 2	13 ± 2	17 ± 2	18 ± 2	15 ± 2	15 ± 2	14 ± 2	16 ± 5
06/13/94	20 ± 2	16 ± 2	15 ± 2	22 ± 2	14 ± 2	16 ± 2	14 ± 2	14 ± 2	15 ± 2	16 ± 2	16 ± 5
06/20/94	28 ± 2	24 ± 2	21 ± 2	28 ± 2	20 ± 2	24 ± 2	20 ± 2	17 ± 2	19 ± 2	19 ± 2	22 ± 8
06/27/94	22 ± 2	20 ± 2	16 ± 2	26 ± 2	14 ± 2	20 ± 2	16 ± 2	15 ± 2	19 ± 2	15 ± 2	18 ± 8
Quarterly Avg.	**20 ± 10**	**16 ± 9**	**16 ± 7**	**21 ± 11**	**14 ± 8**	**17 ± 8**	**15 ± 8**	**14 ± 7**	**14 ± 7**	**17 ± 11**	**16 ± 9**

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

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	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buff	South Bend	Average ± 2 s.d.
JULY											
07/04/94	22 ± 2	16 ± 2	16 ± 2	22 ± 2	17 ± 2	18 ± 2	18 ± 2	19 ± 2	17 ± 2	17 ± 2	18 ± 4
07/11/94	20 ± 2	15 ± 2	15 ± 2	20 ± 2	13 ± 2	17 ± 2	16 ± 2	12 ± 2	13 ± 2	15 ± 2	16 ± 6
07/18/94	26 ± 2	(a)	17 ± 2	23 ± 2	17 ± 2	20 ± 2	19 ± 2	17 ± 2	15 ± 2	18 ± 2	19 ± 7
07/24/94	23 ± 2	(a)	18 ± 2	23 ± 2	15 ± 2	18 ± 2	20 ± 2	15 ± 2	18 ± 2	18 ± 2	19 ± 6
08/01/94	15 ± 2	(a)	13 ± 2	14 ± 2	14 ± 2	12 ± 2	13 ± 2	13 ± 2	14 ± 2	15 ± 2	14 ± 2
AUGUST											
08/08/94	17 ± 2	18 ± 4 (b)	12 ± 2	13 ± 2	15 ± 2	15 ± 2	14 ± 2	13 ± 2	16 ± 2	16 ± 2	15 ± 4
08/15/94	14 ± 2	17 ± 2	10 ± 2	13 ± 2	16 ± 2	14 ± 2	11 ± 2	14 ± 2	15 ± 2	16 ± 2	14 ± 4
08/22/94	26 ± 2	24 ± 2	19 ± 2	20 ± 2	22 ± 2	20 ± 2	18 ± 2	18 ± 2	23 ± 2	24 ± 2	21 ± 6
08/29/94	29 ± 2	30 ± 2	25 ± 2	23 ± 2	30 ± 2	31 ± 2	26 ± 2	27 ± 2	29 ± 2	32 ± 2	28 ± 6
SEPTEMBER											
09/05/94	14 ± 2	12 ± 2	11 ± 2	12 ± 2	15 ± 2	14 ± 2	12 ± 2	12 ± 2	13 ± 2	14 ± 2	13 ± 3
09/12/94	29 ± 2	32 ± 3	25 ± 2	25 ± 2	30 ± 2	30 ± 3	28 ± 2	31 ± 2	30 ± 2	33 ± 3	29 ± 5
09/19/94	32 ± 2	35 ± 3	26 ± 2	27 ± 2	30 ± 2	34 ± 3	26 ± 2	27 ± 2	30 ± 2	32 ± 2	30 ± 7
09/26/94	23 ± 2	28 ± 2	21 ± 2	2.5 ± 1.2	25 ± 2	27 ± 2	26 ± 2	26 ± 2	25 ± 2	29 ± 2	23 ± 15
Quarterly Avg.	**22 ± 12**	**23 ± 16**	**18 ± 11**	**20 ± 13**	**21 ± 15**	**19 ± 12**	**19 ± 13**	**20 ± 13**	**21 ± 15**	**20 ± 3**	**20 ± 13**

(a) Power failure; no sample available.
(b) Equipment malfunction; low sample volume and not included in averages.

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											
10/03/94	13 ± 2	16 ± 2	10 ± 2 (a)	12 ± 2	13 ± 2	14 ± 2	13 ± 2	12 ± 2	15 ± 2	16 ± 2	13 ± 4
10/10/94	18 ± 2	24 ± 2	17 ± 2	19 ± 2	18 ± 2	18 ± 2	18 ± 2	19 ± 2	20 ± 2	21 ± 2	19 ± 4
10/17/94	23 ± 4 (a)	30 ± 2	20 ± 2	22 ± 2	24 ± 2	26 ± 2	23 ± 2	24 ± 2	23 ± 2	25 ± 2	24 ± 5
10/24/94	20 ± 3 (a)	29 ± 3	22 ± 2	22 ± 2	22 ± 2	27 ± 2	22 ± 2	20 ± 2	22 ± 2	21 ± 2	23 ± 6
10/31/94	16 ± 2	20 ± 2	16 ± 2	14 ± 2	15 ± 2	18 ± 2	16 ± 2	17 ± 2	17 ± 2	20 ± 2	17 ± 4
NOVEMBER											
11/07/94	16 ± 2	19 ± 2	13 ± 2	16 ± 2	16 ± 2	18 ± 2	16 ± 2	16 ± 2	18 ± 2	18 ± 2	17 ± 3
11/14/94	27 ± 3	32 ± 3	22 ± 2	25 ± 2	24 ± 2	25 ± 2	26 ± 2	20 ± 2 (a)	21 ± 2	25 ± 2	25 ± 7
11/21/94	26 ± 2	30 ± 2	21 ± 2	23 ± 2	27 ± 2	29 ± 2	22 ± 2	22 ± 2	24 ± 2	27 ± 2	25 ± 6
11/28/94	19 ± 2	24 ± 2	17 ± 2	21 ± 2	27 ± 2	19 ± 2	24 ± 2	19 ± 2	20 ± 2	23 ± 2	21 ± 6
DECEMBER											
12/05/94	35 ± 3	29 ± 2	28 ± 2	28 ± 2	35 ± 2	33 ± 3	41 ± 3	28 ± 2	32 ± 3	32 ± 3	32 ± 8
12/12/94	21 ± 2	28 ± 2	21 ± 2	21 ± 2	26 ± 2	23 ± 2	26 ± 2	19 ± 2	21 ± 2	25 ± 2	23 ± 6
12/19/94	46 ± 3	57 ± 3	38 ± 3	45 ± 3	53 ± 3	50 ± 3	52 ± 3	41 ± 3	46 ± 3	49 ± 3	48 ± 11
12/26/94	35 ± 3	49 ± 3	33 ± 3	34 ± 3	46 ± 3	41 ± 3	42 ± 3	35 ± 3	30 ± 2	39 ± 3	43 ± 15
01/02/95	26 ± 2	36 ± 3	23 ± 2	19 ± 2	30 ± 2	24 ± 2	30 ± 2	26 ± 2	25 ± 2	27 ± 2	27 ± 9
Quarter Avg.	**24 ± 18**	**30 ± 22**	**22 ± 15**	**23 ± 17**	**27 ± 23**	**26 ± 20**	**27 ± 23**	**23 ± 15**	**24 ± 16**	**26 ± 18**	**25 ± 5**
Annual Avg.	**24 ± 15**	**23 ± 19**	**19 ± 12**	**22 ± 14**	**22 ± 18**	**23 ± 17**	**21 ± 17**	**20 ± 16**	**21 ± 16**	**22 ± 15**	**22 ± 16**

(b) Equipment malfunction; low sample volume 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 01/03/94-04/04/94	Second Quarter 04/04/94-07/04/94	Third Quarter 07/04/94-10/03/94	Fourth Quarter 10/03/94-01/02/95	Average ± 2 s.d.
A-1	Be-7	169 ± 17	210 ± 21	167 ± 17	138 ± 14	171 ± 59
	K-40	10.7 ± 2.6	< 5	< 4	< 5	10.7 ± 2.6
	Cs-134	< 0.3	< 0.2	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.2	< 0.2	< 0.3	-
A-2	Be-7	158 ± 16	186 ± 19	170 ± 17	149 ± 15	166 ± 32
	K-40	< 6	< 6	3.89 ± 1.97	< 8	3.89 ± 1.97
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.3	-
A-3	Be-7	136 ± 14	156 ± 16	127 ± 13	107 ± 11	132 ± 42
	K-40	< 8	< 8	< 5	< 10	-
	Cs-134	< 0.3	< 0.3	< 0.2	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.3	-
A-4	Be-7	150 ± 15	203 ± 20	133 ± 13	126 ± 13	153 ± 70
	K-40	< 10	< 6	< 6	< 4	-
	Cs-134	< 0.4	< 0.3	< 0.3	< 0.2	-
	Cs-137	< 0.4	< 0.4	< 0.3	< 0.2	-
A-5	Be-7	163 ± 16	159 ± 16	135 ± 14	126 ± 13	146 ± 36
	K-40	< 5	< 5	< 9	< 10	-
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.4	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.4	-

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

TABLE B-2 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIRBORNE PARTICULATES

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

Stations	Nuclides	First Quarter 01/03/94-04/04/94	Second Quarter 04/04/94-07/04/94	Third Quarter 07/04/94-10/03/94	Fourth Quarter 10/03/94-01/02/95	Average ± 2 s.d.
A-6	Be-7	167 ± 17	180 ± 18	174 ± 17	168 ± 17	172 ± 12
	K-40	< 6	6.32 ± 2.93	< 6	< 5	6.32 ± 2.93
	Cs-134	< 0.2	< 0.4	< 0.3	< 0.3	-
	Cs-137	< 0.2	< 0.4	< 0.4	< 0.3	-
Coloma	Be-7	177 ± 18	216 ± 22	128 ± 13	135 ± 14	164 ± 82
	K-40	< 5	< 10	< 5	< 5	-
	Cs-134	< 0.3	< 0.4	< 0.2	< 0.2	-
	Cs-137	< 0.3	< 0.4	< 0.3	< 0.2	-
Dowagiac	Be-7	144 ± 14	169 ± 17	129 ± 13	127 ± 13	142 ± 39
	K-40	< 4	< 6	< 10	< 6	-
	Cs-134	< 0.3	< 0.3	< 0.4	< 0.4	-
	Cs-137	< 0.2	< 0.3	< 0.3	< 0.3	-
New Buffalo	Be-7	137 ± 14	167 ± 17	125 ± 13	136 ± 14	141 ± 36
	K-40	4.44 ± 2.15	< 5	10.2 ± 3.0	< 5	7.32 ± 8.2
	Cs-134	< 0.3	< 0.2	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.3	< 0.4	-
South Bend	Be-7	174 ± 17	155 ± 16	169 ± 17	141 ± 14	160 ± 30
	K-40	< 6	< 7	< 6	< 9	-
	Cs-134	< 0.3	< 0.3	< 0.3	< 0.3	-
	Cs-137	< 0.3	< 0.3	< 0.2	< 0.4	-

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

TABLE B-3

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

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 94										
01/03/94	< 10	< 10	< 20	< 10	< 7	< 8	< 8	< 9	< 6	< 8
01/10/94	< 10	< 10	< 10	< 10	< 8	< 20	< 20	< 20	< 8	< 20
01/17/94	< 20	< 20	< 10	< 20	< 10	< 20	< 20	< 20	< 10	< 20
01/24/94	< 20	< 20	< 20	< 10	< 7	< 8	< 8	< 8	< 6	< 8
01/31/94	< 10	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 10	< 20
FEBRUARY										
02/07/94	< 20	< 20	< 20	< 20	< 7	< 9	< 8	< 8	< 6	< 8
02/14/94	< 10	< 10 (a)	< 10	< 10	< 8	< 10	< 10	< 10	< 8	< 10
02/21/94	< 20	< 9 (a)	< 20	< 20	< 7	< 10	< 20	< 20	< 10	< 10
02/28/94	< 7	< 5 (a)	< 7	10.1 ± 5.2	< 10	< 20	< 20	< 20	< 8	< 20
MARCH										
03/07/94	< 10	21.0 ± 10.4	< 10	< 10	26.7 ± 8.4	< 20	< 20	< 20	< 10	< 10
03/14/94	8.8 ± 5.0	< 9	< 8	11.2 ± 5.7	< 10	< 10	< 10	< 10	< 8	< 10
03/21/94	< 10	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 8	< 10
03/28/94	< 20	< 20	< 20	< 20	< 30 (b)	< 10	< 20	< 10	< 9	< 10

(a) No measureable volume. Results in total pCi.
(b) Equipment malfunction: low sample volume.

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

COLLECTION DATES	STATION CODES									
	A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
APRIL										
04/04/94	< 10	< 10	< 10	(a)	< 20	< 9	< 20	< 20	< 20	< 30 (b)
04/11/94	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 8	< 20
04/18/94	< 20	< 20	< 20	< 20	< 8	< 9	< 10	< 10	< 7	< 10
04/25/94	< 20	< 20	< 20	< 20	< 8	< 9	< 9	< 9	< 6	< 8
05/02/94	< 20	< 10	< 20	< 20	< 7	< 10	< 20	< 20	< 9	< 10
MAY										
05/09/94	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 20	< 6	< 10
05/16/94	< 20	< 20	< 20	< 20	< 7	< 20	< 10	< 20	< 9	< 10
05/23/94	< 20	< 20	< 20	< 20	< 7	< 10	< 10	< 20	< 10 (b)	< 10
05/30/94	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
JUNE										
06/06/94	< 20	< 20	< 20	< 20	< 10	< 10	< 10	< 10	< 10	< 10
06/13/94	< 20	< 20	< 20	< 20	< 7	< 8	< 9	< 8	< 6	< 8
06/20/94	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 8	< 20
06/27/94	< 20	< 20	< 20	< 20	< 7	< 10	< 20	< 10	< 9	< 10

(a) Sample not collected.
(b) Equipment malfunction; low sample volume.

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
JULY										
07/04/94	< 10	< 10	< 10	< 10	< 8	< 9	< 10	< 9	< 7	< 10
07/11/94	< 20	< 20	< 20	< 20	< 8	< 20	< 10	< 10	< 10	< 20
07/18/94	< 30	(a)	< 30	< 30	< 20	< 10	< 10	< 10	< 8	< 10
07/24/94	< 20	(a)	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 20
08/01/94	< 20	(a)	< 10	< 20	< 20	< 7	< 20	< 20	< 20	< 20
AUGUST										
08/08/94	< 20	< 50 (b)	< 20	< 20	< 8	< 10	< 9	< 10	< 8	< 10
08/15/94	< 20	< 20	< 20	< 20	< 7	< 10	< 10	< 10	< 9	< 10
08/22/94	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
08/29/94	< 20	< 20	< 20	< 20	< 7	< 20	< 10	< 20	< 9	< 10
SEPTEMBER										
09/05/94	< 7	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
09/12/94	< 9	< 10	< 10	< 10	< 7	< 20	< 20	< 20	< 10	< 10
09/19/94	< 20	< 20	< 20	< 20	< 7	< 20	< 20	< 20	< 10	< 20
09/26/94	< 20	< 20	< 20	< 10	< 8	< 9	< 10	< 9	< 7	< 10

(a) Power failure; no sample available.
(b) Equipment malfunction; low sample volume.

TABLE B-3 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

COLLECTION DATES	STATION CODES A-1	A-2	A-3	A-4	A-5	A-6	Coloma	Dowagiac	New Buffalo	South Bend
OCTOBER										
10/03/94	< 20	< 20	< 20 (a)	< 20	< 7	< 9	< 9	< 8	< 6	< 9
10/10/94	< 20	< 20	< 20	< 20	< 7	< 20	< 10	< 10	< 9	< 10
10/17/94	< 40 (a)	< 20	< 20	< 20	< 8	< 9	< 9	< 8	< 6	< 8
10/24/94	< 20 (a)	< 20	< 10	< 20	< 7	< 20	< 10	< 10	< 9	< 10
10/31/94	< 8	< 8	< 8	< 8	< 5	< 20	< 20	< 20	< 10	< 20
NOVEMBER										
11/07/94	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20	< 10	< 20
11/14/94	< 20	< 20	< 20	< 20	< 8	< 20	< 20	< 20 (a)	< 10	< 20
11/21/94	< 10	< 10	< 10	< 10	< 6	< 6	< 7	< 7	< 5	< 7
11/28/94	< 8	< 8	< 8	< 8	< 6	< 10	< 20	< 10	< 9	< 10
DECEMBER										
12/05/94	< 10	< 20	< 10	< 10	< 6	< 20	< 20	< 10	< 10	< 20
12/12/94	< 10	< 10	< 10	< 10	< 9	< 20	< 20	< 20	< 10	< 20
12/19/94	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 10	< 9	< 10
12/26/94	< 20	< 20	< 20	< 20	< 7	< 10	< 10	< 10	< 8	< 10
01/02/95	< 20	< 20	< 20	< 20	< 8	< 9	< 10	< 10	< 7	< 10

(a) Equipment malfunction: low sample volume.

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 01/02/94-04/03/94	SECOND QUARTER 04/03/94-07/03/94	THIRD QUARTER 07/03/94-10/02/94	FOURTH QUARTER 10/02/94-01/08/95	AVERAGE ± 2 s.d.
A-1	3.6 ± 0.2	4.1 ± 0.2	3.2 ± 0.1	4.0 ± 0.2	3.7 ± 0.8
A-2	3.9 ± 0.5	3.9 ± 0.2	3.6 ± 0.3	4.3 ± 0.4	3.9 ± 0.6
A-3	3.4 ± 0.1	3.5 ± 0.2	2.9 ± 0.2	3.8 ± 0.3	3.4 ± 0.7
A-4	3.9 ± 0.4	4.2 ± 0.3	3.5 ± 0.3	4.4 ± 0.4	4.0 ± 0.8
A-5	3.7 ± 0.6	3.9 ± 0.1	3.2 ± 0.7	4.5 ± 0.2	3.8 ± 1.1
A-6	3.6 ± 0.3	3.9 ± 0.2	3.2 ± 0.6	4.3 ± 0.3	3.8 ± 0.9
A-7	4.0 ± 0.5	3.8 ± 0.4	3.3 ± 0.3	4.0 ± 0.5	3.8 ± 0.7
A-8	3.7 ± 0.3	3.6 ± 0.3	3.4 ± 0.6	3.9 ± 0.2	3.7 ± 0.4
A-9	3.9 ± 0.3	4.2 ± 0.3	3.7 ± 0.6	4.3 ± 0.5	4.0 ± 0.6
A-10	3.6 ± 0.4	4.0 ± 0.4	2.9 ± 0.9	3.7 ± 0.2	3.6 ± 0.9
A-11	4.0 ± 0.3	4.3 ± 0.5	3.6 ± 0.5	4.4 ± 0.4	4.1 ± 0.7
A-12	4.0 ± 0.4	4.1 ± 0.5	3.6 ± 0.6	4.5 ± 0.3	4.1 ± 0.7
OFS-1	3.9 ± 0.3	(a)	3.4 ± 0.4	4.1 ± 0.6	3.8 ± 0.7
OFS-2	3.8 ± 0.4	3.9 ± 0.3	3.3 ± 0.5	4.2 ± 0.4	3.8 ± 0.7
OFS-3	3.9 ± 0.5	4.0 ± 0.4	3.3 ± 0.9	4.6 ± 0.6	4.0 ± 1.1
OFS-4	3.6 ± 0.2	4.6 ± 0.3	3.7 ± 0.2	4.7 ± 0.8	4.2 ± 1.2
OFS-5	4.1 ± 0.7	4.4 ± 0.1	4.0 ± 0.6	4.7 ± 0.6	4.3 ± 0.6
OFS-6	4.4 ± 0.6	4.9 ± 0.4	4.6 ± 0.5	5.6 ± 0.8	4.9 ± 1.1
OFS-7	4.0 ± 0.4	4.1 ± 0.3	3.9 ± 0.6	4.4 ± 0.4	4.1 ± 0.4
OFS-8	4.5 ± 0.4	5.0 ± 0.3	4.6 ± 0.8	5.5 ± 1.0	4.9 ± 0.9
OFS-9	4.2 ± 0.6	4.5 ± 0.2	4.2 ± 0.6	5.1 ± 0.6	4.5 ± 0.8
OFS-10	3.8 ± 0.1	4.0 ± 0.3	3.6 ± 0.6	5.0 ± 0.6	4.1 ± 1.2
OFS-11	4.6 ± 0.6	5.0 ± 0.8	4.2 ± 0.8	5.2 ± 0.6	4.8 ± 0.9
NBF	4.1 ± 0.4	4.3 ± 0.3	3.9 ± 0.8	4.9 ± 0.3	4.3 ± 0.9
SBN	4.2 ± 0.4	6.9 ± 0.4	5.9 ± 0.8	7.3 ± 0.6	6.1 ± 2.8
DOW	3.5 ± 0.3	3.9 ± 0.1	3.5 ± 0.3	4.0 ± 0.4	3.7 ± 0.5
COL	3.5 ± 0.3	3.9 ± 0.3	3.3 ± 0.3	4.0 ± 0.2	3.7 ± 0.7
Average ± 2 s.d.	**3.9 ± 0.6**	**4.3 ± 1.3**	**3.7 ± 1.3**	**4.6 ± 1.5**	**4.1 ± 1.4**

(a) TLD lost.
* 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	01/06/94	< 0.3	< 60	220 ± 110
(Condenser Circ.)	02/03/94	< 1	< 90	
	03/01/94	< 0.4	< 100	
	03/31/94	< 0.7	< 60	
	05/03/94	< 0.6	< 50	< 200
	05/31/94	< 0.4	< 50	
	06/30/94	< 0.3	< 50	
	07/31/94	< 0.3	< 50	< 200
	08/31/94	< 0.2	< 40	
	09/30/94	< 0.4	< 90	
	10/31/94	< 1	< 50	< 200
	11/30/94	< 0.2	< 100	
	12/31/94	< 0.6	< 50	
L-2	01/06/94	< 0.3	< 100	< 200
(South Comp)	02/03/94	(a)		
	03/01/94	(a)		
	03/31/94	< 0.8	< 70	
	05/03/94	< 0.5	< 60	< 200
	05/31/94	< 0.3	< 90	
	06/30/94	< 0.4	< 50	
	07/31/94	< 0.4	< 40	< 200
	08/31/94	< 0.09	< 50	
	09/30/94	< 0.5	< 80	
	10/31/94	< 1	< 50	< 200
	11/30/94	< 0.1	< 50	
	12/31/94	< 0.5	< 50	

(a) No sample available; lake frozen.
* [illegible]al 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)	01/06/94	< 0.3	< 50	< 200
	02/03/94	(a)		
	03/01/94	(a)		
	03/31/94	< 1	< 60	
	05/03/94	< 0.4	< 50	< 200
	05/31/94	< 0.3	< 100	
	06/30/94	< 0.4	< 100	
	07/31/94	< 0.3	< 100	< 200
	08/31/94	< 0.2	< 50	
	09/30/94	< 0.5	< 90	
	10/31/94	< 1	< 60	< 200
	11/30/94	< 0.2	< 100	
	12/31/94	< 0.6	< 80	
L-4 (South 500)	01/06/94	< 0.3	< 100	< 100
	02/03/94	(a)		
	03/01/94	(a)		
	03/31/94	(b)		
L-5 (North 500)	01/06/94	< 0.3	< 50	150 ± 100
	02/03/94	(a)		
	03/01/94	(a)		
	03/31/94	(b)		

(a) No sample available; lake frozen.
(b) Station discontinued due to program change.
* 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	01/29/94	< 0.1	< 70	< 200
	05/01/94	< 0.1	< 90	< 200
	07/31/94	< 0.1	< 90	< 200
	10/30/94	< 0.1	< 40	< 100
Well - 2	02/16/94	< 0.7	< 80	< 200
	05/01/94	< 0.1	< 100	< 200
	07/31/94	< 0.1	< 70	< 200
	10/30/94 (a)			
Well - 3	01/29/94	< 0.1	< 100	< 200
	05/01/94	< 0.1	< 100	< 200
	07/31/94	< 0.09	< 100	< 300
	10/30/94	< 0.2	< 50	< 200
Well - 4	01/29/94	< 0.1	< 60	870 ± 140
	05/01/94	< 0.1	< 100	900 ± 130
	07/31/94	< 0.1	< 50	930 ± 130
	10/30/94	< 0.2	< 40	930 ± 130
Well - 5	01/29/94	< 0.1	< 50	380 ± 130
	05/01/94	< 0.1	< 100	710 ± 130
	07/31/94	< 0.1	< 80	470 ± 130
	10/30/94	< 0.2	< 50	410 ± 140
Well - 6	01/29/94	< 0.1	< 100	360 ± 110
	05/01/94	< 0.2	< 90	610 ± 120
	07/31/94	< 0.1	< 60	520 ± 110
	10/30/94	< 0.2	< 50	680 ± 120
Well - 7	01/29/94	< 0.1	< 90	< 200
	05/01/94	< 0.1	< 60	< 200
	07/31/94	< 0.1	< 100	< 100
	10/30/94	< 0.2	< 50	< 200

(a) Ground water pump malfunction; no sample collected.

* 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	02/03/94	< 0.1	< 50	< 200
	05/01/94	< 0.2	< 70	< 200
	07/31/94	< 0.1	< 60	< 100
	10/30/94	< 0.2	< 90	170 ± 100
Well - 9	01/29/94	< 0.1	< 60	< 200
	05/01/94	< 0.1	< 50	< 200
	07/31/94	< 0.1	< 100	< 100
	10/30/94	< 0.2	< 50	< 200
Well - 10	01/29/94	< 0.1	< 70	< 200
	05/01/94	< 0.1	< 60	< 200
	07/31/94	< 0.1	< 50	< 100
	10/30/94	< 0.2	< 40	< 200
Well - 11	01/29/94	< 0.1	< 50	< 200
	05/01/94	< 0.1	< 50	< 200
	07/31/94	< 0.1	< 60	< 200
	10/30/94	< 0.2	< 80	< 200
Well - 12	01/29/94	< 0.1	< 100	< 200
	05/01/94	< 0.2	< 50	< 200
	07/31/94	< 0.1	< 100	< 100
	10/30/94	< 0.2	< 80	< 200
Well - 13	01/29/94	< 0.1	< 50	< 200
	05/01/94	< 0.1	< 90	< 100
	07/31/94	< 0.1	< 70	< 100
	10/30/94	< 0.2	< 50	< 200
Well - 14	02/14/94	< 0.1	< 50	1200 ± 100
	05/01/94	< 0.1	< 60	1700 ± 200
	07/31/94	< 0.1	< 40	440 ± 100
	10/30/94	< 0.2	< 70	640 ± 130
Average ± 2 s.d.				**701 ± 737**

* 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				
01/06/94	5.1 ± 1.2	< LLD	< 0.3	< 200
01/20/94	4.0 ± 1.1	< LLD	< 0.3	
02/03/94	3.5 ± 1.0	< LLD	< 0.3	
02/17/94	4.3 ± 1.0	< LLD	< 0.5	
03/03/94	3.4 ± 1.2	< LLD	< 0.3	
03/17/94	4.7 ± 1.1	< LLD	< 0.3	
03/31/94	4.4 ± 1.1	< LLD	< 0.3	
04/14/94	4.8 ± 1.1	< LLD	< 0.3	< 200
04/28/94	2.8 ± 1.0	< LLD	< 0.3	
05/12/94	8.8 ± 1.5	< LLD	< 0.3	
05/26/94	3.9 ± 1.0	< LLD	< 0.3	
06/23/94 (a)	4.0 ± 1.1	< LLD	< 0.2	
07/07/94	3.3 ± 1.1	< LLD	< 0.2	< 200
07/21/94	2.8 ± 1.0	< LLD	< 0.3	
08/04/94	4.4 ± 1.1	< LLD	< 0.2	
08/18/94	4.2 ± 1.1	< LLD	< 0.3	
09/01/94	2.8 ± 1.0	< LLD	< 0.3	
09/15/84	3.5 ± 1.0	< LLD	< 0.2	
09/29/94	4.1 ± 1.4	< LLD	< 0.4	
10/13/94	3.3 ± 0.9	< LLD	< 0.2	< 200
10/27/94	4.1 ± 1.1	< LLD	< 0.3	
11/10/94	2.7 ± 0.8	< LLD	< 0.2	
11/24/94	2.9 ± 0.9	< LLD	< 0.2	
12/08/94	3.0 ± 1.0	< LLD	< 0.3	
12/22/94	1.6 ± 0.9	< LLD	< 0.3	
01/05/95	2.1 ± 1.0	< LLD	< 0.3	
Average ± 2 s. d.	**3.8 ± 2.7**			

(a) N[illegible]ple collected on 06/10/94.

* Typ[illegible]l LLDs are found in table B-12.

TABLE (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				
01/06/94	2.9 ± 1.0	< LLD	< 0.2	< 100
01/20/94	3.4 ± 1.1	< LLD	< 0.3	
02/03/94	3.3 ± 1.1	< LLD	< 0.3	
02/17/94	4.9 ± 1.1	< LLD	< 0.3	
03/03/94	3.4 ± 1.3	< LLD	< 0.3	
03/17/94	3.7 ± 1.1	< LLD	< 0.4	
03/31/94	3.8 ± 1.1	< LLD	< 0.4	
04/14/94	4.4 ± 1.1	< LLD	< 0.3	< 200
04/28/94	2.6 ± 1.0	< LLD	< 0.3	
05/12/94	4.5 ± 1.3	< LLD	< 0.3	
05/26/94	4.4 ± 1.0	< LLD	< 0.4	
06/23/94	4.2 ± 1.1	< LLD	< 0.3	
07/07/94	3.6 ± 1.1	< LLD	< 0.3	< 200
07/21/94	3.4 ± 1.1	< LLD	< 0.3	
08/04/94	4.6 ± 1.1	< LLD	< 0.3	
08/18/94	3.7 ± 1.1	< LLD	< 0.3	
09/01/94	3.2 ± 1.1	< LLD	< 0.3	
09/15/94	3.3 ± 1.0	< LLD	< 0.2	
09/29/94	2.9 ± 1.4	< LLD	< 0.3	
10/13/94	5.0 ± 1.0	< LLD	< 0.2	
10/27/94	4.0 ± 1.1	< LLD	< 0.2	
11/10/94	4.2 ± 1.0	< LLD	< 0.2	< 200
11/24/94	3.3 ± 0.9	< LLD	< 0.2	
12/08/94	2.1 ± 0.7	< LLD	< 0.3	
12/22/94	2.2 ± 1.0	< LLD	< 0.3	
01/05/95	3.0 ± 1.0	< LLD	< 0.3	
Average ± 2 s. d.	**3.6 ± 1.5**			

* 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	04/30/94	< 200	5810 ± 580	< 30	< 400	90.3 ± 32.4
L-3	04/30/94	< 100	6630 ± 660	< 20	< 300	134 ± 20
L-4	04/30/94	< 100	4960 ± 500	< 20	< 300	111 ± 18
L-5	04/30/94	< 300	9010 ± 900	< 30	691 ± 389	206 ± 27
L-2	10/14/94	< 200	4840 ± 480	< 20	< 300	124 ± 20
L-3	10/14/94	< 200	5130 ± 510	< 20	< 300	155 ± 28
L-4 (a)						
L-5 (a)						
Average ± 2 s.d.			6063 ± 3182		691 ± 389	137 ± 81

(a) Locations L4 and L5 were discontinued due to a program change.
* Ty[illegible]l LLDs are found in table B-12. All other gamma emitters were [illegible]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
01/07/94	K-40 I-131	1560 ± 160 < 0.2	1560 ± 160 < 0.2	1280 ± 130 < 0.2	1420 ± 140 < 0.2	1460 ± 150 < 0.2	1320 ± 130 < 0.1
01/21/94	K-40 I-131	1380 ± 140 < 0.2	1390 ± 140 < 0.2	1530 ± 150 < 0.2	1390 ± 140 < 0.2	1410 ± 140 < 0.2	1330 ± 130 < 0.2
02/04/94	K-40 I-131	1390 ± 140 < 0.1	1500 ± 150 < 0.2	1440 ± 140 < 0.2	1290 ± 130 < 0.2	1300 ± 130 < 0.2	1460 ± 150 < 0.2
02/18/94	K-40 I-131	1340 ± 130 < 0.2	1460 ± 150 < 0.2	1380 ± 140 < 0.2	1360 ± 140 < 0.2	1430 ± 140 < 0.2	1230 ± 120 < 0.2
03/04/94	K-40 I-131	1260 ± 130 < 0.1	1470 ± 150 < 0.1	1330 ± 130 < 0.2	1370 ± 140 < 0.2	1510 ± 150 < 0.2	1180 ± 120 < 0.2
03/18/94	K-40 I-131	1060 ± 110 < 0.1	1460 ± 150 < 0.1	1300 ± 130 < 0.1	1440 ± 140 < 0.1	1530 ± 150 < 0.1	1320 ± 130 < 0.2
04/01/94	K-40 I-131	1260 ± 130 < 0.2	1370 ± 140 < 0.2	1220 ± 120 < 0.2	1420 ± 140 < 0.1	1450 ± 140 < 0.2	1280 ± 130 < 0.2
04/15/94	K-40 I-131	1350 ± 130 < 0.2	1490 ± 150 < 0.2	1410 ± 140 < 0.1	1230 ± 120 < 0.2	1420 ± 140 < 0.2	1340 ± 130 < 0.2
04/29/94	K-40 I-131	1460 ± 150 < 0.2	1540 ± 150 < 0.2	1380 ± 140 < 0.2	1490 ± 150 < 0.2	1330 ± 130 < 0.2	1300 ± 130 < 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

		STATION CODES					
COLLECTION DATES	**ANALYSIS**	**SHULER**	**TOTZKE**	**FREEHLING**	**WARMBEIN**	**LIVINGHOUSE**	**WYANT**
05/13/94	K-40	1400 ± 140	1300 ± 130	1290 ± 130	1380 ± 140	1430 ± 140	1410 ± 140
	I-131	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
05/27/94	K-40	1500 ± 150	1350 ± 130	1400 ± 140	1480 ± 150	1390 ± 140	1360 ± 140
	I-131	< 0.2	< 0.2	< 0.3	< 0.2	< 0.2	< 0.3
06/10/94	K-40	1170 ± 120	1360 ± 140	1280 ± 130	1270 ± 130	1470 ± 150	1290 ± 130
	I-131	< 0.2	< 0.3	< 0.2	< 0.2	< 0.2	< 0.2
06/24/94	K-40	1530 ± 150	1440 ± 140	1380 ± 140	1590 ± 160	1330 ± 130	1200 ± 120
	I-131	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
07/08/94	K-40	1290 ± 130	1420 ± 140	1220 ± 120	1430 ± 140	1410 ± 140	1310 ± 130
	I-131	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1
07/22/94	K-40	1800 ± 180	(a)	1370 ± 140	1380 ± 140	1450 ± 140	1430 ± 140
	I-131	< 0.2		< 0.2	< 0.2	< 0.2	< 0.2
08/05/94	K-40	1490 ± 150		1330 ± 130	1240 ± 120	1370 ± 140	1310 ± 130
	I-131	< 0.2		< 0.1	< 0.2	< 0.2	< 0.2
08/19/94	K-40	1490 ± 150		1400 ± 140	1420 ± 140	1350 ± 130	1320 ± 130
	I-131	< 0.2		< 0.2	< 0.2	< 0.2	< 0.2
			SCHUTZE (b)				
09/02/94	K-40	1270 ± 130	1300 ± 130	1410 ± 140	1280 ± 130	1430 ± 140	1260 ± 130
	I-131	< 0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
09/16/94	K-40	1430 ± 140	1380 ± 140	1470 ± 150	1240 ± 120	1320 ± 130	1520 ± 150
	I-131	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2

(a) Totzke withdrew from program in July 1994.
(b) Schutze became part of milk program in September 1994.
* 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	SCHUTZE	FREEHLING	WARMBEIN	LIVINGHOUSE	WYANT
09/30/94	K-40 I-131	1200 ± 120 < 0.2	1330 ± 130 < 0.2	1380 ± 140 < 0.2	1490 ± 150 < 0.2	1420 ± 140 < 0.2	1360 ± 140 < 0.2
10/14/94	K-40 I-131	1490 ± 150 < 0.1	1240 ± 120 < 0.1	1500 ± 150 < 0.1	1420 ± 140 < 0.2	1450 ± 140 < 0.1	1380 ± 140 < 0.1
10/28/94	K-40 I-131	1310 ± 130 < 0.2	1260 ± 130 < 0.2	1430 ± 140 < 0.4	1360 ± 140 < 0.2	1480 ± 150 < 0.2	1230 ± 120 < 0.3
11/11/94	K-40 I-131	1360 ± 140 < 0.1	1200 ± 120 < 0.1	1400 ± 140 < 0.1	1360 ± 140 < 0.1	1400 ± 140 < 0.1	1380 ± 140 < 0.1
11/25/94	K-40 I-131	1350 ± 130 < 0.1	1360 ± 140 < 0.1	1330 ± 130 < 0.1	1370 ± 140 < 0.1	1440 ± 140 < 0.2	1030 ± 100 < 0.1
12/09/94	K-40 I-131	1510 ± 150 < 0.2	1450 ± 140 < 0.2	1440 ± 140 < 0.2	1360 ± 140 < 0.2	1410 ± 140 < 0.2	1250 ± 120 < 0.2
12/23/94	K-40 I-131	1410 ± 140 < 0.2	1440 ± 140 < 0.2	1370 ± 140 < 0.3	1270 ± 130 < 0.2	1370 ± 140 < 0.3	1290 ± 130 < 0.2

* 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
06/08/94	OFS-South	Lake Trout	< 90	2980 ± 300	< 10	< 200	< 10
06/08/94	ONS-South	Lake Trout	< 100	3030 ± 300	< 20	< 200	< 20
06/08/94	ONS-North	Lake Trout	< 100	2970 ± 300	< 20	< 200	< 20
06/08/94	OFS-North	Sucker	< 100	2490 ± 250	19.5 ± 10.0	< 200	< 20
10/18/94	OFS-South (a)						
10/18/94	ONS-South	Walleye	< 100	3430 ± 340	59.6 ± 14.3	< 300	< 30
10/18/94	ONS-North	Sucker	< 100	3500 ± 350	80.1 ± 14.0	< 300	< 20
10/18/94	OFS-North	Sucker	< 100	2870 ± 290	28.8 ± 11.9	< 300	< 30
Average ± 2 s.d.				3039 ± 685	47.0 ± 55.9		

(a) Sample unavailable.

* 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
10/01/94	SECTOR-A	Broadleaf	3840 ± 380	3850 ± 380	< 20	< 20
10/01/94	SECTOR-K	Broadleaf	1450 ± 150	2470 ± 250	< 20	< 10
10/01/94	SECTOR-B	Grapes	114 ± 32	2670 ± 270	< 6	< 5
10/01/94	SECTOR-K	Grapes	56.9 ± 32.8	2280 ± 230	< 7	< 5
Average ± 2 s.d.			**1365 ± 3542**	**2818 ± 1413**		

* 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/m^3**		
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 PB[illegible]032-11.
* Charc[illegible]rap

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

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

APPENDIX C
ANALYTICAL PROCEDURES SYNOPSIS

ANALYTICAL PROCEDURES SYNOPSIS

Appendix C is a synopsis of the analytical procedures performed during 1994 on samples collected for the Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by Indiana Michigan and Teledyne Brown Engineering and include those recommended by the USNRC Regulatory Guide 4.8,BTP, Rev. 1, November 1979.

GROSS BETA ANALYSIS OF SAMPLES

Airborne Particulates

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

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

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

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

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

where:

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

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

1.0 INTRODUCTION

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

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

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

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

2.0 DETECTION CAPABILITY

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

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

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

ANALYSIS OF SAMPLES FOR TRITIUM

(Liquid Scintillation)

Water

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

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

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

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

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

where:

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

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

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

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

RESULT = $(N/\Delta t-B)/(2.22\ E\ V\ Y\ DF)$

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

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

where:

N	=	total counts from sample (counts)
Δt	=	counting time for sample (min)
B	=	background rate of counter (cpm)
2.22	=	dpm/pCi
V	=	volume or weight of sample analyzed
Y	=	chemical yield of the mount or sample counted
DF	=	decay factor from the collection to the counting date
E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
E	=	$E_s(\exp-0.0085M)/(\exp-0.0085M_s)$
E_s	=	efficiency of the counter determined from an I-131 standard mount
Ms	=	mass of PdI_2 on the standard mount, mg
M	=	mass of PdI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

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

Dried Solids Other Than Soils and Sediments

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

Fish

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

Soils and Sediments

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

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 Brown Engineering participates in the EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1994 data summary tables are presented for isotopes in the various sample media applicable to the Donald C. Cook Nuclear Plant's Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases and the steps taken to prevent reoccurrence.

EPA INTERLABORATORY COMPARISON PROGRAM 1994
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)	
01/14/94	Water	Sr-89	25.0 ±	5.0	24.00 ±	1.00	-0.35	
		Sr-90	15.0 ±	5.0	15.67 ±	1.53	0.23	
01/28/94	Water	Gr-Alpha	15.0 ±	5.0	21.67 ±	0.58	2.31	(d)
		Gr-Beta	62.0 ±	10.0	72.33 ±	3.79	1.79	
02/04/94	Water	I-131	119.0 ±	12.0	110.33 ±	0.00	-1.30	
02/11/94	Water	Ra-226	19.9 ±	3.0	21.00 ±	1.00	0.64	
		Ra-228	14.7 ±	3.7	15.67 ±	1.53	0.45	
03/04/94	Water	H-3	4936.0 ±	494.0	4833.33 ±	152.75	-0.36	
04/19/94	Water	Gr-Beta	117.0 ±	18.0	102.67 ±	6.43	-1.38	
		Sr-89	20.0 ±	5.0	19.00 ±	1.00	-0.35	
		Sr-90	14.0 ±	5.0	13.00 ±	0.00	-0.35	
		Co-60	20.0 ±	5.0	23.67 ±	3.21	1.27	
		Cs-134	34.0 ±	5.0	34.00 ±	1.73	0.00	
		Cs-137	29.0 ±	5.0	34.00 ±	2.65	1.73	
		Gr-Alpha	86.0 ±	22.0	78.00 ±	3.00	-0.63	
		Ra-226	20.0 ±	3.0	15.67 ±	1.53	-2.50	(e)
		Ra-228	20.1 ±	5.0	15.33 ±	0.58	-1.65	
06/10/94	Water	Co-60	50.0 ±	5.0	43.00 ±	2.00	-2.42	(f)
		Zn-65	134.0 ±	13.0	13.33 ±	0.58	-16.08	(g)
		Ru-106	252.0 ±	25.0	201.33 ±	9.29	-3.51	(h)
		Cs-134	40.0 ±	5.0	29.33 ±	3.79	-3.70	(i)
		Cs-137	49.0 ±	5.0	49.67 ±	1.53	0.23	
		Ba-133	98.0 ±	10.0	85.00 ±	3.00	-2.25	(j)
06/17/94	Water	Ra-226	15.0 ±	2.3	15.33 ±	0.58	0.25	
		Ra-228	15.4 ±	3.9	16.33 ±	1.53	0.41	
07/15/94	Water	Sr-89	30.0 ±	5.0	26.00 ±	1.73	-1.39	
		Sr-90	20.0 ±	5.0	19.00 ±	0.00	-0.35	
07/22/94	Water	Gr-Alpha	32.0 ±	8.0	25.33 ±	2.89	-1.44	
		Gr-Beta	10.0 ±	5.0	16.00 ±	0.00	2.08	(k)
08/05/94	Water	H-3	9951.0 ±	995.0	9700.00 ±	100.04	-0.44	
08/26/94	Air Filter	Gr-Alpha	35.0 ±	9.0	31.33 ±	2.08	-0.71	
		Gr-Beta	56.0 ±	10.0	59.33 ±	3.21	0.58	
		Sr-90	20.0 ±	5.0	18.00 ±	1.00	-0.69	
		Cs-137	15.0 ±	5.0	17.00 ±	1.73	0.69	
09/16/94	Water	U	35.0 ±	3.0	38.67 ±	0.58	2.12	(l)
		Ra-226	10.0 ±	1.5	10.67 ±	0.58	0.77	
		Ra-228	10.2 ±	2.6	9.70 ±	0.52	-0.33	

EPA INTERLABORATORY COMPARISON PROGRAM 1994
Environmental

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Brown Engineering Result(b)		Deviation(c)	
09/30/94	Milk	Sr-89	25.0 ±	5.0	24.33 ±	2.52	-0.23	
		Sr-90	15.00 ±	5.0	17.67 ±	1.53	0.92	
		I-131	75.0 ±	8.0	81.67 ±	5.86	1.44	
		Cs-137	59.0 ±	5.0	70.33 ±	4.62	3.93	(m)
		K	1715.0 ±	86.0	1740.00 ±	153.95	0.50	
10/07/94	Water	I-131	79.0 ±	8.0	71.00 ±	3.00	-1.73	
10/18/94	Water	Gr-Beta	142.0 ±	21.0	120.00 ±	0.00	-1.81	
		Sr-89	25.0 ±	5.0	24.67 ±	2.08	-0.12	
		Sr-90	15.0 ±	5.0	14.33 ±	1.15	-0.23	
		Co-60	40.0 ±	5.0	41.00 ±	1.00	0.35	
		Cs-134	20.0 ±	5.0	21.67 ±	1.53	0.58	
		Cs-137	39.0 ±	5.0	41.67 ±	2.31	0.92	
		Gr-Alpha	57.0 ±	14.0	51.33 ±	1.53	-0.70	
		Ra-226	9.9 ±	1.5	11.33 ±	0.58	1.66	
		Ra-228	10.1 ±	2.5	9.33 ±	0.58	-0.53	
10/28/94	Water	Gr-Alpha	57.0 ±	14.0	47.00 ±	3.00	-1.24	
		Gr-Beta	23.0 ±	5.0	25.33 ±	1.53	0.81	
11/04/94	Water	Co-60	59.0 ±	5.0	52.00 ±	0.00	-2.42	(n)
		Zn-65	100.0 ±	10.0	81.33 ±	7.02	-3.23	(n)
		Cs-134	24.0 ±	5.0	19.67 ±	2.52	-1.50	
		Cs-137	49.0 ±	5.0	54.33 ±	2.31	1.85	
		Ba-133	73.0 ±	7.0	58.33 ±	2.89	-3.63	(n)

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) There appears to be variation in self-absorption matrix. The EPA confirms that the composition of their tap water from Lake Mead, varies seasonally which can cause variation in alpha, beta results. No corrective action required at this time since results are within ± 3 sigma control limits.

(e) No specific or apparent reason found. Data sheets verified and detector efficiencies calibrated. Will exert extra care in making dilutions and using correct sample type on concentration of acids. Will check future samples to see if a pattern develops.

EPA INTERLABORATORY COMPARISON PROGRAM 1994
Environmental

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Brown Engineering Result(b)	Deviation(c)

(f) A second aliquot was analyzed, paying particular attention to volume aliquoted. The result, 52 pCi/l, was in good agreement with the EPA. The three original results, each counted on a different detector, showed good precision. The measurement of Co-60 has not been a problem. Future EPA cross-checks will be weighed and results followed to check for a possible trend "out of control".

(g) The average value of three analyses on the "Report of Analysis" was 133 pCi/liter which is in good agreement with the EPA. Apparently, incorrect results were entered into the EPA computer. Future data will be printed from the computer screen to check entries.

(h) The EPA has indicated that the Radiation Quality Assurance Program has been experiencing problems with the ruthenium-106 analysis. See attached letter from EPA.

(i) The first aliquot, prepared according to EPA dilution instructions was counted on four detectors in the 1 liter Marinelli geometry with Cs-134 results (based on the 796 KeV peak) in pCi/l of 32.0, 25.1, 31.7, and 30.8. The 31.7 result was not reported. Had that been reported instead of 25.1, the average would have been 31.5 and the normalized deviation would have been -2.94 instead of -3.70. A second aliquot was prepared and a single measurement was made with the result of 31.1 pCi/l. An undiluted aliquot was measured in a 150 ml geometry with the result of 33.5 pCi/l. That result is comparable with the Marinelli results. Thus none of : sample preparation (dilution, volume determination, maintaining correct pH, etc.), sample geometry, or detector efficiency seem to be the cause of the low results.

(j) There is no apparent reason for the low result, however the average value, 85 pCi/l is in good agreement to the grand average (86.46). No corrective action planned.

(k) EPA results for gross beta in water were corrected for 20% crosstalk into the beta channel from the Th-230 alpha spike. Recent measurements show that the crosstalk can be much higher (37% for Tennelec counter #3 and 54% for gamma products counter #1). The normalized deviation from the grand average was only 0.38. Future results will be corrected with specific crosstalk values determined by counting Th-230 standards.

(l) Possible aliquoting error. The instrument calibration, spike, and blank results all appear normal. No procedural changes are planned. Previous results were well within one normalized deviation. Future measurements will be reviewed to determine if a trend in results above the two sigma warning limit is occurring.

(m) The milk sample was counted four times. The reported Cs-137 values were based on one aliquot of 1 liter volume and an aliquot of 0.865 liter counted two times. It is suspected that the 0.865 liter volume was incorrectly determined. If 1 liter (the usual volume for counting milk samples) is used in the calculation, then the average of three results equals 63.6 pCi/l which gives a normalized deviation to the Known of 1.59. The fourth count (a 1 liter aliquot) had a Cs-137 equal to 64.2 pCi/l which is in good agreement with the average of the other three. Teledyne will set up a log for recording aliquots used for EPA samples and record how the aliquot volume was determined.

Collection Date	Media	Nuclide	EPA Result(a)	Teledyne Brown Engineering Result(b)	Deviation(c)

(n) The EPA requires that water samples be diluted before gamma analysis. That imposes a feature not appropriate for the handling of environmental samples. As in the 06/10/94 water sample, it appears that the first aliquot may not have been accurately prepared. A second aliquot was prepared and counted three times with results in pCi/l and normalized deviation of:

Co-60	60.6	+0.55
Zn-65	100.	0.0
Cs-134	22.9	-0.38
Cs-137	58.5	+3.29
Ba-133	69.8	-0.79

Four of the five are now in good agreement with the EPA results. The Cs-137 is high, but within the control limits when compared to the grand average deviation of all laboratories of 2.89. The grand average was 51.9 pCi/l. For future samples of this type we will have two technicians each prepare an aliquot and compare the counting results to check for preparation technique differences.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P O BOX 93478
LAS VEGAS NEVADA 89193-3478
(702/798-2100 - FTS 545-2100)

Dear Participant:

The Radiation Quality Assurance Program has been experiencing problems with the Ruthenium-106 currently used in the Performance Evaluation (PE) Studies and in the Standards Distribution Program. If these problems can be satisfactorily resolved, this analyte will once again be placed into this PE Study. If the problems cannot be resolved, the Ruthenium-106 will be replaced.

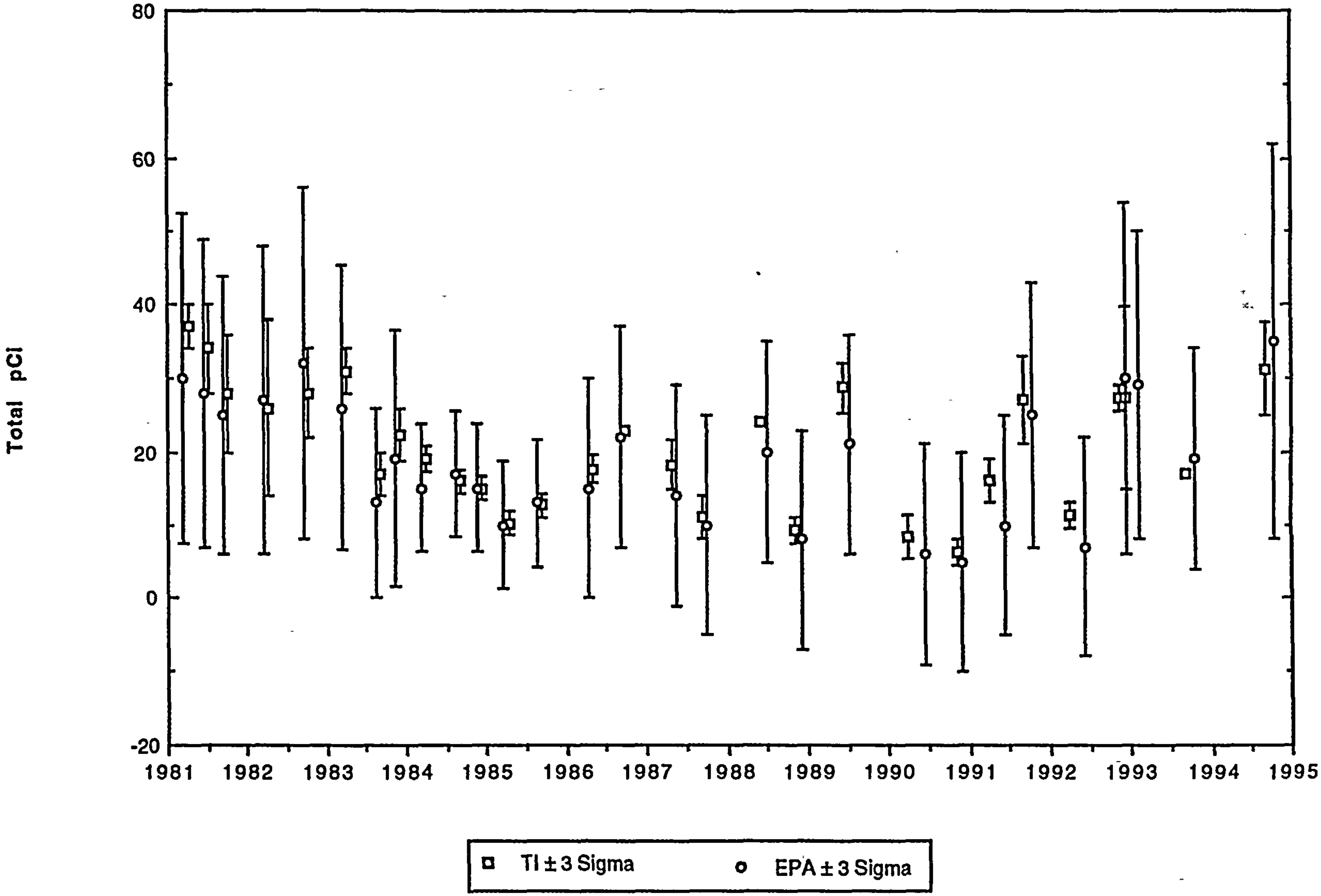
Formal written notice will be given to all participants that are enrolled in the Gamma in Water PE Study before the Ruthenium-106 is reintroduced or replaced. At that time, new calibration standards will be available to all participants in the Gamma in Water PE Study.

Sincerely,

George Dilbeck
Chemist
Performance Evaluation Program
Radioanalysis Branch (RSA-RADQA)

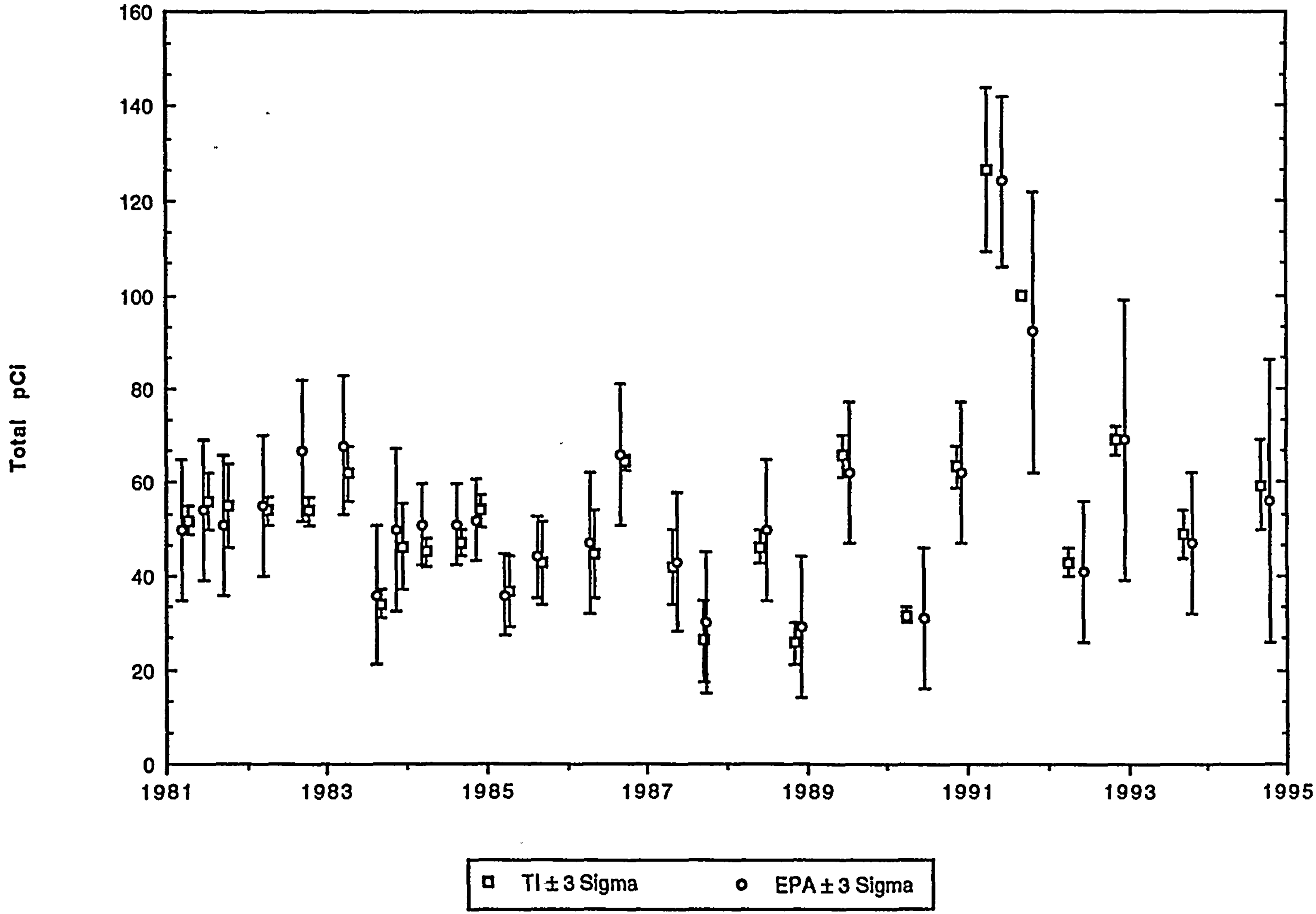
EPA CROSS CHECK PROGRAM

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



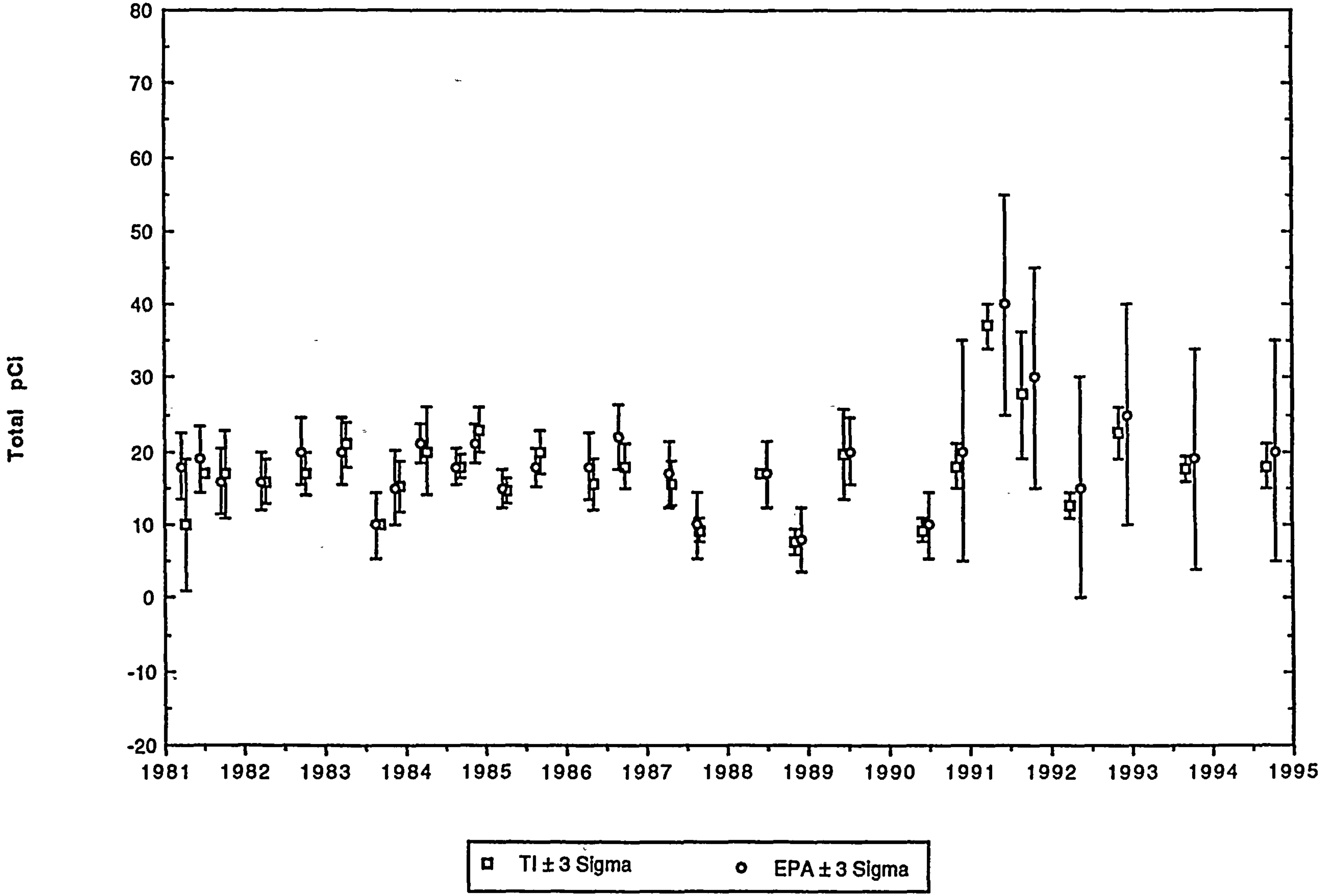
EPA CROSS CHECK PROGRAM

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



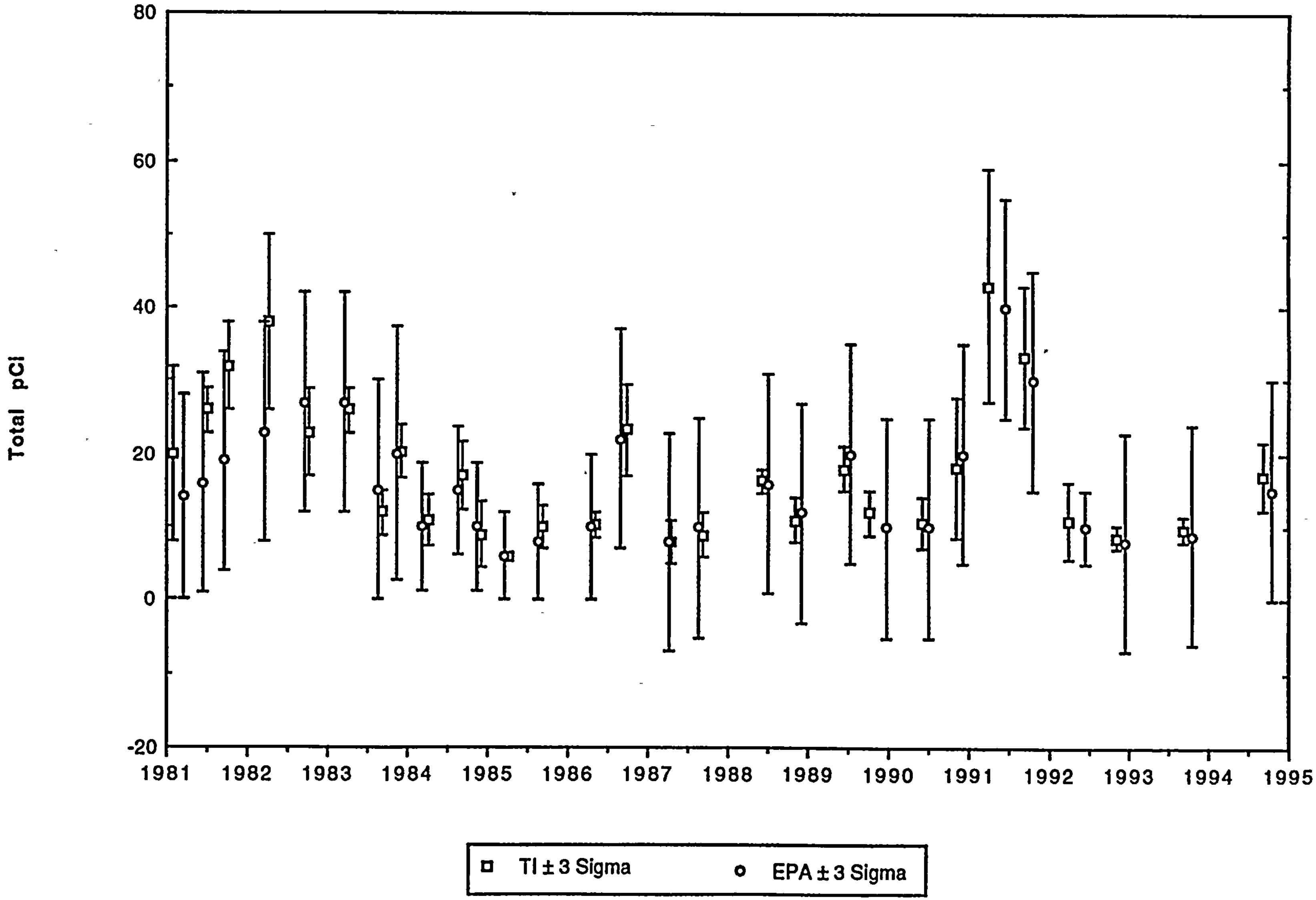
EPA CROSS CHECK PROGRAM

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



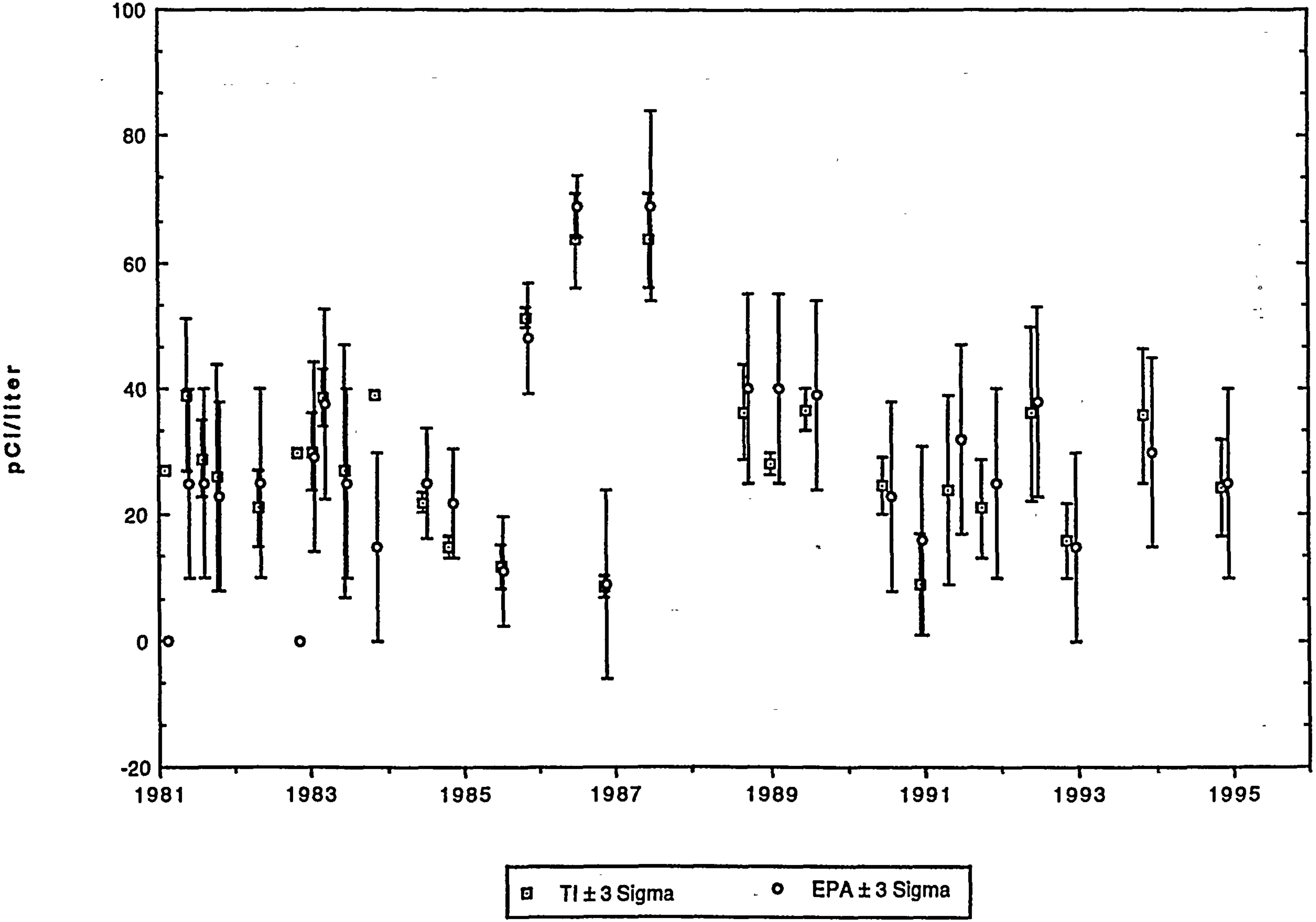
EPA CROSS CHECK PROGRAM

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



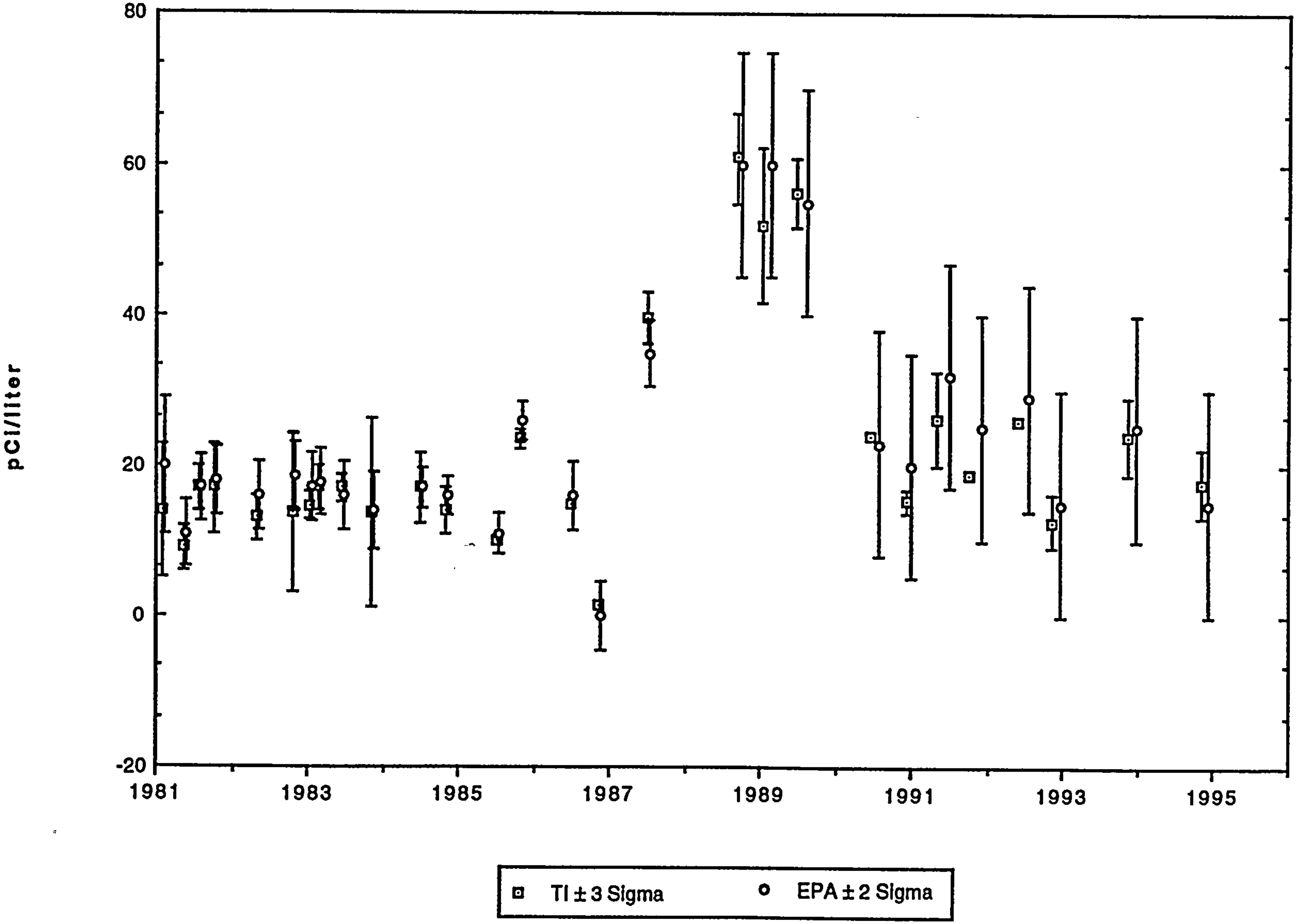
EPA CROSS CHECK PROGRAM

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



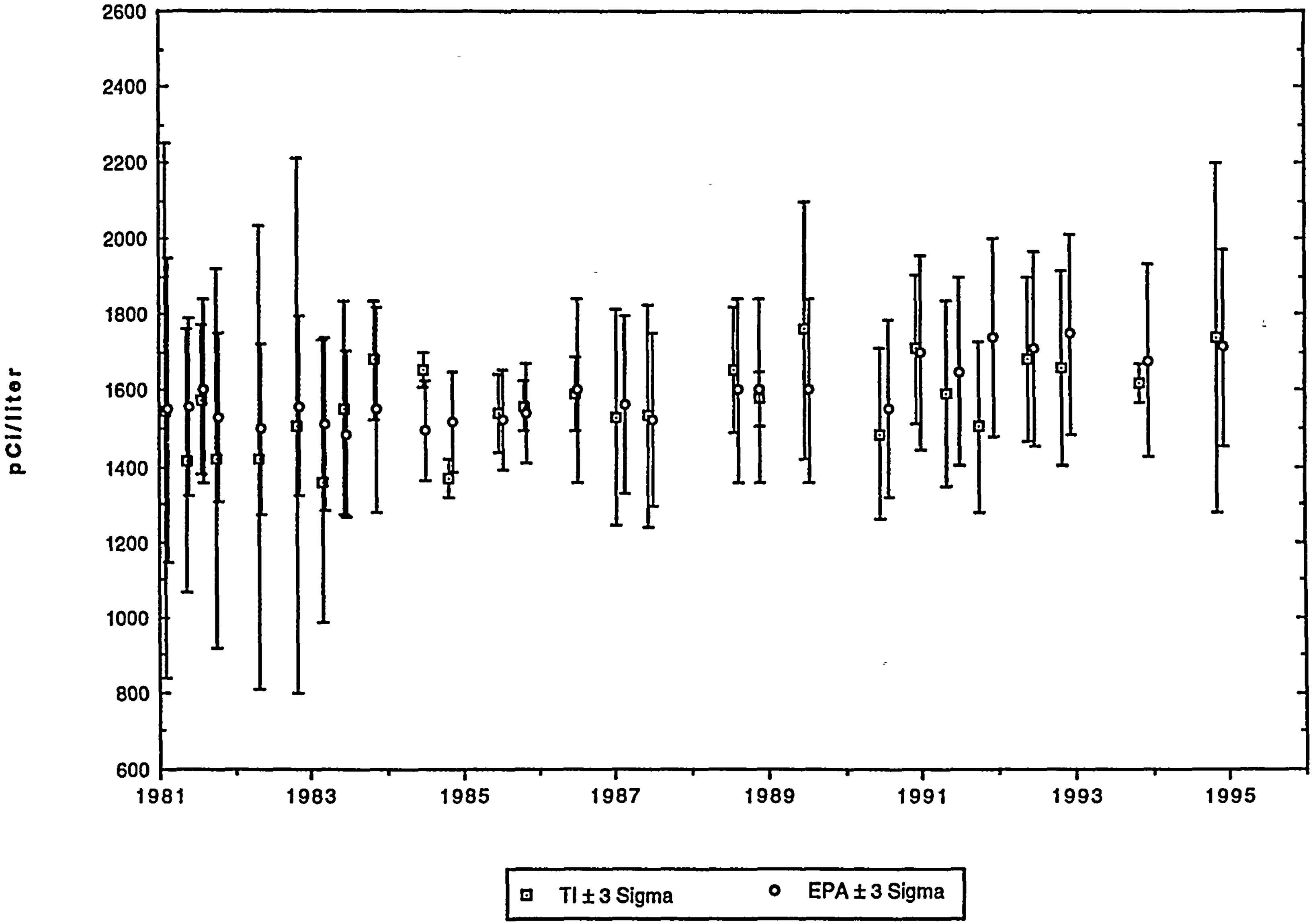
EPA CROSS CHECK PROGRAM

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



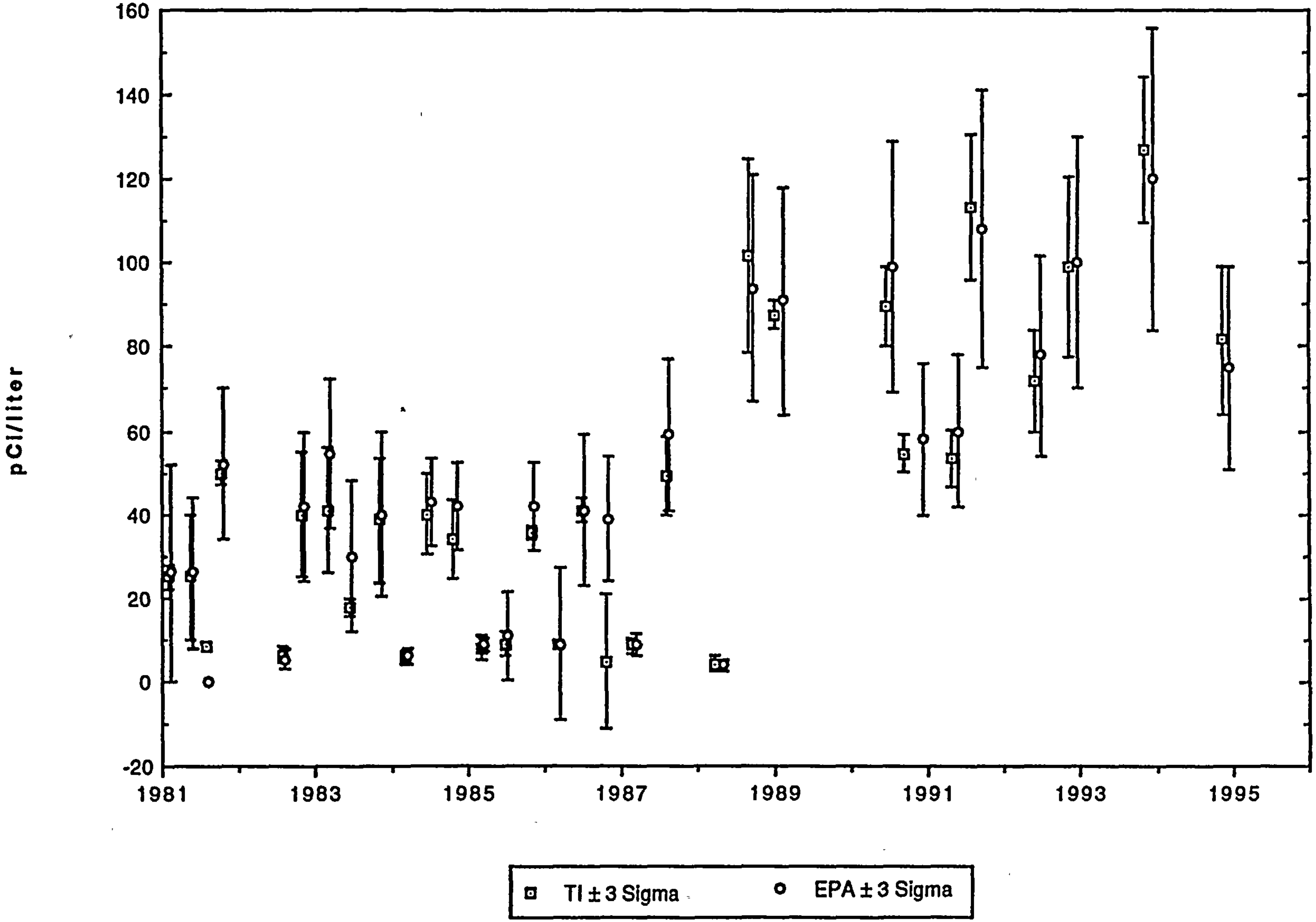
EPA CROSS CHECK PROGRAM

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



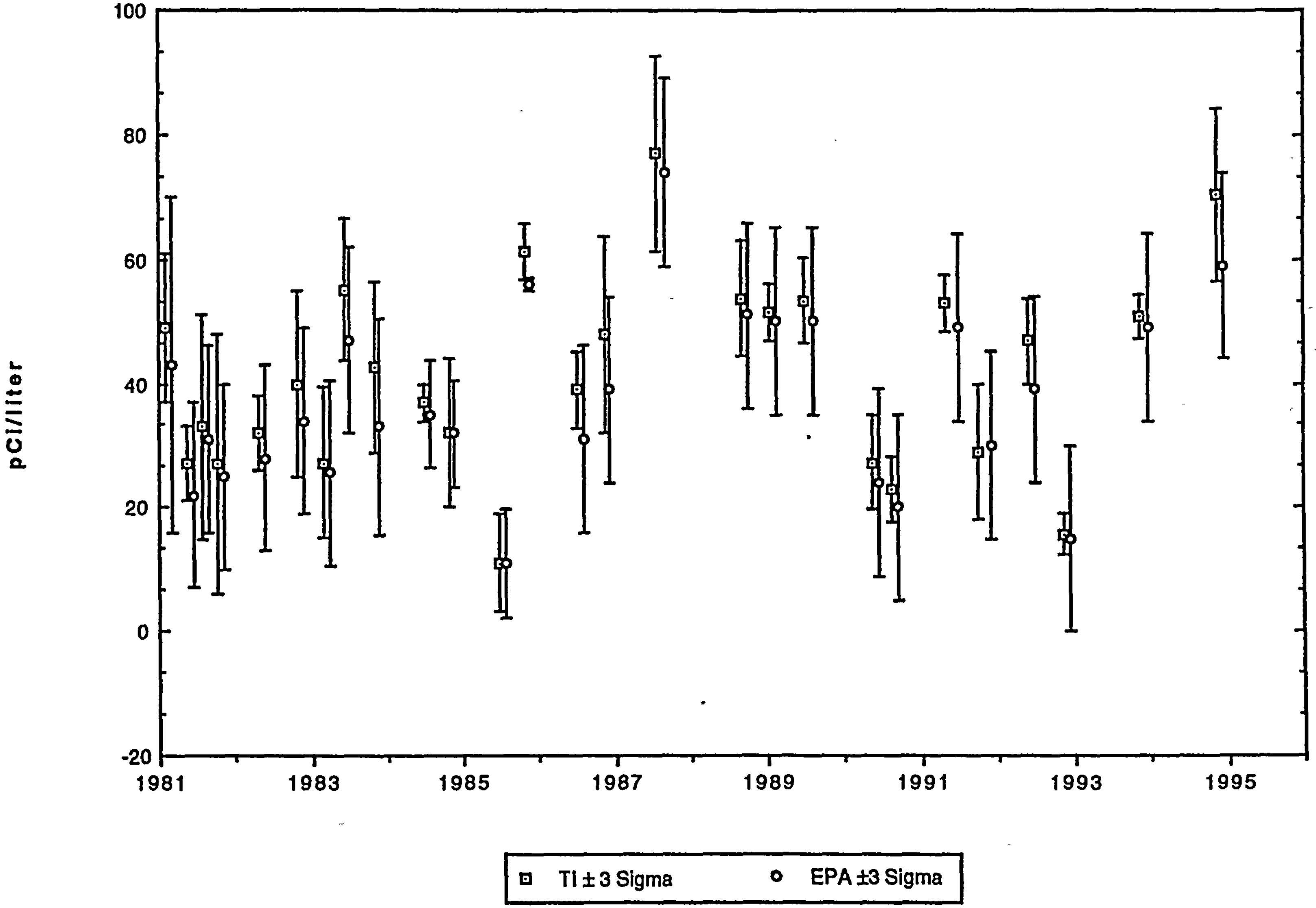
EPA CROSS CHECK PROGRAM

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



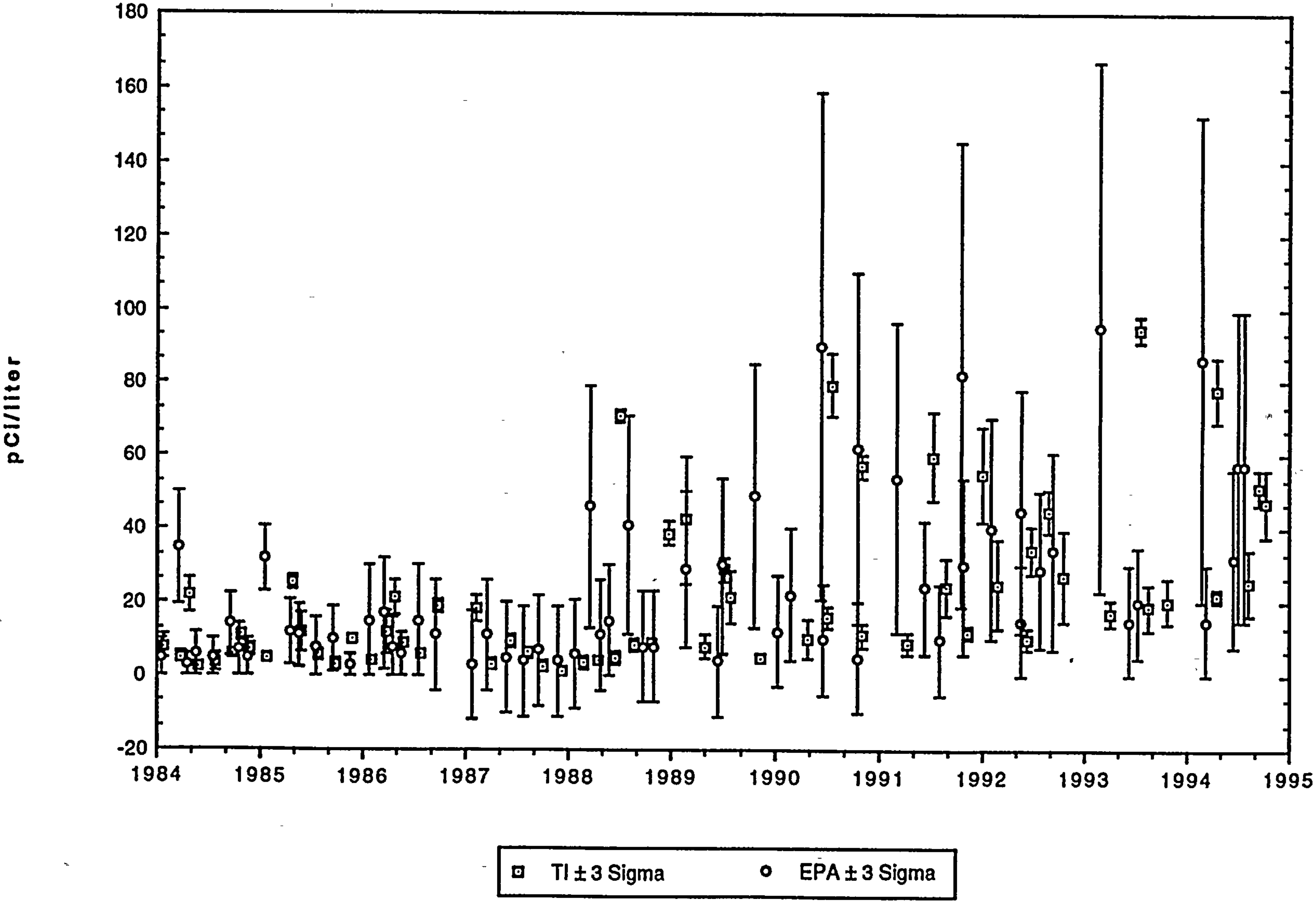
EPA CROSS CHECK PROGRAM

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



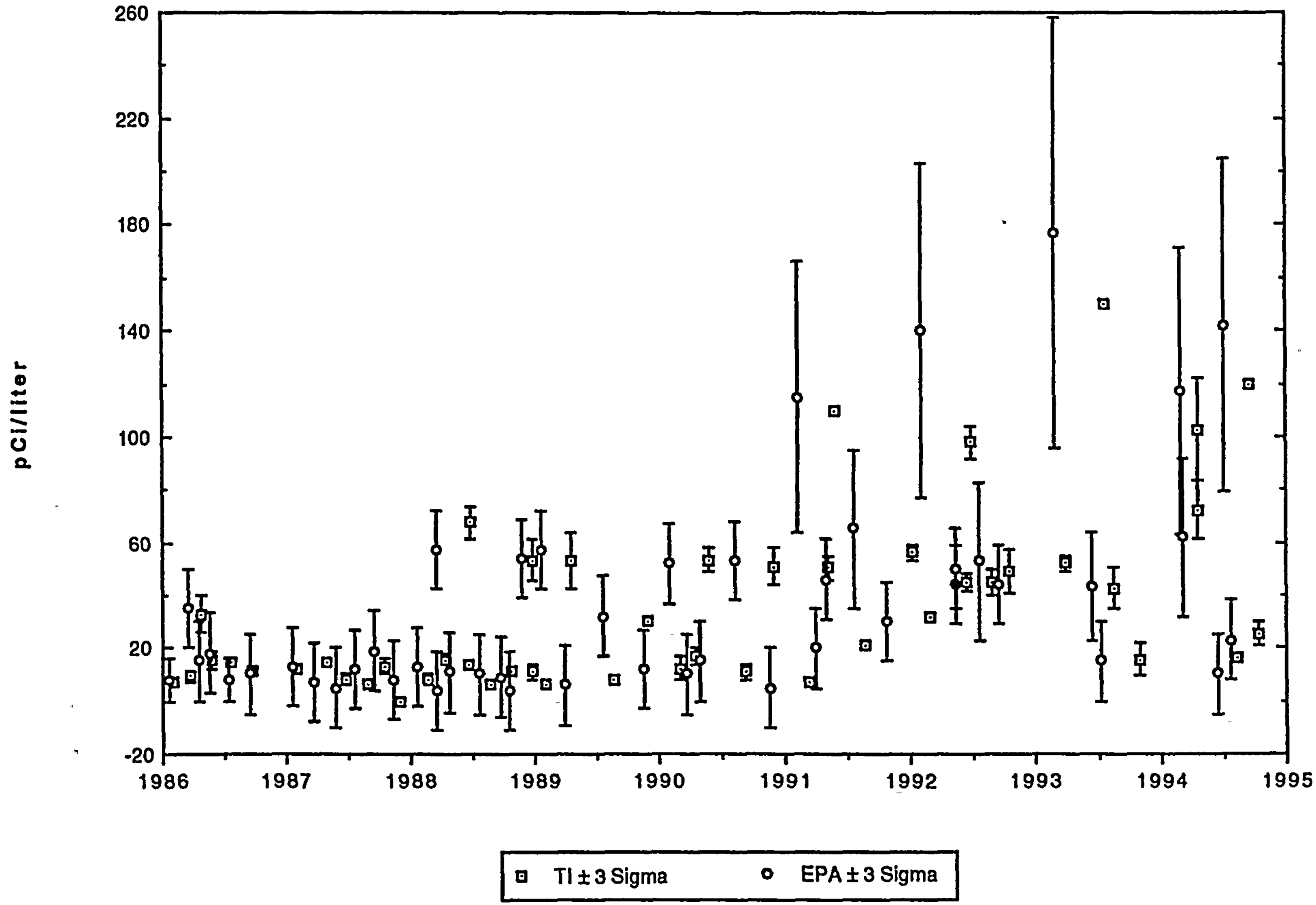
EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER (pg. 1 of 1)



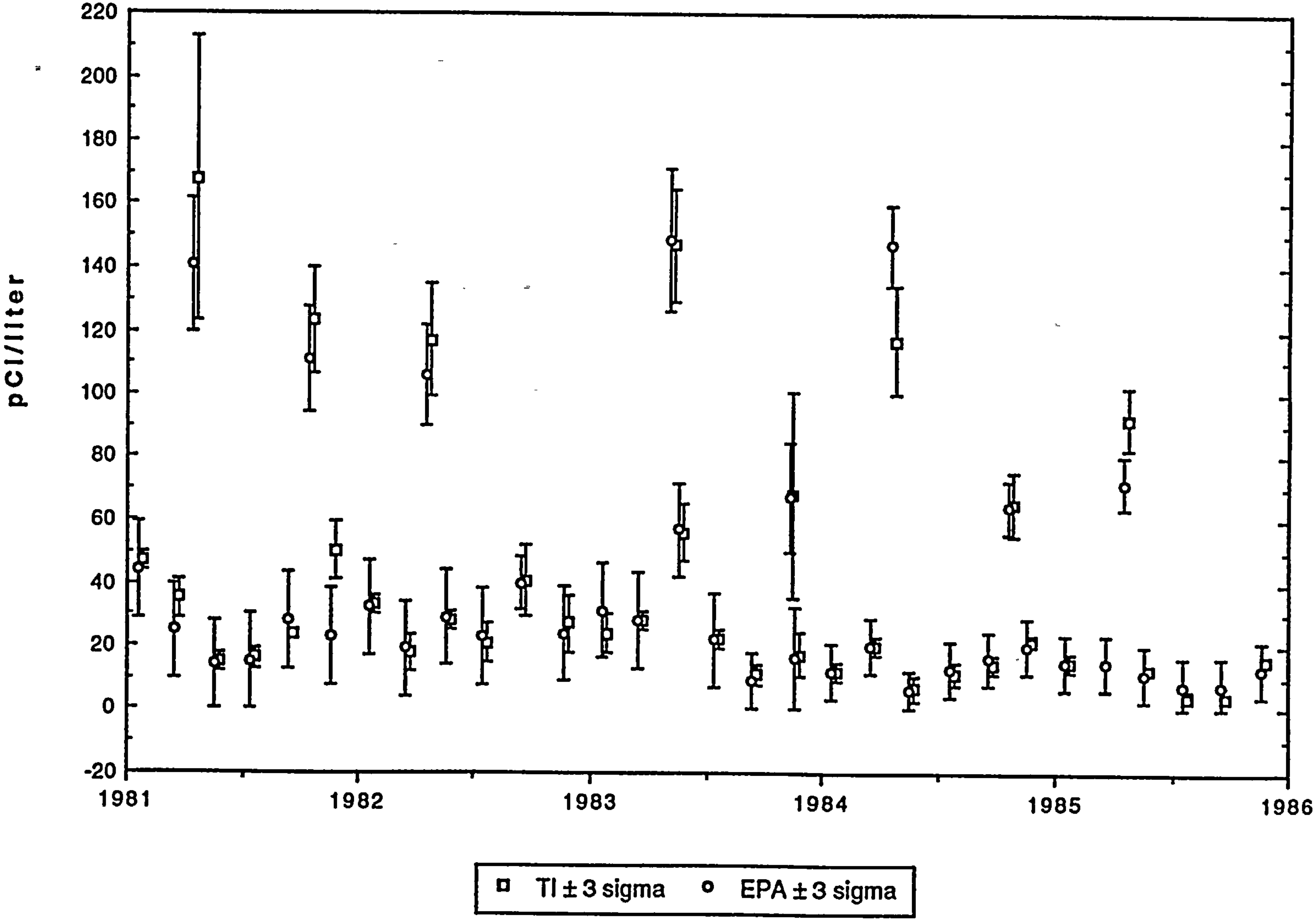
EPA CROSS CHECK PROGRAM

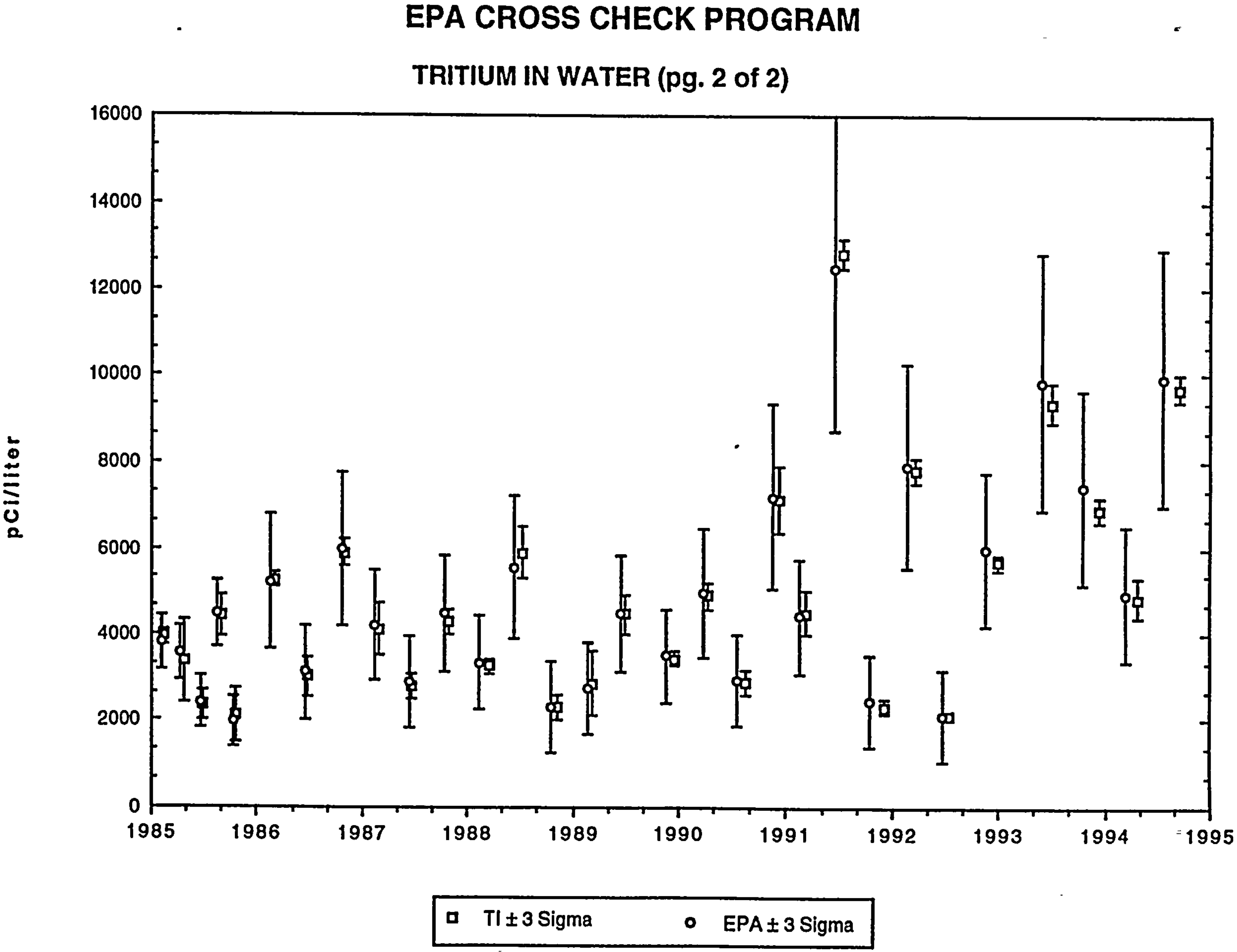
GROSS BETA IN WATER (pg. 2 of 2)



EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (pg. 1 of 2)

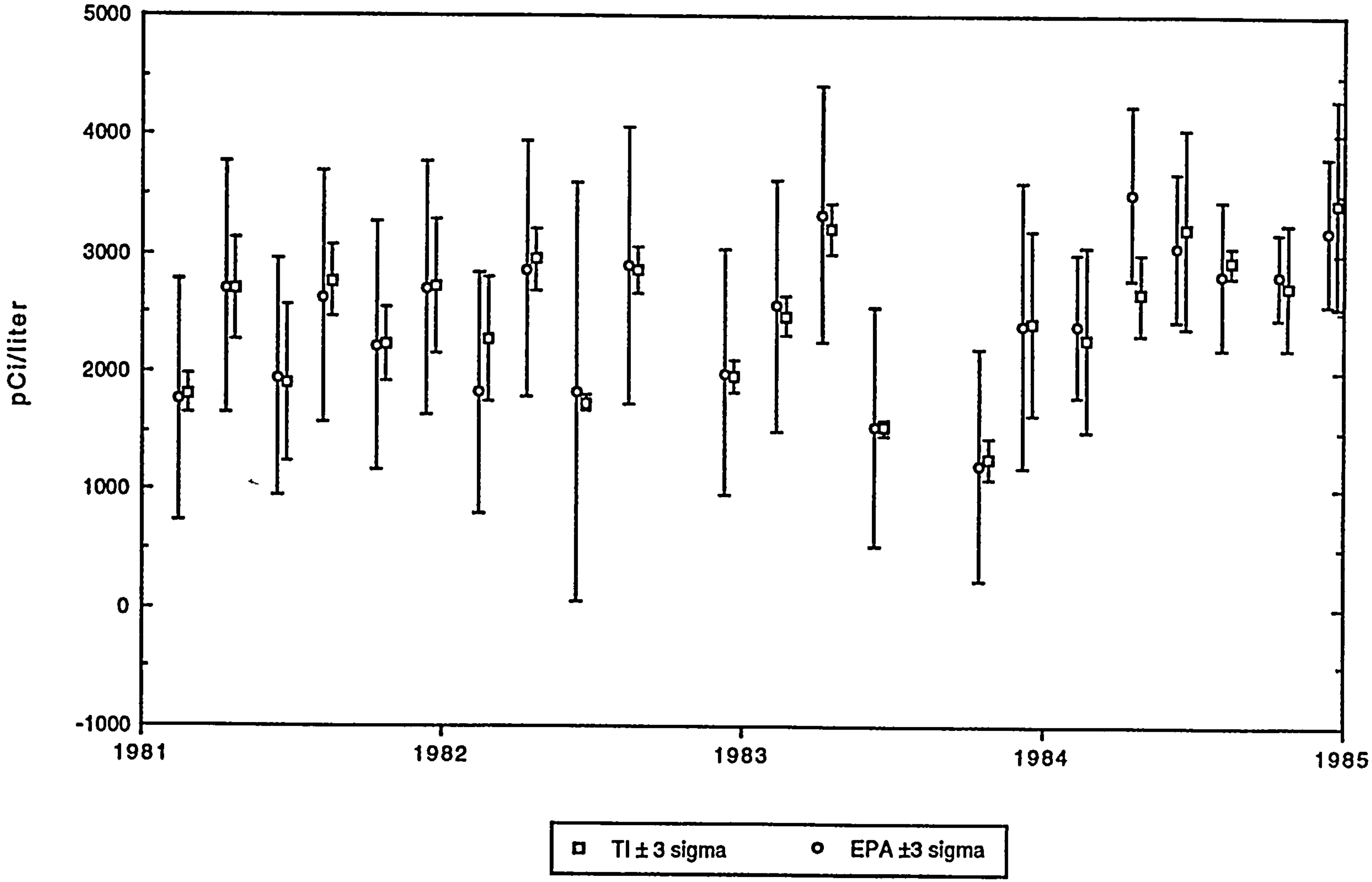




EPA CROSS CHECK PROGRAM
TRITIUM IN WATER (pg. 2 of 2)
pCi/liter
16000
14000
12000
10000
8000
6000
4000
2000
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
TI ± 3 Sigma
EPA ± 3 Sigma

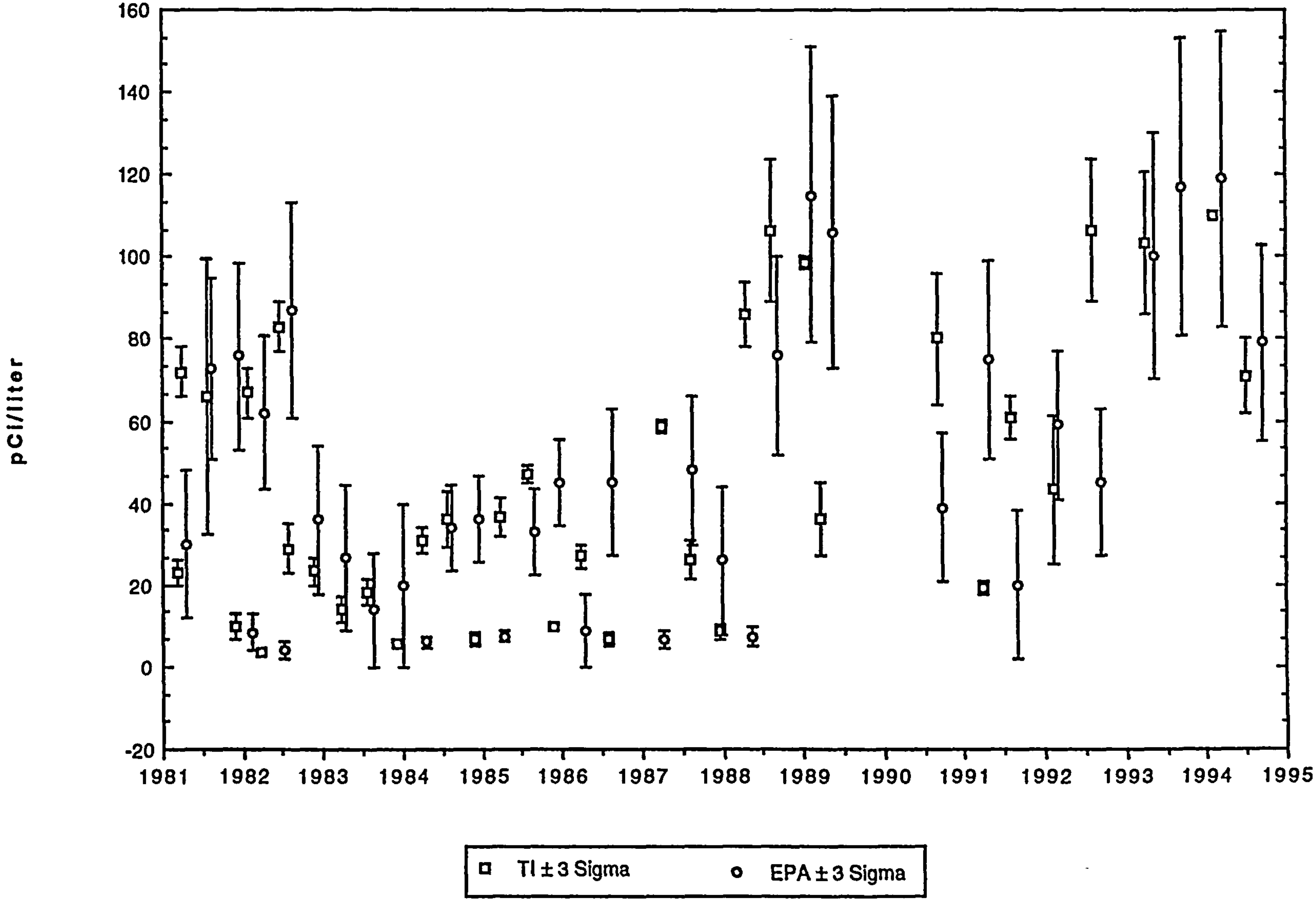
EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (pg. 1 of 2)



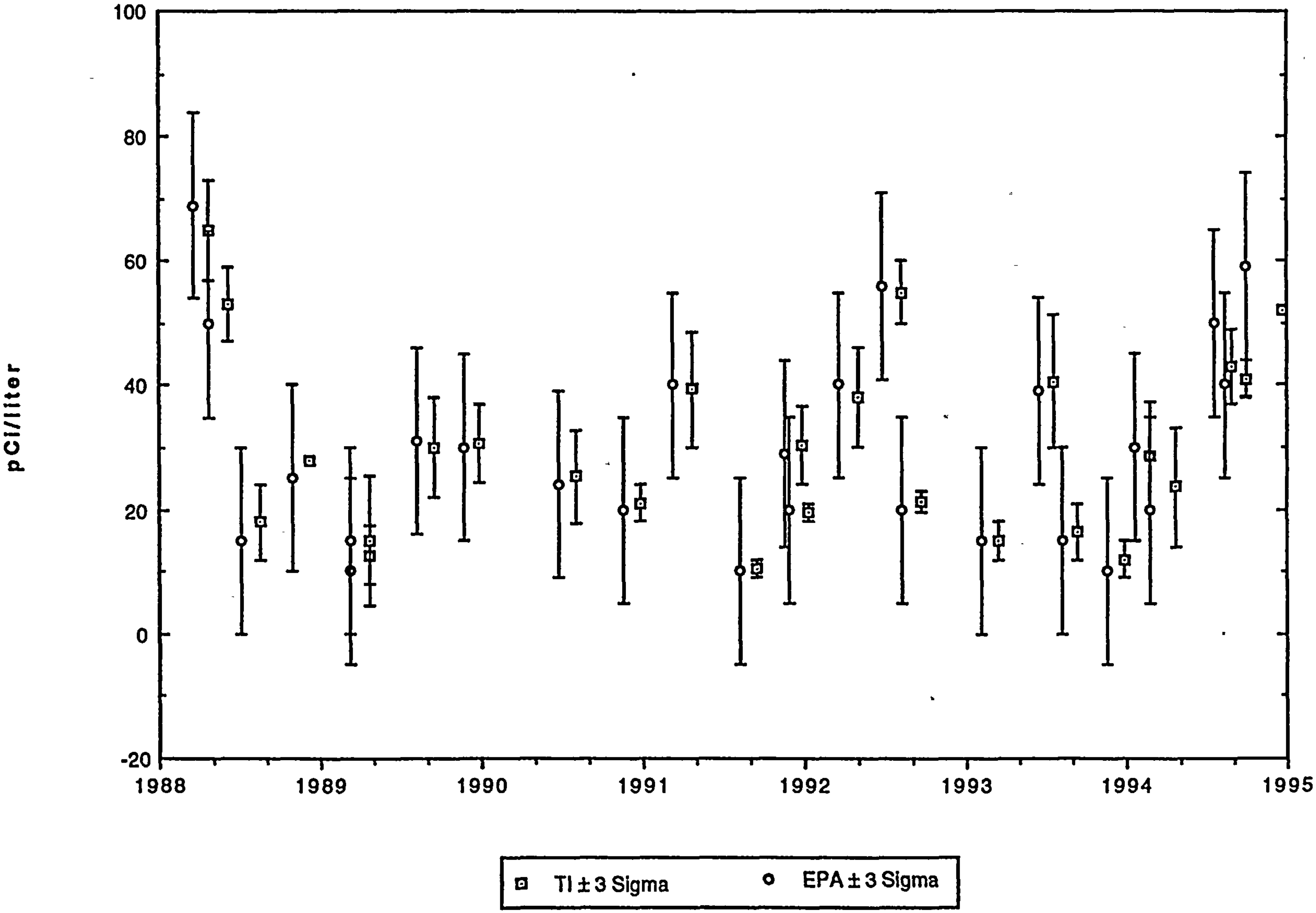
EPA CROSS CHECK PROGRAM

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



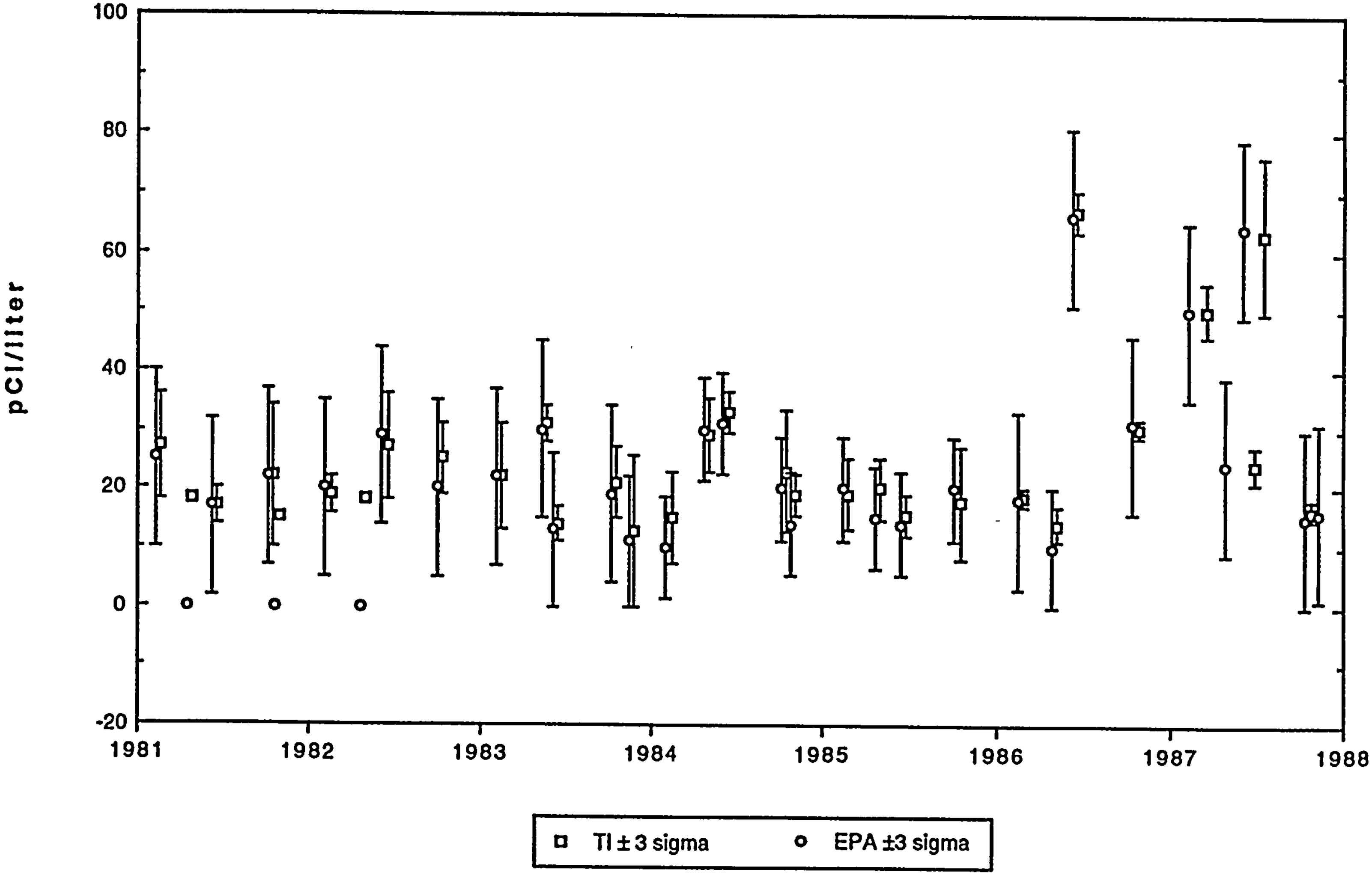
EPA CROSS CHECK PROGRAM

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



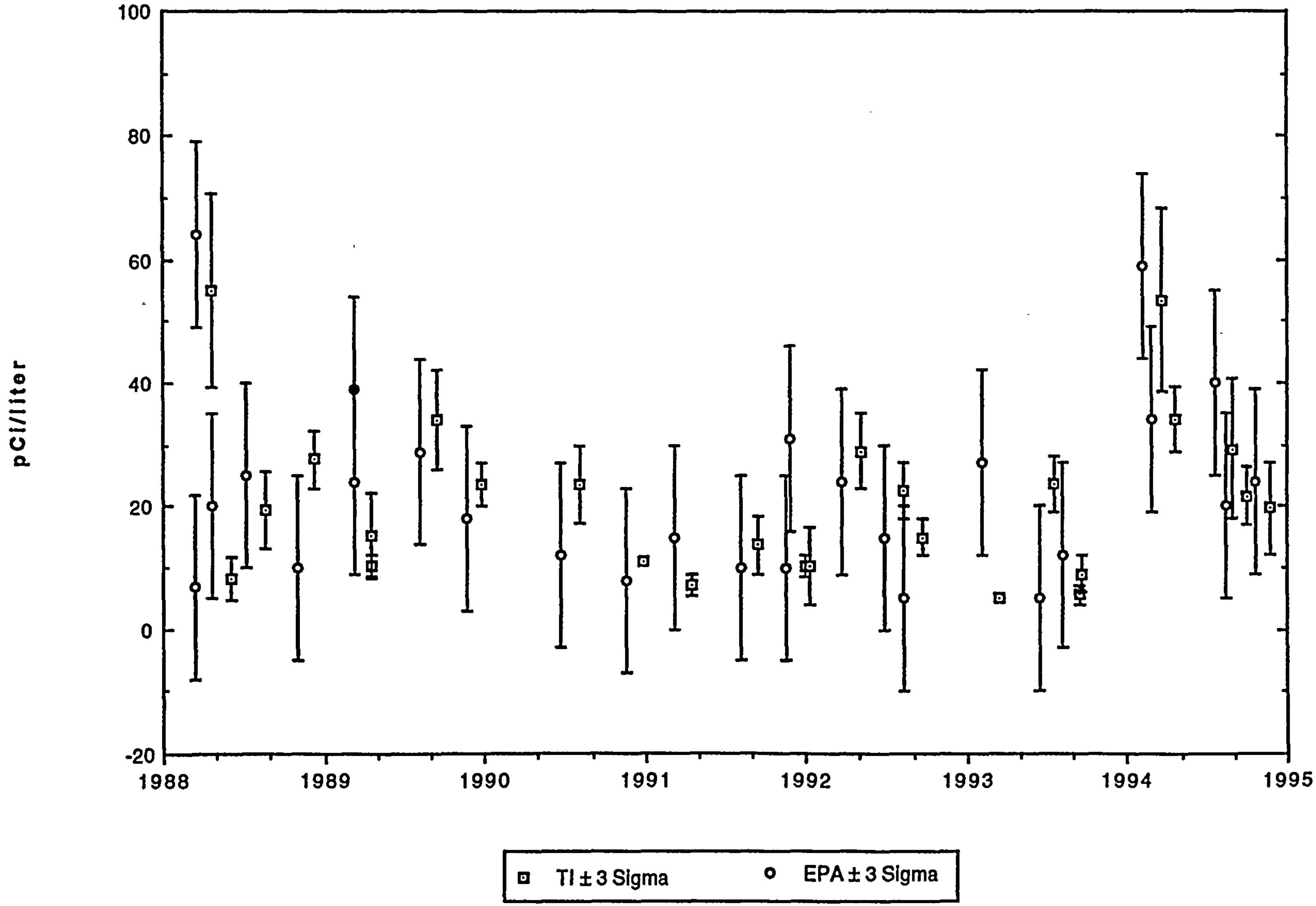
EPA CROSS CHECK PROGRAM

COBALT-60 IN WATER (pg 1 of 2)



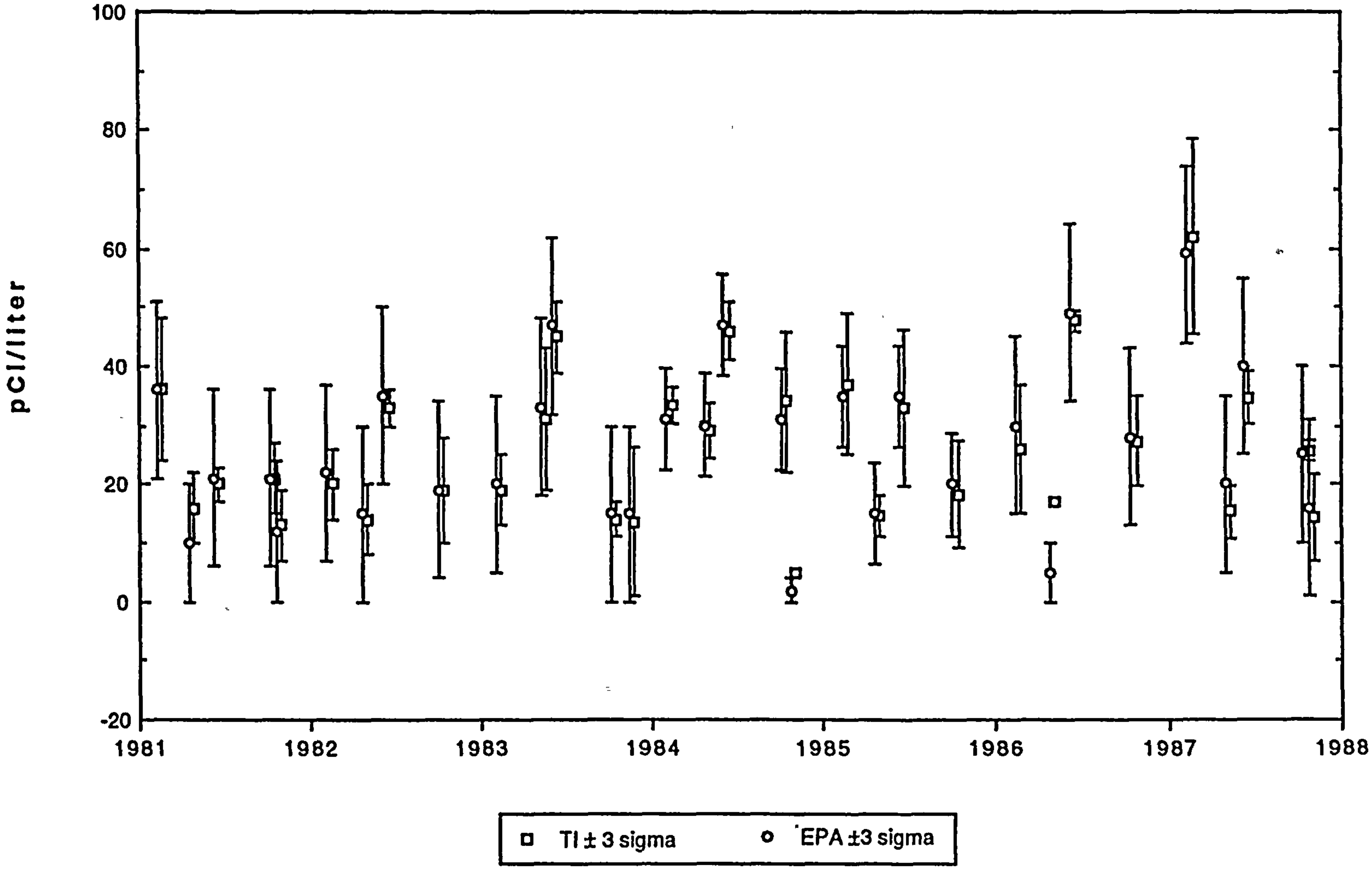
EPA CROSS CHECK PROGRAM

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



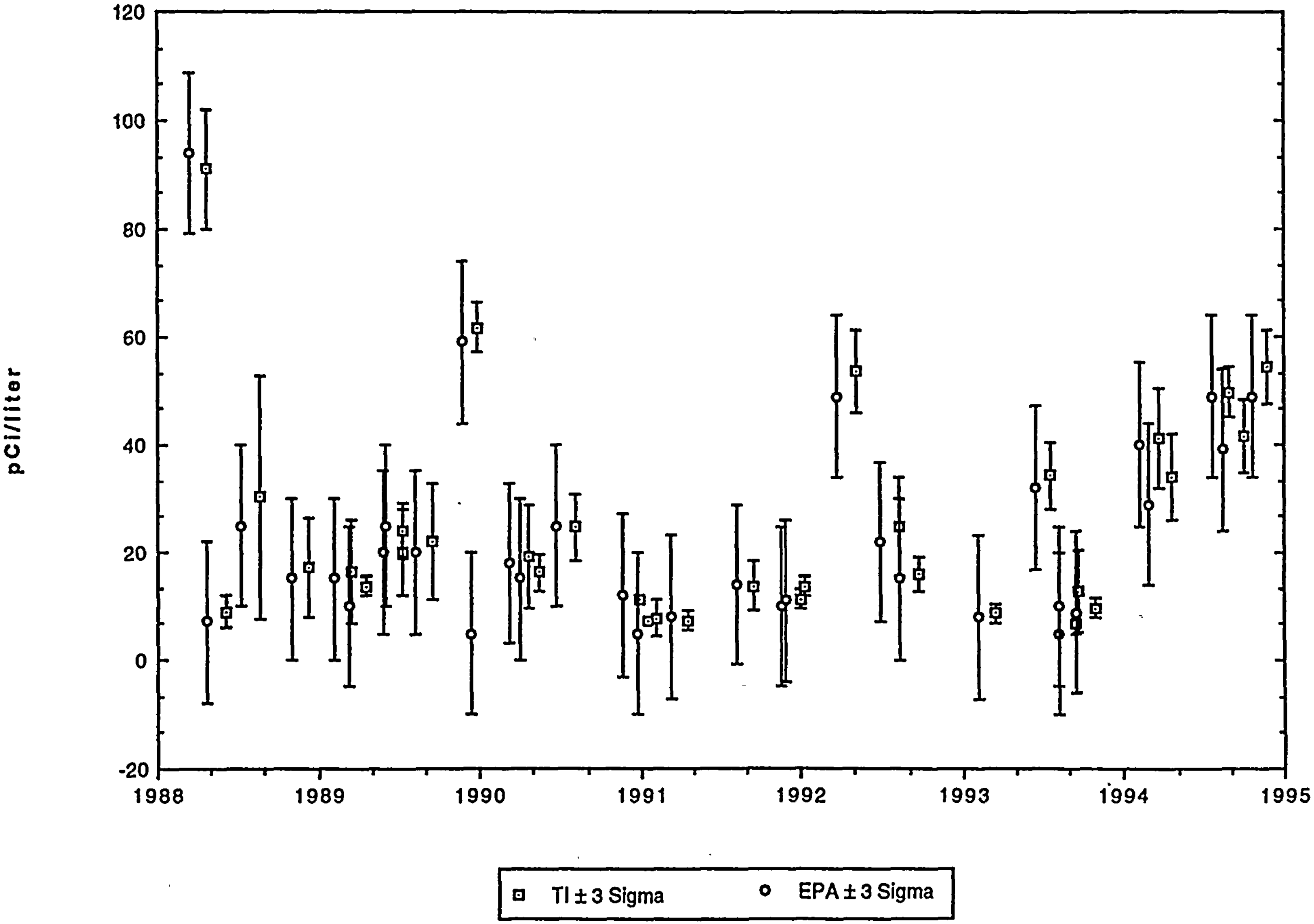
EPA CROSS CHECK PROGRAM

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



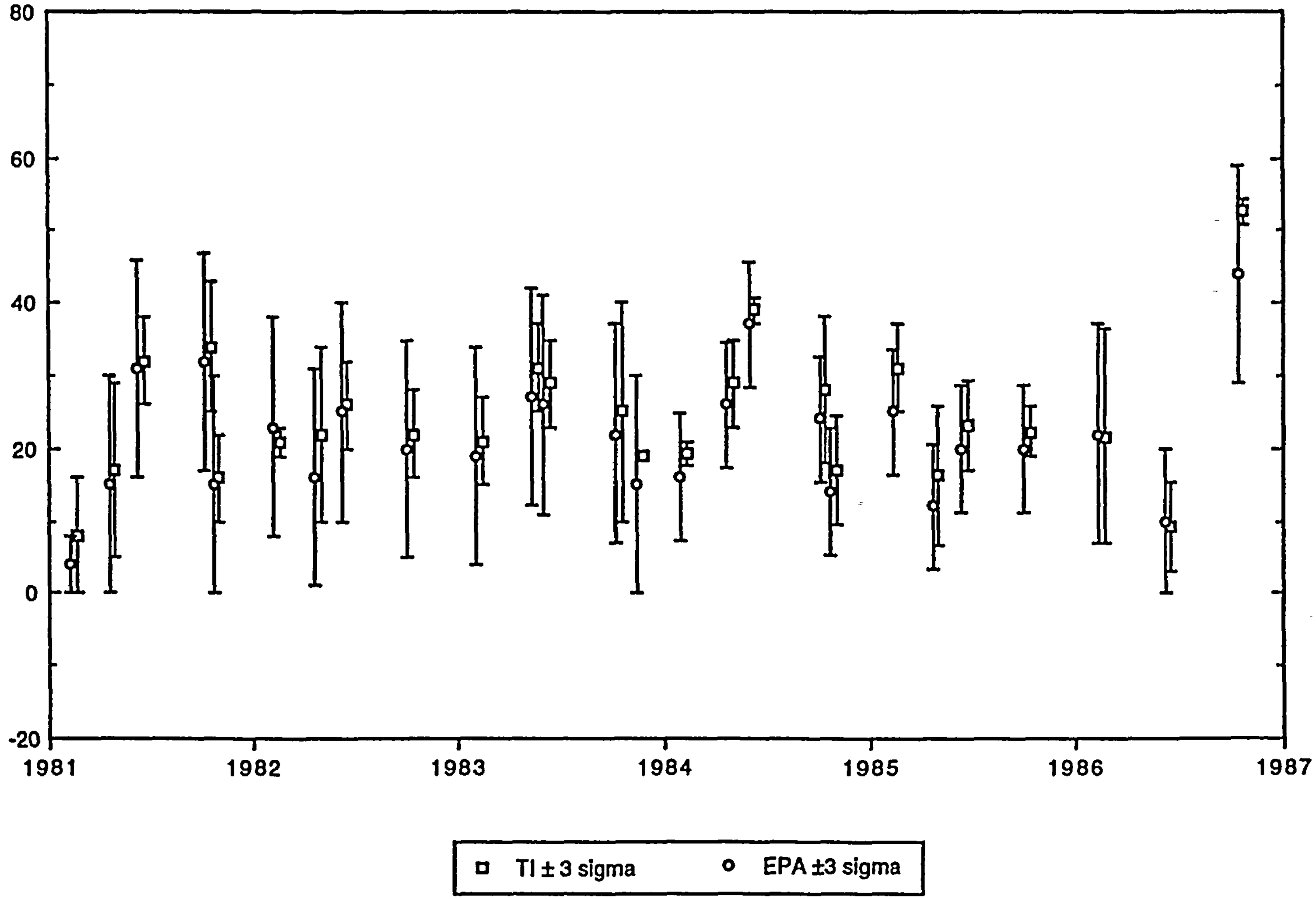
EPA CROSS CHECK PROGRAM

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



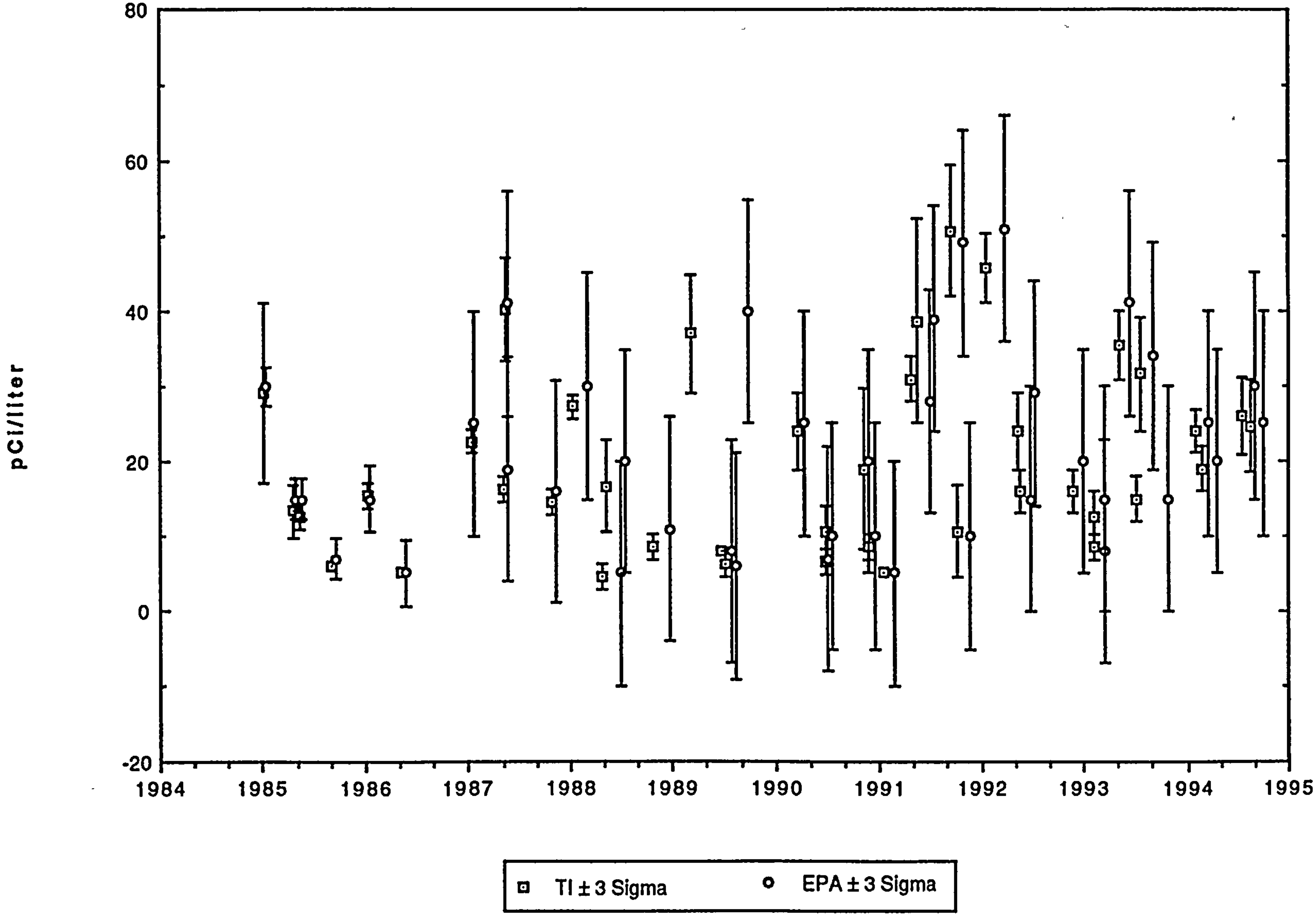
EPA CROSS CHECK PROGRAM

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



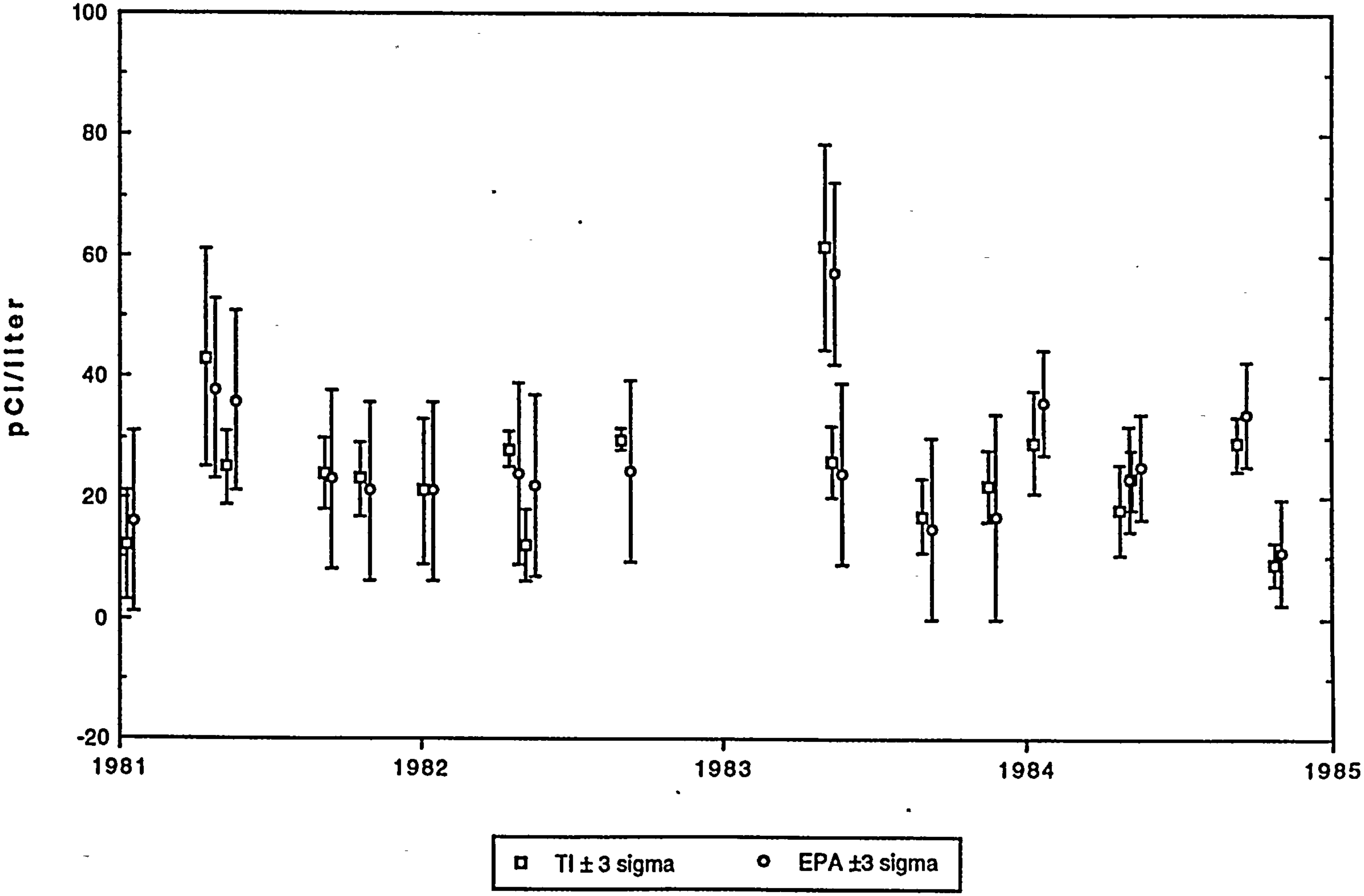
EPA CROSS CHECK PROGRAM

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



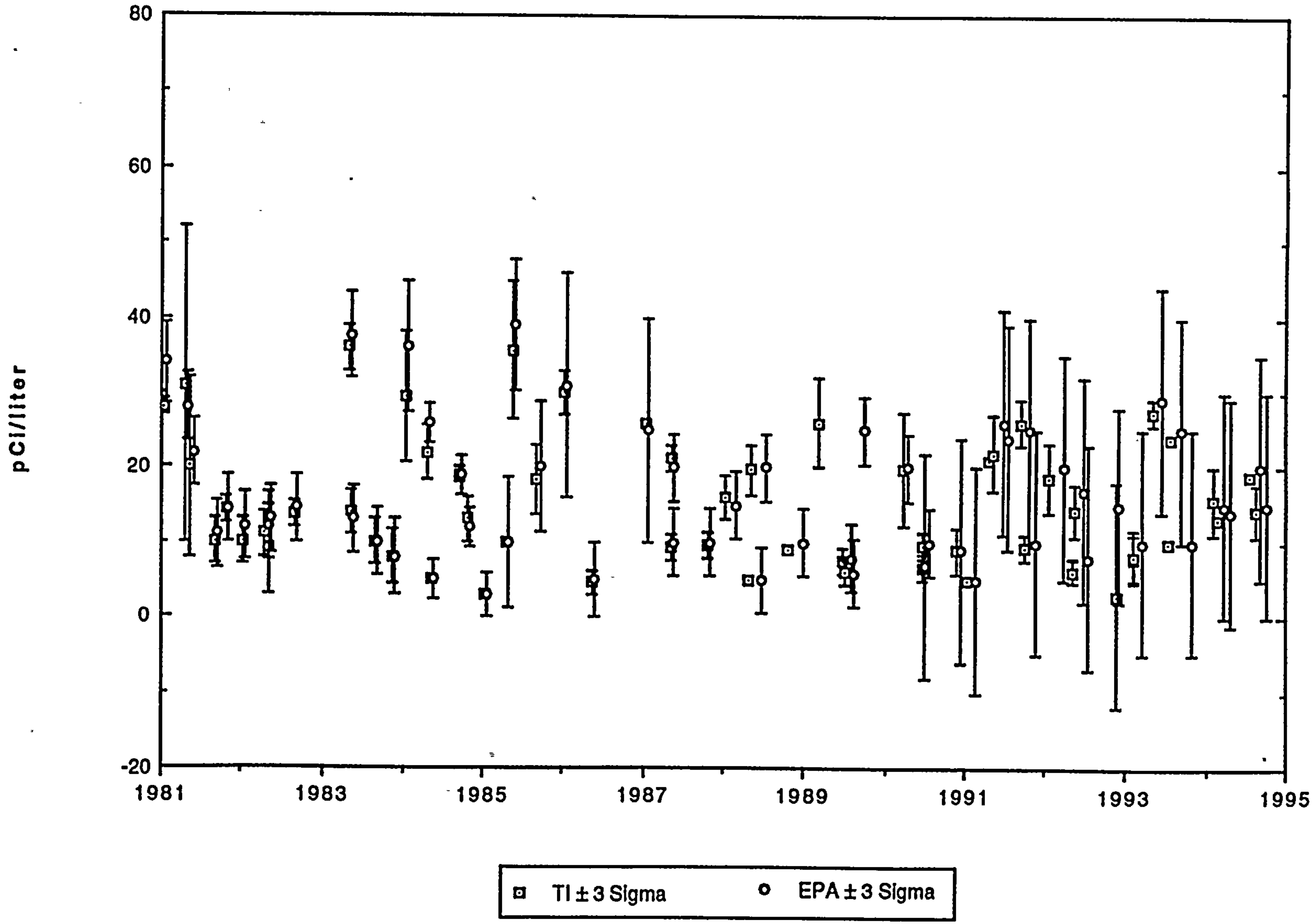
EPA CROSS CHECK PROGRAM

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



EPA CROSS CHECK PROGRAM

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



APPENDIX E

REMP SAMPLING AND ANALYTICAL EXCEPTIONS

PROGRAM EXCEPTIONS

REMP deviations for 1994 are listed at the end of this appendix. Where possible, the causes of the deviations have been corrected to prevent recurrence.

There were several incidents involving air samplers. One was the result of a damaged underground power cable and most others involved temporary voltage spikes which temporarily disabled the air sampler. All REMP air samplers were received from the manufacturer with a integral 10 amp breaker. This breaker increased the tendency for the air sampler to "trip the breaker" and become disabled until the breaker could be manually reset. The breaker was removed from ALL REMP air samplers. This reduced the frequency of tripped breakers resulting from voltage spikes without sacrificing equipment safety.

One air sampler was discovered with the filter jar off. This was evaluated and determined not to have a significant effect on the accumulated sample volume.

The Dowagiac air station had low sample volume on 11/14/94 likely attributed to a power outage at the Dowagiac switch yard.

Teledyne Brown reported the particulate filter at onsite air station A-4 to be "nearly as white as the blank". The possibility of leak in the air sampling train was evaluated with no discrepancies noted.

There were two incidents involving human error where a sample was not collected. On 04/04/94 the sample collector inadvertently did not place air sampling media in the A-4 onsite air sampling station. This resulted in a sample not being obtained for one sampling period. The sample collector was counseled regarding complacency and three preventive actions were imposed. First, the REMP air sample collection technique was standardized to emulate the RP Departments air sampling technique. Second, increased supervisory direction will be provided to the sample collector including a requirement for the sample collector to notify the plant after each sampling evolution. Third, increased random surveillance of the sample collectors actions and procedural adherence.

On 06/10/94 the Lake Township Water Treatment Facility did not collect the daily surface water sample. This was the result of technician oversight. The surface water samples are collected manually by water treatment personnel. This has been successfully performed for the past seven years. Automatic sampling equipment is available to perform this task, however based on past performance this option will not be utilized at this time.

The RP Department began collecting surface water samples for the REMP on 03/01/94. The actual collection began on 03/13/94 due to hazardous

conditions of shoreline ice. On 11/28/94 surface water was not collected due to high winds and hazardous conditions.

The surface water and sediment locations were revised to:
L-2 500 feet south of plant center intake pipeline
L-3 500 feet north of plant center intake pipeline
L-4 and L-5 station designators were discontinued.

Extreme cold temperatures and frozen pipes delayed groundwater sampling at two wells, W-2 and W-8. A new electrical service was being installed at groundwater well W-14 and power was unavailable until 02/14/94. All groundwater samples were collected within the 25% Tech Spec grace period.

Electricians working on groundwater pump electrical supply delayed sampling at well W-3, however the sample was eventually collected within the Tech Spec 25% grace period.

Malfunction of a drain back value at groundwater well W-2, a sample was unavailable for collection during the fourth quarter 1994. The drain back valve was replaced in December 1994.

Offsite TLD T-1 was missing from its designated location during the second quarter of 1994. This is believed to be the result of vandalism. There were additional TLDs in proximity which verified the measured dose to be consistent with environmental background levels.

The Totzke dairy farmers "sold the herd" and will no longer participate in the REMP Milk Sampling Program. A replacement farm (Schutze) began sampling 09/02/94.

On 08/01/94 Teledyne inadvertently analyzed only one air particulate QC sample when two had been sent. The "control" air particulate filter for the week 08/01/94 was utilized as the second blank sample.

Fish samples were unavailable at the offsite south location. Gill nets were deployed overnight at all four locations, however the offsite south net was without fish. High winds and rough water prevented leaving the nets deployed for additional sampling time.

The REMP Quality Control program is being performed by the contract analytical laboratory, Teledyne Brown Engineering, and the Donald C. Cook Nuclear Plant QC program was discontinued during the fourth quarter 1994. Several Donald C. Cook Nuclear Plant QC samples were performed during 1994, however the program was discontinued and results will be available by request from Teledyne Brown Engineering.

REMP Exceptions For Scheduled Sampling And Analysis During 1994

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
A-1	Air Particulate/ Air Iodine	10/17/94 10/24/94	Equipment malfunction; low sample volume.
A-2	" " "	02/14/94 02/28/94 08/08/94	Equipment malfunction; low sample volume.
A-2	" " "	07/18/94 07/24/94 08/01/94	Power failure; no sample available.
A-3	"	10/03/94	Equipment malfunction; low sample volume.
A-4	"	04/04/94	Sample not collected. Collector did not place at sampling location.
A-5	"	03/28/94	Equipment malfunction; low sample volume.
Dowagiac	"	11/14/94	Equipment malfunction; low sample volume.
New Buff	"	05/23/94	Equipment malfunction; low sample volume.
South Bend	"	04/04/94	Equipment malfunction; low sample volume.
Well-2	Ground Water	10/30/94	Malfunction of a drain back valve; no sample available.
L-2	Surface Water "	01/01/94 03/13/94 11/28/94	Lake frozen; no sample available.
L-3	Surface Water "	01/01/94 03/13/94 11/28/94	Lake frozen; no sample available.
L-4	Surface Water "	01/01/94 03/13/94	Lake frozen; no sample available.
L-5	Surface Water "	01/01/94 03/13/94	Lake frozen; no sample available.
Lake Twp	Drinking Water	06/23/94	No sample collected on 06/10/94.
OFS-South	Fish	10/18/94	Fish sample unavailable.
OFS-1	TLD	Second Qtr.	TLD and holder vandalized. Holder subsequently found but TLD never located.
Totzke	Milk	07/22/94	"Sold the herd".

APPENDIX F

1994 LAND USE CENSUS

APPENDIX F
SUMMARY OF THE 1994 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 1994 Land Use Census. The following is a summary of the 1994 results.

Milk Farm Survey

The milk farm survey is performed to update the list of milk farms located in the plant area, to identify the closest milk farm in each land sector, and to identify the nearest milk animal whose milk is used for human consumption. The milk farm survey for the Donald C. Cook Nuclear Plant was conducted on September 23, 1994.

In 1994 there were three deletions to the Michigan Department of Agriculture's list of dairy farms in Berrien County Michigan. One of the deleted farms was an indicator location and 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 Donald C. Cook Nuclear Plant whose milk is used for human consumption. The closest edge of the animals pasture is 13,425 feet from the Plant's centerline axis.

Residential Survey

The residential survey is performed to identify the closest residence in each land sector surrounding the Donald C. Cook Nuclear Plant. The residential survey was completed on September 23, 1994 using new residential building permits issued by Lake Township during the previous year. In addition a door-to-door survey was then conducted using a local area map. The closest residence to the Donald C. Cook Nuclear Plant in each sector remains unchanged from the previous year.

Broadleaf Survey

In accordance with 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 1994 were less than the Technical Specification LLDs.

Figure 4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Milk Farm Survey - 1994

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, Snow Rd. Baroda
	b	6.8	Lee Nelson	RFD 1, Box 390A, Snow Rd. Baroda
G	a	4.1	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda
	b	4.1	G. G. Shuler & Sons	RFD 1, Snow Rd., Baroda
H	a	7.0	George Freehling	2221 W. Glendora Rd., Buchanan
	b	7.0	George Freehling	2221 W. Glendora Rd., Buchanan
J	a	7.7	Jerry Warmbein	14143 Mill Rd., Three Oaks
	b	7.7	Jerry Warmbein	14143 Mill Rd., Three Oaks
K	a	12	Kenneth Tappan	Rt. 2, Kruger Rd, Three Oaks
	b	12	Kenneth Tappan	Rt. 2, Kruger Rd, Three Oaks

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

Figure 5

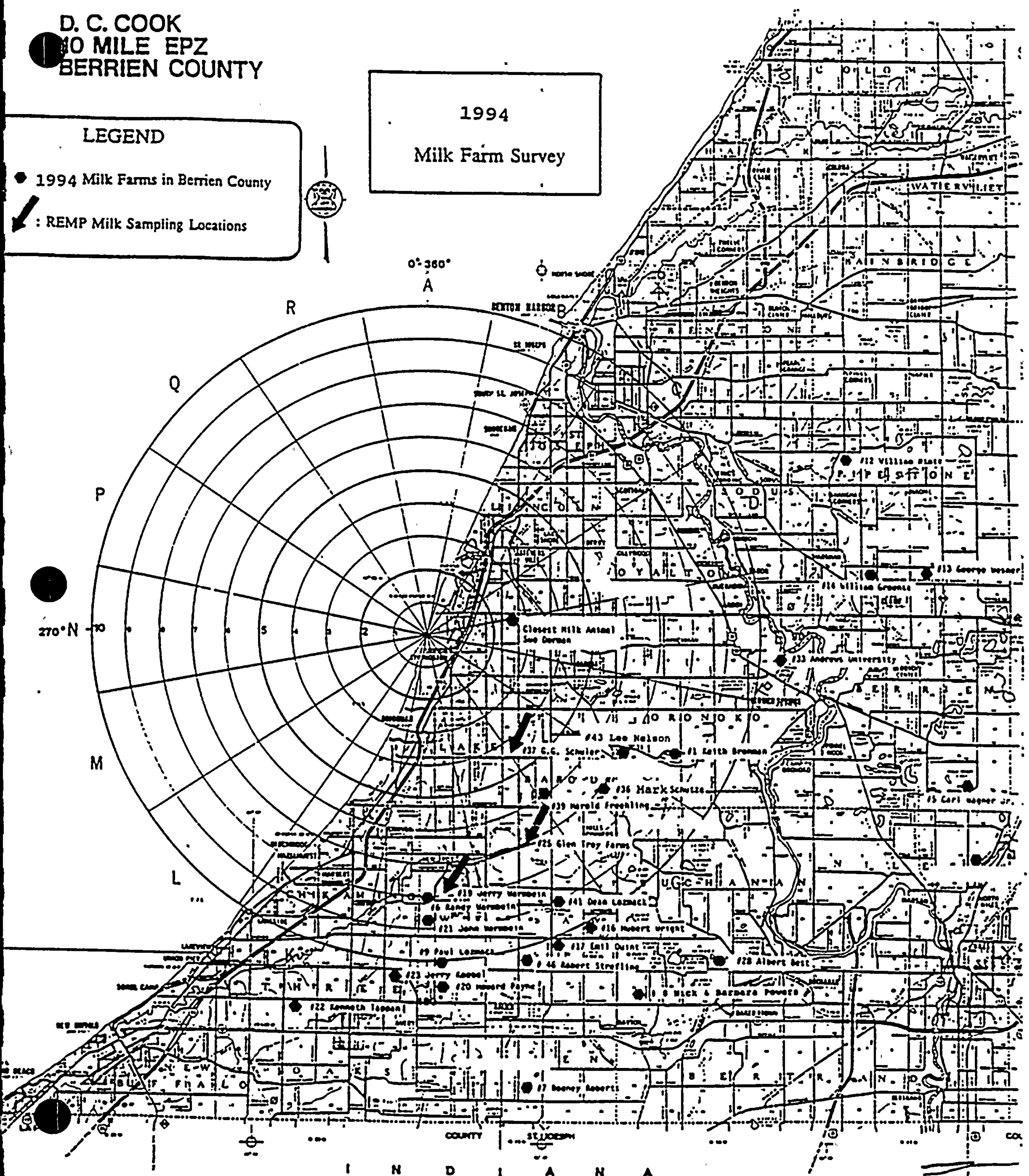
INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Residential Land Use Survey - 1994

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.

FIGURE 6


D. C. COOK
10 MILE EPZ
BERRIEN COUNTY
LEGEND
1994 Milk Farms in Berrien County
: REMP Milk Sampling Locations
1994
Milk Farm Survey
0°-360°
A
R
Q
P
270° N
M
L
#12 William Pratt
#13 George Wesner
#14 William Groenke
Closest Milk Animal
Sue Dorman
#33 Andrews University
#43 Lee Nelson
#37 G.C. Schuler
#1 Keith Brennan
#36 Mark Schutze
#39 Harold Froehling
#5 Carl Wagner Jr.
#25 Glen Troy Farms
#19 Jerry Wermbein
#6 Randy Wermbein
#41 Dean Lozmack
#21 John Wermbein
#16 Hubert Wright
#9 Paul Lozmack
#17 Emil Ouint
#46 Robert Strefling
#28 Albert Best
#23 Jerry Koebel
#20 Howard Payne
#22 Kenneth Tappan
Mick & Barbara Powers
#7 Rodney Roberts
WATERVLIET
BENTON HARBOR
COUNTY
ST. JOSEPH
I N D I A N A

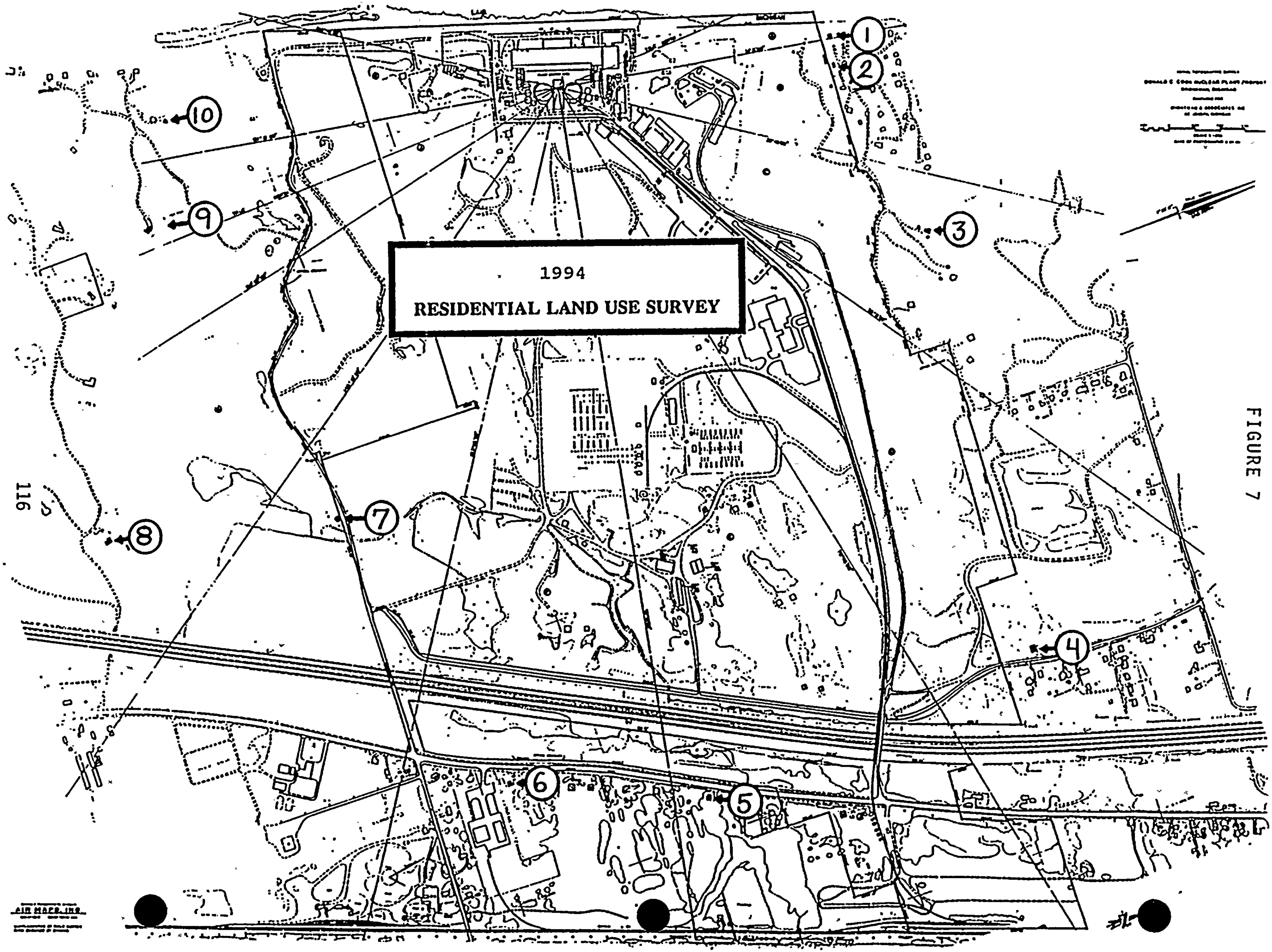


FIGURE 7

APPENDIX G

SUMMARY OF THE PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

SUMMARY OF THE PREOPERATIONAL RADIOLOGICAL MONITORING PROGRAM

A preoperational radiological environmental monitoring program was performed for the Donald C. Cook Nuclear Plant from August 1971 until the initial criticality of Unit 1 on January 18, 1975. The analyses of samples collected in the vicinity of the Donald C. Cook Nuclear Plant were performed by Eberline Instrument Corporation. The summary of the preoperational program presented in this appendix is based on the seven semi-annual reports covering the period. The purpose of this summary is to provide a comparison of the radioactivity measured in the environs of the Donald C. Cook Nuclear Plant during the pre-start up of Unit 1 and the radioactivity measured in 1994.

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

The Donald C. Cook Nuclear Plant's procedures for implementing the quality control program references Regulatory Guide 4.15 which outlines the use of blank, replicate and spike samples within four different parameters: gross beta, iodine, gamma isotopic, and tritium. The blank and replicate samples are prepared at Donald C. Cook Nuclear Plant and spiked samples are prepared by Teledyne Brown Engineering.

A Radiological Self Assessment of the REMP at Teledyne Brown Engineering was conducted by engineers of the American Electric Power Service Corporation (AEPSC). This audit was performed in the fall of 1994 and intended to ensure that the Donald C. Cook Nuclear Plant Technical Specifications and Regulatory Guide 4.15 and 4.1 were being adhered to by Teledyne Brown Engineering. It was concluded that Teledyne Brown Engineering is operating in accordance with Regulatory Guidelines and Plant Technical Specifications. It was determined by AEPSC that the Donald C. Cook Nuclear Plant REMP Quality Control samples are not required. This is based on Teledyne Brown Engineering's continual operation of an internal REMP Quality Control Program, inclusive of blank, replicate and spike samples, and participation in the EPA Interlaboratory Comparison Program. The AEPSC Radiological Self Assessment did recommend that the Donald C. Cook Nuclear Plant initiating a split sample program, utilizing an independent contractor, to realize the fullest intent of regulatory guidance. An independent contract to provide split samples is being prepared by the AEPSC and will be implemented in 1995.

Based on recommendations from the Radiological Self Assessment, the Donald C. Cook Nuclear Plant discontinued the REMP QC Program in the fourth quarter of 1994. There had been 12 QC samples analyzed as part of the REMP QC Program during 1994, all of which had acceptable results.

APPENDIX I

SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

TELEDYNE BROWN ENGINEERING QUALITY CONTROL PROGRAM

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

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

The gamma spectrometers are calibrated annually with a NIST traceable standard reference material selected to cover the energy range of the nuclides to be monitored and to include all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency were plotted at two energy levels on charts and held within three sigma control limits. From January 1, 1994 through August 31, 1994 the energy levels were 59.5 and 661.6 KeV and from September 1, 1994 through December 31, 1994 the energy levels were 59.5 and 1332 KeV. This procedure is described in PRO-042-44, "Calibration and Control of Gamma Ray Spectrometers".

The efficiency of the liquid scintillation counters is determined at least annually by counting NIST traceable standards which have been diluted in a known amount of distilled water and various amounts of quenching agent. The procedure is described in PRO-052-35, "Determination of Tritium by Liquid Scintillation". The background of each counter is measured with each batch of samples. A control chart is maintained for the background and check source measurements as a stability check. Preparation of carrier solutions and acceptability criteria are contained in procedure PRO-032-49 "Standardization of Radio-chemical Carrier Solutions". Preparation of

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

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

No deviations from written procedures occurred during 1994.

Results of Duplicate Analyses for 1994

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates	Gr-Beta	1.6 ± 0.3 E-02	1.7 ± 0.3 E-02
Results in Units of	"	2.0 ± 0.3 E-02	1.9 ± 0.3 E-02
10^{-3} pCi/m^3	"	3.2 ± 0.3 E-02	3.0 ± 0.3 E-02
	"	2.0 ± 0.3 E-02	2.0 ± 0.3 E-02
	"	2.0 ± 0.3 E-02	1.9 ± 0.3 E-02
	"	2.5 ± 0.3 E-02	2.6 ± 0.3 E-02
	"	1.9 ± 0.3 E-02	2.1 ± 0.3 E-02
	"	2.6 ± 0.3 E-02	2.8 ± 0.3 E-02
	"	2.7 ± 0.3 E-02	2.4 ± 0.3 E-02
	"	3.4 ± 0.3 E-02	3.4 ± 0.3 E-02
	"	3.0 ± 0.3 E-02	2.7 ± 0.3 E-02
	"	2.5 ± 0.3 E-02	2.3 ± 0.3 E-02
	"	3.3 ± 0.4 E-02	3.4 ± 0.4 E-02
	"	2.6 ± 0.3 E-02	2.6 ± 0.3 E-02
	"	4.3 ± 0.4 E-02	4.2 ± 0.4 E-02
	"	1.6 ± 0.3 E-02	1.9 ± 0.4 E-02
	"	2.2 ± 0.3 E-02	2.0 ± 0.3 E-02
Air Particulates/ Charcoal Filters	Iodine-131	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
Results in Units of	"	L. T. 1. E-02	L. T. 1. E-02
10^{-3} pCi/m^3	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 9. E-03	L. T. 2. E-02
	"	L. T. 8. E-03	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 7. E-03
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 3. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 3. E-02
	"	L. T. 2. E-02	L. T. 8. E-03
Surface Water	Gamma	(a)	(a)
Results in Units of	"	(a)	(a)
pCi/liter	H-3	1.1 ± 0.1 E 04	1.0 ± 0.1 E 04
	H-3	1.0 ± 0.1 E 04	1.1 ± 0.1 E 04

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

Results of Duplicate Analyses for 1994 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Ground Water	Gamma	(a)	(a)
Results in Units of	"	(a)	(a)
pCi/liter	"	(a)	(a)
	"	(a)	(a)
	H-3	(a)	(a)
	H-3	(a)	(a)
	H-3	(a)	(a)
Drinking Water	Gr-Beta	2.7 ± 0.8 E 00	2.3 ± 0.8 E 00
Results in Units of	Gr-Beta	4.4 ± 1.0 E 00	3.8 ± 0.8 E 00
pCi/liter	Gr-Beta	2.7 ± 0.8 E 00	2.3 ± 0.8 E 00
	Gamma	(a)	(a)
	"	(a)	(a)
	"	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)
Sediment	K-40	1.14 ± 0.11 E 04	1.40 ± 0.14 E 04
Results in Units of	Co-60	8.97 ± 0.90 E 02	9.42 ± 0.94 E 02
pCi/kg (wet)	Cs-134	1.68 ± 0.41 E 02	1.87 ± 0.32 E 02
	Cs-137	5.40 ± 0.54 E 02	6.78 ± 0.68 E 02
	Ra-226	2.60 ± 0.70 E 03	1.87 ± 0.56 E 03
	Th-228	1.12 ± 0.11 E 03	1.17 ± 0.12 E 03
Milk	Cs-137	1.36 ± 0.14 E 03	1.33 ± 0.13 E 03
Results in Units of	Sr-90	2.3 ± 0.2 E 00	2.0 ± 0.2 E 00
pCi/liter	K-40	1.38 ± 0.14 E 03	1.44 ± 0.14 E 03
	K-40	1.30 ± 0.13 E 03	1.38 ± 0.14 E 03
	Sr-90	3.2 ± 0.2 E 00	4.2 ± 0.3 E 00
	K-40	1.34 ± 0.13 E 03	1.42 ± 0.14 E 03
	Sr-90	2.4 ± 0.2 E 00	2.1 ± 0.3 E 00
	K-40	1.42 ± 0.42 E 03	1.42 ± 0.14 E 03
	Sr-90	3.4 ± 0.2 E 00	2.9 ± 0.2 E 00
	K-40	1.25 ± 0.13 E 03	1.26 ± 0.13 E 03
	I-131	(a)	(a)
	K-40	1.25 ± 0.13 E 03	1.55 ± 0.16 E 03
Fish Results in Units of pCi/kg (wet)	K-40	2.33 ± 0.23 E 03	2.24 ± 0.22 E 03
Food Results in Units of pCi/kg (wet)	K-40	1.64 ± 0.16 E 04	1.63 ± 0.16 E 04

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

Results of Duplicate Analyses for 1994

Sample Type	Analysis	First Analysis	Second Analysis
Air Particulates	Gr-Beta	1.6 ± 0.3 E-02	1.7 ± 0.3 E-02
Results in Units of	"	2.0 ± 0.3 E-02	1.9 ± 0.3 E-02
10^{-3} pCi/m^3	"	3.2 ± 0.3 E-02	3.0 ± 0.3 E-02
	"	2.0 ± 0.3 E-02	2.0 ± 0.3 E-02
	"	2.0 ± 0.3 E-02	1.9 ± 0.3 E-02
	"	2.5 ± 0.3 E-02	2.6 ± 0.3 E-02
	"	1.9 ± 0.3 E-02	2.1 ± 0.3 E-02
	"	2.6 ± 0.3 E-02	2.8 ± 0.3 E-02
	"	2.7 ± 0.3 E-02	2.4 ± 0.3 E-02
	"	3.4 ± 0.3 E-02	3.4 ± 0.3 E-02
	"	3.0 ± 0.3 E-02	2.7 ± 0.3 E-02
	"	2.5 ± 0.3 E-02	2.3 ± 0.3 E-02
	"	3.3 ± 0.4 E-02	3.4 ± 0.4 E-02
	"	2.6 ± 0.3 E-02	2.6 ± 0.3 E-02
	"	4.3 ± 0.4 E-02	4.2 ± 0.4 E-02
	"	1.6 ± 0.3 E-02	1.9 ± 0.4 E-02
	"	2.2 ± 0.3 E-02	2.0 ± 0.3 E-02
Air Particulates/ Charcoal Filters	Iodine-131	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 1. E-02
Results in Units of	"	L. T. 1. E-02	L. T. 1. E-02
10^{-3} pCi/m^3	"	L. T. 2. E-02	L. T. 1. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 1. E-02
	"	L. T. 9. E-03	L. T. 2. E-02
	"	L. T. 8. E-03	L. T. 2. E-02
	"	L. T. 2. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 7. E-03
	"	L. T. 1. E-02	L. T. 2. E-02
	"	L. T. 3. E-02	L. T. 2. E-02
	"	L. T. 1. E-02	L. T. 3. E-02
	"	L. T. 2. E-02	L. T. 8. E-03
Surface Water	Gamma	(a)	(a)
Results in Units of	"	(a)	(a)
pCi/liter	H-3	1.1 ± 0.1 E 04	1.0 ± 0.1 E 04
	H-3	1.0 ± 0.1 E 04	1.1 ± 0.1 E 04
Direct Radiation	TLD	5.5 ± 0.3 E 00	5.5 ± 0.6 E 00
TLDs	"	5.8 ± 0.3 E 00	5.7 ± 0.4 E 00
Results in mR/month	"	5.5 ± 0.5 E 00	5.8 ± 0.8 E 00
	"	5.6 ± 0.4 E 00	5.6 ± 1.3 E 00
	"	5.5 ± 0.4 E 00	5.8 ± 0.1 E 00

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

Results of Duplicate Analyses for 1994 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Surface Water	Gamma	(a)	(a)
Results in Units of	"	(a)	(a)
pCi/liter	H-3	1.1 ± 0.1 E 04	1.0 ± 0.1 E 04
	H-3	1.0 ± 0.1 E 04	1.1 ± 0.1 E 04
Ground Water	Gamma	(a)	(a)
Results in Units of	"	(a)	(a)
pCi/liter	"	(a)	(a)
	"	(a)	(a)
	H-3	(a)	(a)
	H-3	(a)	(a)
	H-3	(a)	(a)
Drinking Water	Gr-Beta	2.7 ± 0.8 E 00	2.3 ± 0.8 E 00
Results in Units of	Gr-Beta	4.4 ± 1.0 E 00	3.8 ± 0.8 E 00
pCi/liter	Gr-Beta	2.7 ± 0.8 E 00	2.3 ± 0.8 E 00
	Gamma	(a)	(a)
	"	(a)	(a)
	"	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)
	I-131	(a)	(a)
Sediment	K-40	1.14 ± 0.11 E 04	1.40 ± 0.14 E 04
Results in Units of	Co-60	8.97 ± 0.90 E 02	9.42 ± 0.94 E 02
pCi/kg (wet)	Cs-134	1.68 ± 0.41 E 02	1.87 ± 0.32 E 02
	Cs-137	5.40 ± 0.54 E 02	6.78 ± 0.68 E 02
	Ra-226	2.60 ± 0.70 E 03	1.87 ± 0.56 E 03
	Th-228	1.12 ± 0.11 E 03	1.17 ± 0.12 E 03
Milk	Cs-137	1.36 ± 0.14 E 03	1.33 ± 0.13 E 03
Results in Units of	Sr-90	2.3 ± 0.2 E 00	2.0 ± 0.2 E 00
pCi/liter	K-40	1.38 ± 0.14 E 03	1.44 ± 0.14 E 03
	K-40	1.30 ± 0.13 E 03	1.38 ± 0.14 E 03
	Sr-90	3.2 ± 0.2 E 00	4.2 ± 0.3 E 00
	K-40	1.34 ± 0.13 E 03	1.42 ± 0.14 E 03
	Sr-90	2.4 ± 0.2 E 00	2.1 ± 0.3 E 00
	K-40	1.42 ± 0.42 E 03	1.42 ± 0.14 E 03
	Sr-90	3.4 ± 0.2 E 00	2.9 ± 0.2 E 00
	K-40	1.25 ± 0.13 E 03	1.26 ± 0.13 E 03
	I-131	(a)	(a)
	K-40	1.25 ± 0.13 E 03	1.55 ± 0.16 E 03

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

Results of Duplicate Analyses for 1994 (Cont.)

Sample Type	Analysis	First Analysis	Second Analysis
Fish Results in Units of pCi/kg (wet)	K-40	2.33 ± 0.23 E 03	2.24 ± 0.22 E 03
Food Results in Units of pCi/kg (wet)	K-40	1.64 ± 0.16 E 04	1.63 ± 0.16 E 04

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

Teledyne Brown Engineering In-House Spiked Sample Results - 1994
Water

Analysis	Spike Levels (pCi/L)	Acceptable Range (pCi/l)
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 (1/1-4/30/94)	1.2 - 1.6 E 03 (1/1-4/30/94
H-3 (LS)	1.3 ± 0.2 E 03 (5/1-12/31/94	1.1 - 1.5 E 03 (5/1-12/31/94)

TI #	Analysis Date	Gross Beta Activity (pCi/l)
38026	01/05/94	2.2 ± 0.2 E 01
39087	01/12/94	2.2 ± 0.2 E 01
39533	01/19/94	2.7 ± 0.2 E 01
39854	01/26/94	1.7 ± 0.2 E 01
40729	02/02/94	2.2 ± 0.2 E 01
41319	02/09/94	2.4 ± 0.2 E 01
41837	02/16/94	2.3 ± 0.2 E 01
42228	02/23/94	2.2 ± 0.2 E 01
42678	03/02/94	2.2 ± 0.2 E 01
43622	03/09/94	1.6 ± 0.1 E 01
44596	03/16/94	1.9 ± 0.1 E 01
45290	03/23/94	2.0 ± 0.2 E 01
45856	03/30/94	1.9 ± 0.2 E 01
46492	04/06/94	1.7 ± 0.1 E 01
47089	04/13/94	2.3 ± 0.2 E 01
48196	04/20/94	2.0 ± 0.2 E 01
48585	04/27/94	1.9 ± 0.1 E 01
49509	05/04/94	2.2 ± 0.2 E 01
50026	05/11/94	2.3 ± 0.2 E 01
50854	05/18/94	1.9 ± 0.2 E 01
51456	05/25/94	1.9 ± 0.1 E 01
52009	06/01/94	2.6 ± 0.2 E 01
52588	06/08/94	2.4 ± 0.2 E 01
53334	06/15/94	2.2 ± 0.2 E 01
53901	06/22/94	1.9 ± 0.2 E 01
54517	06/29/94	2.1 ± 0.1 E 01
55311	07/06/94	1.7 ± 0.1 E 01
56281	07/13/94	2.1 ± 0.2 E 01
57029	07/20/94	2.1 ± 0.2 E 01
57164	07/27/94	2.2 ± 0.2 E 01
58331	08/03/94	2.1 ± 0.2 E 01
58653	08/10/94	1.8 ± 0.1 E 01
59459	08/17/94	2.1 ± 0.2 E 01
60105	08/24/94	2.5 ± 0.2 E 01
60717	08/31/94	1.8 ± 0.1 E 01

TI #	Analysis Date	Gross Beta Activity (pCi/l)
61230	09/07/94	11.7 ± 0.1 E 01
62077	09/14/94	12.0 ± 0.1 E 01
62627	09/21/94	11.8 ± 0.1 E 01
63246	09/28/94	11.9 ± 0.1 E 01
63785	10/05/94	12.0 ± 0.2 E 01
64460	10/12/94	11.7 ± 0.1 E 01
65349	10/19/94	12.4 ± 0.2 E 01
65883	10/26/94	11.6 ± 0.1 E 01
66472	11/02/94	12.0 ± 0.1 E 01
67231	11/09/94	11.8 ± 0.1 E 01
67859	11/16/94	12.6 ± 0.2 E 01
68461	11/23/94	82.4 ± 0.2 E 01
68952	11/30/94	11.9 ± 0.1 E 01
69568	12/07/94	12.1 ± 0.2 E 01
70715	12/14/94	12.0 ± 0.2 E 01
71441	12/21/94	11.7 ± 0.1 E 01
72382	12/28/94	12.2 ± 0.2 E 01

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
38031	01/05/94	2.21 ± 0.22 E 04
39092	01/12/94	2.23 ± 0.22 E 04
39538	01/19/94	2.26 ± 0.23 E 04
39859	01/26/94	2.17 ± 0.22 E 04
40734	02/02/94	2.17 ± 0.24 E 04
41324	02/09/94	2.25 ± 0.23 E 04
41842	02/16/94	2.24 ± 0.22 E 04
42233	02/23/94	2.23 ± 0.22 E 04
42683	03/02/94	2.15 ± 0.22 E 04
43627	03/09/94	2.27 ± 0.23 E 04
44601	03/16/94	2.25 ± 0.23 E 04
45295	03/23/94	2.18 ± 0.22 E 04
45861	03/30/94	2.18 ± 0.22 E 04
46497	04/06/94	2.21 ± 0.22 E 04
47094	04/13/94	2.21 ± 0.22 E 04
48201	04/20/94	2.25 ± 0.23 E 04
48590	04/27/94	2.22 ± 0.22 E 04
49514	05/04/94	2.17 ± 0.22 E 04
50031	05/11/94	2.11 ± 0.21 E 04
50859	05/18/94	2.28 ± 0.23 E 04
51461	05/25/94	2.28 ± 0.23 E 04
52014	06/01/94	2.27 ± 0.23 E 04
52593	06/08/94	2.18 ± 0.22 E 04
53339	06/15/94	2.06 ± 0.21 E 04

SPIKES - GAMMA (Cs-137)

TI #	Analysis Date	Activity (pCi/l)
53906	06/22/94	2.25 ± 0.23 E 04
54522	06/29/94	2.26 ± 0.23 E 04
55316	07/06/94	2.06 ± 0.21 E 04
56286	07/13/94	2.17 ± 0.22 E 04
57034	07/20/94	2.17 ± 0.22 E 04
57169	07/27/94	2.21 ± 0.22 E 04
58336	08/03/94	2.26 ± 0.23 E 04
58658	08/10/94	2.26 ± 0.23 E 04
59464	08/17/94	2.22 ± 0.22 E 04
60110	08/24/94	2.27 ± 0.23 E 04
60722	08/31/94	2.12 ± 0.21 E 04
61235	09/07/94	2.27 ± 0.23 E 04
62082	09/14/94	2.19 ± 0.22 E 04
62632	09/21/94	2.30 ± 0.23 E 04
63251	09/28/94	2.15 ± 0.22 E 04
63790	10/05/94	2.22 ± 0.22 E 04
64465	10/12/94	2.30 ± 0.23 E 04
65354	10/19/94	2.09 ± 0.21 E 04
65888	10/26/94	2.28 ± 0.23 E 04
66477	11/02/94	2.09 ± 0.21 E 04
67236	11/09/94	2.21 ± 0.22 E 04
67864	11/16/94	2.21 ± 0.22 E 04
68466	11/23/94	2.23 ± 0.22 E 04
68957	11/30/94	2.32 ± 0.23 E 04
69573	12/07/94	2.22 ± 0.22 E 04
70720	12/14/94	2.28 ± 0.23 E 04
71446	12/21/94	2.18 ± 0.22 E 04
72387	12/28/94	2.27 ± 0.23 E 04

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
38028	01/05/94	1.2 ± 0.1 E 03
39089	01/12/94	1.3 ± 0.2 E 03
39535	01/19/94	1.3 ± 0.1 E 03
39856	01/26/94	1.3 ± 0.1 E 03
40731	02/02/94	1.3 ± 0.1 E 03
41321	02/09/94	1.3 ± 0.1 E 03
41839	02/16/94	1.4 ± 0.1 E 03
42230	02/23/94	1.4 ± 0.1 E 03
42680	03/02/94	1.4 ± 0.1 E 03
43624	03/09/94	1.4 ± 0.1 E 03
44598	03/16/94	1.4 ± 0.1 E 03
45292	03/23/94	1.2 ± 0.1 E 03
45858	03/30/94	1.6 ± 0.1 E 03

SPIKES - TRITIUM - (H-3) 10ml

TI #	Analysis Date	Activity (pCi/l)
46494	04/06/94	1.4 ± 0.2 E 03
47091	04/13/94	1.4 ± 0.1 E 03
48198	04/20/94	1.5 ± 0.1 E 03
48587	04/27/94	1.4 ± 0.1 E 03
49511	05/04/94	1.1 ± 0.1 E 03
50028	05/11/94	1.4 ± 0.1 E 03
50856	05/18/94	1.4 ± 0.1 E 03
51458	05/25/94	1.4 ± 0.2 E 03
52011	06/01/94	1.4 ± 0.1 E 03
52590	06/08/94	1.5 ± 0.1 E 03
53336	06/15/94	1.4 ± 0.1 E 03
53903	06/22/94	1.3 ± 0.1 E 03
54519	06/29/94	1.4 ± 0.2 E 03
55313	07/06/94	1.2 ± 0.1 E 03
56283	07/13/94	1.4 ± 0.1 E 03
57031	07/20/94	1.4 ± 0.1 E 03
57166	07/27/94	1.4 ± 0.1 E 03
58333	08/03/94	1.5 ± 0.2 E 03
58655	08/10/94	1.4 ± 0.1 E 03
59461	08/17/94	1.4 ± 0.2 E 03
60107	08/24/94	1.2 ± 0.2 E 03
60719	08/31/94	1.3 ± 0.1 E 03
61232	09/07/94	1.3 ± 0.1 E 03
62079	09/14/94	1.2 ± 0.2 E 03
62629	09/21/94	1.4 ± 0.2 E 03
63248	09/28/94	1.4 ± 0.1 E 03
63787	10/05/94	1.3 ± 0.2 E 03
64462	10/12/94	1.34 ± 0.16 E 03
65351	10/19/94	1.33 ± 0.14 E 03
65885	10/26/94	1.33 ± 0.14 E 03
66474	11/02/94	1.34 ± 0.14 E 03
67233	11/09/94	1.33 ± 0.15 E 03
67861	11/16/94	1.44 ± 0.17 E 03
68463	11/23/94	1.43 ± 0.16 E 03
68954	11/30/94	1.21 ± 0.15 E 03
69570	12/07/94	1.38 ± 0.15 E 03
70717	12/14/94	1.25 ± 0.15 E 03
71443	12/21/94	1.35 ± 0.15 E 03
72387	12/28/94	1.41 ± 0.15 E 03

Teledyne Brown Engineering In-House Blanks Sample Results - 1994
Water

GROSS BETA BLANKS

TI #	Analysis Date	Gross Beta Activity (pCi/l)
38025	01/05/94	L. T. 9. E-01
39086	01/12/94	L. T. 1. E 00
39532	01/19/94	L. T. 1. E 00
39853	01/26/94	L. T. 1. E 00
40728	02/02/94	L. T. 1. E 00
41318	02/09/94	L. T. 6. E-01
41836	02/16/94	L. T. 1. E 00
42227	02/23/94	L. T. 1. E 00
42677	03/02/94	L. T. 1. E 00
43621	03/09/94	L. T. 6. E-01
44595	03/16/94	L. T. 8. E-01
45289	03/23/94	L. T. 9. E-01
45855	03/30/94	L. T. 9. E-01
46491	04/06/94	L. T. 1. E 00
47088	04/13/94	L. T. 9. E-01
48195	04/20/94	L. T. 8. E-01
48584	04/27/94	L. T. 7. E-01
49508	05/04/94	L. T. 8. E-01
50025	05/11/94	L. T. 1. E 00
50853	05/18/94	L. T. 1. E 00
51455	05/25/94	L. T. 7. E-01
52006	06/01/94	L. T. 1. E 00
52587	06/08/94	L. T. 1. E 00
53333	06/15/94	L. T. 8. E-01
54516	06/29/94	L. T. 7. E-01
55310	07/06/94	L. T. 9. E-01
56280	07/13/94	L. T. 9. E-01
57028	07/20/94	L. T. 1. E 00
57163	07/27/94	L. T. 8. E-01
58330	08/03/94	L. T. 9. E-01
58652	08/10/94	L. T. 9. E-01
59458	08/17/94	L. T. 8. E-01
60104	08/24/94	L. T. 8. E-01
60716	08/31/94	L. T. 8. E-01
61229	09/07/94	L. T. 7. E-01
62076	09/14/94	L. T. 7. E-01
62626	09/21/94	L. T. 7. E-01
63245	09/28/94	L. T. 8. E-01
63784	10/05/94	L. T. 1. E 00
64459	10/12/94	L. T. 8. E-01

GROSS BETA - BLANKS (Cont.)

TI #	Analysis Date	Gross Beta Activity (pCi/l)
65348	10/19/94	L. T. 8. E-01
65882	10/26/94	L. T. 9. E-01
66471	11/02/94	L. T. 9. E-01
67230	11/09/94	L. T. 8. E-01
67858	11/16/94	L. T. 1. E 00
68460	11/23/94	L. T. 1. E 00
68951	11/30/94	L. T. 1. E 00
69567	12/07/94	L. T. 1. E 00
70714	12/14/94	L. T. 1. E 00
71440	12/21/94	L. T. 8. E-01
72381	12/28/94	L. T. 7. E-01

TRITIUM - (H-3) - BLANKS

TI #	Analysis Date	Activity (pCi/l)
38030	01/05/94	L. T. 1. E 02
39091	01/12/94	L. T. 2. E 02
39537	01/19/94	L. T. 2. E 02
39858	01/26/94	L. T. 2. E 02
40733	02/02/94	L. T. 1. E 02
41323	02/09/94	L. T. 2. E 02
41841	02/16/94	L. T. 1. E 02
42232	02/23/94	L. T. 1. E 02
42682	03/02/94	L. T. 1. E 02
43626	03/09/94	L. T. 2. E 02
44600	03/16/94	L. T. 2. E 02
45294	03/23/94	L. T. 2. E 02
45860	03/30/94	L. T. 1. E 02
46496	04/06/94	L. T. 2. E 02
47093	04/13/94	L. T. 1. E 02
48200	04/20/94	L. T. 1. E 02
48589	04/27/94	L. T. 2. E 02
49513	05/04/94	L. T. 2. E 02
50030	05/11/94	L. T. 1. E 02
50858	05/18/94	L. T. 1. E 02
51460	05/25/94	L. T. 2. E 02
52013	06/01/94	L. T. 2. E 02
52592	06/08/94	L. T. 1. E 02
53338	06/15/94	L. T. 1. E 02
53905	06/22/94	L. T. 1. E 02
54521	06/29/94	L. T. 2. E 02

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

TI #	Analysis Date	Activity (pCi/l)
55315	07/06/94	L. T. 1. E 02
56285	07/13/94	L. T. 1. E 02
57033	07/20/94	L. T. 1. E 02
57168	07/27/94	L. T. 2. E 02
58335	08/03/94	L. T. 2. E 02
58657	08/10/94	L. T. 2. E 02
59463	08/17/94	L. T. 2. E 02
60109	08/24/94	L. T. 2. E 02
60721	08/31/94	L. T. 1. E 02
61234	09/07/94	L. T. 2. E 02
62081	09/14/94	L. T. 2. E 02
62631	09/21/94	L. T. 2. E 02
63250	09/28/94	L. T. 2. E 02
63789	10/05/94	L. T. 1.6 E 02
64464	10/12/94	L. T. 1.86 E 02
65353	10/19/94	L. T. 1.32 E 02
65887	10/26/94	L. T. 1.45 E 02
66476	11/02/94	L. T. 1.39 E 02
67235	11/09/94	L. T. 1.55 E 02
67863	11/16/94	L. T. 2.13 E 02
68465	11/23/94	L. T. 1.63 E 02
68956	11/30/94	L. T. 1.73 E 02
69572	12/07/94	L. T. 1.55 E 02
70719	12/14/94	L. T. 1.55 E 02
71445	12/21/94	L. T. 1.54 E 02
72386	12/28/94	L. T. 1.45 E 02

APPENDIX J
TLD QUALITY CONTROL PROGRAM

TLD QUALITY CONTROL PROGRAM

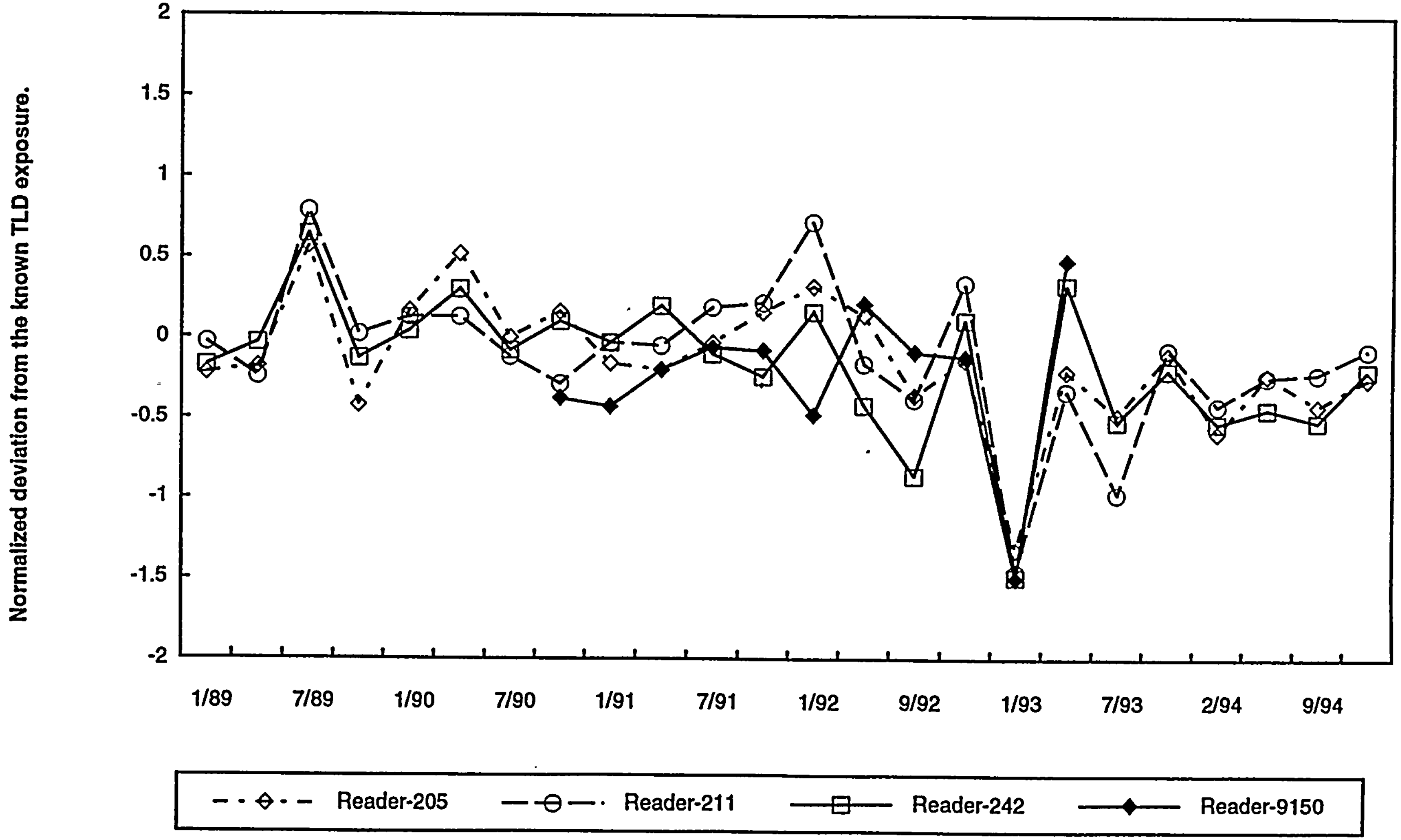
Teledyne Brown Engineering performs an in-house quality assurance testing program for the environmental TLD laboratory. On a quarterly basis the QA manager or a qualified designate exposes groups of TLDs to three different doses using a known exposure rate from a cesium-137 source..

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

For 1994 all results were within the requirements of Regulatory Guide 4.13, Section C. The standard deviations of three measurements at each exposure for each reader was less than 7.5%. The percent deviation of the average of the three measurements from the known exposure at each exposure for each reader was less than 30%. The accompanying graphs indicate the normalized deviations of the average measurements from the known exposures at each exposure for each reader.

QUALITY CONTROL - TLDs

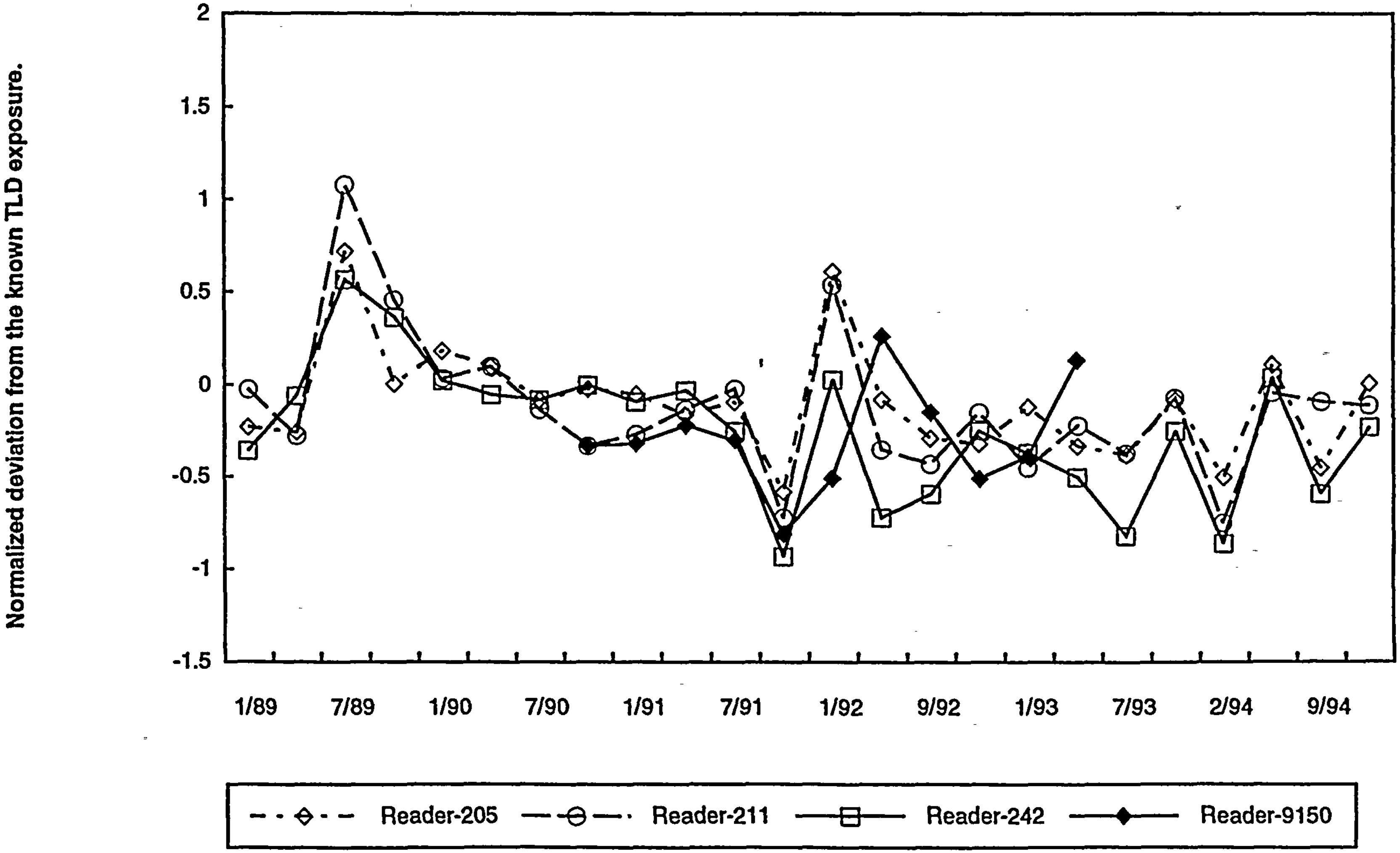
LOW DOSE



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

QUALITY CONTROL - TLDs

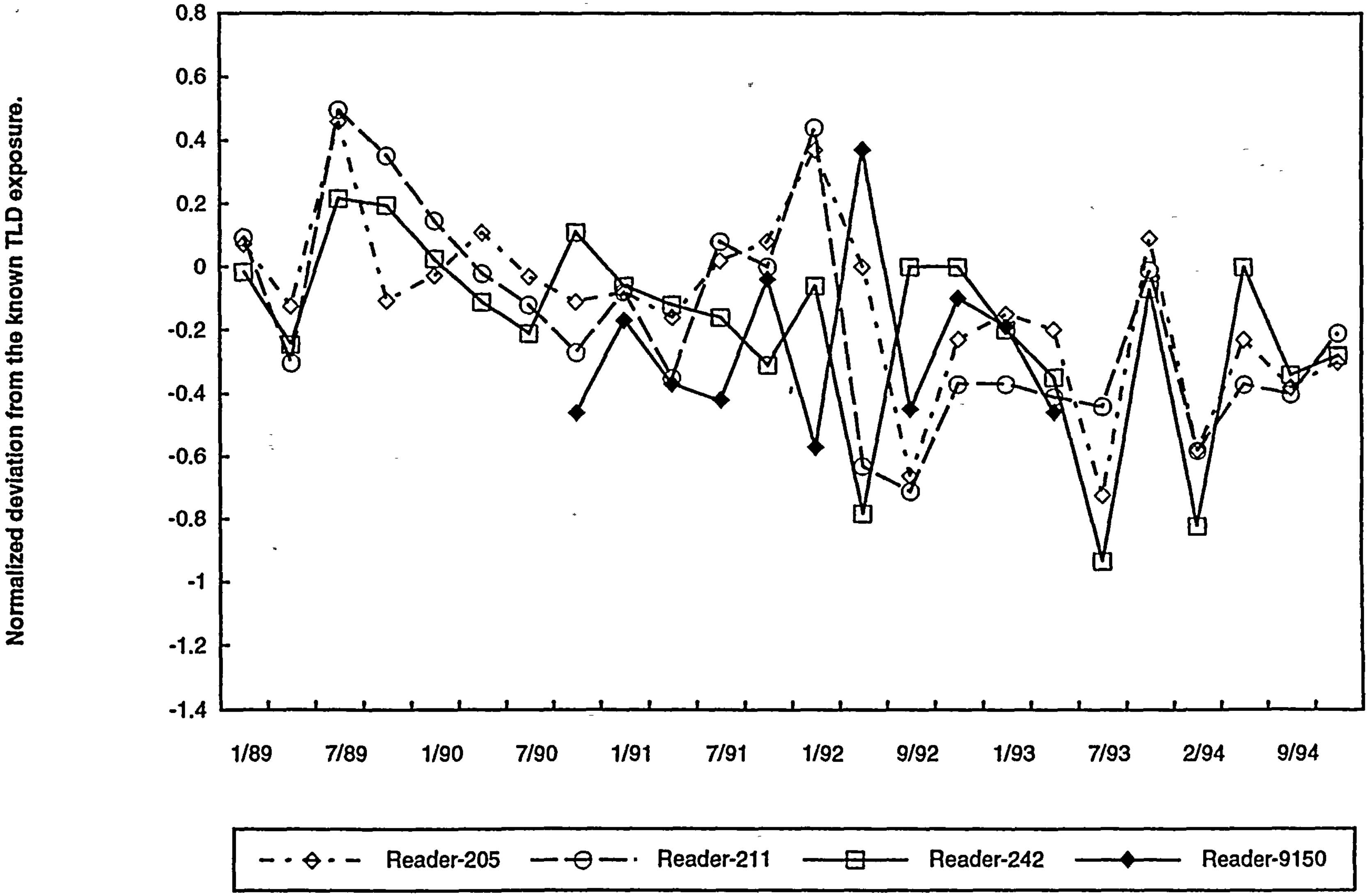
MIDDLE DOSE



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

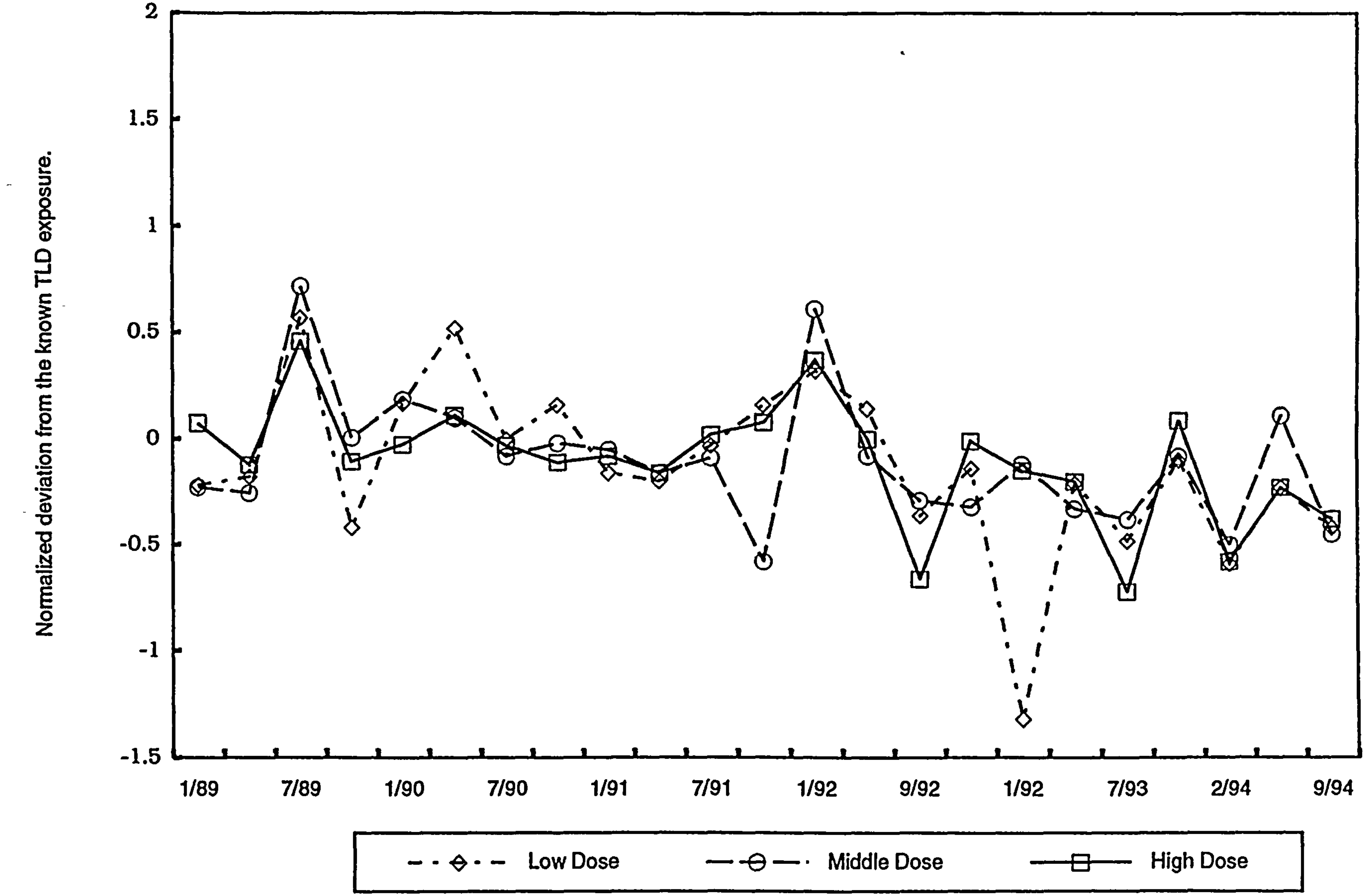
QUALITY CONTROL - TLDs

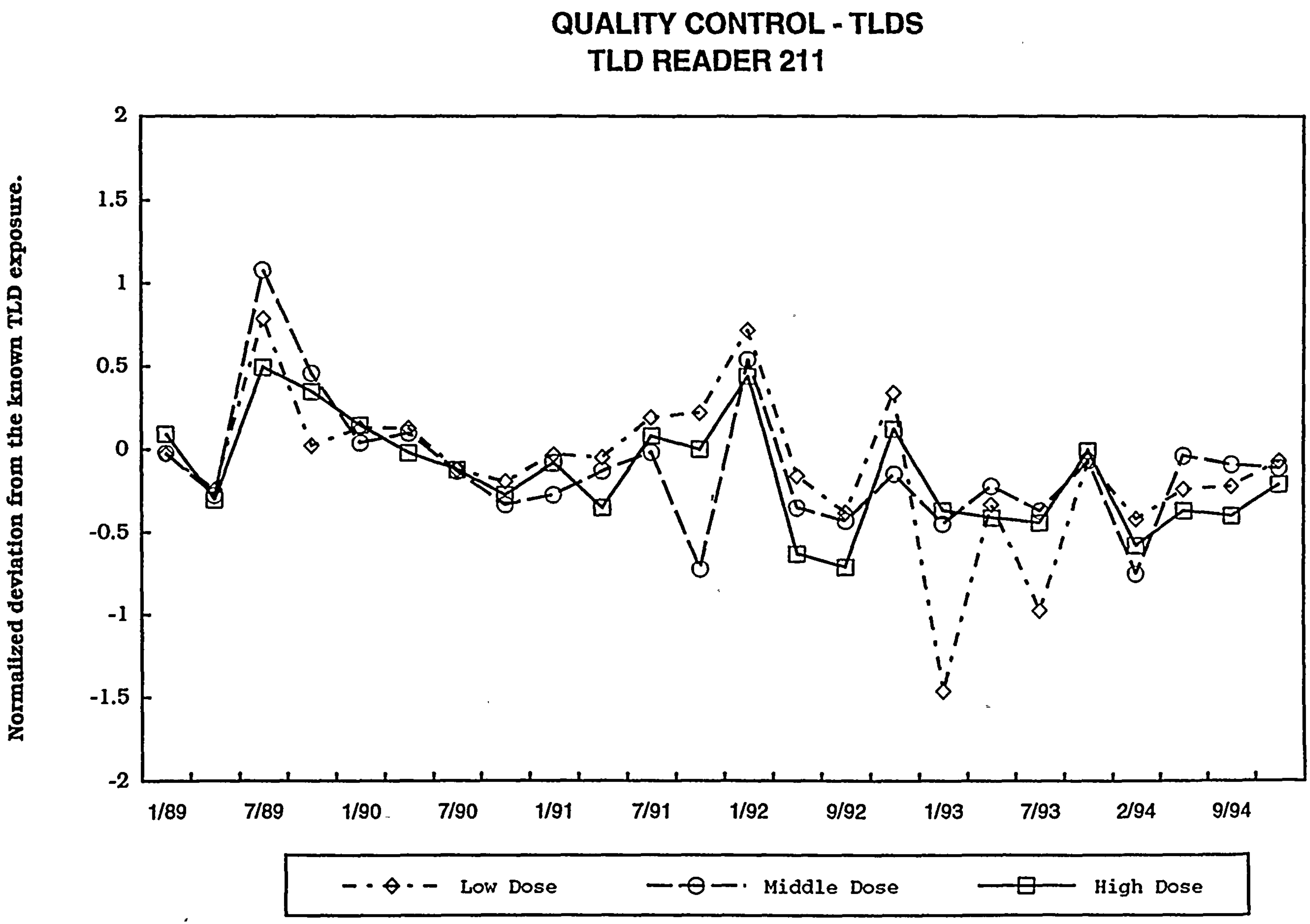
HIGH DOSE



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

QUALITY CONTROL - TLDS
TLD READER 205





QUALITY CONTROL - TLDS
TLD READER 211
Normalized deviation from the known TLD exposure.
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1/89
7/89
1/90
7/90
1/91
7/91
1/92
9/92
1/93
7/93
2/94
9/94
Low Dose
Middle Dose
High Dose

QUALITY CONTROL - TLDs
TLD READER 242