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FITZPATRICK,E. Indiana Michigan Power Co. (formerly Indiana & Michigan Ele
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Donald C. Cook Nuclear Plant Units 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74
ANNUAL ENVIRONMENTAL OPERATING REPORT - 1990

See rpt.

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

ATTN: Dr. T. E. Murley

April 30, 1991

Dear Dr. Murley:

Please find attached to this letter the Annual Environmental Operating Report for the Donald C. Cook Nuclear Plant for the year 1990. This report was prepared in accordance with Appendix A, Section 6.9.1.6 and Appendix B, Part II, Section 5.4.1 of the Donald C. Cook Nuclear Plant Technical Specification.

This document has been prepared following Corporate Procedures that incorporate a reasonable set of controls to ensure its accuracy and completeness prior to signature by the undersigned.

Very truly yours,

R. T. Hering for E. E. Fitzpatrick

E. E. Fitzpatrick
Vice President

edg
Attachment
cc: D. H. Williams
A. A. Blind - Bridgman
NFEM Section Chief
J. R. Padgett
G. Charnoff
A. B. Davis, Region III
NRC Resident Inspector - Bridgman



IE25
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Donald C. Cook Nuclear Plant • Units 1 & 2

# Annual Environmental Operating Report

January 1, Through December 31, 1990

Indiana & Michigan Electric Company
Bridgman, Michigan

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

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## LIST OF APPENDICES

## I. INTRODUCTION

Technical Specification Section 6.9.1.6 and Appendix B, Part II, Section 5.4.1 require that an annual report be submitted to the Nuclear Regulatory Commission which details the results and findings of ongoing environmental radiological and non-radiological surveillance programs. 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, 1990 through December 31, 1990.

During 1990, 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) | 6,559,000 | 4,990,730 |
| Unit Service Factor (%) | 79.2 | 55.4 |
| Unit Capacity Factor - MDC* Net (%) | 70.5 | 51.8 |

* Maximum Dependable Capacity

## II. CHANGES TO THE ENVIRONMENTAL TECHNICAL SPECIFICATIONS

There were no Technical Specification changes in 1990.

## III. NON-RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

### A.1 Plant Design and Operation

During 1990 no 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.

No construction activities during the reporting period occurred which required an environmental assessment of the activity.

### A.2 Notifications Related to the NPDES and State Certifications

Notifications made to the Michigan Department of Natural Resources regarding the NPDES Permit are listed under Nonroutine Reports in Appendix I.

### A.3 Environmental Protection Plan

There were no Environmental Protection Plan noncompliances in 1990.

A.4 Potentially Significant Unreviewed Environmental Issues

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

No construction activities during the reporting period occurred which required an environmental assessment of the activity.

A.5 NPDES Permit

A new permit was issued on September 20, 1990. Also included are letters from the Michigan Department of Natural Resources authorizing the use of Clam-trol for Zebra Mussel control, as well as authorization to continuously discharge chlorine. These documents are in Appendix II.

B. Environmental Monitoring - Herbicide Application

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

Herbicide applications are the only activity to be monitored per Subsection 4.2, and the applications are discussed in Appendix III. There were no preoperational herbicide studies to which comparisons could be made. Herbicide applications are controlled by plant procedure 12THP6020.ENV.104. The observed impacts are also discussed in Appendix III.

C. Macrofouler Monitoring and Treatment

Macrofouler studies and activities during 1990, are discussed in Appendix IV.

## IV. SOLID RADIOACTIVE WASTE TREATMENT SYSTEM

There were no changes in the Solid Radioactive Waste Treatment System in 1990.

## V. RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

The Radiological Environmental Monitoring Program is designed to serve the following purposes (Appendix V):

1. Establish baseline radiation levels in the environment prior to the Plant's operation.

2. Monitor potential critical pathways of radioactive effluent to man.

3. Determine radiological impact on the total environment caused by the operation of the Donald C. Cook Nuclear Plant.

A.1 Changes to the REMP

The second quarter OFS-6 Thermoluminescent dosimetry (TLD) sample station was located on power pole # B426-70. While collecting TLD's for the second quarter, it was found that the entire pole had been removed. The TLD sample station was relocated to pole # B426-1, 4/10 of a mile east of Holden Road on Snow Road.

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

This report summarizes the collection and analysis of various environmental sample media in 1990 for the Radiological Environmental Monitoring Program for the Donald C. Cook Nuclear Plant.

The various analyses of most sample media suggest that there was no discernable impact of the nuclear plant on the environment. The analysis of air particulate filters, charcoal cartridges, direct radiation by thermoluminescent dosimeters, fish, water, milk and sediments from Lake Michigan, drinking water, and food products, either did not detect any radioactivity or measured only naturally occurring radionuclides at normal background levels.

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

B. Land Use Census and Well Report

The Land Use Census is performed to ensure that significant changes in the areas in the immediate vicinity of the plant site are identified. Any identified changes are evaluated to determine whether modification must be made to the REMP or other related programs. No such changes were identified during the 1990 Land Use Census.

A residential well survey was performed in 1990 to monitor the groundwater aquifer north and south of the Cook Nuclear Plant for radionuclides and to identify wells in the

vicinity of the plant used to supply water for human consumption. Communities to the east of the plant were not involved in the well census due to the fact that they are located greater than a mile from the plant center and are upstream of the prevailing east to west groundwater flow.

## VI. CONCLUSION

Based upon the results of the radiological environmental monitoring program and the radioactive effluent release reports for the 1990 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

## NPDES NON-ROUTINE REPORT

## 1990

## NON-ROUTINE REPORTS

| EVENT DATE | DESCRIPTION |
|---|---|
| January 31, 1990 | Sixty-three floor drains and thirteen equipment drains previously believed to be routed to the Turbine Room Sump (Outfall 00D) were determined to be routed to the north storm drain outfall (Outfall S01). |
| October 15, 1990 | Clam-Trol (a proprietary molluscicide) was released to Lake Michigan in detectable concentrations during treatment of various Cook Plant water systems for zebra mussels. |
| October 30, 1990 | Five unmonitored (for pH) discharges from the Turbine Room Sump to the Absorption Pond occurred between 0000 and 0345 hours due to a loss of flow to the TRS sample line caused by blockage downstream. |

# APPENDIX II

## NPDES PERMITS

## 1990

STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
P.O. BOX 30028
LANSING, MI 48909

DAVID F. HALES, Director



October 23, 1990

CERTIFIED MAIL

Indiana Michigan Power Company
P.O. Box 60
Fort Wayne, Indiana 46801

Gentlemen:

SUBJECT: NPDES Permit No. MI0005827
Cook Plant, Bridgman, Michigan

Your National Pollutant Discharge Elimination System (NPDES) Permit has been processed in accordance with appropriate state and federal regulations. It contains the requirements necessary for you to comply with state and federal water pollution control laws.

REVIEW THE PERMIT EFFLUENT LIMITS AND COMPLIANCE SCHEDULES CAREFULLY. These are subject to the criminal and civil enforcement provisions of both state and federal law. Permit violations are audited by the Michigan Department of Natural Resources and the United States Environmental Protection Agency and may appear in a published quarterly noncompliance report made available to agencies and the public.

Your monitoring and reporting responsibilities must be complied with in accordance with this permit. If applicable, Discharge Monitoring Report forms will be transmitted to you in the near future. These reports are to be submitted monthly or otherwise as required by your NPDES permit.

Any reports, notifications, or questions regarding the attached permit or NPDES program should be directed to the following address:

Fred Morley, District Supervisor
621 North Tenth Street
P.O. Box 355
Plainwell, Michigan 49080
Telephone: (616) 685-9886

NOTE: All references within this permit made to the Water Quality Division or Chief of the Water Quality Division are to refer to the Surface Water Quality Division or Chief of the Surface Water Quality Division, respectively.

Sincerely,

William E. McCracken

William E. McCracken, P.E.
Chief, Permits Section
Surface Water Quality Division
517-373-8088

Enclosure: Permit

cc: EPA-Region V (2)
208 Agency - Southwest Michigan Regional Planning Commission
Planning and Special Programs Section, SWQD
Mr. Fred Morley - Plainwell District, SWQD (2)
Mr. Paul Blakeslee, Regional Supervisor, Region III, SWQD
Compliance and Enforcement, SWQD
Data Entry, SWQD
Point Source Studies (Grand Rapids District Office), SWQD
Files

PERMIT NO. MI0005827

MICHIGAN WATER RESOURCES COMMISSION
AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et seq; the "Act"), and the Michigan Water Resources Commission Act, as amended, (Act 245, Public Acts of 1929, as amended, the "Michigan Act"),

Indiana Michigan Power Company
P.O. Box 60
Fort Wayne, Indiana 46801

is authorized to discharge from a facility located at

One Cook Place
Bridgman, Michigan 49106

designated as IN MI Power Co-Cook Plt

to the receiving water named the Lake Michigan in accordance with effluent limitations, monitoring requirements and other conditions set forth in this permit.

This permit takes effect on January 1, 1991. Any person who feels aggrieved by this permit may file a sworn petition with the Executive Secretary of the Michigan Water Resources Commission, setting forth the conditions of the permit which are being challenged and specifying the grounds for the challenge. The Commission may reject any petition filed more than 60 days after issuance as being untimely. Upon granting of a contested case to the applicant, the Commission shall review the permit to determine which contested term shall be stayed until the Commission takes its final action. If a contested condition is a requirement placed on wastewater covered by a new or increased discharge authorization, such increased discharge authorization shall be stayed until the Commission takes final action. All other conditions of the permit remain in full effect. If the contested condition is a modification of a previous permit condition and the Commission determines the contested condition shall be stayed, then such previous condition remains in effect until the Commission takes final action. During the course of any administrative proceeding brought by a person other than the applicant, the conditions of this permit will remain in effect, unless the Commission determines otherwise.

This permit and the authorization to discharge shall expire at midnight October 1, 1994. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit such information and forms as are required by the Michigan Water Resources Commission to the Permits Section of the Surface Water Quality Division no later than 180 days prior to the date of expiration.

This permit is based on an application submitted on March 6, 1990. On its effective date this permit shall supersede NPDES Permit No. MI0005827, expiring August 31, 1990.

Issued this 20th day of September, 1990, by the Michigan Water Resources Commission.

Paul D. Zugger
Executive Secretary

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. Final Effluent Limitations, Outfalls 001 and 002 (condenser cooling water and low volume wastes)

During the period beginning on the effective date of this permit and lasting until the date of expiration, the permittee is authorized to discharge one billion four hundred seventeen million (1,417,000,000) gallons per day* of noncontact cooling water and miscellaneous low volume wastewater from outfall 001 to Lake Michigan; and one billion eight hundred ninety million (1,890,000,000) gallons per day* of noncontact cooling water and miscellaneous low volume wastewater from outfall 002 to Lake Michigan. Such discharges shall be limited and monitored by the permittee as specified below:

| | Discharge Limitations | | | | Monitoring Requirements | |
|---|---|---|---|---|---|---|
| | lbs/day | | Other Limitations | | | |
| Effluent Characteristic | Monthly Average | Daily Maximum | Monthly Average | Daily Maximum | Measurement Frequency | Sample Type |
| Flow (MGD) | (report) | (report) | | | Daily | Report Total Daily Flow |
| Temperature (°F) | | | | | | |
| Intake | | | | (report) | Daily | Reading |
| Discharge | | | | (report) | Daily | Reading |
| Heat Addition (BTU/Hr) | | | | $15.5 \times 10^9$ | Daily | Calculation |
| Total Residual Chlorine (TRC)** | | | | | | |
| Continuous Use | | | | 0.036 mg/l | 5x Weekly | Grab |
| Intermittent Use | | | | 0.2 mg/l | 5x Weekly | Grab |
| TRC Discharge Time | | | | (report) | 5x Weekly | Report Discharge Time |
| Outfall Observation | | | | | Daily | Visual |
| | | | Daily Minimum | Daily Maximum | | |
| pH (Standard Units) | | | 6.5 | 9.0 | Weekly | Grab |

* The flow is not to be considered as a limitation on either the quantity or rate over time of discharge.

PART I

ction A.1. (continued)

** The daily maximum value for TRC shall be reported as the average of a minimum of three grab samples taken during the the time of chlorination. The samples must be equally spaced and no single sample may exceed 0.3 mg/1. TRC monitoring is only required during periods of chlorination. The term continuous use shall mean the application of chlorine greater than 160 minutes per day. The term intermittent use shall mean the application of chlorine 160 minutes per day or less. The permittee shall enter a zero on the Discharge Monitoring Report for the TRC mode not being used.

The permittee is authorized to substitute bromine for chlorine as a biocide. If bromine is used in lieu of chlorine, the same effluent limitations and monitoring requirements specified for chlorine will also be applicable for bromine. The permittee shall use the amperometric titration method to determine the total residual oxidant. Prior to the use of any product containing bromine, the permittee shall notify the Plainwell District Supervisor of the Surface Water Quality Division of the product to be used, and the intended schedule of application. The permittee shall notify the District Supervisor of any changes to the application schedule.

The permittee may use dechlorination techniques to achieve the applicable limitations using sodium sulfite or other dechlorination agents as approved by the Chief of the Surface Water Quality Division as dechlorination agents. The quantity of reagent used shall be the stoichiometric amount needed for dechlorination of applied chlorine. The permittee shall report monthly the quantity of each dechlorination reagent used per day.

a. The receiving stream shall contain no unnatural turbidity, color, oil film, floating solids, foams, settleable solids, or deposits as a result of this discharge.

b. Samples, measurements, and observations taken in compliance with the monitoring requirements above shall be taken prior to discharge to Lake Michigan.

c. Any unusual characteristics of the discharge (i.e., unnatural turbidity, color, oil film, floating solids, foams, settleable solids, or deposits) shall be reported immediately to the Plainwell District Supervisor of the Surface Water Quality Division followed with a written report within 5 days detailing the findings of the investigation and the steps taken to correct the condition.

d. In the event the permittee shall require the discharge of water treatment additives in addition to any previously approved by the Plainwell District Supervisor of the Surface Water Quality Division, the permittee shall notify the Plainwell District Supervisor. Written approval from the Plainwell District Supervisor to discharge such additives at specified levels shall be obtained prior to discharge by the permittee. The permit will be modified in accordance with the requirements of Part II.B.4. if a constituent of the additive or additives requires limiting.

e. The term noncontact cooling water shall mean water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product, or finished product.

PART I

Section A.

2. Final Effluent Limitations, Outfalls 00A and 00B (steam generator blowdown)

During the period beginning on the effective date of this permit and lasting until the date of expiration, the permittee is authorized to discharge seven hundred twelve thousand (712,000) gallons per day* of low volume wastewater consisting of steam generator blowdown from outfall 00A through outfalls 001 and 002 to Lake Michigan; and seven hundred thirty seven thousand (737,000) gallons per day of low volume wastewater consisting of steam generator blowdown from outfall 00B through outfalls 001 and 002 to Lake Michigan. Such discharges shall be limited and monitored by the permittee as specified below:

| | Discharge Limitations | | | | Monitoring Requirements | |
|---|---|---|---|---|---|---|
| | lbs/day | | Other Limitations | | | |
| Effluent Characteristic | Monthly Average | Daily Maximum | Monthly Average | Daily Maximum | Measurement Frequency | Sample Type |
| Flow (MGD) | (report) | (report) | | | Daily Per Occurrence | Report Total Daily Flow |
| Total Suspended Solids | | | 30 mg/l | 100 mg/l | Weekly Per Occurrence | Grab |

* The flow is not to be considered as a limitation on either the quantity or rate over time of discharge.

a. Samples, measurements, and observations taken in compliance with the monitoring requirements above shall be taken at outfalls 00A and 00B prior to discharge to outfall 001 or 002.

PART I

ction A.

3. Final Effluent Limitations, Outfall 00C (heating boiler blowdown)

During the period beginning on the effective date of this permit and lasting until the date of expiration, the permittee is authorized to discharge nineteen thousand (19,000) gallons per day* of low volume wastewater consisting of heating boiler blowdown from outfall 00C through outfalls 001 and 002 to Lake Michigan. Such discharge shall be limited and monitored by the permittee as specified below:

| | Discharge Limitations | | | | Monitoring Requirements | |
|---|---|---|---|---|---|---|
| | lbs/day | | Other Limitations | | | |
| Effluent Characteristic | Monthly Average | Daily Maximum | Monthly Average | Daily Maximum | Measurement Frequency | Sample Type |
| Flow (MGD) | (report) | (report) | | | Daily Per Occurrence | Report Total Daily Flow |
| Total Suspended Solids | | | 30 mg/1 | 100 mg/1 | Daily Per Occurrence** | Grab |

* The flow is not considered as a limitation on either the quantity or rate over time of discharge.

**Total Suspended Solids are to be monitored once per occurrence or weekly if the heating boiler is operated continuously for periods greater than one week.

a. Samples, measurements, and observations taken in compliance with the monitoring requirements above shall be taken at outfall 00C prior to discharge to outfall 001 or 002.

PART I

Section A.

4. Final Effluent Limitations, Outfall 00F (prefilter backwash)

During the period beginning on the date of issuance and lasting until the date of expiration, the permittee is authorized to discharge five hundred eighty three thousand (583,000) gallons per day* of low volume wastewater consisting of prefilter backwash from outfall 00F through outfalls 001 and 002 to Lake Michigan. Such discharge shall be limited and monitored by the permittee as specified below:

| Effluent Characteristic | Discharge Limitations lbs/day Monthly Average | lbs/day Daily Maximum | Other Limitations Monthly Average | Other Limitations Daily Maximum | Monitoring Requirements Measurement Frequency | Monitoring Requirements Sample Type |
|---|---|---|---|---|---|---|
| Flow (MGD) | (report) | (report) | | | Daily Per Occurrence | Report Total Daily Flow |
| Total Suspended Solids | | | 30 mg/1 | 100 mg/1 | Daily Per Occurrence | Grab |
| Oil and Grease | | | 15 mg/1 | 20 mg/1 | 2x Monthly | Grab |

* The flow is not to be considered as a limitation on either the quantity or rate over time of discharge.

a. Samples, measurements, and observations taken in compliance with the monitoring requirements above shall be taken prior to discharge to outfall 001 or 002.

PART I

ction A.

5. Final Effluent Limitations, Outfalls 001S, 002S, 003S and 004S (stormwater runoff)

During the period beginning on the effective date of this permit and lasting until the date of expiration, the permittee is authorized to discharge an unspecified amount of stormwater runoff from outfalls 001S, 002S, 003S, and 004S to Lake Michigan. Such discharges shall be limited and monitored by the permittee as specified below:

| Effluent Characteristic | Discharge Limitations lbs/day Monthly Average | lbs/day Daily Maximum | Other Limitations Monthly Average | Other Limitations Daily Maximum | Monitoring Requirements Measurement Frequency | Monitoring Requirements Sample Type |
|---|---|---|---|---|---|---|
| Retained Self-Monitoring Requirements (See Part I.B.2.b.) | | | | | During Discharge | |
| Outfall Observation | | | | | Monthly* | Visual |
| Total Copper** | | | | (report) | Quarterly | Grab |
| Total Zinc** | | | | (report) | Quarterly | Grab |

Monitoring is not required at this time for outfalls 003S and 004S due to the inaccessability of the outfalls.

**Monitoring for total copper and total zinc shall be conducted on a quarterly basis for outfall 001S. The results of such monitoring shall be submitted to the Chief of the Surface Water Quality Division on or before March 1 of each year.

a. The receiving stream shall contain no unnatural turbidity, color, oil film, floating solids, foams, settleable solids, or deposits as a result of this discharge.

b. Samples, measurements, and observations taken in compliance with the monitoring requirements above shall be taken prior to discharge to Lake Michigan.

PART I

Section A.

6. Special Condition - Deicing Discharge Authorization

The permittee is authorized to discharge a portion of the flow from outfall 001 or outfall 002 through intake structure outfall 003 to prevent ice buildup. The permittee is not required to provide any additional monitoring of this discharge because the effluent limitations and monitoring requirements specified for outfalls 001 and 002 will determine compliance with applicable water quality standards.

7. Special Condition - Short Term Waste Characterization Study

As a condition of this permit, the permittee shall monitor the discharge from outfalls 001 and 002 for the constituents, at the frequency, and for the duration specified below. This monitoring is designed to determine whether these constituents are discharged in significant quantities. The results of the analysis of such monitoring shall be submitted to the Plainwell District Supervisor of the Surface Water Quality Division in accordance with Part I.C.2., Schedule of Compliance. If, upon review of the analysis, it is determined that any of the materials or constituents require limiting to protect the receiving waters in accordance with applicable water quality standards, the permit may then be modified after public notice and Commission approval of the recommended permit modification in accordance with Part II.B.4.

| CONSTITUENT | SAMPLE TYPE | SAMPLE FREQUENCY | SAMPLE DURATION | DESIRED DETECTION LEVEL |
|---|---|---|---|---|
| Hexavalent Chromium | Grab | Weekly. | Six Weeks | 5 ug/l |

8. Special Condition - PCB Prohibition

Effective upon the date of issuance of this permit, the permittee shall not discharge any polychlorinated biphenyls to the receiving waters of the State of Michigan as a result of plant operations other than due to the presence of such compounds in the intake water.

9. Special Condition - Intake Screen Backwash

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge intake screen backwash to Lake Michigan. The permittee shall collect and remove debris accumulated on intake trash bars and dispose of such material on land in an appropriate manner.

PART I

tion A.

10. Special Condition - Reopener Clause

This permit may be modified or, alternatively, revoked and reissued to comply with any applicable standard(s) or limitation(s) promulgated under Section 301(b)(2)(c)(d), 304(b)(2) and 307(a)(2) of the Act, if the effluent standard(s) or limitation(s) so promulgated:

a. is(are) either different in condition or more stringent than any effluent limitation in the permit; or

b. control(s) any pollutant not limited in the permit.

11. Special Condition - Notification Requirement

The permittee shall notify the Plainwell District Supervisor of the Surface Water Quality Division, in writing, within 10 days of knowing, or having reason to believe, that any activity or change has occurred or will occur which would result in the discharge of:

a. Detectable levels* of chemicals on the current Michigan Critical Materials Register or priority pollutants or hazardous substances set forth in 40 CFR 122.21, Appendix D, which were not acknowledged in the application** or listed in the application at less than detectable levels.

b. Detectable levels* of any other chemical not listed in the application or listed at less than detection, for which the application specifically requested information.

c. Any chemical at levels greater than five times the average level reported in the application**.

Any other monitoring results obtained as a requirement of this permit shall be reported in accordance with the schedule of compliance.

*The detectable level shall be defined as the Method Detection Limit (MDL) as given in Appendix B to Part 136, Federal Register, Vol. 49, No. 209, October 26, 1984, pp. 43430-31.

**The application submitted on March 6, 1990.

PART I

Section A.

12. Discharge to the Groundwaters

This site is a known source of groundwater pollution. The reissuance of this permit does not authorize venting of contaminated groundwaters to the surface waters, nor does it constitute a release of liability for any groundwater contamination at or around the site. The State reserves its rights to seek remedies to abate any groundwater contamination.

13. Special Condition - Temperature Modification

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

PART I

MONITORING AND REPORTING

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Reporting:

a. DMR Submittal Requirements - The permittee shall submit Discharge Monitoring Report (DMR) forms to the Michigan Department of Natural Resources, Surface Water Quality Division, Data Entry Unit, P.O. Box 30028, Lansing, Michigan, 48909, for each calendar month of the authorized discharge period(s). The DMRs shall be postmarked no later than the 10th day of the month following each month of the authorized discharge period(s).

b. Retained Self-Monitoring Requirements (outfalls 001S, 002S, 003S, & 004S) - The permittee shall maintain a year-to-date log of retained self-monitoring results and provide such log for inspection to the staff of the Surface Water Quality Division, Michigan Department of Natural Resources upon request. Retained self-monitoring results are public information and shall be promptly provided to the public upon request.

The permittee shall certify, in writing, to the Plainwell District Supervisor of the Surface Water Quality Division, Department of Natural Resources in accordance with the Schedule of Compliance, Part I.C.3., that;

(1) all retained self-monitoring requirements have been complied with and a year-to-date log has been maintained,
(2) the flow rate(s) (if part of retained self-monitoring results) from all outfalls have been substantially the same as the flow rate(s) authorized by this permit, or if
(3) the flow rate(s) (if part of retained self-monitoring results) is (are) substantially different from the flow rate(s) authorized by this permit and the permittee shall provide reasons for the difference in flow rates.

If, for any reason, the permittee does not comply with or will be unable to comply with any requirements specified in Part I.A. of this permit, the permittee shall provide the Plainwell District Supervisor of the Surface Water Quality Division with the following information, in writing, within five (5) days of becoming aware of such noncompliance:

(1) A description of the discharge and cause of noncompliance; and

(2) The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and the steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

PART I

Section B.

3. Definitions

a. The monthly average discharge is defined as the total discharge by weight, or concentration if specified, during the reporting month divided by the number of days in the reporting month that the discharge from the production or commercial facility occurred. If the pollutant concentration in any sample is less than the detection limit, regard that value as zero when calculating monthly average concentration. When less than daily sampling occurs, the monthly average discharge shall be determined by the summation of the measured daily discharges by weight, or concentration if specified, divided by the number of days during the reporting month when the samples were collected, analyzed and reported.

b. The daily maximum discharge means the total discharge by weight, or concentration if specified, during any calendar day.

c. The Regional Administrator is defined as the Region V Administrator, U.S. EPA, located at 230 South Dearborn, 13th Floor, Chicago, Illinois, 60604.

d. The Executive Secretary of the Michigan Water Resources Commission is located in the KNAPP'S OFFICE CENTRE. The mailing address is P.O. Box 30028, Lansing, Michigan, 48909.

e. The Chief of the Surface Water Quality Division's mailing address is P.O. Box 30028, Lansing, Michigan, 48909.

4. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(h) of the Act, under which such procedures may be required.

5. Recording Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of measurement or sampling;

b. The person(s) who performed the measurement or sample collection;

c. The dates the analyses were performed;

d. The person(s) who performed the analyses;

e. The analytical techniques or methods used;

f. The date of and person responsible for equipment calibration; and

g. The results of all required analyses.

PART I

ection B.

6. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report. Such increased frequency shall also be indicated.

7. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the Michigan Water Resources Commission.

PART I

C. SCHEDULE OF COMPLIANCE

1. The permittee shall continue to operate the installed facilities to achieve the effluent limitations specified for outfall(s) 001, 002 and 003.

2. The permittee shall achieve compliance with the Short Term Waste Characterization Study requirements specified in Part I.A.7., in accordance with the following schedule. All submittals shall be to the Plainwell District Supervisor of the Surface Water Quality Division.

a. On or before February 1, 1991, the permittee shall implement the study.

b. On or before April 1, 1991, the permittee shall have completed all monitoring as required.

c. On or before June 1, 1991, the permittee shall submit the analytical results of such monitoring.

3. On or before January 10th of each year, during the effectiveness of this permit, the permittee shall submit the retained self-monitoring written certification as required in the Monitoring and Reporting Section, Part I.B.2. The certification shall be submitted to the Plainwell District Supervisor of the Surface Water Quality Division, Michigan Department of Natural Resources.

4. Reapplication

If the discharges authorized by this permit are expected to continue beyond the expiration date of this permit, the permittee is required to submit an application for reissuance to the Chief of the Permits Section of the Surface Water Quality Division on or before April 1, 1994.

5. Written Report Required

Within 14 days following each date specified in Part I.C., Schedule of Compliance, the permittee shall submit written notification to the Plainwell District Supervisor of the Surface Water Quality Division regarding its compliance or noncompliance with each schedule requirement. If a requirement was not met, the permittee's written notification shall include an explanation of the failure to meet the requirement, actions taken or planned by the permittee to correct the situation, and an estimate of when the requirement will be met. If the requirement involves submittal of a written report and the written report was submitted in accordance with the schedule date, separate written notification is not required.

PART II

MANAGEMENT REQUIREMENTS

1. Duty to Comply

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit.

It is the duty of the permittee to comply with all the terms and conditions of this permit. Any noncompliance with the Effluent Limitations, Special Conditions, or terms of this permit constitutes a violation of Public Acts 245, of 1929, as amended, and/or PL 92-500, as amended, and constitutes grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of an application for permit renewal.

2. Change of Conditions

Any anticipated facility expansion, production increases, or process modification which will result in new, different, or increased discharges of pollutants must be reported by submission of a new application to the Chief of the Permits Section of the Surface Water Quality Division or, if such changes will not violate the effluent limitations specified in this permit, by notice to the Plainwell District Supervisor of the Surface Water Quality Division. Following such notice, the permit may be modified to specify and limit any pollutant not previously limited.

3. Containment Facilities

The permittee shall provide facilities for containment of any accidental losses of concentrated solutions, acids, alkalies, salts, oils, or other polluting materials in accordance with the requirements of the Michigan Water Resources Commission Rules, Part 5. This requirement is included pursuant to Section 5 of the Michigan Water Resources Commission Act 245, P.A. of 1929, as amended, and the Part 5 Rules of the General Rules of the Commission.

4. Operator Certification

The permittee shall have the waste treatment facilities under direct supervision of an operator certified by the Michigan Department of Natural Resources, as required by Section 6a of the Michigan Act.

5. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Plainwell District Supervisor of the Surface Water Quality Division with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and the steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

PART II

Section A.

6. Spill Notification

The permittee shall immediately report any spill or loss of any product, by-product, intermediate product, oils, solvents, waste material, or any other polluting substance which occurs to the surface waters or groundwaters of the state by calling the Department of Natural Resources 24-hour Emergency Response telephone number, 1-800-292-4706 (calls from out-of-state dial 1-517-373-8166); and within ten (10) days of the spill or loss, the permittee shall submit to the Plainwell District Supervisor of the Surface Water Quality Division a full written explanation as to the cause and discovery of the spill or loss, clean-up and recovery measures taken, preventative measures to be taken, and schedule of implementation. This requirement is included pursuant to Section 5 of the Michigan Water Resources Commission Act 245, P.A. of 1929, as amended.

7. Facility Operation

The permittee shall at all times properly operate and maintain all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

8. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the surface or groundwaters of the state resulting from noncompliance with any effluent limitation specified in this permit including, but not limited to, such accelerated or additional monitoring as necessary to determine the nature and impact of the discharge in noncompliance.

9. By-Passing

Any diversion from or by-pass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (a) where unavoidable to prevent loss of life, personal injury, or severe property damage, or (b) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Plainwell District Supervisor of the Surface Water Quality Division and the Regional Administrator, in writing, of such diversion or by-pass.

10. Power Failures

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. Provide an alternative power source sufficient to operate facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit which provision shall be indicated in this permit by inclusion of a specific compliance date in each appropriate "Schedule of Compliance for Effluent Limitations".

b. Upon the reduction, loss, or failure of one or more of the primary sources of power to facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit, the permittee shall halt, reduce or otherwise control production and/or all discharge in order to maintain compliance with the effluent limitations and conditions of this permit.

PART II

tion A.

11. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed from or resulting from treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters, or the entry of toxic or harmful contaminants thereof onto the groundwaters in concentrations or amounts detrimental to the groundwater resource.

12. Upset Noncompliance Notification

If a process "upset" (defined as an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee) has occurred, the permittee who wishes to establish the affirmative defense of upset shall notify the Plainwell District Supervisor of the Surface Water Quality Division by telephone within 24 hours of becoming aware of such conditions and within five (5) days, provide in writing, the following information:

a. That an upset occurred and that the permittee can identify the specific cause(s) of the upset;

b. That the permitted wastewater treatment facility was, at the time, being properly operated;

c. That the permittee has specified and taken action on all responsible steps to minimize or correct any adverse impact in the environment resulting from noncompliance with this permit.

In any enforcement proceedings the permittee, seeking to establish the occurrence of an upset, has the burden of proof.

13. Any requirement of this permit which is included under the unique terms of the Water Resources Commission, Act 245, P.A. of 1929, as amended, and rules promulgated thereunder, is not enforceable under the Federal Clean Water Act regulations.

PART II

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Executive Secretary of the Michigan Water Resources Commission, the Regional Administrator and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharge emanates, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Plainwell District Supervisor of the Surface Water Quality Division and the Regional Administrator.

3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Act and Rule 2128 of the Water Resources Commission Rules, Part 21, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State Water Pollution Control Agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act and Sections 7 and 10 of the Michigan Act.

4. Permit Modification

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully, all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

PART II

ction B.

5. Toxic Pollutants

Notwithstanding Part II.B.4. above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. Civil and Criminal Liability

Except as provided in permit conditions on "By-Passing" (Part II.A.9., pursuant to 40 CFR 122.41(m)) and "Upset" (Part II.A.12., pursuant to 40 CFR 122.41(n)), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond his control, such as accidents, equipment breakdowns, or labor disputes.

7. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee may be subject under Section 311 of the Act except as are exempted by federal regulations.

8. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize violation of any Federal, State or local laws or regulations, nor does it obviate the necessity of obtaining such permits or approvals from other units of government as may be required by law.

10. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstances, if held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

11. Notice to Public Utilities (Miss Dig)

The issuance of this permit does not exempt the permittee from giving notice to public utilities and complying with each of the requirements of Act 53 of the Public Acts of 1974, being sections 460.701 to 460.718 of the Michigan Compiled Laws, when constructing facilities to meet the terms of this permit.

# PERMIT CONDITIONS

## PART III

### A. GROUNDWATER DISCHARGE AUTHORIZATION

The permittee is authorized to discharge from its wastewater treatment facility to the groundwaters of the state in accordance with the conditions below. This authorization shall continue until the Michigan Water Resources Commission makes its final determination on a state groundwater discharge permit.

### B. GROUNDWATER DISCHARGE REQUIREMENTS

During the period beginning on the date of issuance of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge process wastes and sanitary wastes to the groundwater. Such discharges shall be monitored by the permittee as specified below:

Process wastes shall be disposed of into the ground in such a manner and by means of such facilities and at such location that they shall not injuriously affect public health, welfare, or commercial, industrial, domestic, agricultural, recreational, or other uses of the underground waters.

Monitoring requirements for boiler water treatment systems process water (water softener, clarifiers, make-up demineralizers) and boiler cleaning water prior to discharge into the ground.

| PARAMETER TO BE MEASURED | FREQUENCY | TYPE OF SAMPLE |
|---|---|---|
| Flow | Continuous | |
| pH | Continuous | Daily maximu, minimum |
| Cadmium | At times of boiler cleaning water discharge | Grab |
| Oil & Grease | Weekly | Grab |
| Sulfate ($SO_4$) | At all times when regeneration of ion exchange resins occurs | 24-Hr. Composite |
| Chloride (CL) | Weekly | 24-Hr. Composite |
| Total Phosphorus | Weekly | 24-Hr. Composite |
| Chemical Oxygen Demand | Weekly | 24-Hr. Composite |
| Total Dissolved Solids | At all times when regeneration of ion exchange resins occurs | 24-Hr. Composite |

Monitoring requirements for sanitary wastewaters prior to discharge into the ground:

| PARAMETER TO BE MEASURED | FREQUENCY | REPORT |
|---|---|---|
| Flow | Continuous | |
| State which seepage area is being utilized | List when seepage areas are alternated | List beginning and ending date and time of use of each seepage area |

Part III-B (continued)

Monitoring requirements for groundwater collected in monitoring wells:

| PARAMETER TO BE MEASURED | FREQUENCY | TYPE OF SAMPLE |
|---|---|---|
| Record static water elevation | Quarterly | Reading at time of sampling |
| pH | Quarterly | Grab |
| Total Chromium (Cr) | Quarterly | Grab |
| Copper (Cu) | Quarterly | Grab |
| Sulfate($SO_4$) | Quarterly | Grab |
| Chloride (Cl) | Quarterly | Grab |
| Hardness | Quarterly | Grab |
| Nitrate-Nitrogen as N | Quarterly | Grab |
| Sodium (Na) | Quarterly | Grab |
| Polychlorinated Biphenyls | Quarterly | Grab |
| Chemical Oxygen Demand | Quarterly | Grab |
| Boron (B) | Quarterly | Grab |
| Total Phosphorus (P) | Quarterly | Grab |
| Total Dissolved Solids | Quarterly | Grab |
| Cadmium | Quarterly | Grab |
| Oil & Grease | Quarterly | Grab |

Results of all monitoring required in Part III of this permit shall be submitted to the Plainwell District Office of the Waste Management Division.

STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
P.O. BOX 30028
LANSING, MI 48909

DAVID F. HALES, Director



October 4, 1990

Mr. Donald L. Baker
Environmental Affairs Director
Indiana Michigan Power Company
P.O. Box 60
Fort Wayne, Indiana 46801

Dear Mr. Baker:

Staff of the Surface Water Quality Division of the Michigan Department of Natural Resources has reviewed your August 7, 1990 request for authorization to use Betz Clam-Trol CT-1 Molluscicde (Clam-Trol) to control zebra mussels (Dreissena polymorpha) at the Cook Nulcear Plant. According to your letter, the dose rate will be 15 mg/l of Clam-Trol added to the intake water for various in-plant usages. With the exception of fire protection, treatment will be accomplished in 12 hours. The residual Clam-Trol would be detoxified with bentonite, prior to final discharge to Lake Michigan. The treatment is to take place on October 8, 1990.

The requested use is authorized with the following conditions:

The final concentration of Clam-Trol in the discharge to Lake Michigan shall not exceed 0.08 mg/l, as a maximum. The concentration of Clam-Trol in the discharge shall be determined by analyses or, if an approved analytical technique is not available, by calculation based on the mass balance through the system. If the detection level is not adequate to determine compliance with the maximum limit, the discharge concentration of Clam-trol shall be less than detectable and the discharge shall be treated by appropriate detoxification measures.

The Company proposes to use bentonite clay at 30 mg/l to detoxify the Clam-Trol. Be advised that your current NPDES Permit contains the statement, "The receiving water shall contain no unnatural turbidity, color, oil film, floating solids, foams, settleable solids, or deposits in quantities which are or may become injurious to any designated use as a result of this discharge." The treatment must be conducted in such a manner to assure compliance with this requirement.

There shall be no discharge of Clam-Trol to the ground. All treated water shall be captured so that it is detoxified prior to discharge to Lake Michigan.

If you have any questions, please contact Mr. Fred Morley of the Plainwell District Office at 616-685-6851.

Sincerely,

Paul D. Zugger, Chief
Surface Water Quality Division
517-373-1949

STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

# DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
P.O. BOX 30028
LANSING, MI 48909

DAVID F. HALES, Director

December 5, 1990

Mr. Donald L. Baker
Environmental Affairs Director
Indiana Michigan Power Company
One Summit Square
P.O. Box 60
Fort Wayne, Indiana 46801

Dear Mr. Baker:

This letter is in response to your December 3, 1990 letter requesting authorization to continuously discharge chlorine, as a water treatment additive, to control Zebra Mussels in the essential service water system at the Cook Nuclear Plant, located in Bridgman, Michigan.

The NPDES permit, MI0005827, issued to the Cook Nuclear Plant expired at midnight August 31, 1990. The NPDES permit reissued on September 20, 1990 does not take effect until January 1, 1991. Therefore, the expired permit is still in force until that date.

The permit currently in force limits the chlorine discharge time to 30 minutes per day. You have advised us that due to zebra mussel infestation which threatens the safety of the facility, the plant needs to immediately commence the use of chlorine on a continuous basis. The permit that was issued on September 20, 1990 and which takes affect January 1, 1990 allows for the continuous discharge of chlorine at 0.036 mg/l.

The permit currently in force, Part I-A-1.e., contains the authority for the Chief of the Surface Water Quality Division to approve the discharge of water treatment additives:

> "In the event the permittee shall require the discharge of water treatment additives in addition to any previously approved by the Chief of the Surface Water Quality Division, the permittee shall notify the Division Chief. Written approval from the Chief of the Surface Water Quality Division to discharge such additives at specified levels shall be obtained prior to discharge by the permittee."

According to your December 3, 1990 letter, the control of Zebra Mussels in the essential service water system at the Cook Nuclear Plant is, in your Company's judgement, absolutely necessary for the safe operation of the plant. On the basis of that representation, and upon the authority granted me in the current permit, the continuous discharge of chlorine at 0.036 mg/l is hereby approved. This approval is effective from the date of this letter until January 1, 1991, when the reissued permit takes effect.

The environmental consequences are expected to be the same as those which would result from the continuous discharge of chlorine as authorized in the reissued permit. All conditions regarding chlorination contained in the reissued permit are to be met when continuous chlorination is practiced under authority of this letter. Failure to do so would void this authorization and subject you to enforcement action for violation of your current permit.

If you have any questions in this matter please contact Mr. Fred Morley at the Plainwell District Office at 616-685-9886, or you may contact me.

Sincerely,

Paul D. Zugger, Chief
Surface Water Quality Division
517-373-1949

cc: Mr. Paul Blakeslee, MDNR
Mr. Fred Morley, MDNR

# APPENDIX III

# HERBICIDE APPLICATION REPORT

# 1990

INDIANA MICHIGAN POWER

Date December 10, 1990

Subject 1990 Herbicide Spray Report - Cook Plant

From Dane M. McKay

To H. E. Brooks

Summary of Program

A. During the month of May, Noxious Vegetation Control, Inc. applied a mixture of Karmex, Krovar and Banvell 720 to control grass and weed growth on the plant site. Locations treated include:

KV Switchgear Yards, roadways, parking lots, perimeters of the sewage ponds, and controlled/uncontrolled areas inside the protected area.

A total of 231 lbs. of Karmex, 42 lbs. of Krovar, and 3.75 gallons of Banvell 720 was applied over 35 acres.

B. Right-of-Way Maintenance was performed under various bus ties and KV lines on Cook Plant lands (see letter from R. J. Cheeney) attached. Five gallons of Tordon 101R and ten pounds of Spike 80-W25 was used during 1990.

C. Major areas covered and observations made in November.

1. Moderate weed growth on the sides of both sewage ponds.

2. Road to Absorption Pond: Good control on road. No weeds found at all.

3. 765 KV Switchgear Yard: Sparse patches of grass growing throughout yard. Perimeter fence is clear of grass and weeds.

4. 345 KV Switchgear Yard: Sparse patches of grass growing throughout yard. Perimeter fence is clear of grass and weeds.

5. Railroad tracks east of Training Center: Good weed control, no weeds found at all.

6. CESA: Good weed control, a few weeds growing along N-NE sides of fence.

7. Contractor supervisors parking lot: Patches of grass growing along the east fence.

8. East Sewage Plant: Patches of grass and weeds growing along north and south sides of the building.

9. South Sewage Plant: Grass is growing on all sides of the plant.

10. 69 KV Switchgear Yard: Good weed control, no grass or weeds growing in yard or along fence.

11. North protected area fence: Good weed control, no grass or weeds found at all.

12. South Perimeter Fence: Sparse patches of grass growing along fence.

13. East Perimeter Fence: Good weed control, no weeds found at all.

14. Site Design Building: Good weed control, small patches of grass growing along east side of the building.

15. Contractors Trailer Complex: Sparse grass and weeds growing along base of trailers.

16. ICMS Office Trailer: Good weed control, no weeds found at all.

17. ICMS Fab Shop: Good weed control, no weeds found at all.

18. Southwest Side of Turbine Building: Good weed control, no weeds found at all.

19. South End of Turbine Building: Good weed control, no weeds found at all.

20. Unit 1 RWST Area: Good weed control, no weeds found at all.

21. Unit 2 RWST Area: Good weed control, no weeds found at all.

22. Hydrogen/Nitrogen Storage Tank Area: Good weed control, no weeds found at all.

23. Met Tower building: Grass and Weeds growing around building.

24. Air Stations: Grass and weeds growing inside air station fences.

25. Environmental Warehouse: Grass and weeds growing around base of building.

26. Construction Fab Shop: Grass growing on north and west sides of the building.

27. Environmental Polebarn: Grass and weeds growing around base of building.

New areas to be sprayed next year:
Road to Met Tower Building.
Gravel on both sides of access road to Red Arrow Highway.

Apparently the selected herbicides and their application continues to conform with plant Technical Specifications to control encroaching vegetation, resulting in a reduction of maintenance costs and improving overall plant site visibility.

COOK NUCLEAR PLANT
HERBICIDE APPLICATION DATA
1990

| Date | Location | Lbs. Karmex | Lbs. Krovar | Gals. Banvell 720 | Gals. H20 | # of Acres Covered |
|---|---|---|---|---|---|---|
| 5-17-90 | 765 KV Yard | 132 | 24 | | 2000 | 20 |
| 5-18-90 | 345 KV Yard | 33 | 6 | 1.25 | 500 | 5 |
| 5-18-90 | All unpaved areas inside the protected area | 33 | 6 | 1.25 | 500 | 5 |
| 5-18-90 | 69 KV Yard, Sewage Ponds, Absorption Pond Road, Site Design Buildings, Sewage Plants and all other grounds outside the protected area | 33 | 6 | 1.25 | 500 | |
| | | 231 Lbs. | 42 Lbs. | 3.75 Gals. | 3500 Gals. | 35 Acres |

AEP
INDIANA MICHIGAN POWER

Date December 4, 1990

Subject R/W Maintenance Herbicide Use on Cook Plant Lands

From R. J. Cheeney

To D. McKay

The following cutting and chemical usage was done at the Cook Plant during the 1990 calendar year.

Under the Unit 1 765 KV Bus tie:

Cut 31 brush units (15,500 square feet).
Used ½ gallon of Tordon 101R for stump treatment.

Under the Dumont-Cook 765 KV line:

Cut 80 brush units (40,000 square feet).
Used 1 gallon of Tordon 101R for stump treatment.

Under the Unit 2 345 KV Bus tie:

Cut 14 trees and 65 brush units (32,500 square feet).
Used 1 gallon of Tordon 101R for stump treatment.

Under the Cook-Cook Jct. 345 KV lines:

Cut 110 brush units (55,000 square feet).
Used 2½ gallons of Tordon 101R for stump treatment.

Under the E. Elkhart-Cook 345 KV line:

Cut 80 brush units (40,000 square feet).
Used 10 pounds of Spike 80-W25 for stump treatment.

If you have any questions about the work, please call me at Ext. 2254.

R. J. Cheeney / et

R. J. Cheeney

RJC:et

c: H. E. Brooks

8/016

Intra-System

# APPENDIX IV

## MACROFOULER MONITORING PROGRAM

## 1990

INDIANA MICHIGAN POWER COMPANY
Cook Nuclear Plant

# 1990 Zebra Mussel and Asiatic Clam Monitoring and Control Report
April 4, 1991
by
Eric C. Mallen

Since 1982, Cook Nuclear Plant has been utilizing a macrofouler monitoring program to detect the presence of Asiatic Clams (Corbicula fluminea). Isolated finds of Asiatic Clams occurred in May of 1984, December of 1988 and November of 1989, and were summarized in previously submitted annual reports. Because of their extremely sparse population density and distribution at the Cook Nuclear Plant and local environs, Asiatic Clams have posed no operational problems.

In 1990, a program was instituted to detect the presence of Zebra Mussels (Dreissena polymorpha) as well as Asiatic Clams. The discovery of Zebra Mussels on July 18, 1990 during routine diving inspections and cleaning of the Unit #2 Screenhouse Intake Forebay, prompted further investigation into their population density and distribution in the plant's raw water systems. Dives were performed on the east and west sides of the plant's Unit #2 traveling screens and condenser inlet tunnel. Individuals living in sizes of 1/4"-1" in length were found in densities of 0.25-0.67 individuals per square yard. The lake intake structures and the limestone rip rap adjacent to these structures were inspected, with only three individuals encountered. No mussels were reported on the breakwaters or beaches at St. Joseph.

On September 13, 1990, plant divers collected sediment samples from the vicinity of the plant intakes, and in front of Traveling Screens 1-7 and 2-1 in the Screenhouse Intake Forebay. A total of three Zebra Mussels were found in the two samples, and no Asiatic Clams were discovered. (See Attachment #1.)

Concurrent with these monitoring efforts, control strategies were evaluated, and a procedure was developed to use Betz Industrial's Clam-Trol CT-1 to treat the raw water systems. The procedure to apply Clam-Trol to the Plant's raw water systems was performed on October 8-9, 1990. A 1.2% to 100% mortality rate was realized, as measured by the placement of Bio-Boxes on the different raw water systems. The results of the treatment are summarized in the tables and graphs in Attachment #2. The Bio-Boxes on systems which displayed low mortality rates did not receive the vendor's specified CT-1 residuals of 15 ppm for a duration of 12 hours.

1990 Zebra Mussel and Asiatic Clam Monitoring and Control Report

From October 9-11, 1990, five water samples were taken from the Unit #2 Discharge Tunnel and examined for Zebra Mussel larvae. No veligers were found. (See Attachment #1.)

On October 12, 1990, the Bio-Monitor installed on the ESW system for the previous six months was cleaned out. The test substrates and sediment were examined for Zebra Mussels and clams. Two juvenile Zebra Mussels were discovered.

Four fire hydrants, (two within the protected area and two outside), were flushed and the rinse water sieved on November 15, 1990. No Zebra Mussel or Asiatic Clam adults, juveniles, or shell fragments were detected. Green algae, iron piping corrosion products, pebbles, and two snails of the genus Physa were identified in the samples. (See Attachment #1.)

Diving inspections of the Unit #1 Intake Forebay were performed by Underwater Construction Corp. in November of 1990. Inspections showed increasing numbers of Zebra Mussels 1/8"-1/4" growing in densities approaching 100 individuals per square yard. These appeared to be from this year's crop. Divers continued to report young-of-the-year mussels growing on trash racks, and traveling screen components as they were being removed for refurbishing. (See Attachment #3.)

During a routine inspection of the Unit #1 West CCW Heat Exchanger on December 1, 1990, live Zebra Mussels 1/8"-1/2" in size were found attached to the discharge channel and end bell sections of the heat exchanger. Their density was estimated to be 50 individuals per square yard.

Zebra Mussel sitings have been made at other raw water users' facilities toward the south end of Lake Michigan. To date, none have been discovered on the breakwaters and beaches of St. Joseph, MI.

Due to their low densities and population distribution within the raw water systems, Zebra Mussels and Asiatic Clams have yet to pose operational problems at the Cook Nuclear Plant. A joint plant/corporate task force was formed in 1990 to develop a Zebra Mussel eradication/control plan. This plan is being implemented in 1991.

**Environmental Resources Management, Inc.**

Suite 200 • 3025 Boardwalk Drive • Ann Arbor, Michigan 48108 • (313) 769-6080 • Telefax (313) 769-6264

22 January 1991

Mr. Allen E. Gaulke
Environmental Engineering
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

RE: End of Year Report for Biofouling Monitoring at Cook Nuclear Power Plant, Bridgman, Michigan

Dear Mr. Gaulke

Enclosed for your review are the results of our biofouling monitoring sampling efforts for 1990. We are in the process of developing a revised sampling plan and proposal for this years monitoring to include the use of artificial substrates in the foreby area.

Should you have any questions concerning the report please do not hesitate to call us.

Sincerely
ERM, Inc.

Richard F. Gendernalik

Richard F. Gendernalik
Project Scientist

Enclosure

cc
E. Mallen
P. McCall
R. Dwyer

# MOLLUSC BIOFOULING MONITORING
# 1990 END OF YEAR REPORT
# D.C. COOK NUCLEAR POWER PLANT
# BRIDGMAN, MICHIGAN

22 January 1991

Richard F. Gendernalik
Project Scientist

Robert L. Dwyer, Ph.D.
Project Manager

Prepared For:
**American Electric Power Service Corporation**
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:
Environmental Resources Management, Inc.
855 Springdale Drive
Exton, Pennsylvania 19341

File No.: B017-01-0001

## INTRODUCTION

Environmental Resources Management, Inc. (ERM) was retained by American Electric Power Service Company (AEP) to undertake a monitoring program for two molluscs that have the potential for fouling the open-cycle cooling system and other water supplies of the Cook Nuclear Power Plant in Bridgman, Michigan. The monitoring program is required by the U.S. Nuclear Regulatory Commission as part of the ongoing nonradiological environmental monitoring program at the plant.

The two molluscs are the zebra mussel (*Dreissena polymorpha*) and the asiatic clam (*Corbicula fluminea*). Both organisms have established themselves in the Great Lakes. Zebra mussels in particular have colonized much of the hard substrate along the Lake Erie coast, and have fouled the intake structures of power plants and municipal water supplies.

This report presents the results of initial sampling of several water systems in the Cook plant, conducted in October and November 1990. The program was intended to monitor for both veligers (juveniles) and adults. However, the program was begun late in the year, so comprehensive sampling was not undertaken. A full sampling program is planned for 1991.

## METHODS

The ERM biofouling monitoring at the Cook Facility in 1990 consisted of three types of sampling efforts: plankton sampling, sediment sampling and fire hydrant sampling. The plankton sampling was undertaken to determine the number of veliger larvae of the zebra mussel present in the forebay area of the power plant. The sediment and fire hydrant sampling were used to monitor the presence of juveniles and adults of both the asiatic clam and the zebra mussel.

All sampling was conducted according to D.C. Cook Nuclear Plant Procedure No. 12 THP 6020 ENV.101 as follows: five plankton samples were collected on 9-11 October 1990 from the intake forebay of Unit 2. The samples were collected by pumping 41 gpm (using a nondestructive diaphragm pump) through a plankton net and collecting the sample in the cod end. Samples were refrigerated (unpreserved) until they were counted on 12 October 1990 in order to be able to identify veligers by their movement patterns.

Samples were sorted and counted by concentrating the volume of the sample down to 75 ml using a 63 µm plankton cup, and counting 5 successive 1.0 ml (or 0.75 ml in one case) aliquots in a Sedgwick-Rafter cell under 100-400x magnifications. This subsampling is the equivalent of examining 0.67 to 7.02 $m^3$ of Lake Michigan water (intake water) for larvae.

Sediment samples were collected by AEP personnel at the bottom of the intake forebay and near the intakes in Lake Michigan. A biomonitoring chamber (containing cobble-sized stones as an artificial substrate and exposed to flowing water from the essential circulating water systems of the plant) was also sampled for sediment and attached mussels. Sediment samples were placed in a pan and examined under a magnifying lens for juvenile mussels and clams.

Four hydrants were sampled using a No. 35 mesh benthos sieve. A fire hose was connected to each hydrant and directed to a 55-gallon drum. The 55-gallon drum was outfitted with a 3-inch drain pipe/flow meter located approximately 3-inches from the bottom of the drum. The drain pipe was directed to the nearest storm drain. No direct discharge to any other waterways took place.

The benthos sieve was placed inside the drum against the drain pipe opening. The sieve was held in place by hand until the force of the draining water held it tight against the walls of the drum.

Flow rates were controlled at the hydrant and were noted at the flowmeter on the discharge pipe. Initial flows were collected for 10 minutes and ranged from 31 gallons/minute to 95 gallons/minute. A second flush of 5 minutes duration was conducted at the highest rate that could be controlled by personnel handling the hose. The flow rates for this second flush ranged from 94 gallons/minute to 124 gallons/minute.

At the end of each flush the sieve was removed from the drum and any material collected on it was carefully washed into a collection jar. Material collected from the first and second flushes were combined for each location. Any remaining water and/or debris left in the 55-gallon drum was drained through a 1-inch diameter opening in the bottom of the drum into a sieve placed under the drum. The samples were visually observed at the sampling site for the presence of juvenile or adult mussels and clams. The following day, all samples were screened for the presence of adult mussels or clams using a fluorescent magnifying lamp.

## RESULTS

Five plankton samples were examined for zebra mussel larvae (see Table 1). The samples all contained a diverse zooplankton fauna (indicating that the pump/net sampling system was operating efficiently and nondestructively). However, no zebra mussel larvae were found.

Sediment sample results are presented in Table 2. No asiatic clams were found in the two sediment samples or the biomonitoring sample. A total of five zebra mussels were found in the three samples, ranging in size from 3 to 21 mm.

Table 3 summarizes the hydrant sampling at each location. No asiatic clams, zebra mussels or fragments were found at any of the sampling locations. The aquatic snail *Physa* sp. was identified at two locations :12-HYD-11 and 12-HYD-12. The freshwater algae *Cladophora* sp. was found at all locations. Numerous small fragments of what appeared to be corroded iron piping and pebbles were also observed at each location.

## DISCUSSION

The sediment and biomonitoring samples indicate that zebra mussels are present in very low abundance in Lake Michigan near the circulating water intake, in the intake forebay, and in the essential water system of the plant. Also, zebra mussels were not found to be present in the fire protection system. No zebra mussel larvae were detected in the five plankton samples, collected from 0.6 to 7.0 $m^3$ of water from the main circulating water system. It should be noted that the samples were collected in October, when larvae would not be expected to be present in the water column. Thus, these plankton samples may not give an accurate assessment of the potential abundance of larvae which may be present earlier in the year.

No evidence of asiatic clams was found in any of the plankton, sediment, or hydrant samples.

**Table 1**
**Plankton Sample Results**

Cook Nuclear Power Plant, Bridgman, Michigan 12 October 90

Cook Unit 2 Discharge Bay Plankton Pump Sampling

| Sample Number | Flow rate | Total gallons | Sample Volume | Conc. Volume | Sub-Sample * Volume | Veliger ** Count |
|---|---|---|---|---|---|---|
| CK U2 10/09/90 | 41 gpm | 37,108 | 850ml | 75ml | 0.75ml | 0 |
| CK U2 10/10/90 | 41 gpm | 11,690 | 800ml | 75ml | 1.0ml | 0 |
| CK U2 10/10/90 | 41 gpm | 3,989 | 500ml | 75ml | 1.0ml | 0 |
| CK U2 10/10/90 | 41 gpm | 3,710 | 900ml | 75ml | 1.0ml | 0 |
| CK U2 10/11/90 | 41 gpm | 2,649 | 230ml | 75ml | 1.0ml | 0 |

* Five sub-samples were taken of each concentrated volume
** Total counts for the five sub-samples is shown

ATTACHMENT 1

**Table 2**
**Sediment Sample Results**

Cook Nuclear Power Plant, Bridgman, Michigan — 12,13,14 September 90

| Sample Location | Date | Organisms | Total number |
|---|---|---|---|
| Intake Structure | 9-13-90 | | |
| | | *Dreissena polymorpha* | 1 (21 mm) |
| | | *Sphaerium* sp. | 12 (1/2 shells) |
| | | Gastropoda | |
| | | *Lymnaea* sp.(Bulimnea) | 8 |
| | | *Goniobasis* sp. | 2,1* |
| | | *Physa* sp. | 1* |
| | | *Gyraulus* sp. | 1 |
| Travel Screen 1-7 and 2-1 | 9-13-90 | | |
| | | *Dreissena polymorpha* | 2 (3,20 mm) |
| | | *Sphaerium* sp. | 12 (1/2 shells) |
| | | Gastropoda | |
| | | *Lymnaea* sp.(Bulimnea) | 15 |
| | | *Goniobasis* sp. | 8 |
| | | *Physa* sp. | 7 |
| Biomonitor (sediment and washing from hard substrate) | 10-12-90 | *Dreissena polymorpha* | 2 (3,5 mm) |
| | | *Sphaerium* sp. | 20 (1/2 shells) |

* Denotes live specimen

**Table 3**
**Fire Hydrant Sampling**

Cook Nuclear Power Plant - Fire Hydrant Sampling — 19 November 1990

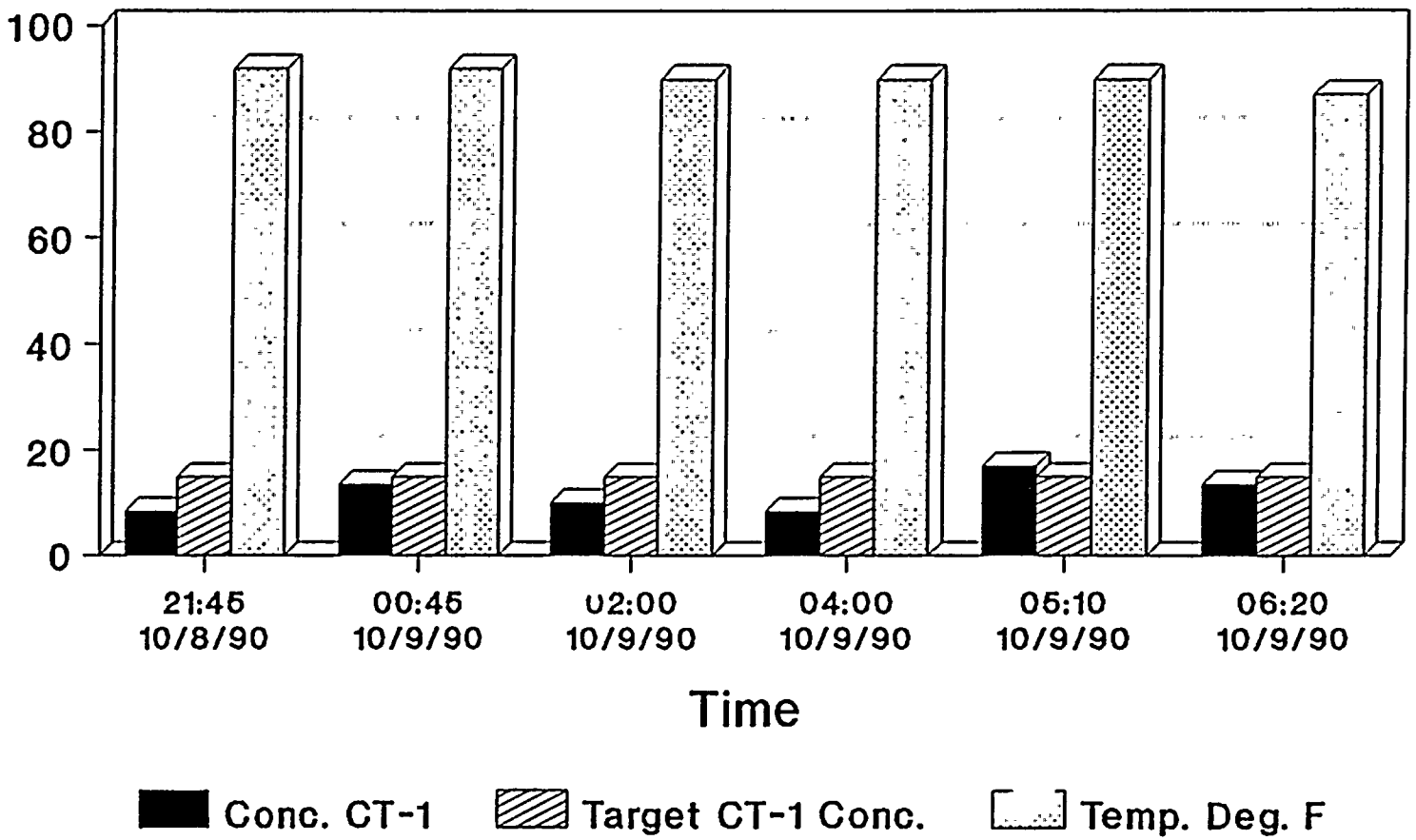
| Sample Location | Flow Meter Reading Start | End | Elapsed Time | Flow Rate | Total Gallons | Asiatic Clams | Zebra Mussels | Other |
|---|---|---|---|---|---|---|---|---|
| FH 12-HYD-2A | 36583.0 | 36586.1 | 10' | 31 gpm | 310 | 0-A | 0-A | *Cladophora* sp. |
| | 36586.1 | 36590.8 | 5' | 94 gpm | 470 | 0-J | 0-J | metal frag. |
| | | | | | | 0-FR | 0-FR | pebbles |
| FH 12-HYD-12 | 36590.8 | 36596.7 | 10' | 59 gpm | 590 | 0-A | 0-A | *Cladophora* sp. |
| | 36596.7 | 36602.9 | 5' | 124 gpm | 620 | 0-J | 0-J | 1-*Physa* sp. |
| | | | | | | 0-FR | 0-FR | metal frag. |
| | | | | | | | | pebbles |
| FH 12-HYD-21 | 36602.9 | 36611.1 | 10' | 82 gpm | 820 | 0-A | 0-A | *Cladophora* sp. |
| | | | | | | 0-J | 0-J | metal frag. |
| | | | | | | 0-FR | 0-FR | pebbles |
| FH 12-HYD-11 | 36611.1 | 36620.6 | 10' | 95 gpm | 950 | 0-A | 0-A | *Cladophora* sp. |
| | 36620.6 | 36626.3 | 5' | 114 gpm | 570 | 0-J | 0-J | 1-*Physa* sp. |
| | | | | | | 0-FR | 0-FR | metal frag. |
| | | | | | | | | pebbles |

Key:
FH - fire hydrant
A - Adults
J - Juveniles
FR - shell fragments

ATTACHMENT 1

# CIRC. WATER COND. OUT. U1

## Conc. CT-1 ppm and Temperature vs Time

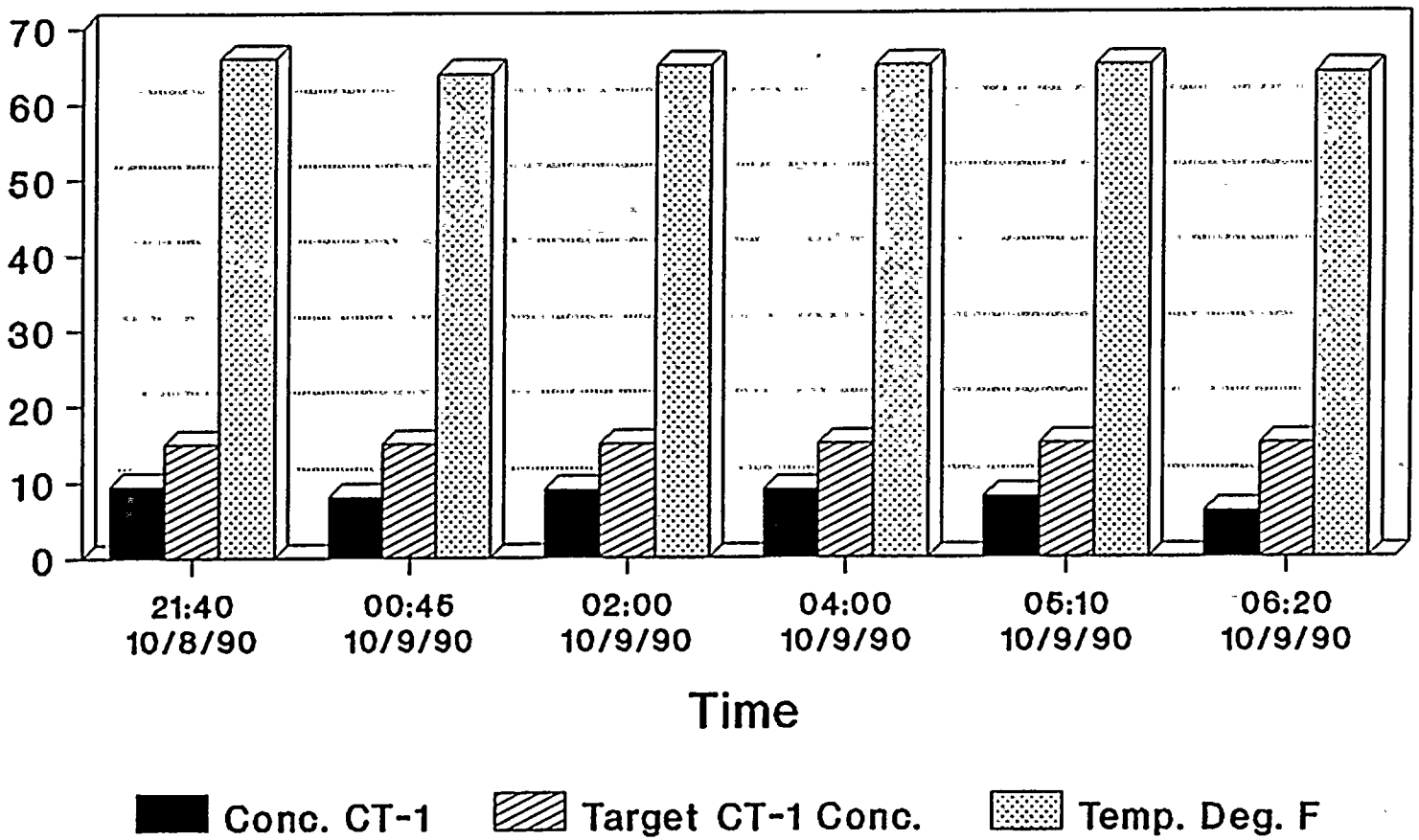



100% Mortality

ATTACHMENT #2

# CIRC. WATER COND. OUT. U2

## Conc. CT-1 ppm and Temperature vs Time

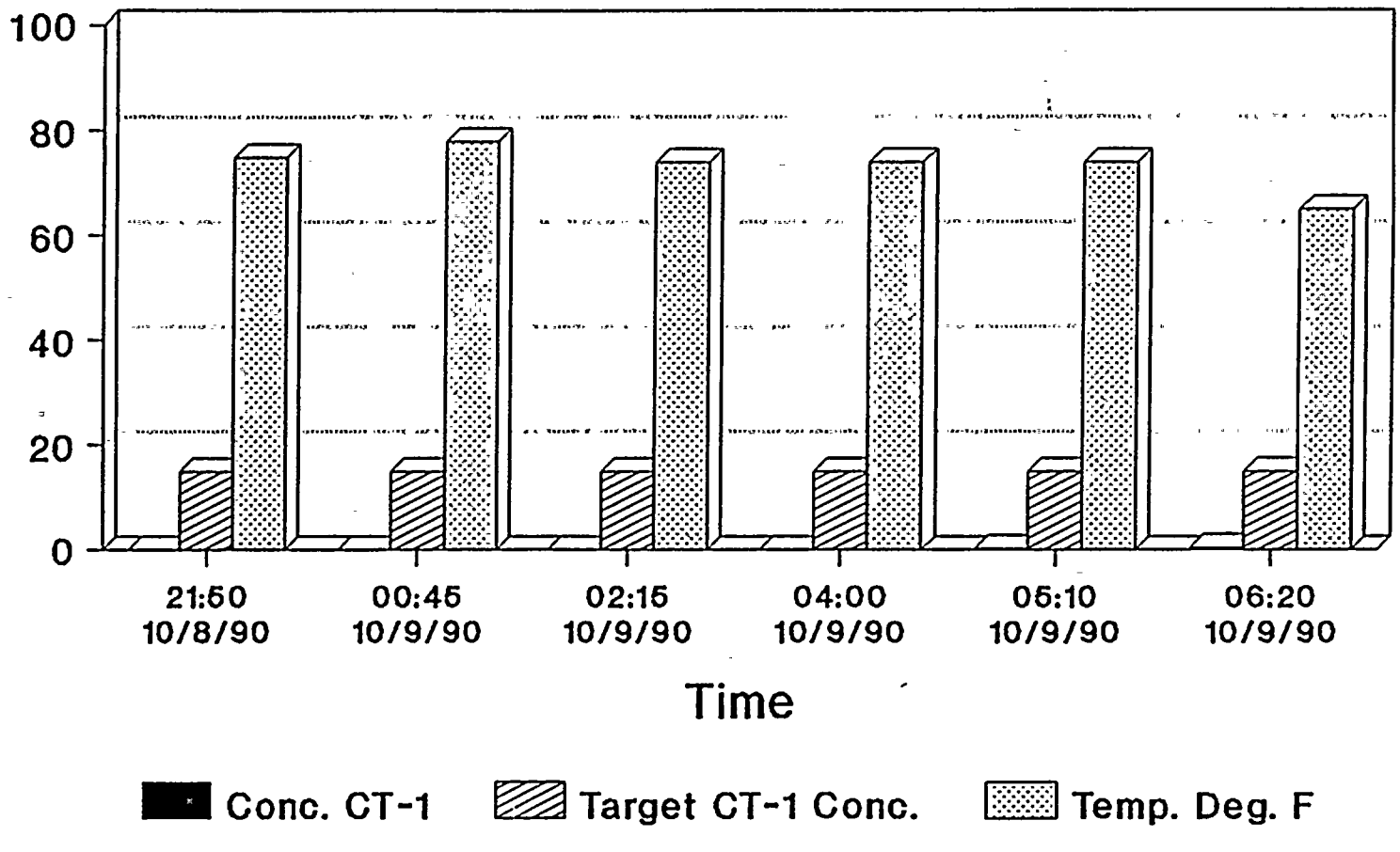



13.3% Mortality

ATTACHMENT #2

# UNIT 1 ESW

## Conc. CT-1 ppm and Temperature vs Time

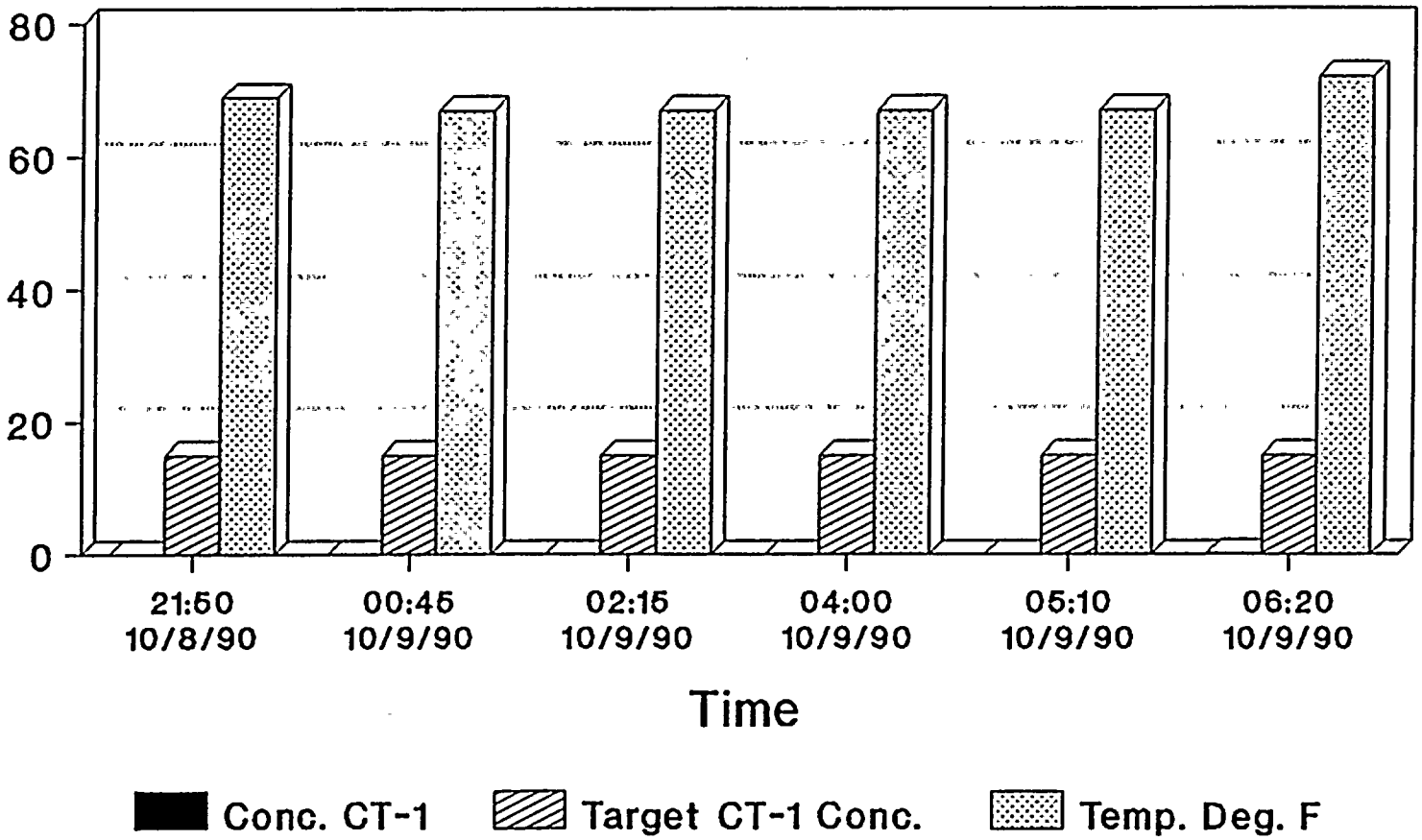



100% mortality

ATTACHMENT #2

# UNIT 2 ESW

## Conc. CT-1 ppm and Temperature vs Time

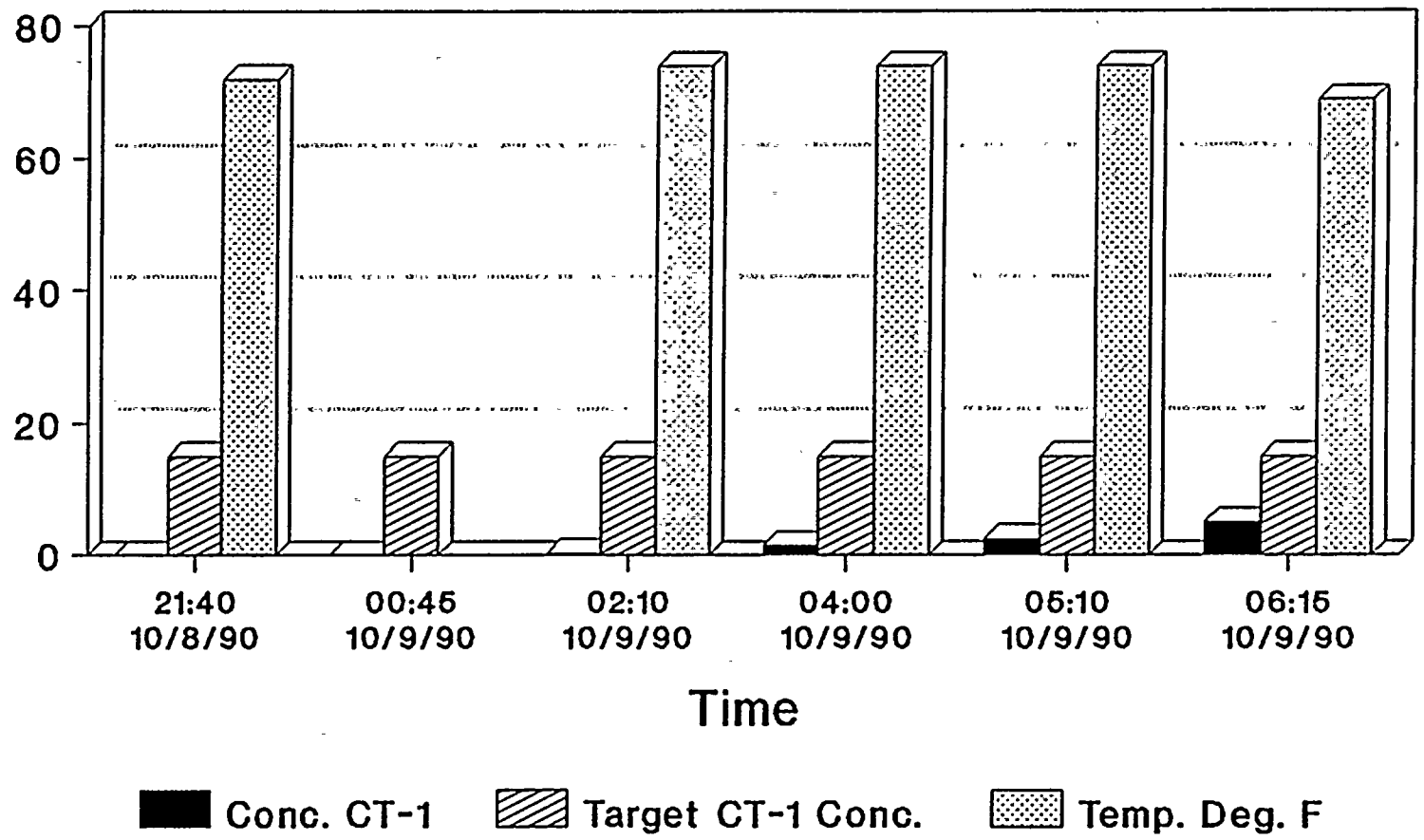



95% mortality

ATTACHMENT #2

# UNIT 1 NESW

## Conc. CT-1 ppm and Temperature vs Time




1.2% mortality

ATTACHMENT #2

# Summary of Clam-trol Application
## Results

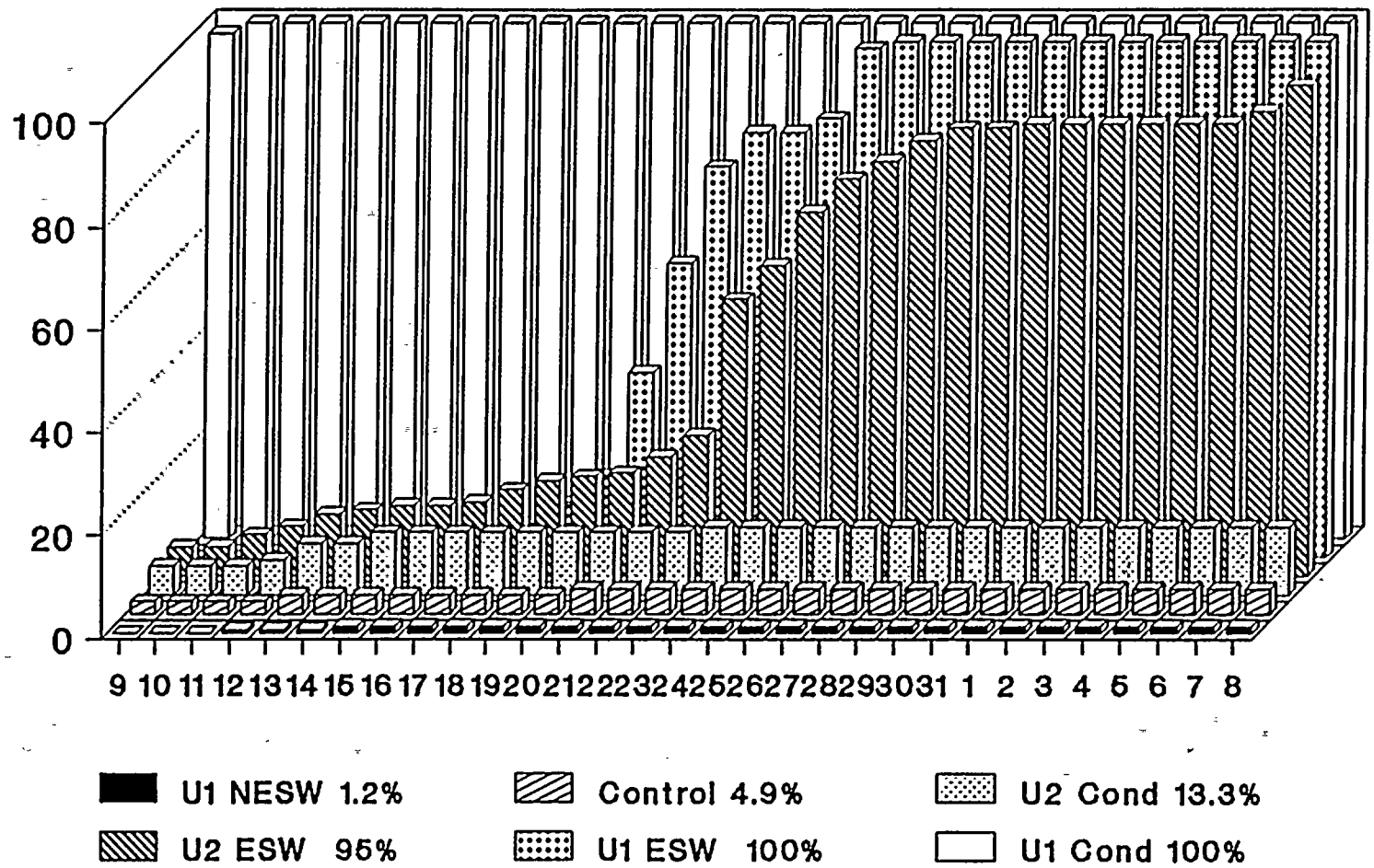
| Bio-Box | % Mortality |
|---|---|
| Control | 4.9 |
| Unit #1 Nesw | 1.2 |
| Unit #2 Circ. Water Condenser Outlet | 13.3 |
| Unit #2 ESW | 95.0* |
| Unit #1 ESW | 100.0* |
| Unit #1 Circ. Water Condenser Outlet | 100.0 |

*Mortalities attributable to causes other than Clam-trol

October 8-9, 1990

ATTACHMENT #2

# MUSSEL MORTALITY CUM%




10/9-11/8/90

ATTACHMENT #2

# Clam-trol Application
## Conclusions

1. Water temperatures were well within vendor's recommended ranges.

2. With the exception of the Unit #1 Circ. Water Condenser Outlet, the recommended residual of 15ppm for 12hrs. was never achieved in the systems treated.

3. Unit #1 Circ. Water Condenser Outlet mortality curve exhibited that typical of a toxic material introduction with a high kill up front.

4. Mortalities registered in the ESW bio-boxes were due to causes other than Clam-trol.

5. Problems with detoxification feed resulted in active Clam-trol being detected in Unit #1 & #2's discharges, and application being terminated.

October 8-9, 1990

ATTACHMENT #2

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK NUCLEAR STATION

ZEBRA MUSSEL INSPECTION UNIT #1

1990

Foreman: Shane Albertson

UNDERWATER CONSTRUCTION CORPORATION
P.O. BOX 6901 / WHEELING, WEST VIRGINIA 26003 / PHONE: (304) 547-0103

INDIANA MICHIGAN POWER COMPANY
DONALD C. COOK NUCLEAR STATION
ZEBRA MUSSEL INSPECTION UNIT #1
1990

1) The keyway inside of bay 1-5, 1-6 south side - approximately 5' off of the floor, 5' east of traveling water screen, a 3' square area contains 33 Zebra Mussels.

2) Same keyway as above on north side, approximately 5' from floor, 5' east of traveling water screen, a 3' square area contains 28 Zebra Mussels.

3) Same keyway as above on southwest corner, 5' off the floor, a 3' square area contains 25 Zebra Mussels.

4) 15' east of traveling water screen 1-6, on the floor, a 3' square area contains 100 Zebra Mussels.

5) On the northeast corner of keyway 1-5, 1-6, approximately 5' off the floor a 3' square area contains 1 Zebra Mussels.

6) On the southwest corner of the dividing wall, between 1-5, 1-4, approximately 5' off the floor, a 3' square area contains 7 Zebra Mussels.

7) The same southwest corner as #6 above (1-5, 1-4), approximately 20' off the floor, a square area contains 5 Zebra Mussels.

8) Inside Unit #1, east southwest bay, on the east wall, approximately 5' from the floor, a 3' square area contains 32 Zebra Mussels.

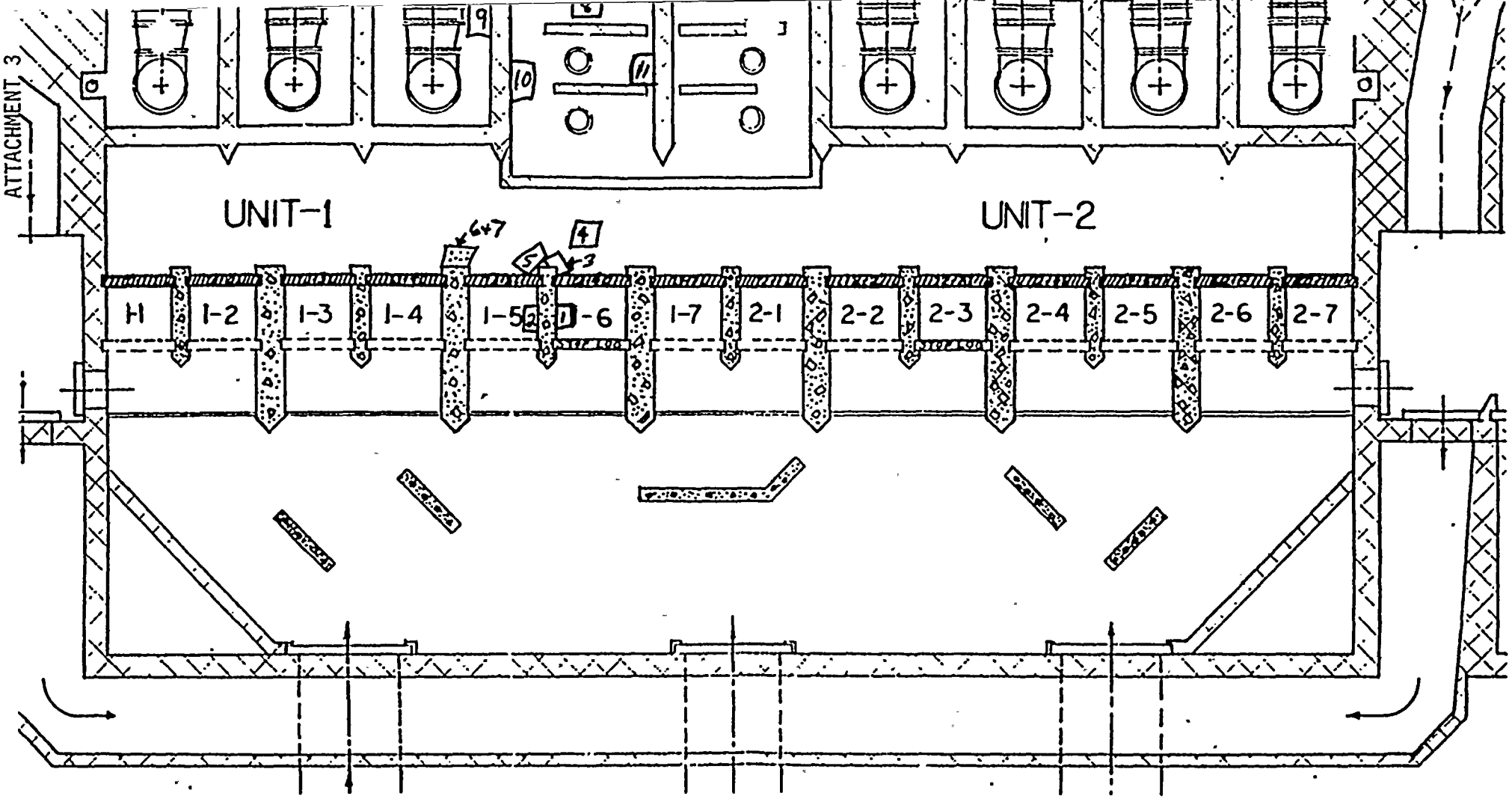
9) On the east wall off the circulating pump #13; approximately 5' from the floor, a 3' square area contains 25 Zebra Mussels.

10) Unit #1 east southwest bay inside north wall, approximately 5' from the floor, a 3' square area contains 17 Zebra Mussels.

11) Unit #1 east southwest bay inside south wall, approximately 5' from the floor, a 3' square area contains 11 Zebra Mussels.

12) The east , east southwest pump is lightly coated with Zebra Mussels.

ATTACHMENT 3




Zebra Mussel Inspection

DATE: 11-90

INSP. BY: ALBERTSON

# APPENDIX V

# ANNUAL REPORT: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

# 1990

# DONALD C. COOK NUCLEAR PLANT

# UNITS 1 & 2

OPERATIONAL

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1990 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1990

Prepared by

INDIANA MICHIGAN POWER COMPANY
and
TELEDYNE ISOTOPES

April 15, 1991

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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 1990 for the Radiological Environmental Monitoring Program for the Donald C. Cook Nuclear plant.

The various analyses of most sample media suggest that there was no discernable impact of the nuclear plant on the environment. The analysis of air particulate filters, charcoal cartridges, direct radiation by thermoluminescent dosimeters, fish, water, milk and sediments from Lake Michigan, drinking water, and food products, either did not detect any radioactivity or measured only naturally occurring radionuclides at normal background levels.

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

# I. INTRODUCTION

# I. INTRODUCTION

The Donald C. Cook Nuclear Power Station's Radiological Environmental Monitoring Program (REMP) is conducted in compliance with NRC Regulatory Guide 1.21 and 4.1, licensing commitments, and Technical Specifications. The REMP was developed in accordance with the NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, November 1979. A synopsis of the sampling program and maps can be found in Section II, Sampling and Analysis Program. This report represents the Annual Environmental Operating Report for Units 1 and 2 of the Donald C. Cook Nuclear Plant for the operating period from January 1, 1990 through December 31, 1990.

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 I summarizes the sampling and analysis program for the Donald C. Cook nuclear plant for 1990. For each sample medium, the table lists the sample locations, including distance and direction from the center of the two units, and the station identification. The station identifications for many of the sampling locations are shown on the maps, Figures 1, 2, and 3. Also for each sample medium the sample collection frequency, type of analysis, and frequency of analysis are listed.

TABLE 1

DONALD C. COOK NUCLEAR PLANT- 1990

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) | 593 m | | 18° | | |
| ONS-2 | (A-2) | 713 m | | 48° | | |
| ONS-3 | (A-3) | 734 m | | 90° | | |
| ONS-4 | (A-4) | 564 m | | 118° | | |
| ONS-5 | (A-5) | 578 m | | 189° | | |
| ONS-6 | (A-6) | 584 m | | 210° | | |
| ONS-7 | (A-7) | 641 m | | 36° | | |
| ONS-8 | (A-8) | 673 m | | 82° | | |
| ONS-9 | (A-9) | 417 m | | 149° | | |
| ONS-10 | (A-10) | 424 m | | 127° | | |
| ONS-11 | (A-11) | 600 m | | 11° | | |
| ONS-12 | (A-12) | 699 m | | 63° | | |
| New Buffalo | (NBF) | 16.0 mi | SSW | | Quarterly | Direct Radiation/Quarterly |
| South Bend | (SBN) | 24.0 mi | SE | | | |
| Dowagiac | (DOW) | 26.0 mi | ENE | | | |
| Coloma | (COL) | 20.0 mi | NNE | | | |
| Intersection of Red Arrow Hwy. & Marquette Woods Rd, Pole #B294-44 | (OFS-1) | 3.5 mi | NNE | | | |
| Stevensville Substation | (OFS-2) | 3.0 mi | NNE | | | |
| Pole #B296-13 | (OFS-3) | 4.0 mi | NE | | | |
| Pole #B350-72 | (OFS-4) | 3.2 mi | ENE | | | |
| Intersection of Shawnee & Cleveland, Pole #B387-32 | (OFS-5) | 3.2 mi | ESE | | | |
| Snow Rd., East of Holden Rd., #B426-1 | (OFS-6) | 3.5 mi | SE | | | |
| Bridgman Substation | (OFS-7) | 2.0 mi | S | | | |
| California Rd., Pole #B424-20 | (OFS-8) | 3.0 mi | SSE | | | |
| Riggles Rd., Pole B369-214 | (OFS-9) | 3.25 mi | E | | | |
| Intersection of Red Arrow Hwy., & Hildebrant Rd.,Pole #B422-152 | (OFS-10) | 2.6 mi | SSW | | | |
| Intersection of Snow Rd. & Baldwin Rd., Pole #B423-12 | (OFS-11) | 2.8 mi | S | | | |

TABLE 1 (Cont.)

DONALD C. COO[illegible]LEAR PLANT- 1990

RADIOLOGICA[illegible]MPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

| Location | Station | Distance | Direction | Degrees | Collection Frequency | Analysis/Frequency |
|---|---|---|---|---|---|---|
| **Air Charcoal/Particulates** | | | | | | |
| ONS-1 | (A-1) | 593 m | | 18° | | |
| ONS-2 | (A-2) | 713 m | | 48° | | |
| ONS-3 | (A-3) | 734 m | | 90° | | |
| ONS-4 | (A-4) | 564 m | | 118° | | |
| ONS-5 | (A-5) | 578 m | | 189° | | |
| ONS-6 | (A-6) | 584 m | | 210° | Weekly | Gross Beta/Weekly |
| New Buffalo | (NBF) | 16.0 mi | SSW | | | I-131/Weekly |
| South Bend | (SBN) | 24.0 mi | SE | | | Gamma Isotopic/ |
| Dowagiac | (DOW) | 26.0 mi | ENE | | | Quarterly Composite |
| Coloma | (COL) | 20.0 mi | NNE | | | |
| **Ground/Well Water** | | | | | | |
| Onsite | (W-1) | 600 m | | 11° | | |
| Onsite | (W-2) | 699 m | | 63° | | |
| Onsite | (W-3) | 999 m | | 107° | | |
| Onsite | (W-4) | 127 m | | 301° | Quarterly | Gamma Isotopic/Quarterly |
| Onsite | (W-5) | 123 m | | 290° | | Tritium/Quarterly |
| Onsite | (W-6) | 129 m | | 273° | | I-131/Quarterly |
| Onsite | (W-7) | 578 m | | 189° | | |
| **Non Technical Specification Related Wells** | | | | | | |
| Steam Generator Storage Facility | (SGRP-1) | 1215 m | | 96° | | |
| Steam Generator Storage Facility | (SGRP-2) | 1190 m | | 93° | | |
| Steam Generator Storage Facility | (SGRP-4) | 1126 m | | 96° | Quarterly | Gross Beta/Quarterly<br>Gross Alpha/Quarterly |
| Steam Generator Storage Facility | (SGRP-5) | 1128 m | | 94° | | Gamma Isotopic/Quarterly<br>I-131/Quarterly |

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1990

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<br>Gamma Isotopic/14 Day Composite<br>I-131/14 Day Composite |
| Lake Township Public Intake Station | | (LTW) | 0.40 mi | S | | | Tritium/Quarterly Composite |
| **Surface Water** | | | | | | | |
| Condenser Circulating Water Intake | | L1 | | | | | |
| Lake Michigan Shoreline | | L-2 | 0.24 mi | S | | Daily | Gamma Isotopic/Monthly Composite |
| Lake Michigan Shoreline | | L-3 | 0.44 mi | N | | | |
| Lake Michigan Shoreline | | L-4 | 0.1 mi | SSW | | | Tritium/Quarterly Composite |
| Lake Michigan Shoreline | | L-5 | 0.1 mi | NNE | | | I-131/Monthly Composite |
| **Sediment** | | | | | | | |
| Lake Michigan Shoreline | | L-2 | 0.24 mi | S | | | |
| Lake Michigan Shoreline | | L-3 | 0.44 mi | N | | Semi-annually | Gamma Isotopic/Semi-Annually |
| Lake Michigan Shoreline | | L-4 | 0.1 mi | SSW | | | |
| Lake Michigan Shoreline | | L-5 | 0.1 mi | NNE | | | |
| **Milk** | | | | | | | |
| Totzke Farm | Baroda | Totzke | 4.5 mi | ENE | | | |
| Wyant Farm | Dowagaic | Wyant | 18.0 mi | E | | | |
| Schuler Farm | Baroda | Schuler | 4.25 mi | SE | | | |
| Livinghouse Farm | La Porte | Livinghouse | 20.0 mi | S | | Once per every | Gamma Isotopic/per Sample |
| Warmbien Farm | Three Oaks | Warmbien | 7.8 mi | S | | 14 Days | I-131 per Sample |
| Zelmer Farm | Bridgman | Zelmer | 4.75 mi | SSE | | | |
| Lomzack Farm | Galien | Lozmack | 9.0 mi | SSE | | | |

TABLE 1 (Cont.)

DONALD C. COOK NUCLEAR PLANT- 1990

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM PLANT AXIS

| Location | | Station | Distance | Direction | Degrees | Collection Frequency | Analysis/Frequency |
|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | |
| Lake Michigan | | ONS-N | .1 mi | N | | Semi-annually | Gamma Isotopic/ |
| Lake Michigan | | ONS-S | .1 mi | S | | | Semi-annually |
| Lake Michigan | | OFS-N | 3 mi | N | | | |
| Lake Michigan | | OFS-S | 5 mi | S | | | |
| **Food** | | | | | | | |
| Grapes,Grape Leaves, | Offsite | Indicator | Variable | Determined from offsite | | | |
| Grapes,Grape Leaves, | Offsite | Control | 20 miles | Dose Calculation manual | | At time of harvest | Gamma Isotopic/ |
| Broadleaf Vegetation | Onsite | | Variable | | | | At time of harvest |

- Composite samples of Drinking and Surface water shall be collected at intervals not to exceed 24 hours.
- Particulate sample filters should be analyzed for gross beta activity 24 or more hours following filter removal. This will allow for radon and thoron daughter decay. If gross beta activity in air or water is greater than 10 times the yearly mean of control samples for any medium, gamma isotopic analysis should be performed on the individual samples.

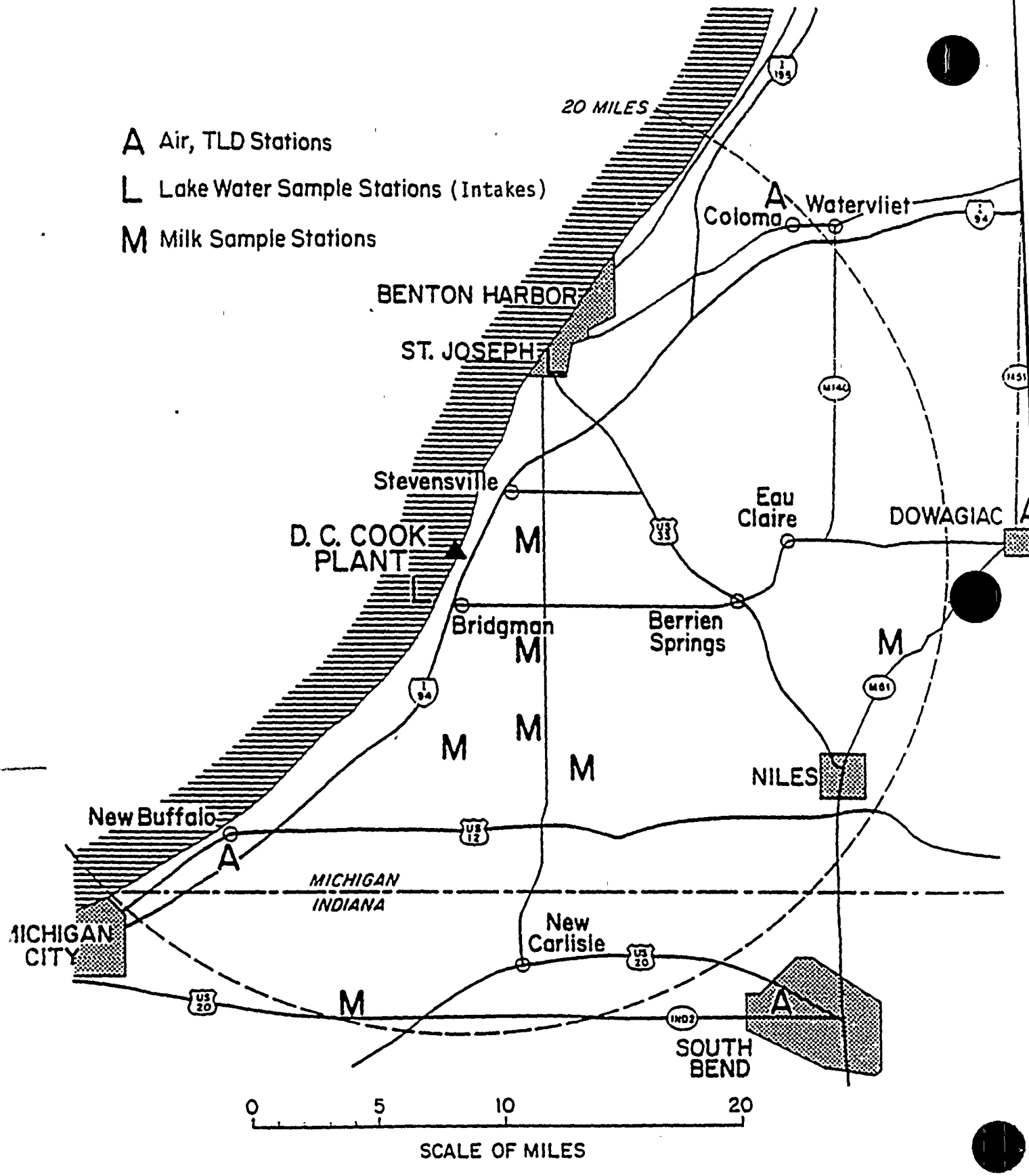
Please note the following defenitions:

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

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

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

Figure 1


A Air, TLD Stations
L Lake Water Sample Stations (Intakes)
M Milk Sample Stations
20 MILES
BENTON HARBOR
ST. JOSEPH
Coloma
Watervliet
Stevensville
D. C. COOK PLANT
Eau Claire
DOWAGIAC
Bridgman
Berrien Springs
NILES
New Buffalo
MICHIGAN
INDIANA
MICHIGAN CITY
New Carlisle
SOUTH BEND
0 5 10 20
SCALE OF MILES

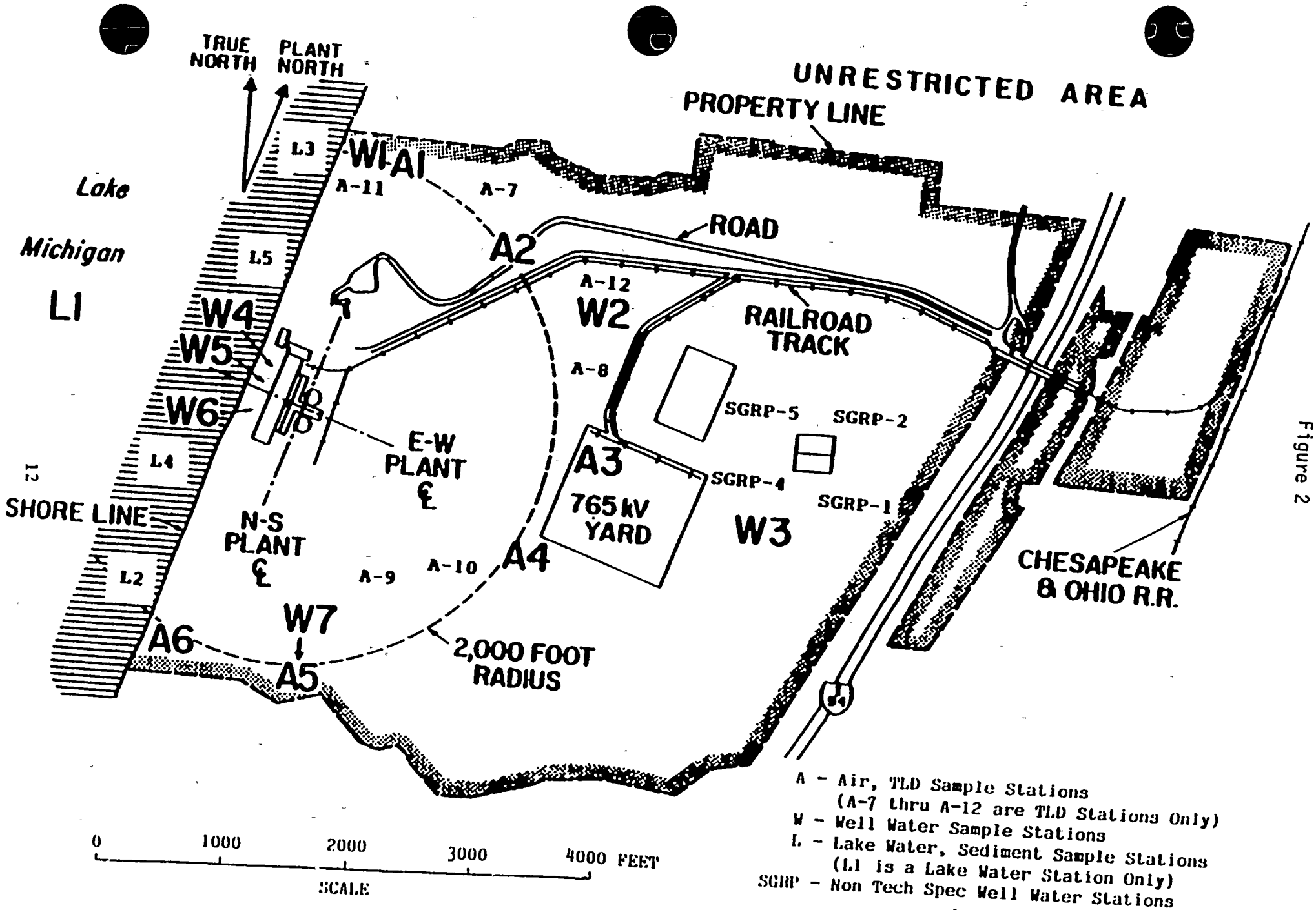
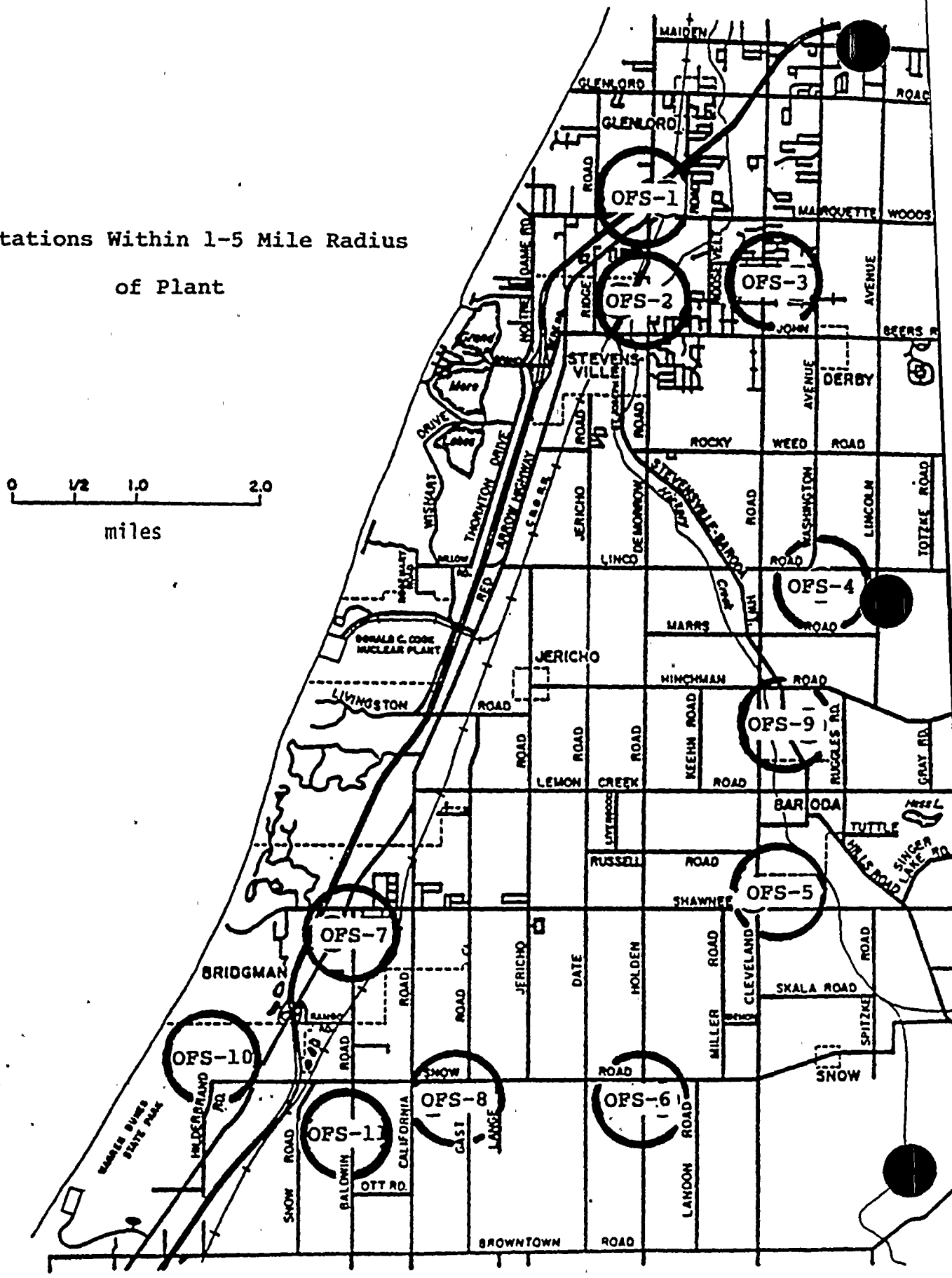

TRUE NORTH
PLANT NORTH
UNRESTRICTED AREA
PROPERTY LINE
Lake Michigan
L1
L2
L3
L4
L5
W1
A1
A-11
A-7
A2
ROAD
A-12
W2
W4
W5
W6
A-8
RAILROAD TRACK
SGRP-5
SGRP-2
E-W PLANT ℄
A3
765 kV YARD
SGRP-4
SGRP-1
W3
SHORE LINE
N-S PLANT ℄
A-9
A-10
A4
CHESAPEAKE & OHIO R.R.
W7
A6
A5
2,000 FOOT RADIUS
0
1000
2000
3000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

Figure 2

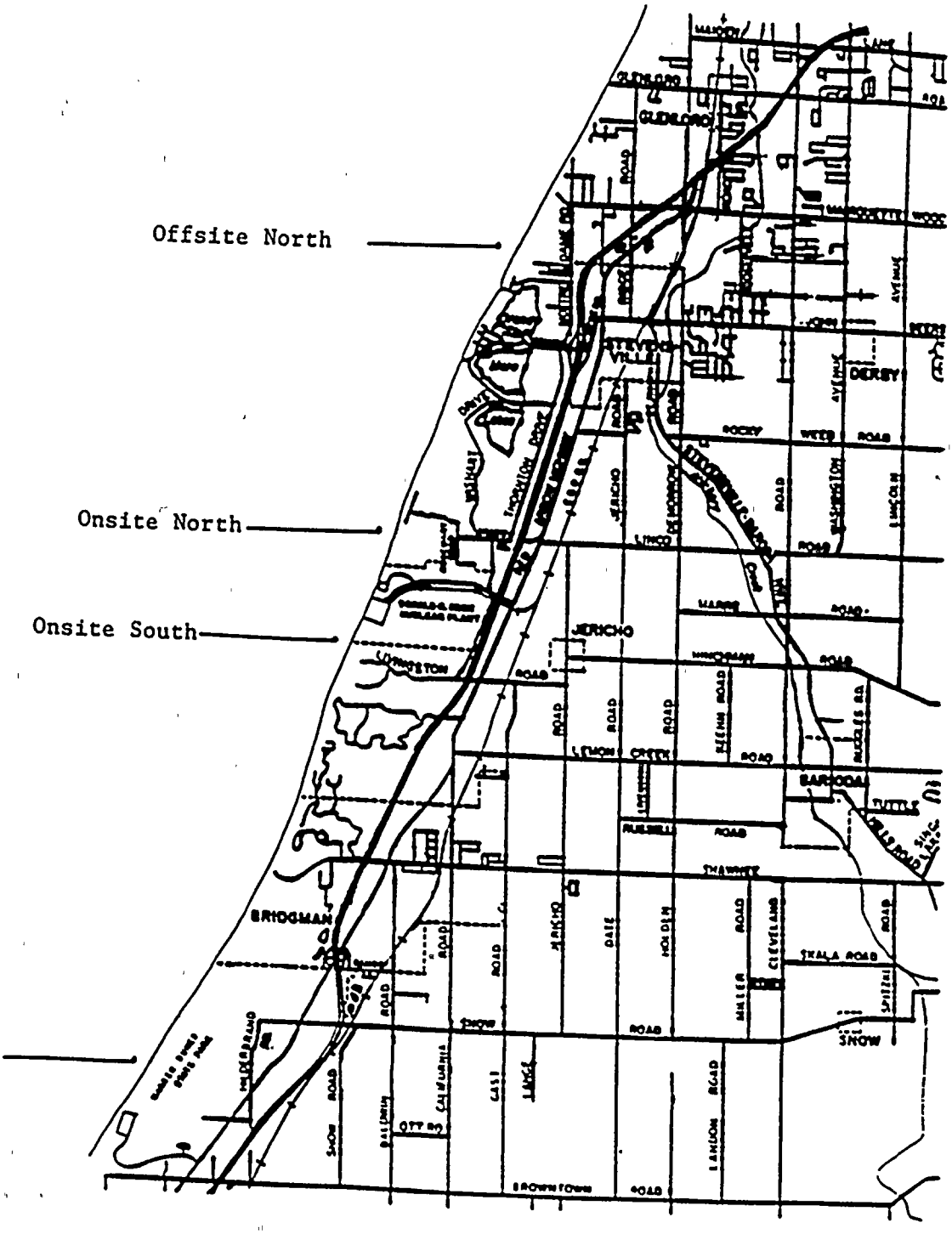
Figure 3

TLD Stations Within 1-5 Mile Radius of Plant



SAMPLING LOCATIONS

FISH COLLECTED FOR RADIOLOGICAL ANALYSIS



# III. SUMMARY AND DISCUSSION OF 1990 ANALYTICAL RESULTS

## III. SUMMARY AND DISCUSSION OF 1990 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 1990 were analyzed by Teledyne Isotopes, Inc. (TI) in Westwood, New Jersey. The procedures and specifications followed at Teledyne Isotopes are in accordance with the Teledyne Isotopes Quality Assurance Manual and are explained in the Teledyne Isotopes Analytical Procedures. A synopsis of analytical procedures used for the environmental samples are proved in Appendix C. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Appendix D.

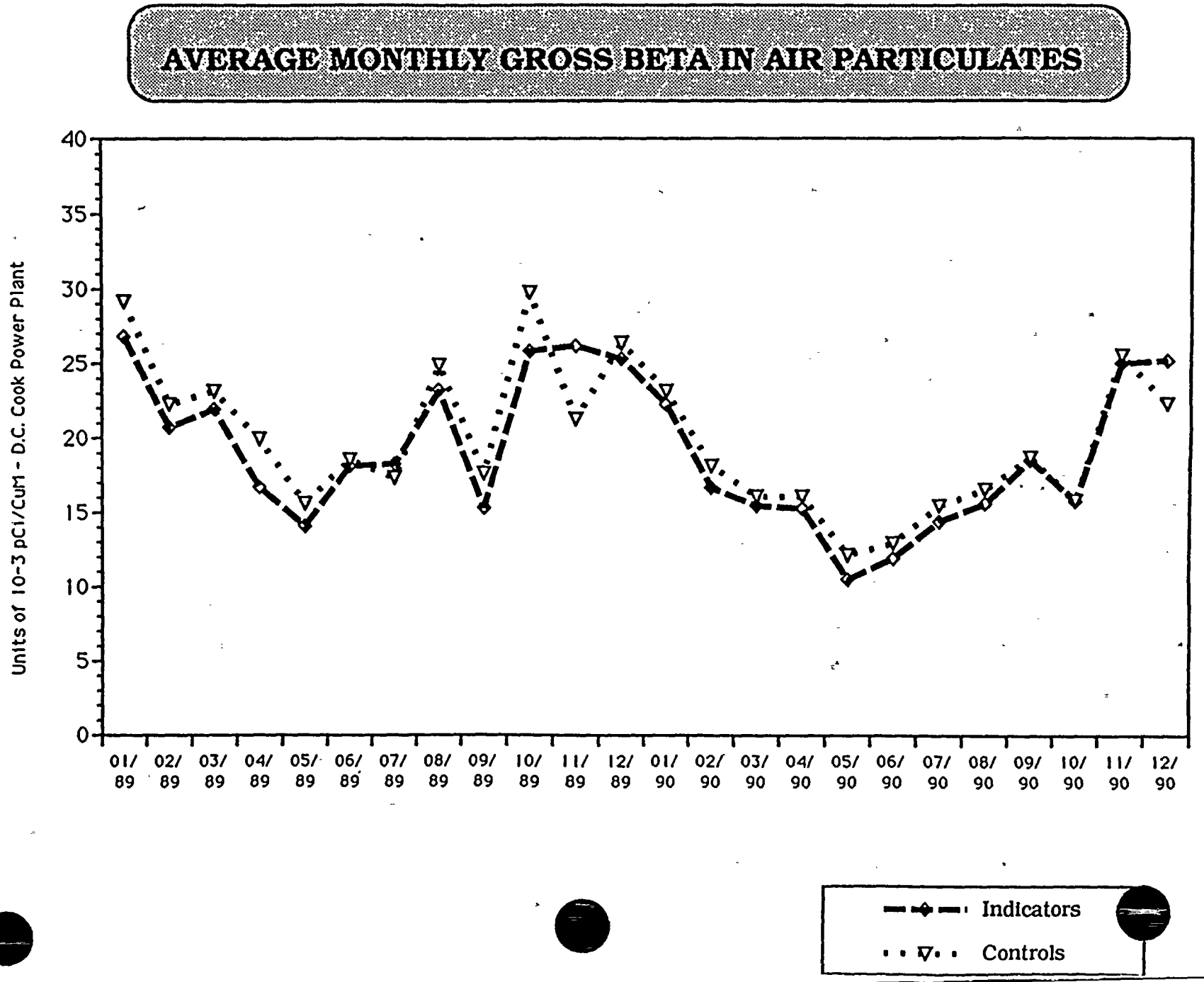
Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. Teledyne Isotopes analytical methods meet or exceed the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring, Revision I, November 1979.

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

### A. Airborne Particulates

Results of gross beta activities are presented in Table B-1. The measurement of the gross beta activity on the weekly air particulate filters is a good indication of the levels of natural and or manmade

## Trending Graph - 1



radioactivity in the environment. The average gross beta concentration of the six indicator locations was 0.017 pCi/$m^3$ with a range of individual values between 0.005 and 0.031 pCi/$m^3$. The average gross beta concentration of the four control locations was 0.018 pCi/$m^3$ with a range between 0.005 and 0.036 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 1990 were lower than at the end of the preoperational period when the effects of the recent atmospheric nuclear tests were being detected.

Air particulate filters were composited by location on a quarterly basis and were analyzed by gamma ray spectroscopy. 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 0.075 pCi/$m^3$ and the values ranged from 0.013 to 0.103 pCi/$m^3$. The average concentration for the indicator locations was 0.073 pCi/$m^3$ with a range of 0.041 to 0.100 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 two of the sixteen control quarterly composites with an average concentration of 0.006 pCi/$m^3$ and a range of 0.005 to 0.007 pCi/$m^3$. Potassium-40 was measured in two of the twenty-four indicator quarterly composites with an average concentration of 0.005 pCi/$m^3$ and a range of 0.003 to 0.006 pCi/$m^3$. No other gamma emitting radioactivity was detected.

B. Airborne Iodine

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

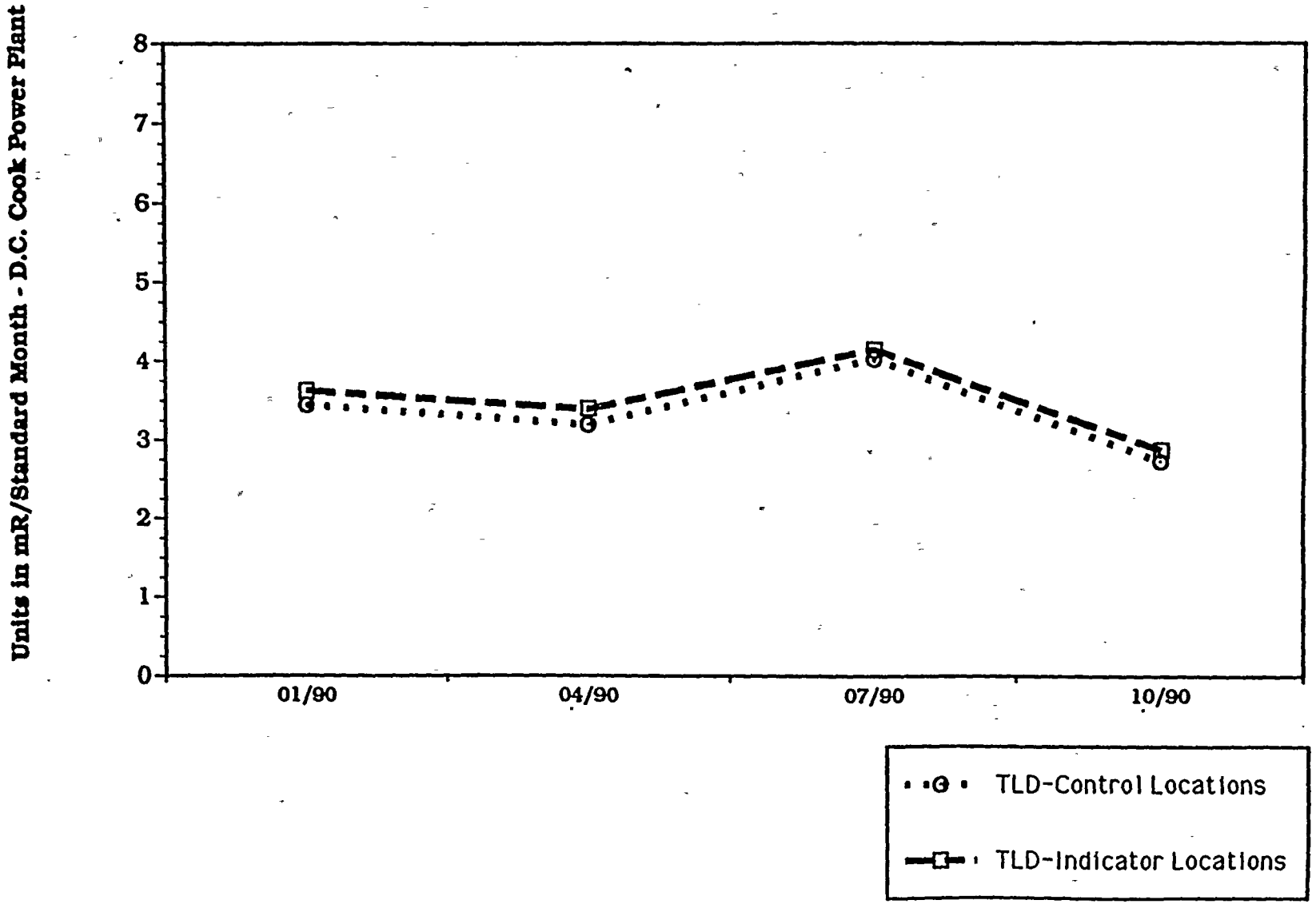
C. Direct Radiation - Thermoluminescent Dosimeters

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 the exposure from all of these potential sources. The TLDs are deployed quarterly at 27 locations in the environs of the D. C. Cook Nuclear Plant site. The average value of the readings of the four areas of each dosimeter (calibrated individually after each field exposure period for response to a known exposure and for intransit exposure) are presented in Table B-4. Those exposure rates are quite typical of observed rates at many other locations in the country. The average measurement for the 16 control samples was 3.35 mR/standard month and a range of 2.3 to 4.5 mR/standard month. The 91 indicator samples had a measurement of 3.51 mR/standard month and a range of 2.3 to 5.1 mR/standard month. The 1990 annual average in the environs of the D. C. Cook plant is at the low range of the exposure rates (1.0 to 2.0 mR/week) measured during the preoperational period. The results of the indicator and control TLDs are in good agreement and are plotted in Trending Graph 2.

D. Surface Water

Lake Michigan surface water samples from the condenser circulating water intake and from four shoreline locations, all within 0.5 mile of the two reactors were collected daily and composited monthly for iodine-131 analysis and analyzed by gamma ray spectroscopy and composited quarterly for tritium analysis. The results of analyses are shown in Table B-5. No iodine-131 nor gamma emitting isotopes were detected. Tritium was detected in 11 of the 20 samples analyzed with an average concentration of 254 pCi/liter and a range of 170 to 340 pCi/liter. This is slightly lower than the average concentration in 1989 of 261 pCi/liter. During the preoperational period tritium was measured in surface water samples

# DIRECT RADIATION - QUARTERLY TLD RESULTS



at concentrations of approximately 400 pCi/liter. Naturally occurring gamma emitting isotopes were detected by gamma ray spectroscopy.

E. Ground/Well Water

Water samples are collected quarterly from seven wells, all within 1000 meters of the reactors. The samples are analyzed for gamma emitters and for tritium. The results are presented in Table B-6. No gamma emitting isotopes were detected. The on-site wells 4, 5, and 6 had measurable tritium activity throughout 1990 with concentrations of 860, 977 and 583 pCi/liter respectively. These measurements are lower than those detected during 1989 of 2300, 1930, and 1560 pCi/liter. Tritium was measured in five of the sixteen samples at the off-site locations with an average concentration of 172 pCi/liter and a range of 130 to 230 pCi/liter. The annual concentrations of tritium in the seven wells are plotted from 1979 through 1990 in Trending Graph 3.

Tritium concentration in wells in the preoperational period were typically about 400 pCi/liter.

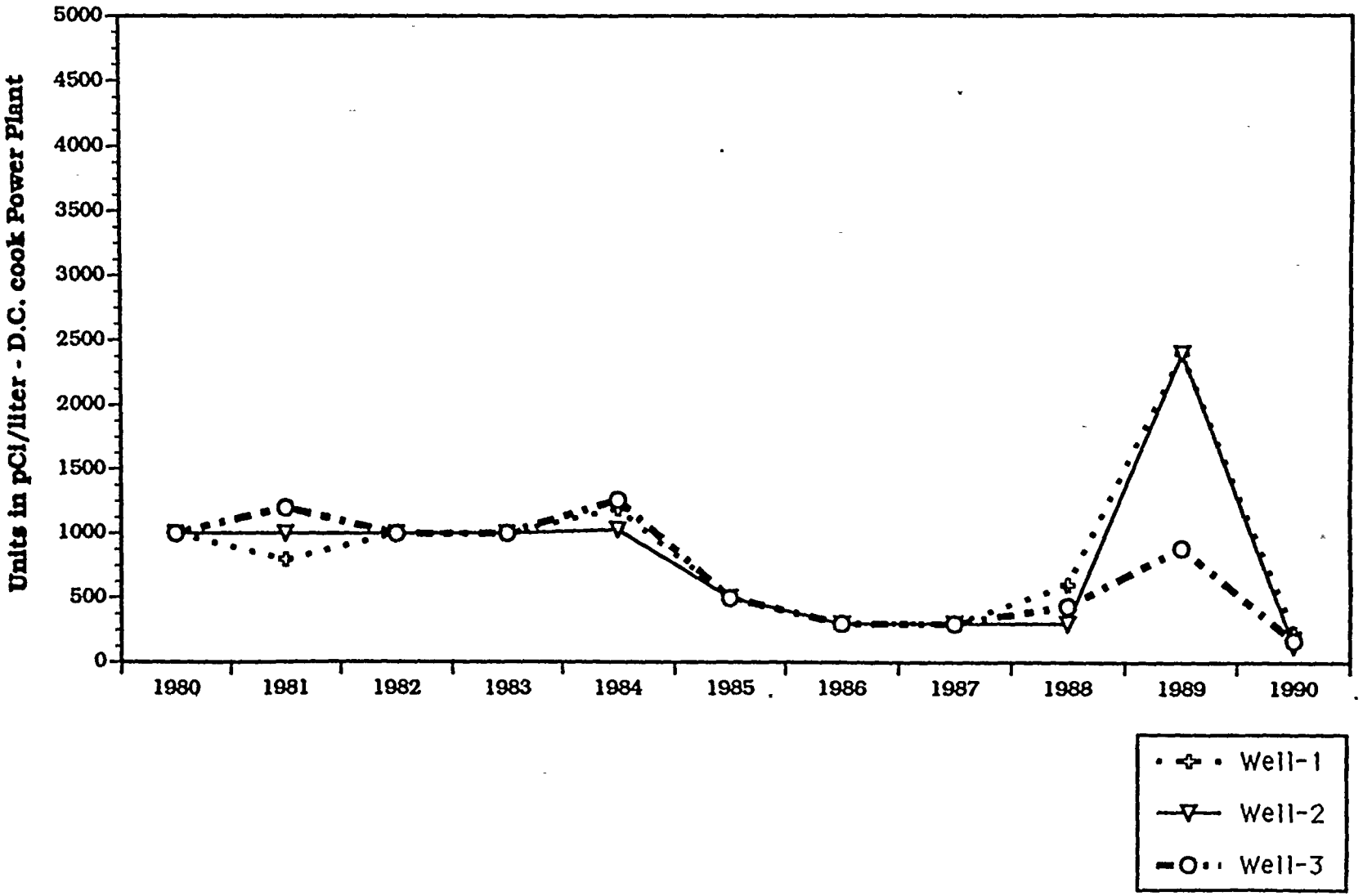
F. Drinking Water

Daily samples are collected at the intake of the the purification plants for St. Joseph and Lake Township. The samples at each location are composited biweekly and analyzed for gross beta, iodine-131 to a sensitivity of 1 pCi/liter, and for gamma emitters. On a quarterly basis the samples are composited and analyzed for tritium. The results of analyses of drinking water samples are shown in Table B-7.

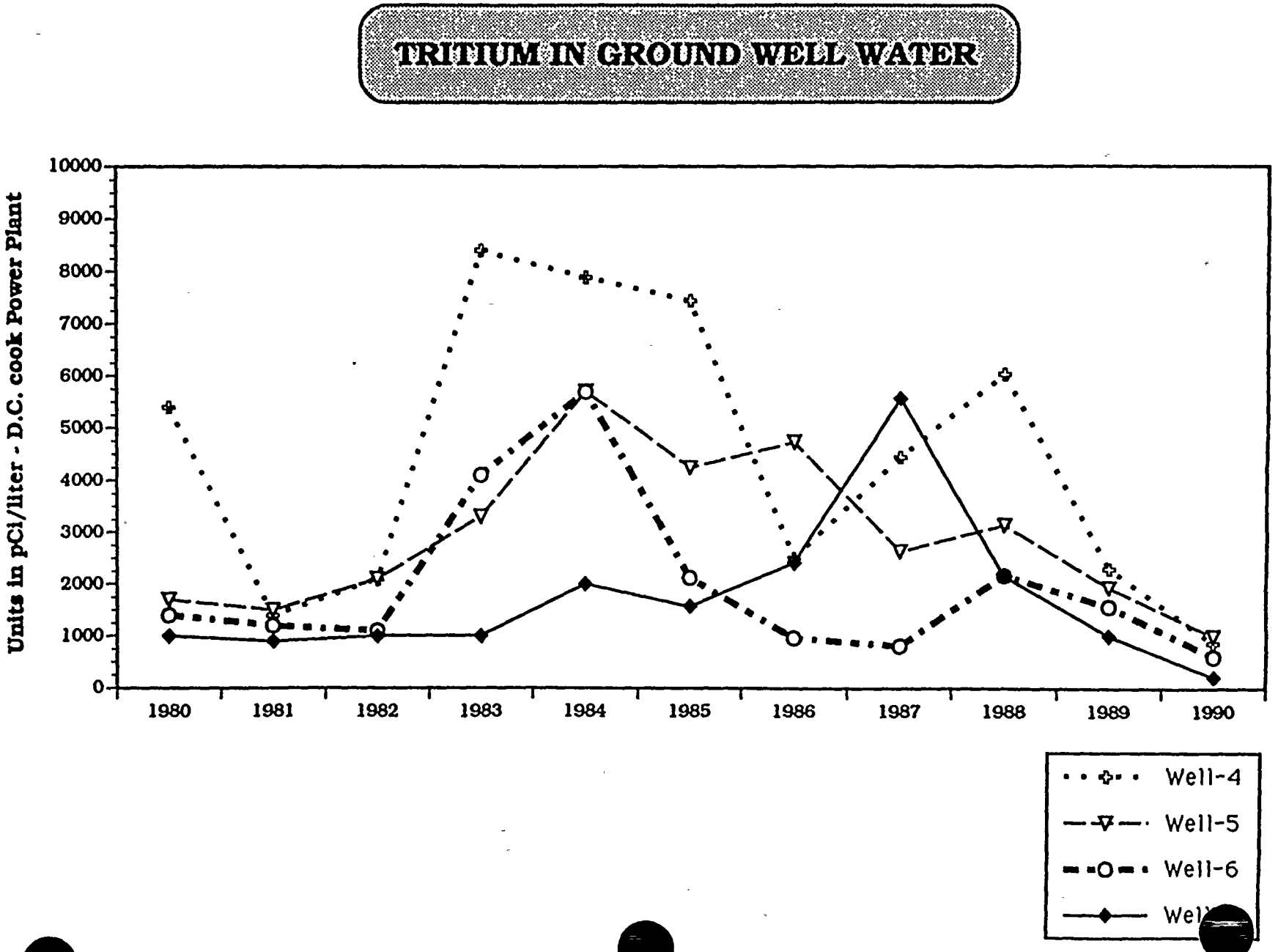
Gross beta activity was measured in all twenty-five samples from the Lake Township intake with an average concentration of 4.1 pCi/liter and a range from 2.7 to 10 pCi/liter. Gross beta activity was measured in all twenty-six samples from the St. Joseph intake with an average concentration of 3.9 pCi/liter and a range from 2.8 to 6.1

Trending Graph - 2

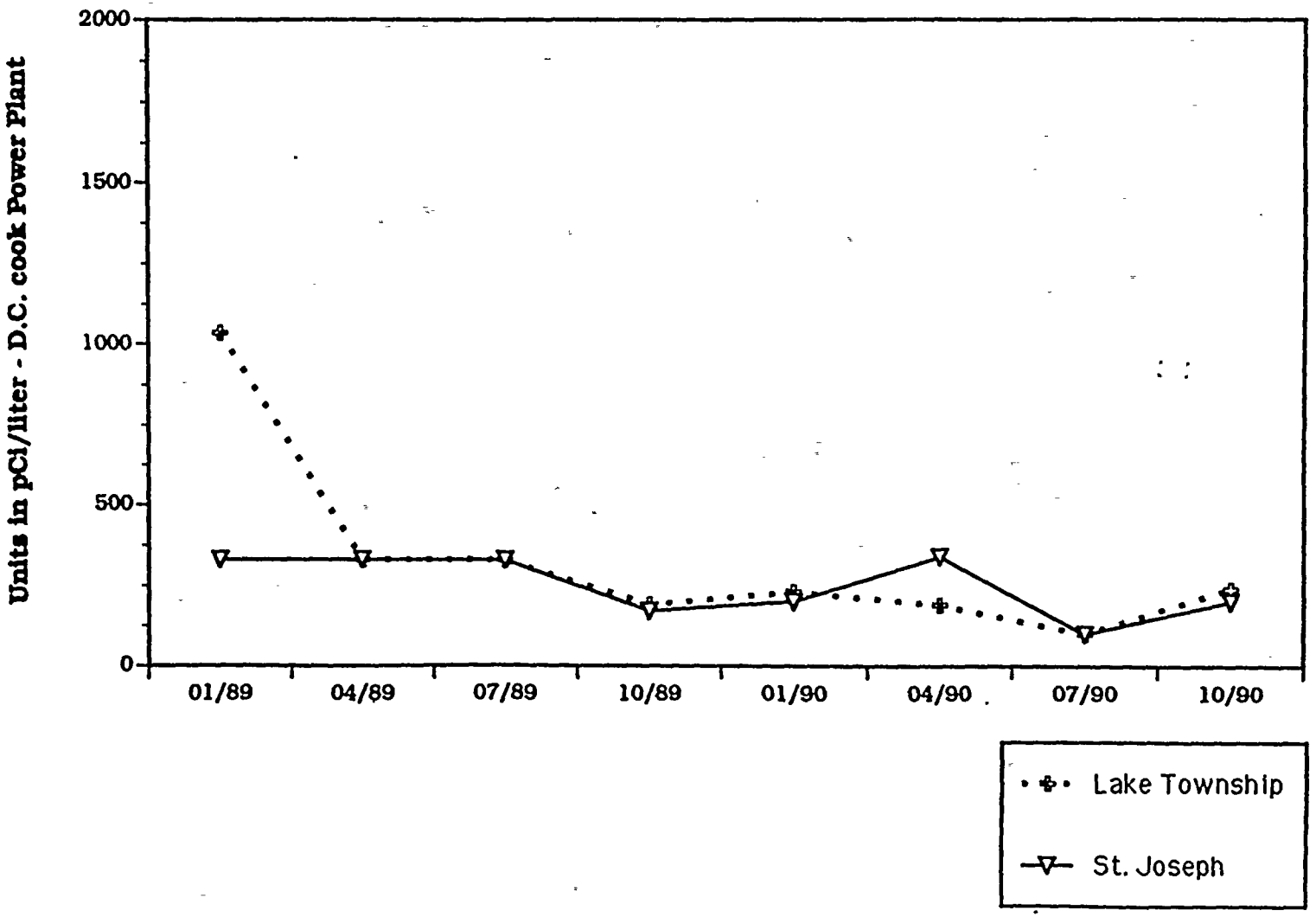
# TRITIUM IN GROUND/WELL WATER



## Trending Graph - 2 (Cont.)



# TRITIUM IN DRINKING WATER



pCi/liter. No gamma emitting isotopes or iodine-131 were detected. Tritium was measured in three of the four samples from Lake Township intake with an average concentration of 220 pCi/liter and a range of 190 to 240 pCi/liter. Tritium was measured in one sample from St. Joseph intake with a concentration of 340 pCi/liter. Tritium in drinking water is plotted in Trending Graph 4.

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

G. Sediment

Sediment samples are collected semiannually along the shoreline of Lake Michigan at the same four locations as the surface water samples. The sediment samples are analyzed by gamma ray spectroscopy, the results of which are shown in Table B-8. In November one sample was collected from each location L2, L3, L4 and L5. Gamma ray spectroscopy detected naturally occurring potassium-40 and thorium-228 in all the samples. The average potassium-40 concentration was 5985 pCi/kg with a range from 4930 to 7250 pCi/kg. The average thorium-228 concentration was 126 pCi/kg with a range from 70.9 to 171 pCi/kg. All the measured activities of the naturally occurring isotopes were at background levels. Cesium-137, attributed to fallout from previous atmospheric nuclear tests, was detected in three of the eight samples. The average concentration of cesium-137 was 25.1 pCi/kg with a range of 18.5 to 30.1 pCi/kg. That activity level is often observed in soils and sediments.

H. Milk

Milk samples are collected every fourteen days from seven farms located between 4.25 miles and 20 miles from the site. The samples are analyzed for iodine-131 and for gamma emitters. The results are shown in Table B-9. Iodine-131 was not measured in any of the 175 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 1990. Iodine-131 was measured in four samples collected soon after an atmospheric nuclear test with concentrations between 0.2 and 0.9 pCi/liter. Cesium-137 was measured in numerous samples after the nuclear test with concentrations between 7 and 64 pCi/liter.

During 1990 the average potassium-40 concentration for the control locations during was 1293 pCi/liter with a range of 1070 to 1490 pCi/liter. The indicator locations had an average concentration of 1302 pCi/liter and a range of 922 to 1950. There were no detections of iodine-131 or cesium-137 during 1990.

I. Fish

Fish are collected semiannually, when available, from four locations in Lake Michigan in the vicinity of the site and analyzed by gamma ray spectroscopy. Naturally occurring potassium-40 was measured in all samples with an average concentration of 2636 pCi/kg (wet weight) and a range of 684 to 3840 pCi/kg (wet weight). Cesium-137, attributed to previous atmospheric nuclear tests was measured in six of the eight fish samples at an average concentration of 37.8 pCi/kg (wet weight) and a range of 20.3 to 80.1 pCi/kg (wet weight).

J. Food Products

Grapes, grape leaves, and broadleaf vegetation are collected annually at harvest time at one on-site location and one off-site location. Naturally occurring potassium-40 was measured in all samples with an average concentration of 2402 pCi/kg (wet weight) and a range of 889 to 3700 pCi/kg (wet weight). Cosmogenically produced beryllium-7 was measured in three of the five samples with an average concentration of 1650 pCi/kg (wet weight) and a range of 1060 to 2700 pCi/kg (wet weight).

# IV. CONCLUSIONS

## IV. CONCLUSIONS

The results of the 1990 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 1990 appears to follow the gross beta concentrations at the control locations. The concentration levels are actually lower than during the preoperational period when the influence of atmospheric nuclear tests was being detected. Gamma isotopic analysis of the particulate samples identified the gamma emitting isotopes as natural products (beryllium-7 and potassium-40). No man-made activity was found in the particulate media during 1990. No iodine-131 was detected in charcoal filters in 1990.

Thermoluminescent dosimeters (TLD) measure external gamma radiation from naturally occurring radionuclides in the air and soil, radiation from cosmic origin and fallout from atmospheric nuclear weapons testing, and potential radioactive airborne releases and direct radiation from the power station. The average annual TLD results were at normal background exposure levels.

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

Ground water samples were collected quarterly at seven wells, all within 1000 meters of the reactors. The three wells within 130 meters had measurable tritium which is attributed to the operation of the plant. The tritium levels in 1990 are lower than in 1989. The highest concentration in 1990 was 1750 pCi/liter as compared to 3600 pCi/liter measured in 1989) The tritium levels in ground water have been plotted for the last decade and indicate decreasing levels of tritium. No gamma emitting isotopes were detected.

Samples are collected daily at the intakes of the drinking purification plants for St. Joseph and Lake Township. Samples composited biweekly are analyzed for iodine-131, gross beta, and for gamma emitting isotopes and analyzed quarterly for tritium. No iodine-131 or gamma emitting isotopes were detected. Gross beta was measured in all fifty samples at normal background concentrations. Tritium was measured in four of the eight samples with background levels that were lower than those measured during 1989.

Sediment samples can be a sensitive indicator of discharges from nuclear power stations. Sediment samples are collected semiannually along the shoreline of Lake Michigan at four locations in close proximity of the reactors. The samples were analyzed by gamma ray spectroscopy. In 1990 only naturally occurring radionuclides were measured. There is no evidence of station discharges affecting Lake Michigan, either in the sediments or in the water, as previously discussed.

Milk samples were collected every fourteen days from seven farms up to a distance of 20 miles from the site. The samples were measured for iodine-131 and for gamma emitting isotopes. Although I-131 was measured during 1989 there were no measurements of iodine-131 in milk in 1990. Potassium-40 was measured in all milk samples at normal background levels.

Fish samples collected in Lake Michigan in the vicinity of the nuclear plant were analyzed by gamma ray spectroscopy. The only gamma emitting isotope measured was cesium-137 which was in very

low concentrations, typical of those found in other parts of the country and which are attributed to previous atmospheric nuclear tests.

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

The results of the analyses have been presented. Based on the evidence of the radiological environmental monitoring program the Donald C. Cook nuclear plant appears to be operating within regulatory limits. Tritium in five on-site wells appears to be the only radionuclide which can be directly correlated with the plant. However the associated ground water does not provide a direct dose pathway to man.

## V. REFERENCES


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

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

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

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

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

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

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

# APPENDIX A
# RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1990

| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED | | ALL INDICATOR LOCATIONS MEAN (a/b) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN RANGE | CONTROL LOCATION MEAN RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS |
|---|---|---|---|---|---|---|---|
| **Air Iodine** ($pCi/m^3$) | I-131 | 520 | -(0/312) - | N/A | N/A | -(0/208) - | 0 |
| **Airborne Particulates** (1E-03 $pCi/m^3$) | Gross Beta (Weekly) | 510 | 17.2(306/306) (5.1-31) | NBF 16.0 mi SSW | 18.4(51/51) (4.8-36) | 17.7(204/204) (4.8-36) | 0 |
| | Gamma | 40 | | | | | |
| | Be-7 | 40 | 73.3(24/24) (40.6-99.6) | SBN 24 mi SE | 83.2(4/4) (52.3-103) | 74.9(16/16) (13.3-103) | 0 |
| | K-40 | 40 | 4.63(2/24) (3.21-6.04) | NBF 16.0 mi SSW | 6.74(1/4) - | 5.76(2/16) (4.77-6.74) | 0 |
| **Direct Radiation** (mR/Standard Month) | Gamma Dose Quarterly | 107 | 3.51(91/91) (2.3-5.1) | 11 3.8 mi S | 4.28(4/4) (3.6-5.1) | 3.35(16/16) (2.3-4.5) | 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, 1990

| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED | | ALL INDICATOR LOCATIONS MEAN (a/b) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN RANGE | CONTROL LOCATION MEAN RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS |
|---|---|---|---|---|---|---|---|
| **Surface Water** (pCi/liter) | Gamma | 65 | | | | | |
| | K-40 | 65 | 71.5(2/65) (66.3-76.6) | L-4 0.33 mi SSW | 71.5(2/13) (66.3-76.6) | -(0/0) - | 0 |
| | H-3 | 24 | 254(11/20) (170-340) | L-5 0.1 mi NNE | 265(4/4) (190-340) | -(0/0) - | 0 |
| **Ground Water** (pCi/liter) | Gamma | 28 | -(0/28) - | N/A | N/A | -(0/0) - | 0 |
| | H-3 | 28 | 580(14/28) (120-1700) | Well 5 0.1 mi WNW Onsite | 977(3/4) (530-1700) | -(0/0) - | 0 |
| **Drinking Water** (pCi/liter) | Gross Beta | 52 | 4.0(52/52) (2.7-10) | LTW 0.40 mi S | 4.1(26/26) (2.7-10) | -(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 | 250(4/8) (190-340) | STJ 9.0 mi NE | 340(1/4) - | -(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-

BERRIEN COUNTY JANUARY 1 to DECEMBER 31, 1990

| 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 wet) | Gamma | 8 | | | | | |
| | K-40 | 8 | 5985(8/8) (4930-7250) | L-5 0.35 mi NNE | 6380(4/4) (5700-7060) | No Control | 0 |
| | Cs-137 | 8 | 25.1(3/8) (18.5-30.1) | L-5 0.35 mi NNE | 30.1(1/2) - | No Control | 0 |
| | Th-228 | 8 | 126(8/8) (70.9-171) | L-4 0.33 mi SSW | 135(2/2) (116-154) | No Control | 0 |
| **Milk** (pCi/liter) | Gamma | 175 | | | | | |
| | K-40 | 175 | 1302(125/125) (922-1950) | Shuler 4.25 mi SE | 1376(25/25) (922-1950) | 1293(50/50) (1070-1490) | 0 |
| | I-131 | 175 | -(0/125) - | N/A | | -(0/50) - | 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, 1990

| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED | | ALL INDICATOR LOCATIONS MEAN (a/b) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN RANGE | CONTROL LOCATION MEAN RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS |
|---|---|---|---|---|---|---|---|
| **Fish** (pCi/kg wet) | Gamma | 8 | | | | | |
| | K-40 | 8 | 2636(8/8) (684-3840) | OFS-South 5 mi N | 3575(2/2) (3310-3840) | -(0/0) - | 0 |
| | Cs-137 | 8 | 37.8(6/8) (20.3-80.1) | OFS-North 3 mi N | 80.1(1/1) - | -(0/0) - | 0 |
| **Food/Vegetation** (pCi/kg wet) | Gamma | 5 | | | | | |
| | Be-7 | 5 | 1650(3/5) (1060-2700) | Sector H Variable | 2700(1/2) - | -(0/0) - | 0 |
| | K-40 | 5 | 2402(5/5) (889-3700) | Sector E Variable | 2830(2/2) (2300-3360) | -(0/0) - | 0 |

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

# APPENDIX B
# DATA TABLES

TABLE B-1

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

| COLLECTION DATES | STATION CODES A-1 | A-2 | A-3 | A-4 | A-5 | A-6 | Coloma | Dowagiac | New Buff | South Bend | Average ± 2 s.d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **JANUARY 90** | | | | | | | | | | | |
| 01/08/90 | 28 ± 2 | 30 ± 2 | 29 ± 2 | 29 ± 2 | 28 ± 2 | 27 ± 2 | 28 ± 2 | 29 ± 2 | 36 ± 2 | 35 ± 2 | 30 ± 6 |
| 01/15/90 | 25 ± 2 | 26 ± 2 | 23 ± 2 | 26 ± 2 | 26 ± 2 | 24 ± 2 | 24 ± 2 | 24 ± 2 | 20 ± 2 | 22 ± 2 | 24 ± 4 |
| 01/22/90 | 16 ± 2 | 17 ± 2 | 16 ± 2 | 18 ± 2 | 17 ± 2 | 16 ± 2 | 18 ± 2 | 18 ± 2 | 21 ± 2 | 18 ± 2 | 18 ± 3 |
| 01/29/90 | 19 ± 2 | 19 ± 2 | 18 ± 2 | 19 ± 2 | 18 ± 2 | 20 ± 2 | 20 ± 2 | 20 ± 2 | 20 ± 2 | 17 ± 2 | 19 ± 2 |
| **FEBRUARY** | | | | | | | | | | | |
| 02/05/90 | 18 ± 2 | 17 ± 2 | 13 ± 2 | 16 ± 2 | 15 ± 2 | 17 ± 2 | 18 ± 2 | 17 ± 2 | 15 ± 2 | 17 ± 2 | 16 ± 3 |
| 02/12/90 | 15 ± 2 | 16 ± 2 | 15 ± 2 | 15 ± 2 | 15 ± 2 | 15 ± 2 | 16 ± 2 | 15 ± 2 | 23 ± 2 | 16 ± 2 | 16 ± 5 |
| 02/19/90 | 18 ± 2 | 17 ± 2 | 19 ± 2 | 19 ± 2 | 18 ± 2 | 20 ± 2 | 19 ± 2 | 19 ± 2 | 22 ± 2 | 21 ± 2 | 19 ± 3 |
| 02/26/90 | 17 ± 2 | 17 ± 2 | 17 ± 2 | 16 ± 2 | 17 ± 2 | 18 ± 2 | 17 ± 2 | 16 ± 2 | 21 ± 2 | 18 ± 2 | 17 ± 3 |
| **MARCH** | | | | | | | | | | | |
| 03/05/90 | 21 ± 2 | 18 ± 2 | 20 ± 2 | 20 ± 2 | 19 ± 2 | 22 ± 2 | 20 ± 2 | 22 ± 2 | 23 ± 2 | 23 ± 2 | 21 ± 3 |
| 03/12/90 | 17 ± 2 | 13 ± 2 | 14 ± 2 | 14 ± 2 | 13 ± 2 | 15 ± 2 | 14 ± 2 | 14 ± 2 | 16 ± 2 | 16 ± 2 | 15 ± 3 |
| 03/19/90 | 12 ± 2 | 12 ± 2 | 13 ± 2 | 12 ± 2 | 13 ± 2 | 14 ± 2 | 12 ± 2 | 12 ± 2 | 12 ± 2 | 15 ± 2 | 13 ± 2 |
| 03/26/90 | 19 ± 2 | 19 ± 2 | 18 ± 2 | 17 ± 2 | 18 ± 2 | 19 ± 2 | 18 ± 2 | 18 ± 2 | 18 ± 2 | 17 ± 2 | 18 ± 2 |
| 04/02/90 | 9 ± 1 | 10 ± 1 | 11 ± 2 | 10 ± 1 | 10 ± 1 | 12 ± 2 | 11 ± 2 | 10 ± 2 | 11 ± 2 | 12 ± 2 | 11 ± 2 |
| **Quarterly Avg. ± 2 Sigma** | **18 ± 10** | **18 ± 11** | **17 ± 10** | **18 ± 10** | **17 ± 10** | **18 ± 8** | **18 ± 9** | **18 ± 10** | **20 ± 13** | **19 ± 11** | **18 ± 2** |

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

| COLLECTION DATES | STATION CODES A-1 | A-2 | A-3 | A-4 | A-5 | A-6 | Coloma | Dowagiac | New Buff | South Bend | Average ± 2 s.d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **APRIL** | | | | | | | | | | | |
| 04/09/90 | 16 ± 2 | 16 ± 2 | 14 ± 2 | 16 ± 2 | 15 ± 2 | 18 ± 2 | 14 ± 2 | 15 ± 2 | 15 ± 2 | 16 ± 2 | 16 ± 2 |
| 04/16/90 | 18 ± 2 | 15 ± 2 | 8 ± 2 | 15 ± 2 | 16 ± 2 | 17 ± 2 | 16 ± 2 | 16 ± 2 | 17 ± 2 | 17 ± 2 | 16 ± 6 |
| 04/23/90 (a) | | | | | | | | | | | |
| 04/30/90 | 16 ± 2 | 16 ± 2 | 14 ± 2 | 14 ± 2 | 15 ± 2 | 16 ± 2 | 17 ± 2 | 15 ± 2 | 18 ± 2 | 17 ± 2 | 16 ± 3 |
| **MAY** | | | | | | | | | | | |
| 05/07/90 | 15 ± 2 | 17 ± 2 | 14 ± 2 | 16 ± 2 | 15 ± 2 | 14 ± 2 | 13 ± 2 | 16 ± 2 | 15 ± 2 | 15 ± 2 | 15 ± 2 |
| 05/14/90 | 14 ± 2 | 14 ± 2 | 15 ± 2 | 13 ± 2 | 8 ± 1 | 13 ± 2 | 13 ± 2 | 14 ± 2 | 15 ± 2 | 14 ± 2 | 13 ± 4 |
| 05/21/90 | 6 ± 2 | 5 ± 2 | 6 ± 2 | 6 ± 2 | 6 ± 2 | 5 ± 2 | 10 ± 2 | 8 ± 2 | 11 ± 2 | 10 ± 2 | 7 ± 5 |
| 05/28/90 | 8 ± 2 | 9 ± 2 | 6 ± 2 | 9 ± 2 | 9 ± 2 | 9 ± 2 | 10 ± 2 | 10 ± 2 | 10 ± 2 | 10 ± 2 | 9 ± 3 |
| **JUNE** | | | | | | | | | | | |
| 06/04/90 | 9 ± 2 | 10 ± 2 | 10 ± 2 | 8 ± 2 | 9 ± 2 | 9 ± 2 | 9 ± 2 | 9 ± 2 | 12 ± 2 | 12 ± 2 | 10 ± 3 |
| 06/11/90 | 10 ± 2 | 11 ± 2 | 10 ± 2 | 9 ± 2 | 11 ± 2 | 10 ± 2 | 11 ± 2 | 12 ± 2 | 11 ± 2 | 12 ± 2 | 11 ± 2 |
| 06/18/90 | 19 ± 2 | 16 ± 2 | 16 ± 2 | 17 ± 2 | 18 ± 2 | 7 ± 2 | 15 ± 2 | 15 ± 2 | 19 ± 2 | 16 ± 2 | 16 ± 7 |
| 06/25/90 | 6 ± 2 | 9 ± 2 | 7 ± 2 | 9 ± 2 | 8 ± 2 | 12 ± 2 | 10 ± 2 | 8 ± 2 | 11 ± 2 | 9 ± 2 | 9 ± 4 |
| 07/02/90 | 14 ± 2 | 17 ± 2 | 17 ± 2 | 17 ± 2 | 15 ± 2 | 18 ± 2 | 18 ± 2 | 16 ± 2 | 15 ± 2 | 19 ± 2 | 17 ± 3 |
| **Quarterly Avg. ± 2 Sigma** | **13 ± 9** | **13 ± 8** | **11 ± 8** | **12 ± 8** | **12 ± 8** | **12 ± 9** | **13 ± 6** | **13 ± 6** | **14 ± 6** | **14 ± 7** | **13 ± 2** |

(a) Samples inadvertently lost at the laboratory.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

| COLLECTION DATES | STATION CODES A-1 | A-2 | A-3 | A-4 | A-5 | A-6 | Coloma | Dowagiac | New Buff | South Bend | Average ± 2 s.d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **JULY** | | | | | | | | | | | |
| 07/09/90 | 14 ± 2 | 15 ± 2 | 14 ± 2 | 12 ± 2 | 13 ± 2 | 15 ± 2 | 13 ± 2 | 16 ± 2 | 16 ± 2 | 16 ± 2 | 14 ± 3 |
| 07/16/90 | 13 ± 2 | 13 ± 2 | 15 ± 2 | 12 ± 2 | 11 ± 2 | 13 ± 2 | 13 ± 2 | 13 ± 2 | 13 ± 2 | 15 ± 2 | 13 ± 2 |
| 07/23/90 | 14 ± 2 | 16 ± 2 | 16 ± 2 | 13 ± 2 | 17 ± 2 | 13 ± 2 | 14 ± 2 | 12 ± 2 | 17 ± 2 | 17 ± 2 | 15 ± 4 |
| 07/30/90 | 15 ± 2 | 15 ± 2 | 17 ± 2 | 18 ± 2 | 14 ± 2 | 17 ± 2 | 17 ± 2 | 16 ± 2 | 21 ± 2 | 18 ± 2 | 17 ± 4 |
| **AUGUST** | | | | | | | | | | | |
| 08/06/90 | 16 ± 2 | 10 ± 2 | 11 ± 2 | 10 ± 2 | 12 ± 2 | 11 ± 2 | 10 ± 2 | 13 ± 2 | 19 ± 3 | 13 ± 2 | 13 ± 6 |
| 08/13/90 | 15 ± 2 | 15 ± 2 | 16 ± 2 | 15 ± 2 | 15 ± 2 | 12 ± 2 | 17 ± 2 | 13 ± 2 | 18 ± 2 | 16 ± 2 | 15 ± 4 |
| 08/20/90 | 14 ± 2 | 14 ± 2 | 14 ± 2 | 15 ± 2 | 15 ± 2 | 13 ± 2 | 16 ± 2 (a) | 16 ± 2 | 16 ± 2 | 17 ± 2 | 15 ± 3 |
| 08/27/90 | 12 ± 2 | 9 ± 2 | 11 ± 2 | 11 ± 2 | 8 ± 2 | 9 ± 2 | 11 ± 2 | 6 ± 1 | 12 ± 2 | 13 ± 2 | 10 ± 4 |
| 09/03/90 | 27 ± 2 | 28 ± 2 | 27 ± 2 | 26 ± 2 | 30 ± 2 | 26 ± 2 | 26 ± 2 | 25 ± 2 | 27 ± 2 | 27 ± 2 | 27 ± 3 |
| **SEPTEMBER** | | | | | | | | | | | |
| 09/10/90 | 19 ± 2 | 20 ± 2 | 20 ± 2 | 20 ± 2 | 21 ± 2 | 19 ± 2 | 21 ± 2 | 19 ± 2 | 23 ± 2 | 21 ± 2 | 20 ± 3 |
| 09/17/90 | 18 ± 2 | 20 ± 2 | 20 ± 2 | 24 ± 2 | 19 ± 2 | 22 ± 2 | 15 ± 2 | 19 ± 2 | 18 ± 2 | 20 ± 2 | 20 ± 5 |
| 09/24/90 | 13 ± 2 | 12 ± 2 | 12 ± 2 | 12 ± 2 | 12 ± 2 | 11 ± 2 | 13 ± 2 | 11 ± 2 | 14 ± 2 | 11 ± 2 | 12 ± 2 |
| 10/01/90 | 22 ± 2 | 20 ± 2 | 26 ± 2 | 22 ± 2 | 21 ± 2 | 19 ± 2 | 19 ± 2 | 21 ± 2 | 23 ± 2 | 31 ± 3 | 22 ± 7 |
| **Quarterly Avg.** ± 2 Sigma | **16 ± 9** | **16 ± 10** | **16 ± 9** | **16 ± 11** | **16 ± 11** | **15 ± 10** | **16 ± 9** | **15 ± 10** | **18 ± 9** | **18 ± 11** | **16 ± 2** |

(a) Pow[illegible]age.

TABLE B-1 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

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

| COLLECTION DATES | STATION CODES A-1 | A-2 | A-3 | A-4 | A-5 | A-6 | Coloma | Dowagiac | New Buff | South Bend | Average ± 2 s.d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OCTOBER** | | | | | | | | | | | |
| 10/08/90 | 16 ± 2 | 17 ± 2 | 17 ± 2 | 16 ± 2 | 16 ± 2 | 16 ± 2 | 17 ± 2 | 15 ± 2 | 16 ± 2 | 17 ± 2 | 16 ± 1 |
| 10/15/90 | 11 ± 2 | 10 ± 2 | 11 ± 2 | 14 ± 2 | 12 ± 2 | 11 ± 2 | 12 ± 2 | 11 ± 2 | 12 ± 2 | 13 ± 3 | 12 ± 2 |
| 10/22/90 | 16 ± 2 | 23 ± 2 | 17 ± 2 | 18 ± 2 | 18 ± 2 | 13 ± 2 | 17 ± 2 | 16 ± 2 | 19 ± 2 | 17 ± 2 | 17 ± 5 |
| 10/29/90 | 18 ± 2 | 16 ± 2 | 18 ± 2 | 18 ± 2 | 19 ± 2 | 17 ± 2 | 19 ± 2 | 17 ± 2 | 18 ± 2 | 17 ± 2 | 18 ± 2 |
| **NOVEMBER** | | | | | | | | | | | |
| 11/05/90 | 27 ± 2 | 28 ± 2 | 27 ± 2 | 28 ± 2 | 29 ± 2 | 26 ± 2 | 28 ± 2 | 31 ± 5 | 21 ± 2 | 29 ± 2 | 27 ± 5 |
| 11/12/90 | 18 ± 2 | 23 ± 2 | 25 ± 2 | 24 ± 2 | 23 ± 2 | 20 ± 2 | 23 ± 2 | 29 ± 3 | 27 ± 2 | 25 ± 2 | 24 ± 6 |
| 11/19/90 | 29 ± 2 | 29 ± 2 | 26 ± 2 | 30 ± 2 | 31 ± 2 | 26 ± 2 | 26 ± 2 | 26 ± 2 | 28 ± 2 | 26 ± 2 | 28 ± 4 |
| 11/26/90 | 30 ± 2 | 29 ± 2 | 28 ± 2 | 28 ± 2 | 27 ± 2 | 27 ± 2 | 27 ± 2 | 29 ± 2 | 28 ± 2 | 24 ± 2 | 28 ± 3 |
| 12/03/90 | 18 ± 2 | 19 ± 2 | 20 ± 2 | 20 ± 2 | 17 ± 2 | 17 ± 2 | 20 ± 2 | 21 ± 2 | 21 ± 2 | 21 ± 2 | 19 ± 3 |
| **DECEMBER** | | | | | | | | | | | |
| 12/10/90 | 23 ± 2 | 24 ± 2 | 26 ± 2 | 25 ± 2 | 23 ± 2 | 23 ± 2 | 23 ± 2 | 23 ± 2 | 23 ± 2 | 22 ± 2 | 24 ± 2 |
| 12/17/90 | 21 ± 2 | 23 ± 2 | 24 ± 2 | 23 ± 2 | 22 ± 2 | 23 ± 2 | 20 ± 2 | 23 ± 2 | 4.8 ± 1.2 | 22 ± 2 | 21 ± 11 |
| 12/24/90 | 30 ± 2 | 29 ± 2 | 27 ± 2 | 28 ± 2 | 31 ± 2 | 28 ± 2 | 27 ± 2 | 28 ± 2 | 30 ± 2 | 27 ± 2 | 29 ± 3 |
| 12/31/90 | 24 ± 2 | 28 ± 2 | 27 ± 2 | 24 ± 2 | 24 ± 2 | 24 ± 2 | 19 ± 2 | 980± 0.08(a) | 26 ± 2 | 16 ± 4 | 24 ± 8 |
| **Quarter Average ± 2 s.d.** | **22 ± 12** | **23 ± 12** | **23 ± 11** | **23 ± 10** | **22 ± 12** | **21± 11** | **21 ± 10** | **22 ± 13** | **21 ± 14** | **21 ± 10** | **22 ± 2** |
| **Annual Average ± 2 s.d.** | **17 ± 12** | **17 ± 12** | **17 ± 12** | **17 ± 12** | **17 ± 13** | **17 ± 11** | **17 ± 10** | **17 ± 12** | **18 ± 12** | **18 ± 11** | **17 ± 1** |

(a) Low sample volume: not included in averages. Filter light in disposition.

TABLE B-2

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIRBORNE PARTICULATES

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

| Stations | Nuclides | First Quarter 01/01/90-04/02/90 | Second Quarter 04/02/90-07/02/90 | Third Quarter 07/02/90-10/01/90 | Fourth Quarter 10/01/90-12/31/90 | Average ±2 s.d. |
|---|---|---|---|---|---|---|
| A-1 | Be-7 | 82.2 ± 8.2 | 97.0 ± 9.7 | 50.8 ± 5.1 | 68.2 ± 7.0 | 74.6 ± 39.4 |
| | K-40 | < 3 | < 6 | < 4 | < 5 | - |
| | Cs-134 | < 0.2 | < 0.2 | < 0.1 | < 0.3 | - |
| | Cs-137 | < 0.2 | < 0.3 | < 0.2 | < 0.3 | - |
| A-2 | Be-7 | 80.1 ± 8.0 | 99.6 ± 10.0 | 49.3 ± 4.9 | 81.2 ± 8.1 | 77.6 ± 41.7 |
| | K-40 | < 4 | < 5 | < 6 | < 6 | - |
| | Cs-134 | < 0.2 | < 0.2 | < 0.2 | < 0.3 | - |
| | Cs-137 | < 0.2 | < 0.3 | < 0.3 | < 0.3 | - |
| A-3 | Be-7 | 72.4 ± 7.2 | 73.1 ± 7.3 | 43.4 ± 4.3 | 76.7 ± 7.7 | 66.4 ± 30.9 |
| | K-40 | < 4 | < 6 | < 10 | < 7 | - |
| | Cs-134 | < 0.2 | < 0.4 | < 0.3 | < 0.3 | - |
| | Cs-137 | < 0.2 | < 0.3 | < 0.3 | < 0.3 | - |
| A-4 | Be-7 | 85.3 ± 8.5 | 85.3 ± 8.5 | 49.6 ± 5.0 | 79.5 ± 7.9 | 74.9 ± 34.2 |
| | K-40 | < 3 | < 7 | < 6 | < 4 | - |
| | Cs-134 | < 0.1 | < 0.3 | < 0.2 | < 0.2 | - |
| | Cs-137 | < 0.1 | < 0.3 | < 0.2 | < 0.2 | - |
| A-5 | Be-7 | 77.0 ± 7.7 | 94.0 ± 9.4 | 40.6 ± 4.1 | 96.2 ± 9.6 | 77.0 ± 51.4 |
| | K-40 | < 3 | 6.04 ± 2.19 | < 9 | < 10 | 6.04 ± 2.19 |
| | Cs-134 | < 0.2 | < 0.2 | < 0.3 | < 0.4 | - |
| | Cs-137 | < 0.2 | < 0.2 | < 0.3 | < 0.4 | - |

* Typical LLDs are found in Table B-12.

TABLE B-2 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIRBORNE PARTICULATES

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

| Stations | Nuclides | First Quarter 01/01/90-04/02/90 | Second Quarter 04/02/90-07/02/90 | Third Quarter 07/02/90-10/01/90 | Fourth Quarter 10/01/90-12/31/90 | Average ±2 s.d. |
|---|---|---|---|---|---|---|
| A-6 | Be-7 | 85.0 ± 8.5 | 77.4 ± 8.3 | 44.8 ± 4.5 | 71.5 ± 7.2 | 69.7 ± 35.0 |
| | K-40 | 3.21 ± 1.22 | < 20 | < 5 | < 4 | 3.21 ± 1.22 |
| | Cs-134 | < 0.1 | < 0.4 | < 0.2 | < 0.2 | - |
| | Cs-137 | < 0.2 | < 0.4 | < 0.2 | < 0.2 | - |
| Coloma | Be-7 | 90.6 ± 9.1 | 99.6 ± 10.0 | 39.8 ± 4.0 | 78.7 ± 7.9 | 77.2 ± 52.7 |
| | K-40 | < 4 | < 6 | < 4 | < 5 | - |
| | Cs-134 | < 0.2 | < 0.2 | < 0.2 | < 0.3 | - |
| | Cs-137 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | - |
| Dowagiac | Be-7 | 82.6 ± 8.3 | 81.8 ± 8.2 | 48.3 ± 4.8 | 90.7 ± 9.1 | 75.9 ± 37.6 |
| | K-40 | < 7 | 6.10 ± 2.76 | 3.44 ± 1.77 | < 10 | 4.77 ± 3.76 |
| | Cs-134 | < 0.2 | < 0.2 | < 0.2 | < 0.4 | - |
| | Cs-137 | < 0.2 | < 0.2 | < 0.2 | < 0.4 | - |
| New Buffalo | Be-7 | 102 ± 10 | 92.1 ± 9.2 | 45.4 ± 4.5 | 13.3 ± 3.9 | 6.32 ± 82.8 |
| | K-40 | < 6 | 6.74 ± 3.28 | < 5 | < 3 | 6.74 ± 3.28 |
| | Cs-134 | < 0.2 | < 0.4 | < 0.3 | < 0.2 | - |
| | Cs-137 | < 0.2 | < 0.3 | < 0.3 | < 0.2 | - |
| South Bend | Be-7 | 103 ± 10 | 94.9 ± 9.5 | 52.3 ± 5.2 | 82.7 ± 8.3 | 83.2 ± 44.5 |
| | K-40 | < 4 | < 7 | < 10 | < 5 | - |
| | Cs-134 | < 0.2 | < 0.3 | < 0.4 | < 0.3 | - |
| | Cs-137 | < 0.2 | < 0.3 | < 0.4 | < 0.2 | - |

* Typical LLDs are found in Table B-12.

TABLE B-3

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE-131 IN WEEKLY AIR CARTRIDGE SAMPLES

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

| COLLECTION DATES | STATION CODES A-1 | A-2 | A-3 | A-4 | A-5 | A-6 | Coloma | Dowagiac | New Buffalo | South Bend |
|---|---|---|---|---|---|---|---|---|---|---|
| **JANUARY 90** | | | | | | | | | | |
| 01/08/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 01/15/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 20 | < 20 | < 10 | < 20 |
| 01/22/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 |
| 01/29/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| **FEBRUARY** | | | | | | | | | | |
| 02/05/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 02/12/90 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 02/19/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 02/26/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| **MARCH** | | | | | | | | | | |
| 03/05/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 10 |
| 03/12/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 03/19/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 8 | < 10 |
| 03/26/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 04/02/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |

E 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **APRIL** | | | | | | | | | | |
| 04/09/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 04/16/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 04/23/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 04/30/90 | < 9 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 20 |
| **MAY** | | | | | | | | | | |
| 05/07/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 05/14/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 9 | < 10 |
| 05/21/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 30 | < 20 | < 10 | < 20 |
| 05/28/90 | < 20 | < 10 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |
| **JUNE** | | | | | | | | | | |
| 06/04/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 06/11/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 06/18/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 06/25/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 07/02/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |

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** | | | | | | | | | | |
| 07/09/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 07/16/90 | < 10 | < 10 | < 10 | < 10 | < 7 | < 7 | < 7 | < 7 | < 6 | < 7 |
| 07/23/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 07/30/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| **AUGUST** | | | | | | | | | | |
| 08/06/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 |
| 08/13/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 08/20/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 |
| 08/27/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 09/03/90 | < 10 | < 10 | < 10 | < 10 | < 8 | < 20 | < 20 | < 20 | < 10 | < 20 |
| **SEPTEMBER** | | | | | | | | | | |
| 09/10/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 09/17/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 09/24/90 | < 60 | < 60 | < 60 | < 60 | < 50 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 10/01/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |

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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **OCTOBER** | | | | | | | | | | |
| 10/08/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 10/15/90 | < 20 | < 30 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 10/22/90 | < 20 | < 80 (a) | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 10/29/90 | < 10 | < 20 | < 10 | < 10 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| **NOVEMBER** | | | | | | | | | | |
| 11/05/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 30 | < 7 | < 10 |
| 11/12/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 11/19/90 | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 7 | < 10 |
| 11/26/90 | < 30 | < 30 | < 30 | < 30 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 12/03/90 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| **DECEMBER** | | | | | | | | | | |
| 12/10/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 12/17/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 20 | < 10 | < 20 |
| 12/24/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 10 | < 20 | < 20 | < 20 | < 20 |
| 12/31/90 | < 20 | < 20 | < 20 | < 20 | < 10 | < 20 | < 20 | < 600 (b) | < 10 | < 50 |

(a) LLD not met due to low sample volume. Unit was out for repairs.
(b) LLD not met due to low sample volume.

TABLE B-4

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

DIRECT MEASUREMENTS - QUARTERLY TLD RESULTS

Results in Units of mR/standard month

| STATION CODES | FIRST QUARTER 01/20/90-04/22/90 | SECOND QUARTER 04/22/90-07/29/90 | THIRD QUARTER 07/29/90-10/28/90 | FOURTH QUARTER 10/28/90-01/27/91 | AVERAGE ± 2 s.d. |
|---|---|---|---|---|---|
| A-1 | 3.3 ± 0.2 | 3.2 ± 0.1 | 3.8 ± 0.1 | 2.5 ± 0.3 | 3.2 ± 1.1 |
| A-2 | 3.5 ± 0.3 | 3.2 ± 0.2 | 4.0 ± 0.3 | 2.8 ± 0.3 | 3.4 ± 1.0 |
| A-3 | 3.6 ± 0.3 | 3.3 ± 0.1 | 3.7 ± 0.2 | 2.8 ± 0.2 | 3.4 ± 0.8 |
| A-4 | 3.3 ± 0.3 | 2.9 ± 0.2 | 3.6 ± 0.2 | 2.3 ± 0.2 | 3.0 ± 1.1 |
| A-5 | 3.4 ± 0.4 | 3.1 ± 0.1 | 3.8 ± 0.1 | 2.5 ± 0.3 | 3.2 ± 1.1 |
| A-6 | 3.3 ± 0.3 | 3.0 ± 0.1 | 3.5 ± 0.2 | 2.4 ± 0.2 | 3.1 ± 1.0 |
| A-7 | 3.6 ± 0.1 | 3.3 ± 0.1 | 3.8 ± 0.2 | 2.7 ± 0.4 | 3.4 ± 1.0 |
| A-8 | 3.4 ± 0.2 | 3.2 ± 0.1 | 3.9 ± 0.2 | 2.6 ± 0.4 | 3.3 ± 1.1 |
| A-9 | 3.8 ± 0.3 | 3.6 ± 0.2 | 4.1 ± 0.4 | 2.8 ± 0.4 | 3.6 ± 1.1 |
| A-10 | 3.3 ± 0.2 | 2.8 ± 0.1 | 3.7 ± 0.3 | 2.5 ± 0.3 | 3.1 ± 1.1 |
| A-11 | 2.8 ± 0.3 | 3.4 ± 0.1 | 4.2 ± 0.5 | 2.8 ± 0.3 | 3.3 ± 1.3 |
| A-12 | 3.8 ± 0.2 | 3.6 ± 0.3 | 4.1 ± 0.4 | 2.9 ± 0.2 | 3.6 ± 1.0 |
| OFS-1 | 3.5 ± 0.4 | 3.2 ± 0.2 | 3.9 ± 0.2 | 2.7 ± 0.5 | 3.3 ± 1.0 |
| OFS-2 | 3.6 ± 0.2 | 3.4 ± 0.1 | 4.1 ± 0.3 | 2.8 ± 0.3 | 3.5 ± 1.1 |
| OFS-3 | 3.7 ± 0.2 | 3.6 ± 0.2 | 4.3 ± 0.4 | 3.3 ± 0.7 | 3.7 ± 0.8 |
| OFS-4 | 4.0 ± 0.3 | 3.7 ± 0.3 | 4.6 ± 0.2 | 3.1 ± 0.4 | 3.9 ± 1.2 |
| OFS-5 | 3.8 ± 0.3 | 3.6 ± 0.3 | 4.5 ± 0.3 | 3.0 ± 0.4 | 3.7 ± 1.2 |
| OFS-6 | 3.8 ± 0.2 | (a) | 5.1 ± 0.4 | 3.8 ± 0.5 | 4.2 ± 1.5 |
| OFS-7 | 3.5 ± 0.1 | 3.3 ± 0.1 | 4.1 ± 0.3 | 2.8 ± 0.5 | 3.4 ± 1.1 |
| OFS-8 | 4.5 ± 0.4 | 4.1 ± 0.3 | 4.9 ± 0.3 | 3.6 ± 0.5 | 4.3 ± 1.1 |
| OFS-9 | 4.0 ± 0.1 | 3.9 ± 0.2 | 4.3 ± 0.3 | 3.2 ± 0.4 | 3.9 ± 0.9 |
| OFS-10 | 3.5 ± 0.2 | 3.5 ± 0.2 | 4.1 ± 0.3 | 2.6 ± 0.4 | 3.4 ± 1.2 |
| OFS-11 | 4.4 ± 0.3 | 4.0 ± 0.4 | 5.1 ± 0.4 | 3.6 ± 0.4 | 4.3 ± 1.3 |
| NBF | 3.9 ± 0.3 | 3.5 ± 0.4 | 4.2 ± 0.3 | 3.0 ± 0.3 | 3.7 ± 1.0 |
| SBN | 3.6 ± 0.2 | 3.5 ± 0.2 | 4.5 ± 0.4 | 3.2 ± 0.4 | 3.7 ± 1.1 |
| DOW | 3.1 ± 0.1 | 2.9 ± 0.1 | 3.7 ± 0.2 | 2.4 ± 0.2 | 3.0 ± 1.1 |
| COL | 3.2 ± 0.2 | 2.9 ± 0.1 | 3.7 ± 0.2 | 2.3 ± 0.2 | 3.0 ± 1.2 |
| **Average ± 2 s.d.** | **3.6 ± 0.7** | **3.4 ± 0.7** | **4.1 ± 0.9** | **2.9 ± 0.8** | **3.5 ± 1.0** |

• S[illegible]d month = 30.4 days.

(a) TL[illegible]re cage and entire telephone pole missing at time of TLD exchange.

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 | 01/11/90 | < 0.9 | < 60 | |
| (Condenser Circ.) | 02/08/90 | < 0.3 | < 50 | |
| | 03/08/90 | < 0.3 | < 50 | < 100 |
| | 04/05/90 | < 0.2 | < 40 | |
| | 05/03/90 | < 0.2 | < 70 | < 100 |
| | 05/31/90 | < 0.3 | < 80 | |
| | 06/28/90 | < 0.3 | < 40 | |
| | 07/20/90 | < 0.1 | < 50 | < 100 |
| | 08/23/90 | < 0.2 | < 50 | |
| | 09/20/90 | < 0.2 | < 50 | |
| | 10/18/90 | < 0.2 | < 50 | |
| | 11/15/90 | < 0.2 | < 50 | |
| | 12/13/90 | < 0.2 | < 100 | < 200 |
| L-2 | 01/11/90 | (a) | | |
| (South Comp) | 02/08/90 | < 0.3 | < 80 | |
| | 03/08/90 | < 0.2 | < 90 | < 100 |
| | 04/05/90 | < 0.2 | < 40 | |
| | 05/03/90 | < 0.4 | < 90 | 170 ± 60 |
| | 05/31/90 | < 0.6 | < 50 | |
| | 06/28/90 | < 0.2 | < 200 | |
| | 07/26/90 | < 0.1 | < 60 | 300 ± 70 |
| | 08/23/90 | < 0.3 | < 50 | |
| | 09/20/90 | < 0.2 | < 50 | |
| | 10/18/90 | < 0.2 | < 50 | |
| | 11/15/90 | < 0.3 | < 90 | |
| | 12/13/90 | < 0.1 | < 40 | < 200 |

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

(a) Sample not available due to ice on the shoreline.

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 | 01/11/90 | (a) | | |
| (North Comp) | 02/08/90 | < 0.2 | < 70 | |
| | 03/08/90 | < 0.3 | < 60 | 220 ± 80 |
| | 04/05/90 | < 0.2 | < 70 | |
| | 05/03/90 | < 0.2 | < 50 | 170 ± 60 |
| | 05/31/90 | < 0.3 | < 40 | |
| | 06/28/90 | < 0.2 | < 50 | |
| | 07/26/90 | < 0.2 | < 100 | 320 ± 100 |
| | 08/23/90 | < 0.1 | < 50 | |
| | 09/20/90 | < 0.2 | < 70 | |
| | 10/18/90 | < 0.2 | < 100 | |
| | 11/15/90 | < 0.2 | < 100 | |
| | 12/13/90 | < 0.2 | < 40 | 240 ± 80 |
| L-4 | 01/11/90 | (a) | | |
| (South 500) | 02/08/90 | < 0.3 | < 100 | |
| | 03/08/90 | < 0.3 | 76.6 ± 30.1 | 230 ± 80 |
| | 04/05/90 | < 0.2 | < 50 | |
| | 05/03/90 | < 0.2 | < 100 | 250 ± 100 |
| | 05/31/90 | < 0.3 | < 60 | |
| | 06/28/90 | < 0.2 | < 40 | |
| | 07/26/90 | < 0.1 | 66.3 ± 25.6 | 190 ± 100 |
| | 08/23/90 | < 0.2 | < 100 | |
| | 09/20/90 | < 0.2 | < 100 | |
| | 10/18/90 | < 0.2 | < 50 | |
| | 11/15/90 | < 0.3 | < 60 | |
| | 12/13/90 | < 0.1 | < 50 | < 200 |

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

(a) Sample not available due to ice on the shoreline.

TABLE B-5 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

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

Results in Units of pCi/liter ± 2 sigma

| STATION | Collection Date | I-131 | K-40 | Tritium |
|---|---|---|---|---|
| L-5 | 01/11/90 | (a) | | |
| (North 500) | 02/08/90 | < 0.3 | < 60 | |
| | 03/08/90 | < 0.5 | < 90 | 230 ± 80 |
| | 04/05/90 | < 0.2 | < 70 | |
| | 05/03/90 | < 0.2 | < 100 | 300 ± 90 |
| | 05/31/90 | < 0.4 | < 50 | |
| | 06/26/90 | < 0.3 | < 70 | |
| | 07/26/90 | < 0.1 | < 50 | 190 ± 100 |
| | 08/23/90 | < 0.2 | < 80 | |
| | 09/20/90 | < 0.2 | < 60 | |
| | 10/18/90 | < 0.2 | < 50 | |
| | 11/15/90 | < 0.3 | < 50 | |
| | 12/13/90 | < 0.2 | < 100 | 340 ± 90 |



* Typical LLDs are found in Table B-12.
(a) Sample not available due to ice on the shoreline.

TABLE B-6

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN QUARTERLY GROUND WATER

Results in Units of pCi/liter ± 2 sigma

| STATION | Collection Date | I-131 | Gamma Spec | Tritium |
|---|---|---|---|---|
| **Well - 1** | 02/03/90 | < 0.1 | < LLD | < 100 |
| Rosemary Beach | 05/06/90 | < 0.1 | < LLD | < 200 |
| | 08/05/90 | < 0.1 | < LLD | < 200 |
| | 11/03/90 | < 0.1 | < LLD | 230 ± 80 |
| **Well - 2** | 02/03/90 | < 0.2 | < LLD | 130 ± 80 |
| Training Center | 05/06/90 | < 0.2 | < LLD | < 200 |
| | 08/05/90 | < 0.1 | < LLD | < 200 |
| | 11/03/90 | < 0.1 | < LLD | < 90 |
| **Well - 3** | 02/03/90 | < 0.2 | < LLD | < 200 |
| Firearms Range | 05/06/90 | < 0.1 | < LLD | < 200 |
| | 08/05/90 | < 0.2 | < LLD | 170 ± 100 |
| | 11/03/90 | < 0.1 | < LLD | < 90 |
| **Well - 4** | 02/04/90 | < 0.2 | < LLD | 1450 ± 500 |
| Onsite | 05/06/90 | < 0.2 | < LLD | 320 ± 100 |
| | 08/05/90 | < 0.1 | < LLD | < 1000 |
| | 11/04/90 | < 0.1 | < LLD | 810 ± 80 |
| **Well - 5** | 02/04/90 | < 0.2 | < LLD | 1700 ± 500 |
| Onsite | 05/06/90 | < 0.1 | < LLD | 700 ± 100 |
| | 08/05/90 | < 0.1 | < LLD | < 1000 |
| | 11/04/90 | < 0.1 | < LLD | 530 ± 80 |
| **Well - 6** | 02/04/90 | < 0.2 | < LLD | 1300 ± 500 |
| Onsite | 05/06/90 | < 0.3 | < LLD | 260 ± 100 |
| | 08/05/90 | < 0.1 | < LLD | < 1000 |
| | 11/04/90 | < 0.1 | < LLD | 190 ± 100 |
| **Well - 7** | 02/03/90 | < 0.2 | < LLD | 210 ± 90 |
| Livingston Beach | 05/06/90 | < 0.2 | < LLD | < 200 |
| | 08/05/90 | < 0.1 | < LLD | < 200 |
| | 11/03/90 | < 0.1 | < LLD | 120 ± 60 |
| **Average ± 2 s.d.** | | | | **580 ± 1076** |

* Typical LLDs are found in Table B-12.

TABLE B-7

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF GROSS BETA, IODINE-131, 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** | | | | |
| 01/11/90 | 4.0 ± 1.1 | < LLD | < 0.4 | 230 ± 90 |
| 01/25/90 | 3.7 ± 1.0 | < LLD | < 0.4 | |
| 02/08/90 | 3.6 ± 1.0 | < LLD | < 0.2 | |
| 02/22/90 | 10 ± 2.0 | < LLD | < 0.1 | |
| 03/08/90 | 5.8 ± 1.1 | < LLD | < 0.3 | |
| 03/22/90 | 3.2 ± 1.0 | < LLD | < 0.1 | |
| 04/05/90 | 3.5 ± 0.9 | < LLD | < 0.2 | 190 ± 60 |
| 04/19/90 | 3.8 ± 1.0 | < LLD | < 0.5 | |
| 05/03/90 | 3.0 ± 1.0 | < LLD | < 0.2 | |
| 05/17/90 | 3.5 ± 1.0 | < LLD | < 0.3 | |
| 05/31/90 | 4.0 ± 1.1 | < LLD | < 0.1 | |
| 06/14/90 | 2.7 ± 0.9 | < LLD | < 0.4 | |
| 06/28/90 | 5.1 ± 1.2 | < LLD | < 0.5 | < 100 |
| 07/12/90 | 3.3 ± 0.9 | < LLD | < 0.2 | |
| 07/26/90 | 4.2 ± 1.1 | < LLD | < 0.2 | |
| 08/09/90 | 3.4 ± 1.1 | < LLD | < 0.3 | |
| 08/23/90 | 3.2 ± 0.9 | < LLD | < 0.4 | |
| 09/06/90 | 3.9 ± 1.0 | < LLD | < 0.2 | |
| 09/20/90 | 5.0 ± 1.1 | < LLD | < 0.4 | |
| 10/04/90 | 4.2 ± 1.0 | < LLD | < 0.3 | |
| 10/18/90 | 3.3 ± 1.0 | < LLD | < 0.4 | |
| 11/01/90 | 2.9 ± 1.0 | < LLD | < 0.2 | |
| 11/15/90 | 3.8 ± 1.0 | < LLD | < 0.4 | |
| 11/29/90 | 4.3 ± 1.0 | < LLD | < 0.2 | |
| 12/13/90 | 4.6 ± 1.1 | < LLD | < 0.2 | |
| 12/27/90 | 4.4 ± 1.0 | < LLD | < 0.3 | 240 ± 80 |
| **Average ± 2 s. d.** | **4.1 ± 2.8** | | | **220 ± 53** |

* Typical LLDs are found in table B-12.

TABLE B-7 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

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

Results in Units of pCi/liter ± 2 sigma

| COLLECTION DATE | Gross Beta | Gamma Spec | Iodine-131 | Tritium |
|---|---|---|---|---|
| **St. Joseph** | | | | |
| 01/11/90 | 4.4 ± 1.2 | < LLD | < 0.3 | < 200 |
| 01/25/90 | 4.1 ± 1.0 | < LLD | < 0.3 | |
| 02/08/90 | 2.8 ± 1.0 | < LLD | < 0.3 | |
| 02/22/90 | 4.5 ± 1.5 | < LLD | < 0.1 | |
| 03/08/90 | 6.1 ± 1.2 | < LLD | < 0.3 | |
| 03/22/90 | 4.7 ± 1.1 | < LLD | < 0.1 | |
| 04/05/90 | 4.3 ± 1.0 | < LLD | < 0.2 | 340 ± 80 |
| 04/19/90 | 3.6 ± 1.0 | < LLD | < 0.4 | |
| 05/03/90 | 3.2 ± 1.0 | < LLD | < 0.2 | |
| 05/17/90 | 3.2 ± 1.0 | < LLD | < 0.3 | |
| 05/31/90 | 3.7 ± 1.0 | < LLD | < 0.3 | |
| 06/14/90 | 3.2 ± 1.0 | < LLD | < 0.4 | |
| 06/28/90 | 2.8 ± 1.0 | < LLD | < 0.3 | < 100 |
| 07/12/90 | 3.2 ± 0.9 | < LLD | < 0.3 | |
| 07/26/90 | 3.8 ± 1.0 | < LLD | < 0.2 | |
| 08/09/90 | 3.1 ± 1.1 | < LLD | < 0.3 | |
| 08/23/90 | 3.9 ± 1.0 | < LLD | < 0.3 | |
| 09/06/90 | 3.1 ± 0.9 | < LLD | < 0.1 | |
| 09/20/90 | 4.1 ± 1.0 | < LLD | < 0.4 | |
| 10/04/90 | 4.6 ± 1.0 | < LLD | < 0.3 | |
| 10/18/90 | 3.6 ± 1.0 | < LLD | < 0.3 | |
| 11/01/90 | 4.1 ± 1.1 | < LLD | < 0.2 | |
| 11/15/90 | 4.3 ± 1.0 | < LLD | < 0.5 | |
| 11/29/90 | 4.2 ± 1.0 | < LLD | < 0.3 | |
| 12/13/90 | 4.6 ± 1.1 | < LLD | < 0.3 | |
| 12/27/90 | 5.1 ± 1.1 | < LLD | < 0.4 | < 200 |
| Average ± 2 s. d. | 3.9 ± 1.5 | | | 340 ± 80 |

* The 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 (wet) ± 2 sigma

| Station | Collection Date | Be-7 | K-40 | Cs-137 | Ra-226 | Th-228 |
|---|---|---|---|---|---|---|
| L-2 | 05/15/90 | < 300 | 6260 ± 630 | < 20 | < 300 | 101 ± 27 |
| L-3 | 05/15/90 | < 300 | 7250 ± 730 | < 20 | < 300 | 171 ± 26 |
| L-4 | 05/15/90 | < 100 | 6000 ± 600 | 26.7 ± 9.9 | < 200 | 154 ± 20 |
| L-5 | 05/15/90 | < 200 | 7060 ± 710 | 30.1 ± 11.8 | < 300 | 147 ± 15 |
| L-2 | 11/15/90 | < 100 | 4930 ± 490 | < 20 | < 200 | 144 ± 14 |
| L-3 | 11/15/90 | < 100 | 5440 ± 540 | < 20 | < 200 | 70.9 ± 9.9 |
| L-4 | 11/15/90 | < 100 | 5240 ± 520 | 18.5 ± 10.4 | < 200 | 116 ± 19 |
| L-5 | 11/15/90 | < 200 | 5700 ± 570 | < 20 | < 300 | 108 ± 13 |
| **Average ± 2 s.d.** | | | **5985 ± 1670** | **25.1 ± 11.9** | | **126 ± 66** |

* Typical LLDs are found in table B-12.

TABLE B-9

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

| COLLECTION DATES | ANALYSIS | STATION CODES SHULER | TOTZKE | LOZMACK | WARMBIEN | ZELMER | LIVING HS | WYANT |
|---|---|---|---|---|---|---|---|---|
| 01/12/90 | K-40 | 1310 ± 130 | 1240 ± 120 | 1270 ± 130 | 1150 ± 120 | 1260 ± 130 | 1140 ± 110 | 1200 ± 120 |
| | I-131 | < 0.3 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 01/26/90 | K-40 | 1500 ± 150 | 1290 ± 130 | 1060 ± 110 | 1360 ± 140 | 1350 ± 130 | 1300 ± 130 | 1370 ± 140 |
| | I-131 | < 0.1 | < 0.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.1 |
| 02/09/90 | K-40 | 1260 ± 130 | 1200 ± 120 | 1320 ± 130 | 1180 ± 120 | 1690 ± 170 | 1260 ± 130 | 1250 ± 130 |
| | I-131 | < 0.2 | < 0.2 | < 0.1 | < 0.2 | < 0.3 | < 0.1 | < 0.1 |
| 02/23/90 | K-40 | 1260 ± 130 | 1290 ± 130 (a) | 1350 ± 130 | 1320 ± 130 | 1050 ± 110 | 1310 ± 130 | 1340 ± 130 |
| | I-131 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 |
| 03/09/90 | K-40 | 1360 ± 140 | 1370 ± 140(b) | 1340 ± 130 | 1350 ± 140 | 1240 ± 120 | 1380 ± 140 | 1180 ± 120 |
| | I-131 | < 0.2 | < 0.1 | < 0.5 | < 0.2 | < 0.2 | < 0.1 | < 0.2 |
| 03/23/90 | K-40 | 1250 ± 120 | 1200 ± 120 | 1300 ± 130 | 1370 ± 140 | 1390 ± 140 | 1280 ± 130 | 1420 ± 140 |
| | I-131 | < 0.2 | < 0.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 |

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

(a) Milk [redacted] wholesaler made early pick-up. No milk left in tank; make up sample collected 2/25/90.

(b) No sample available at collection; make-up sample collected 03/11/90.

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

| COLLECTION DATES | ANALYSIS | STATION CODES SHULER | TOTZKE | LOZMACK | WARMBIEN | ZELMER | LIVING HS | WYANT |
|---|---|---|---|---|---|---|---|---|
| 04/06/90 | K-40 | 1690 ± 170 | 1250 ± 120 | 1280 ± 130 | 1240 ± 120 | 1300 ± 130 | 1260 ± 130 | 1400 ± 140 |
| | I-131 | < 0.1 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.2 |
| 04/20/90 | K-40 | 1400 ± 140 | 1090 ± 110 | 1160 ± 120 | 1360 ± 140 | 1150 ± 110 | 1240 ± 120 | 1290 ± 130 |
| | I-131 | < 0.3 | < 0.3 | < 0.3 | < 0.2 | < 0.2 | < 0.3 | < 0.2 |
| 05/04/90 | K-40 | 1350 ± 140 | 1320 ± 130 | 1240 ± 120 | 1380 ± 140 | 1440 ± 140 | 1270 ± 130 | 1250 ± 130 |
| | I-131 | < 0.1 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.3 |
| 05/18/90 | K-40 | 989 ± 99 | 1420 ± 140 | 1240 ± 120 | 1260 ± 130 | 1400 ± 140 | 1190 ± 120 | 1180 ± 120 |
| | I-131 | < 0.2 | < 0.2 | < 0.3 | < 0.3 | < 0.2 | < 0.2 | < 0.1 |
| 06/01/90 | K-40 | 922 ± 92 | 1080 ± 110 | 1360 ± 140 | 1260 ± 130 | 1310 ± 130 | 1260 ± 130 | 1280 ± 130 |
| | I-131 | < 0.3 | < 0.3 | < 0.2 | < 0.2 | < 0.2 | < 0.3 | < 0.3 |
| 06/15/90 | K-40 | 1420 ± 140 | 1360 ± 140 | 1310 ± 130 | 1290 ± 130 | 1160 ± 120 | 1290 ± 130 | 1250 ± 120 |
| | I-131 | < 0.3 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 06/29/90 | K-40 | 1280 ± 130 | 1320 ± 130 | 1300 ± 130 | 1230 ± 120 | 1450 ± 140 | 1190 ± 120 | 1240 ± 120 |
| | I-131 | < 0.2 | < 0.2 | < 0.2 | < 0.3 | < 0.2 | < 0.2 | < 0.2 |

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

TABLE B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

| COLLECTION DATES | ANALYSIS | STATION CODES SHULER | TOTZKE | LOZMACK | WARMBIEN | ZELMER | LIVING HS | WYANT |
|---|---|---|---|---|---|---|---|---|
| 07/13/90 | K-40 | 1400 ± 140 | 1520 ± 150 | 1270 ± 130 | 1370 ± 140 | 1300 ± 130 | 1280 ± 130 | 1260 ± 130 |
| | I-131 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.2 | < 0.2 | < 0.3 |
| 07/27/90 | K-40 | 1230 ± 120 | 1340 ± 130 | 1410 ± 140 | 1300 ± 130 | 1440 ± 140 | 1490 ± 150 | 1170 ± 120 |
| | I-131 | < 0.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.1 | < 0.2 |
| 08/10/90 | K-40 | 1130 ± 130 | 1380 ± 140 | 1420 ± 140 | 1320 ± 130 | 1320 ± 130 | 1300 ± 130 | 1260 ± 130 |
| | I-131 | < 0.3 | < 0.3 | < 0.2 | < 0.2 | < 0.3 | < 0.2 | < 0.2 |
| 08/24/90 | K-40 | 1390 ± 140 | 1360 ± 140 | 1400 ± 140 | 1030 ± 100 | 1110 ± 110 | 1340 ± 130 | 1360 ± 140 |
| | I-131 | < 0.4 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 09/07/90 | K-40 | 1390 ± 140 | 1350 ± 140 | 1270 ± 130 | 1310 ± 130 | 1260 ± 130 | 1350 ± 140 | 1070 ± 110 |
| | I-131 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 09/21/90 | K-40 | 1950 ± 190 | 1440 ± 140 | 1360 ± 140 | 1180 ± 120 | 1370 ± 140 | 1450 ± 150 | 1240 ± 120 |
| | I-131 | < 0.2 | < 0.2 | < 0.3 | < 0.3 | < 0.2 | < 0.3 | < 0.3 |

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

T B-9 (Cont.)

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

CONCENTRATIONS OF IODINE AND GAMMA EMITTERS* IN MILK

Results in Units of pCi/liter ± 2 sigma

| COLLECTION DATES | ANALYSIS | STATION CODES SHULER | TOTZKE | LOZMACK | WARMBIEN | ZELMER | LIVING HS | WYANT |
|---|---|---|---|---|---|---|---|---|
| 10/05/90 | K-40 | 1200 ± 120 | 1400 ± 140 | 1390 ± 140 | 1480 ± 150 | 1190 ± 120 | 1390 ± 140 | 1310 ± 130 |
| | I-131 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 10/19/90 | K-40 | 1060 ± 110 | 1390 ± 140 | 1310 ± 130 | 1430 ± 140 | 1580 ± 160 | 1340 ± 130 | 1290 ± 130 |
| | I-131 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.2 | < 0.2 |
| 11/02/90 | K-40 | 1570 ± 160 | 1020 ± 100 | 1360 ± 140 | 999 ± 100 | 1020 ± 100 | 1190 ± 120 | 1300 ± 130 |
| | I-131 | < 0.2 | < 0.3 | < 0.2 | < 0.1 | < 0.1 | < 0.2 | < 0.1 |
| 11/16/90 | K-40 | 1180 ± 120 | 1230 ± 120 | 1310 ± 130 | 1360 ± 140 | 1440 ± 140 | 1300 ± 130 | 1290 ± 130 |
| | I-131 | < 0.5 | < 0.5 | < 0.3 | < < 0.3 | < 0.3 | < 0.3 | < 0.4 |
| 11/30/90 | K-40 | 1150 ± 110 | 1450 ± 150 | 922 ± 92 | 1340 ± 130 | 1210 ± 120 | 1280 ± 130 | 1170 ± 120 |
| | I-131 | < 0.2 | < 0.1 | < 0.1 | < 0.2 | < 0.1 | < 0.1 | < 0.2 |
| 12/28/90 | K-40 | 1180 ± 120 | 1460 ± 150 | 1350 ± 140 | 1350 ± 130 | 1230 ± 120 | 1260 ± 130 | 1220 ± 120 |
| | I-131 | < 0.5 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 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 |
|---|---|---|---|---|---|---|---|
| 05/16/90 | OFS-South | | < 100 | 3840 ± 380 | 25.5 ± 8.6 | < 200 | < 20 |
| 05/16/90 | ONS-North | | < 100 | 3150 ± 310 | 35.7 ± 10.3 | < 300 | < 20 |
| 05/16/90 | OFS-North | | < 100 | 1700 ± 170 | 80.1 ± 1.1 | < 200 | < 20 |
| 05/16/90 | ONS-South | | < 80 | 684 ± 89 | 20.3 ± 6.6 | < 200 | < 20 |
| 10/16/90 | OFS-South | | < 200 | 3310 ± 330 | < 20 | < 400 | < 40 |
| 10/16/90 | ONS-North | | < 300 | 3320 ± 330 | < 30 | < 500 | < 50 |
| 10/23/90 | ONS-South | | < 50 | 2490 ± 250 | 30.3 ± 5.2 | < 100 | < 10 |
| 10/23/90 | ONS-North | | < 60 | 2590 ± 260 | 35.0 ± 5.3 | < 100 | < 10 |
| **Average ± 2 s.d.** | | | | **2636 ± 2049** | **37.8 ± 43** | | |

* Typical LLDs are found in table B-12.

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 |
|---|---|---|---|---|---|
| 08/12/90 | SECTOR-A | Broad Leaves | 1060 ± 240 | 889 ± 212 | < 30 |
| 08/18/90 | SECTOR-H | Leaves | 2700 ± 300 | 3700 ± 370 | < 60 |
| 08/18/90 | SECTOR-E | Leaves | 1190 ± 250 | 3360 ± 390 | < 60 |
| 08/18/90 | SECTOR-H | Grapes | < 100 | 1760 ± 180 | < 60 |
| 08/18/90 | SECTOR-E | Grapes | < 100 | 2300 ± 230 | < 50 |
| **Average ± 2 s.d.** | | | **1650 ± 1823** | **2402 ± 2305** | |

* Typical LLDs are found in table B-12.

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 | 30 | 300 |
| Cobalt-58 | 10 | N/A | N/A | 5 | 15 | 1000 |
| Iodine-131 | 20 | 60 | 100 | 10 | 1 | 2 |
| | 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 |

• Charcoal Trap

TABLE (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 | | | Sediment/Soil - pCi/Kg-dry | | |
| Cerium-144 | 40 | N/A | N/A | 150 | N/A | N/A |
| Barium/La-140 | 60 | N/A | N/A | 5 | N/A | N/A |
| Cesium-134 | 6 | 230 | 1000 | 30 | 150 | N/A |
| Ru,Rh-106 | 50 | N/A | N/A | 200 | N/A | N/A |
| Cesium-137 | 6 | 150 | 2000 | 30 | 180 | N/A |
| Zr,Nb-95 | 30 | N/A | N/A | 40 | N/A | N/A |
| Manganese-54 | 5 | 130 | 30000 | 9 | N/A | N/A |
| Iron-59 | 15 | 260 | 10000 | 50 | N/A | N/A |
| Zinc-65 | 10 | 260 | 20000 | 60 | N/A | N/A |
| Cobalt-60 | 5 | 130 | 10000 | 20 | N/A | N/A |
| Cobalt-58 | 5 | 130 | 30000 | 20 | N/A | N/A |
| Iodine-131 | 10 | N/A | N/A | 30 | N/A | N/A |

Gross Beta/Tritium LLDs and Reporting Levels

| | Gross Beta | | |
|---|---|---|---|
| Air Particulates | 0.01 | 0.01 pCi/$m^3$ | N/A |
| Surface Water | 4 | 4.0 pCi/l | N/A |
| Ground Water | 4 | 4.0 pCi/l | N/A |
| Drinking Water | 4 | 4.0 pCi/l | N/A |
| | Tritium | | |
| Surface Water | 2000 | 2000 | 20,000 |
| Ground Water | 2000 | 2000 | 20,000 |
| Drinking Water | 2000 | 2000 | 20,000 |

# APPENDIX C
# ANALYTICAL PROCEDURES SYNOPSIS

## ANALYTICAL PROCEDURES SYNOPSIS

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

## DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

### 1.0 INTRODUCTION

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

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

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

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

## 2.0 DETECTION CAPABILITY

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

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

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

## GROSS BETA ANALYSIS OF SAMPLES

Air Particulates

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

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

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

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

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

where:

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

## ANALYSIS OF SAMPLES FOR TRITIUM

Water

Approximately 2 ml of water are converted to hydrogen by passing the water, heated to its vapor state, over a granular zinc conversion column heated to 400° C. The hydrogen is loaded into a one liter proportional detector and the volume is determined by recording the pressure.

The proportional detector is passively shielded by lead and steel and an electronic, anticoincidence system provides additional shielding from cosmic rays.

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

RESULT = $3.234\ T_N\ V_N(C_G - B)/(C_N\ V_S)$

TWO SIGMA ERROR = $2(3.234)\ T_N\ V_N(E)^{1/2}/(C_N\ V_S)$

LLD = $3.3\ (3.234)T_N\ V_N(E)^{1/2}/(C_N\ V_S)$

where:

| | | |
|---|---|---|
| $T_N$ | = | tritium units of the standard |
| 3.234 | = | conversion factor changing tritium units to pCi/l |
| $V_N$ | = | volume of the standard used to calibrate the efficiency of the detector in psia |
| $V_S$ | = | volume of the sample loaded into the detector in psia |
| $C_N$ | = | the net cpm of the standard of volume $V_N$ |
| $C_G$ | = | the gross cpm of the sample of volume $V_S$ |
| B | = | the background of the detector in cpm |
| $\Delta t$ | = | counting time for the sample |
| E | = | $S/T^2 + B/t^2$ |

## ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

Water

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

Milk

Stable strontium carrier is added to 1 liter of sample and the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved and precipitated as $SrNO_3$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 $mg/cm^2$ aluminum absorber for low level beta counting.

Soil and Sediment

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrachloric acid. The mixture is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90& nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an 80 mg/cm2 aluminum absorber for low level beta counting.

Organic Solids

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

Air Particulates

Stable strontium carrier is added to the sample and it is leached in nitric acid to bring deposits into solution. The mixture is then filtered and

the filtrate is reduced in volume by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with 80 $mg/cm^2$ aluminum absorber for low level beta counting.

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

RESULT Sr-89 = $(N/Dt-B_C-B_A)/(2.22\ V\ Y_S\ DF_{SR-89}\ E_{SR-89})$

TWO SIGMA ERROR Sr-89 = $2((N/Dt+B_C+B_A)/\Delta t)^{1/2}/(2.22\ V\ Y_S\ DF_{SR-89}\ E_{SR-89}$

LLD Sr-89 = $4.66((B_C+B_A)/\Delta t)^{1/2}/(2.22\ V\ YS\ DF_{SR-89}\ E_{SR-89})$

RESULT Sr-90 = $(N/\Delta t - B)/(2.22\ V\ Y_1\ Y_2\ DF\ IF\ E)$

TWO SIGMA ERROR Sr-90 = $2((N/\Delta t+B)/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ DF\ E\ IF))$

LLD Sr-90 = $4.66(B/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ IF\ DF\ E)$

**where:**

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

## ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

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

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

RESULT = $(N/\Delta t - B)/(2.22\ E\ V\ Y\ DF)$

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)
- $\Delta t$ = 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

$E = E_S(\exp -0.0061M)/(\exp -0.0061M_S)$

$E_S$ = efficiency of the counter determined from an I-131 standard mount

$Ms$ = mass of $PdI_2$ on the standard mount, mg

$M$ = mass of $PDI_2$ on the sample mount, mg

## GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

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

Dried Solids Other Than Soils and Sediments

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

Fish

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

Soils and Sediments

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

Charcoal Cartridges (Air Iodine)

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

Air Particulate

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

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

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

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

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

where:

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

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

t = length of time in minutes the sample was counted

2.22 = dpm/pCi

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

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

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

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

## ENVIRONMENTAL DOSIMETRY

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

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

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

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

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

WHERE:

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

$D1 = I_1 K/R_1 - A$

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

K = the known exposure by the Cs-137 source

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

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

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

# APPENDIX D
# SUMMARY OF EPA INTERLABORATORY COMPARISONS

## EPA INTERLABORATORY COMPARISON PROGRAM

Teledyne Isotopes participates in the US EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1990 data summary tables are presented for isotopes in the various sample media applicable to the Donald C. Cook Power Stations Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases.

## US EPA INTERLABORATORY COMPARISON PROGRAM 1990
## (ENVIRONMENTAL)

| Collection Date | Media | Nuclide | EPA Result(a) | | Teledyne Isotopes Result(b) | | |
|---|---|---|---|---|---|---|---|
| 10/31/89 | Lab Perf. | Gr-Alpha | 49.00 ± | 12.00 | 42.33 ± | 5.77 | |
| | Water | Ra-226 | 8.40 ± | 1.30 | 9.20 ± | 0.46 | |
| | Sample A | Ra-228 | 4.10 ± | 0.60 | 4.00 ± | 0.50 | |
| | Sample B | Gr-Beta | 32.00 ± | 5.00 | 30.33 ± | 0.58 | |
| | | Sr-89 | 15.00 ± | 5.00 | 15.00 ± | 3.46 | |
| | | Sr-90 | 7.00 ± | 1.50 | 7.00 ± | 0.00 | |
| | | Cs-134 | 5.00 ± | 5.00 | 5.33 ± | 1.15 | |
| | | Cs-137 | 5.00 ± | 5.00 | 7.00 ± | 0.00 | |
| 11/10/89 | Water | Ra-226 | 8.70 ± | 1.30 | 8.47 ± | 0.49 | |
| | | Ra-228 | 8.57 ± | 1.40 | 8.57 ± | 1.46 | |
| 01/12/90 | Water | Sr-89 | 25.00 ± | 5.00 | 24.00 ± | 1.73 | |
| | | Sr-90 | 20.00 ± | 1.50 | 19.67 ± | 2.52 | |
| 01/26/90 | Water | Gr-Alpha | 12.0 ± | 5.0 | 10.00 ± | 1.73 | |
| | | Gr-Beta | 12.0 ± | 5.0 | 12.33 ± | 1.53 | |
| 02/09/90 | Water | Co-60 | 15.00 ± | 5.00 | 15.00 ± | 3.46 | |
| | | Zn-65 | 139.00 ± | 14.00 | 131.33 ± | 9.07 | |
| | | Ru-106 | 139.00 ± | 14.00 | 113.67 ± | 4.04 | (c) |
| | | Cs-134 | 18.00 ± | 5.00 | 15.33 ± | 2.31 | |
| | | Cs-137 | 18.00 ± | 5.00 | 19.33 ± | 3.21 | |
| | | Ba-133 | 74.00 ± | 7.00 | 66.00 ± | 3.46 | |
| 02/23/90 | Water | H-3 | 4976.00 ± | 498.00 | 4900.00 ± | 100.00 | |
| 03/09/90 | Water | Ra-226 | 4.9 ± | 0.7 | 4.73 ± | 0.47 | |
| | | Ra-228 | 12.7 ± | 1.9 | 13.00 ± | 1.00 | |
| 03/30/90 | Air Filter | Gr-Alpha | 5.0 ± | 5.0 | 6.33 ± | 0.58 | |
| | | Gr-Beta | 31.0 ± | 5.0 | 31.67 ± | 0.58 | |
| | | Sr-90 | 10.0 ± | 1.5 | 9.33 ± | 0.58 | |
| | | Cs-137 | 10.0 ± | 5.0 | 10.67 ± | 1.15 | |
| 04/17/90 | Water | Gr-Alpha | 90.0 ± | 23.0 | 79.33 ± | 2.89 | |
| | (Lab Perf) | Ra-226 | 5.0 ± | 0.8 | 5.67 ± | 0.15 | |
| | Sample A | Ra-228 | 10.2 ± | 1.5 | 9.37 ± | 1.44 | |
| | Sample B | Gr-Beta | 52.0 ± | 5.0 | 53.33 ± | 1.53 | |
| | | Sr-89 | 10.0 ± | 5.0 | 10.67 ± | 1.15 | |
| | | Sr-90 | 10.0 ± | 1.5 | 9.67 ± | 0.58 | |
| | | Cs-134 | 15.0 ± | 5.0 | 12.67 ± | 1.53 | |
| | | Cs-137 | 15.0 ± | 5.0 | 16.33 ± | 1.15 | |

Footnotes at end of table.

## US EPA INTERLABORATORY COMPARISON PROGRAM 1990 (Cont.)
## (ENVIRONMENTAL)

| Collection Date | Media | Nuclide | EPA Result(a) | | Teledyne Isotopes Result(b) | | |
|---|---|---|---|---|---|---|---|
| 04/27/90 | Milk | Sr-89 | 23.0 ± | 5.0 | 24.67 ± | 1.53 | |
| | | Sr-90 | 23.0 ± | 5.0 | 24.00 ± | 0.00 | |
| | | I-131 | 99.0 ± | 10.0 | 89.67 ± | 3.21 | |
| | | Cs-137 | 24.0 ± | 5.0 | 27.33 ± | 2.52 | |
| | | K | 1550.0 ± | 78.0 | 1483.33 ± | 75.06 | |
| 05/04/90 | Water | Sr-89 | 7.0 ± | 5.0 | 6.67 ± | 0.58 | |
| | | Sr-90 | 7.0 ± | 5.0 | 6.67 ± | 0.58 | |
| 05/11/90 | Water | Gr-Alpha | 22.0 ± | 6.0 | 16.00 ± | 1.00 | |
| | | Gr-Beta | 15.0 ± | 5.0 | 17.00 ± | 1.00 | |
| 06/08/90 | Water | Co-60 | 24.0 ± | 5.0 | 25.33 ± | 2.52 | |
| | | Zn-65 | 148.0 ± | 15.0 | 148.67 ± | 3.06 | |
| | | Ru-106 | 210.0 ± | 21.0 | 196.00 ± | 20.66 | |
| | | Cs-134 | 24.0 ± | 5.0 | 23.67 ± | 2.89 | |
| | | Cs-137 | 25.0 ± | 5.0 | 24.67 ± | 2.08 | |
| | | Ba-133 | 99.0 ± | 10.0 | 93.00 ± | 6.08 | |
| 6/22/90 | Water | H-3 | 2933.0 ± | 358.0 | 2900 ± | 100.00 | |
| 07/13/90 | Water | Ra-226 | 12.1 ± | 1.8 | 11.37 ± | 0.60 | |
| | | Ra-228 | 5.1 ± | 1.3 | 4.20 ± | 0.75 | |
| 08/10/90 | Water | I-131 | 39.0 ± | 6.0 | 36.00 ± | 3.00 | |
| 08/31/90 | Air Filter | Gr-Alpha | 10.0 ± | 5.0 | 16.00 ± | 1.00 | (d) |
| | | Gr-Beta | 62.0 ± | 5.0 | 63.33 ± | 1.53 | |
| | | Sr-90 | 20.0 ± | 5.0 | 18.00 ± | 1.00 | |
| | | Cs-137 | 20.0 ± | 5.0 | 18.33 ± | 3.21 | |
| 09/14/90 | Water | Sr-89 | 10.0 ± | 5.0 | 8.67 ± | 0.58 | |
| | | Sr-90 | 9.0 ± | 5.0 | 9.0 ± | 1.00 | |
| 09/21/90 | Water | Gr-Alpha | 10.0 ± | 5.0 | 11.00 ± | 1.00 | |
| | | Gr-Beta | 10.0 ± | 5.0 | 11.00 ± | 1.00 | |

Footnotes at end of table.

## US EPA INTERLABORATORY COMPARISON PROGRAM 1990 (Cont.)
## (ENVIRONMENTAL)

| Collection Date | Media | Nuclide | EPA Result(a) | | Teledyne Isotopes Result(b) | | |
|---|---|---|---|---|---|---|---|
| 09/28/90 | Milk | Sr-89 | 16.0 ± | 5.0 | 9.0 ± | 2.65 | (e) |
| | | Sr-90 | 20.0 ± | 5.0 | 15.33 ± | 0.58 | |
| | | I-131 | 58.0 ± | 6.0 | 54.67 ± | 1.53 | |
| | | Cs-137 | 20.0 ± | 5.0 | 23.00 ± | 1.73 | |
| | | K | 1700.0 ± | 85.0 | 1710.00 ± | 65.51 | |
| 10/15/90 | Water | Co-60 | 20.0 ± | 5.0 | 21.00 ± | 1.00 | |
| | | Zn-65 | 115.0 ± | 12.0 | 115.00 ± | 11.53 | |
| | | Ru-106 | 151.0 ± | 15.0 | 142.00 ± | 8.66 | |
| | | Cs-134 | 12.0 ± | 5.0 | 11.00 ± | 0.00 | |
| | | Cs-137 | 12.0 ± | 5.0 | 16.33 ± | 2.52 | |
| | | Ba-133 | 110.0 ± | 11.0 | 94.67 ± | 5.13 | (f) |
| 10/30/90 | Lab Perf. | Gr-Alpha | 62.00 ± | 16.00 | 57.00 ± | 1.00 | |
| | Water | Ra-226 | 13.6 ± | 2.0 | 12.67 ± | 1.27 | |
| | Sample A | Ra-228 | 5.0 ± | 1.3 | 4.87 ± | 0.23 | |
| | Sample B | Gr-Beta | 53.0 ± | 5.0 | 51.00 ± | 2.31 | |
| | | Sr-89 | 20.0 ± | 5.0 | 19.00 ± | 3.61 | |
| | | Sr-90 | 15.0 ± | 5.0 | 14.33 ± | 0.58 | |
| | | Cs-134 | 7.0 ± | 5.0 | 9.00 ± | 0.00 | |
| | | Cs-137 | 5.0 ± | 5.0 | 7.67 ± | 1.15 | |
| 10/19/90 | Water | H-3 | 7203.0 ± | 720.0 | 7133.33 ± | 251.66 | |
| 11/09/90 | Water | Ra-226 | 7.4 ± | 1.1 | 7.27 ± | 0.38 | |
| | | Ra-228 | 7.7 ± | 1.9 | 7.57 ± | 0.32 | |

Footnotes at end of table.

## US EPA INTERLABORATORY COMPARISON PROGRAM 1990 (Cont.)
## (ENVIRONMENTAL)

**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) No apparent cause for the low results were found. Three aliquots of the sample were counted on three separate detectors. The results of all three were similar. The calibration curve fit is good (0.997). Ruthenium-106 will be obtained from the EPA to further investigate the matter and future mixed gamma in water EPA Intercomparisons will be monitored to identify continuing trends.

(d) The EPA deposit occupies a smaller area than our calibration planchet and hence has a higher counting efficiency. No further corrective action is required, since our calibration standard better represents an air particulate filter.

(e) Incomplete removal of calcium, lead to erroneously high strontium yields. More care is being taken in the strontium nitrate and strontium sulfate precipitation steps to ensure a final volume of at least 20 ml in the strontium sulfate step. Reanalysis of internal QC samples produced good results after implementing the corrective action.

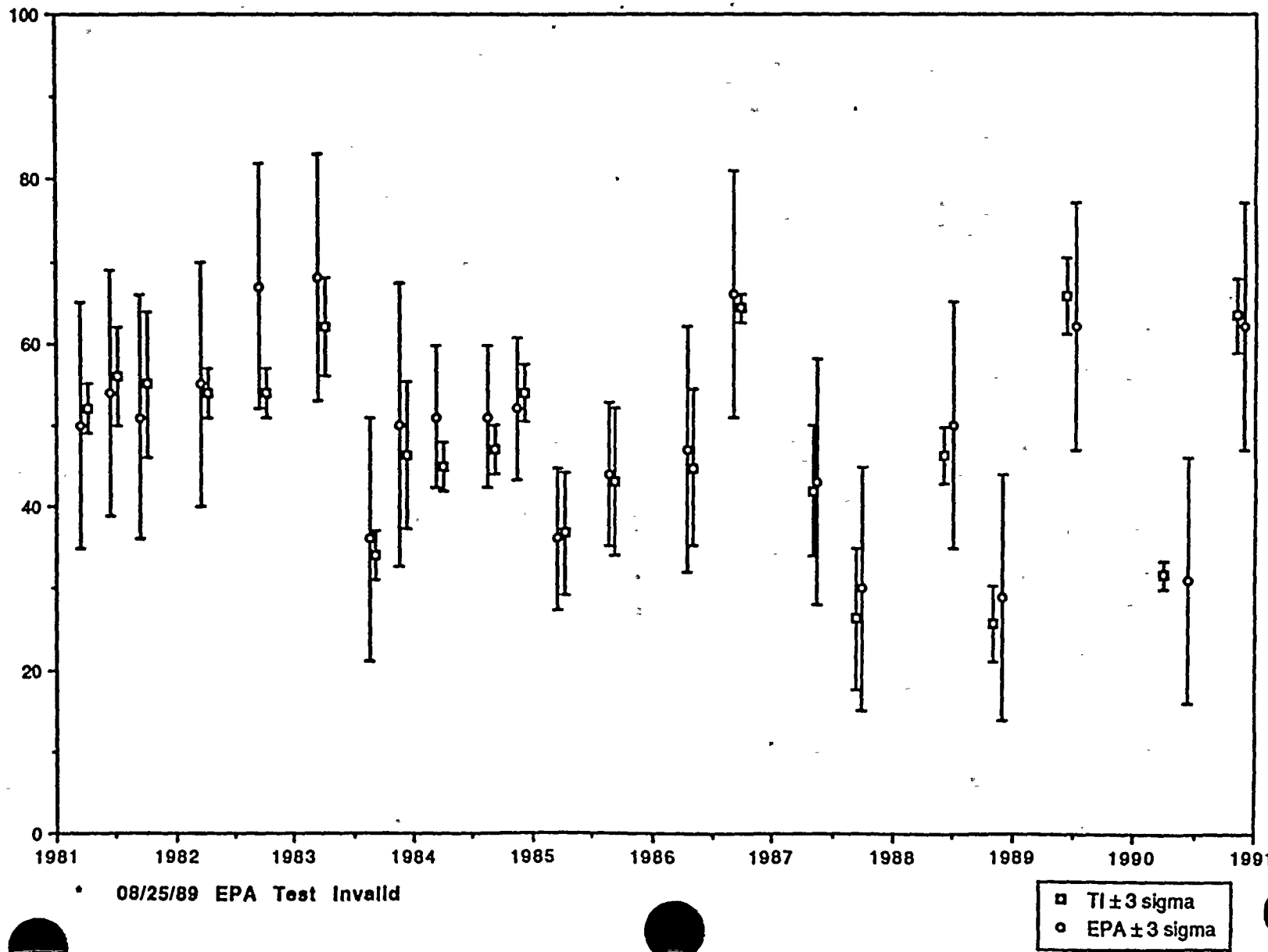
(f) There is no apparent reason for the deviation between the EPA and Teledyne Isotopes values. Other isotopes in the sample were measured accurately. The calculations were reviewed and activities calculated from other Ba-133 gamma rays. Results were reproduced as reported.

4/4/91

TRENDING GRAPH - 5

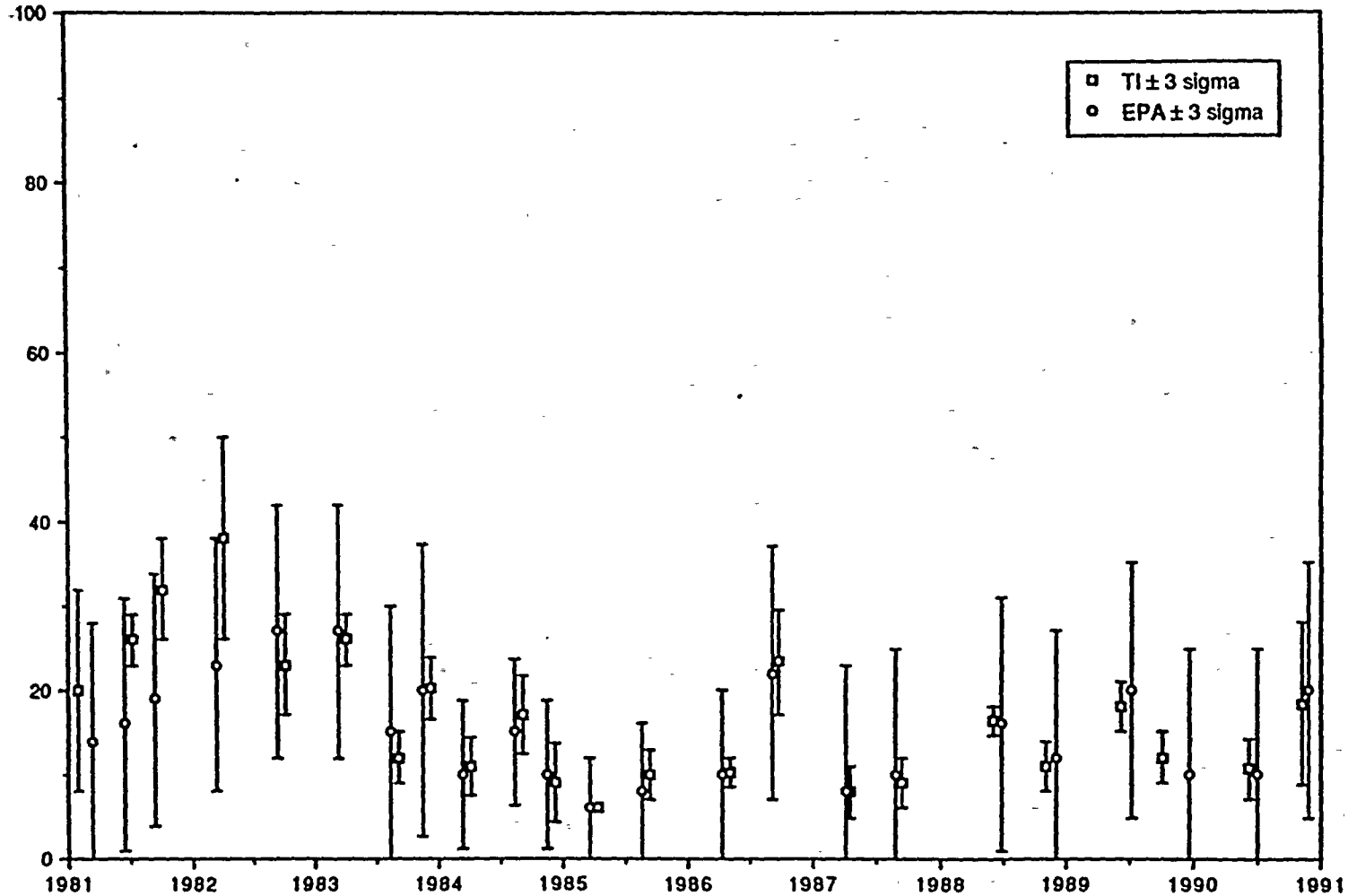
# US EPA CROSS CHECK PROGRAM

## GROSS BETA IN AIR PARTICULATES



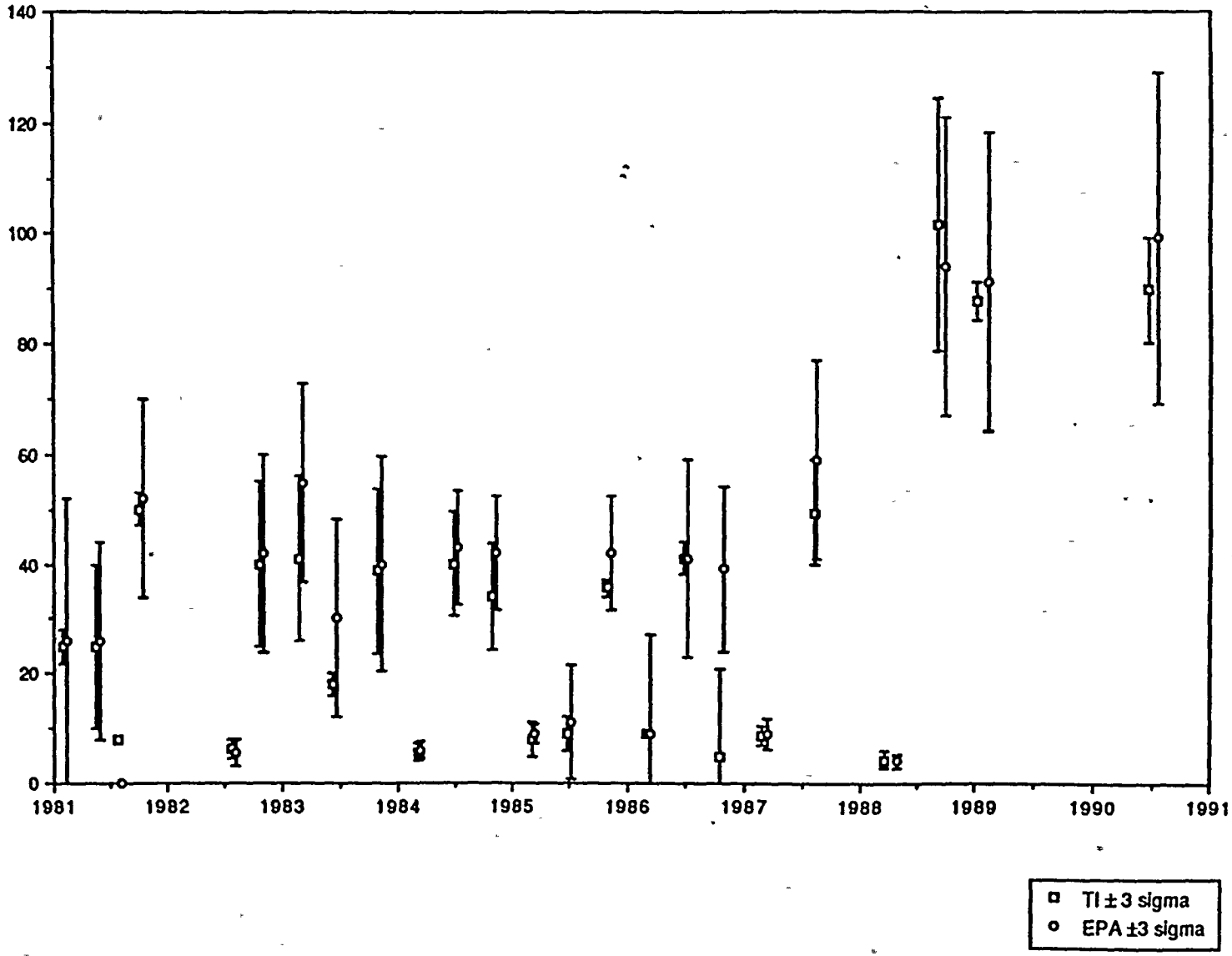
# US EPA CROSS CHECK PROGRAM

## CESIUM-137 IN AIR PARTICULATES



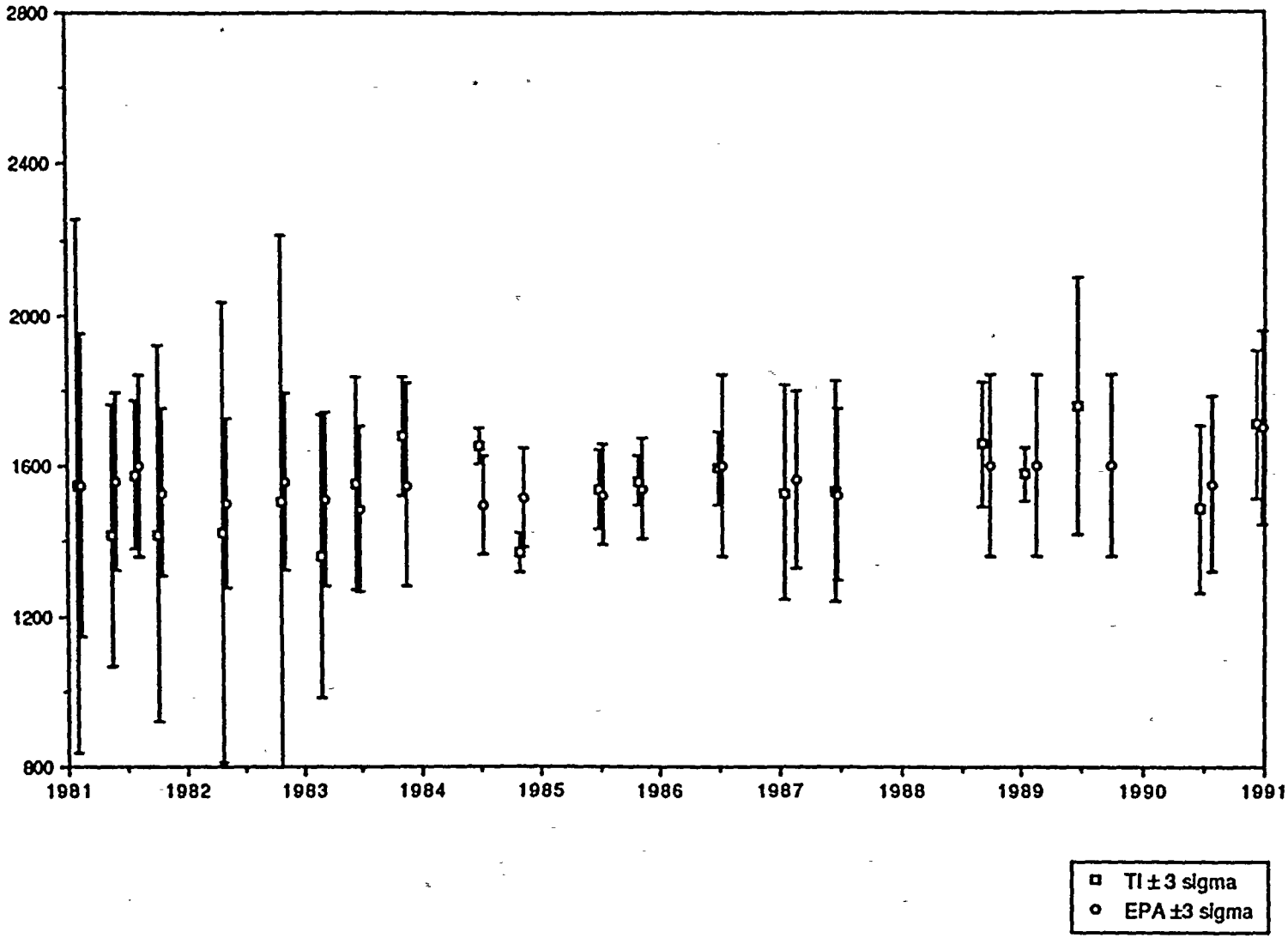
# US EPA CROSS CHECK PROGRAM

## IODINE IN MILK



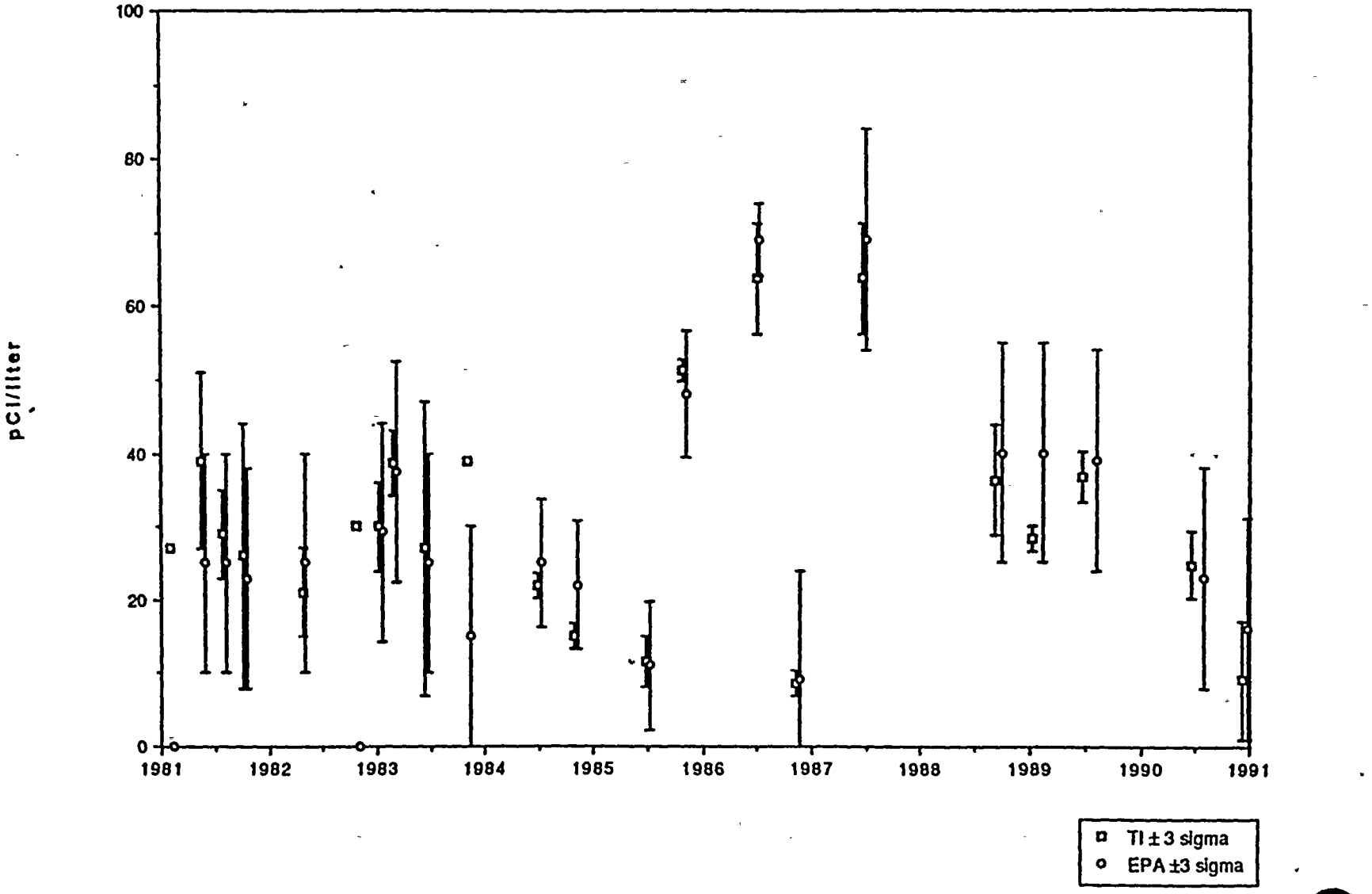
# US EPA CROSS CHECK PROGRAM

## POTASSIUM-40 IN MILK



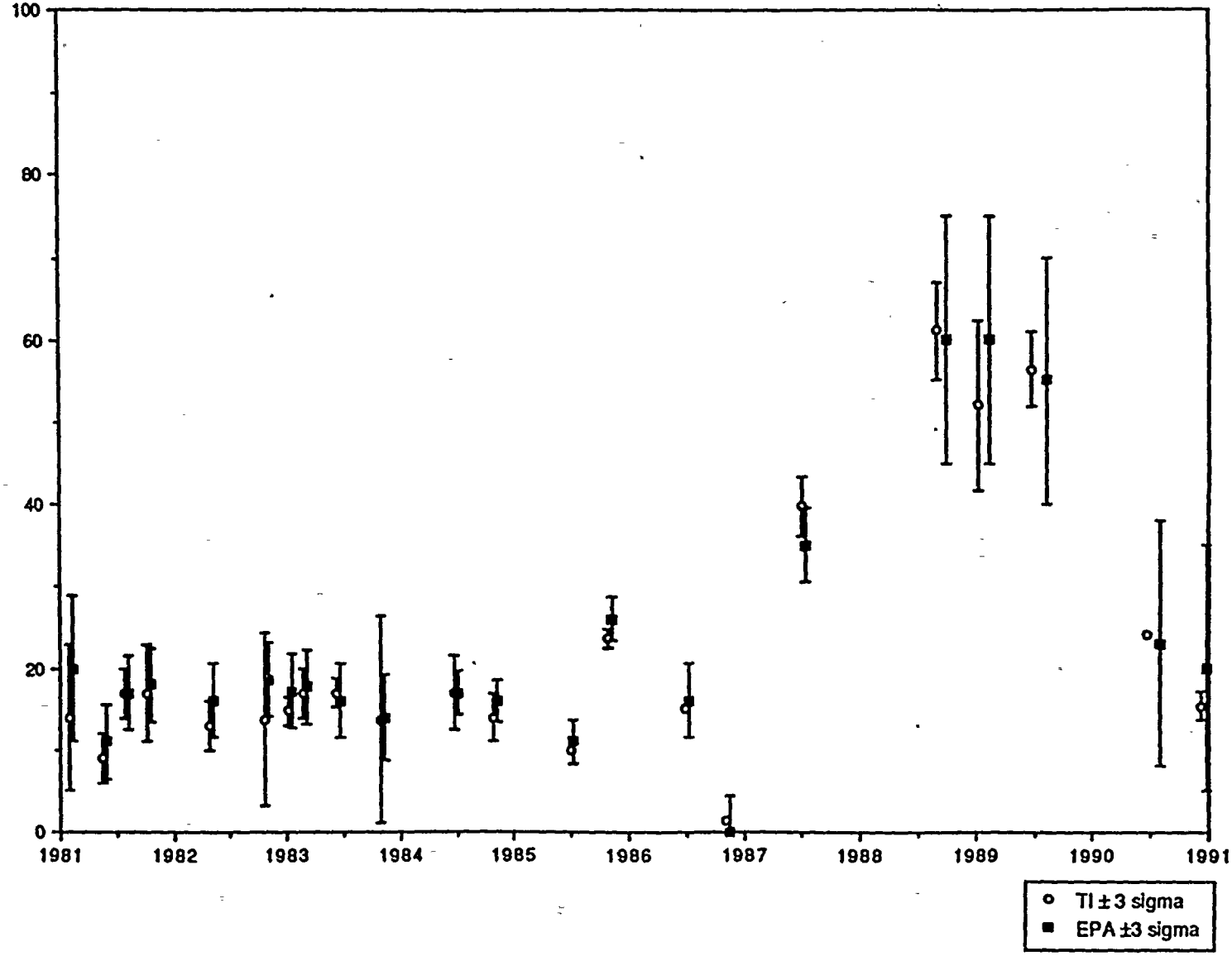
# US EPA CROSS CHECK PROGRAM

## STRONTIUM IN MILK



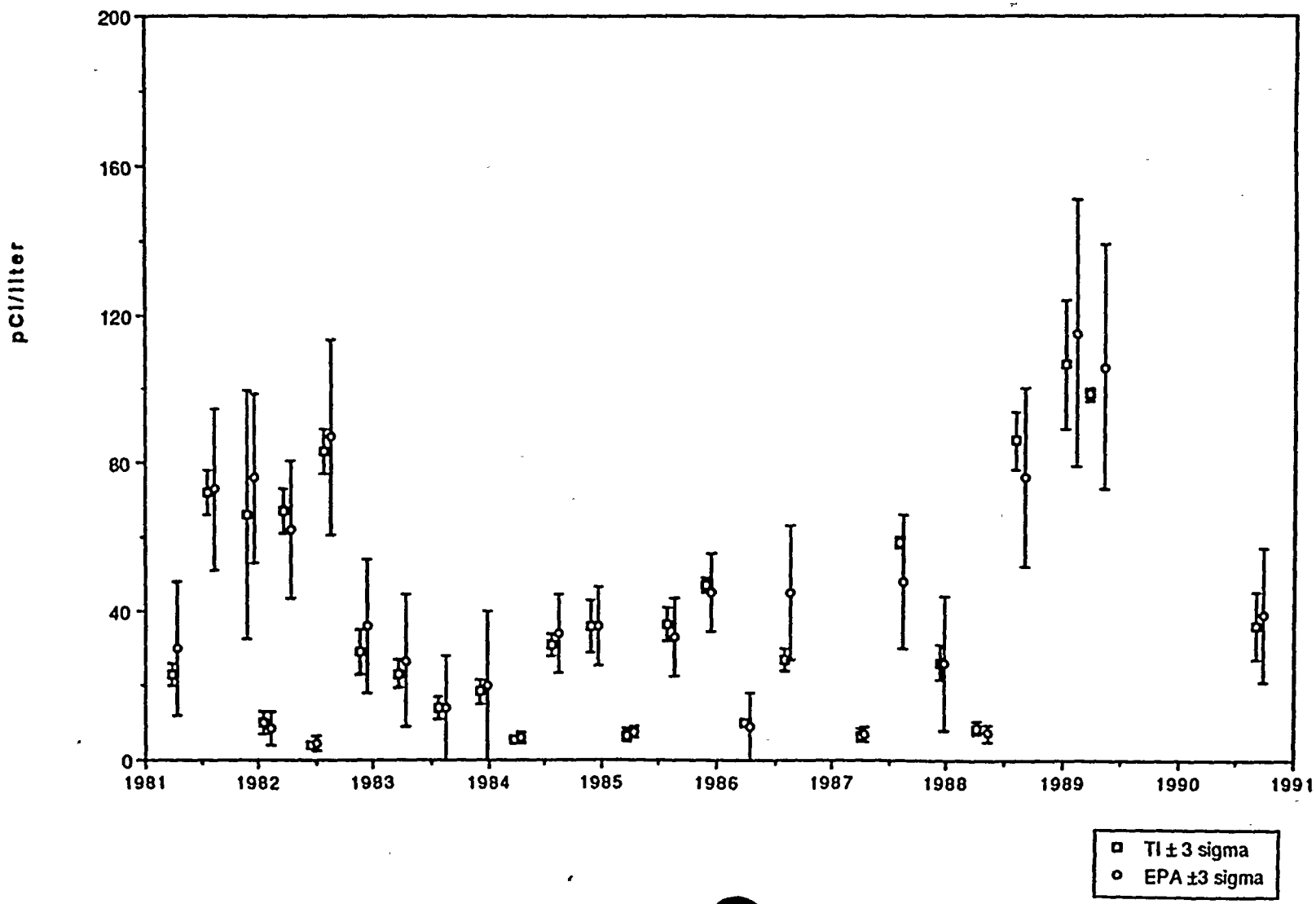
# US EPA CROSS CHECK PROGRAM

## STRONTIUM-90 IN MILK



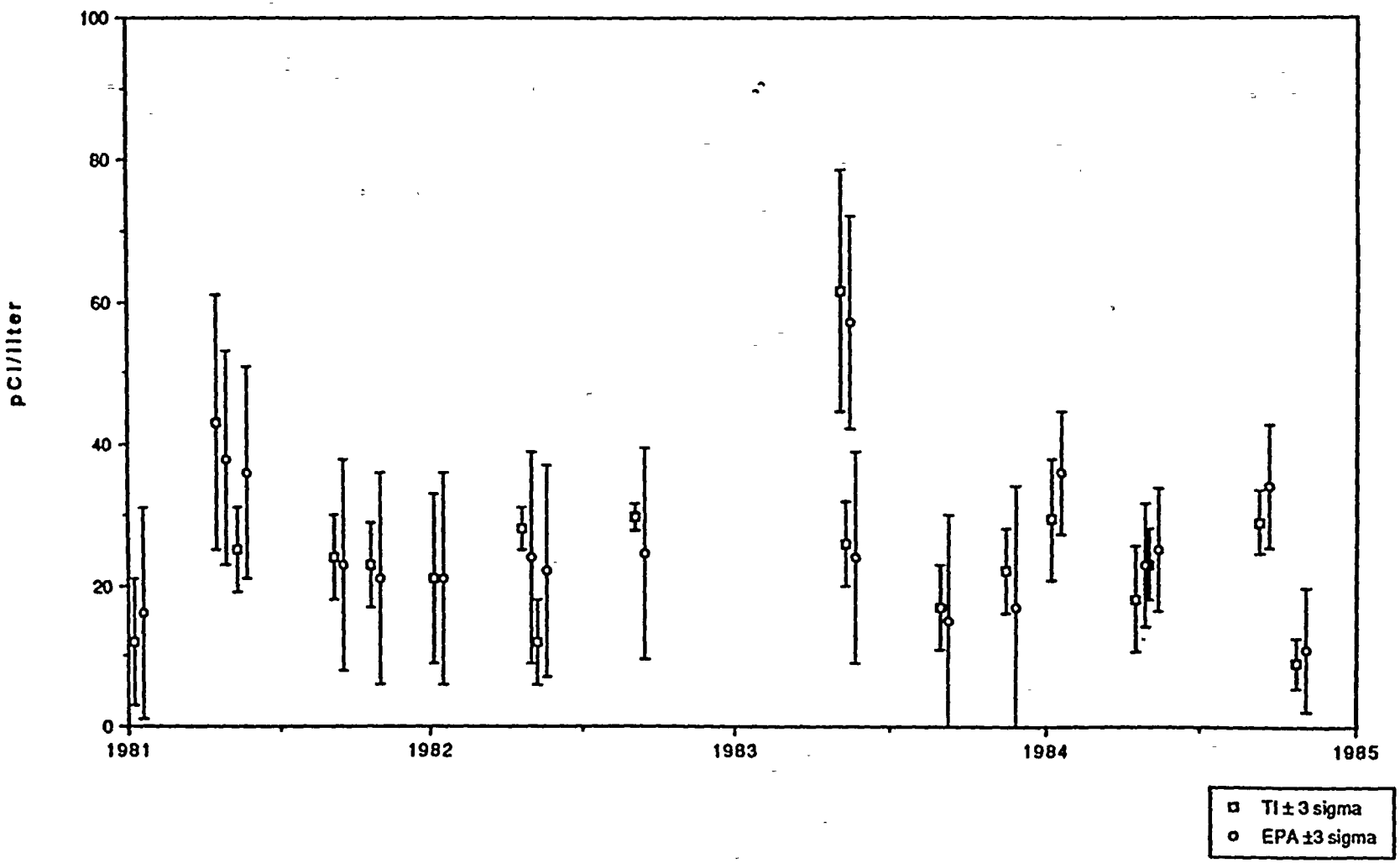
# US EPA CROSS CHECK PROGRAM

## IODINE-131 IN WATER



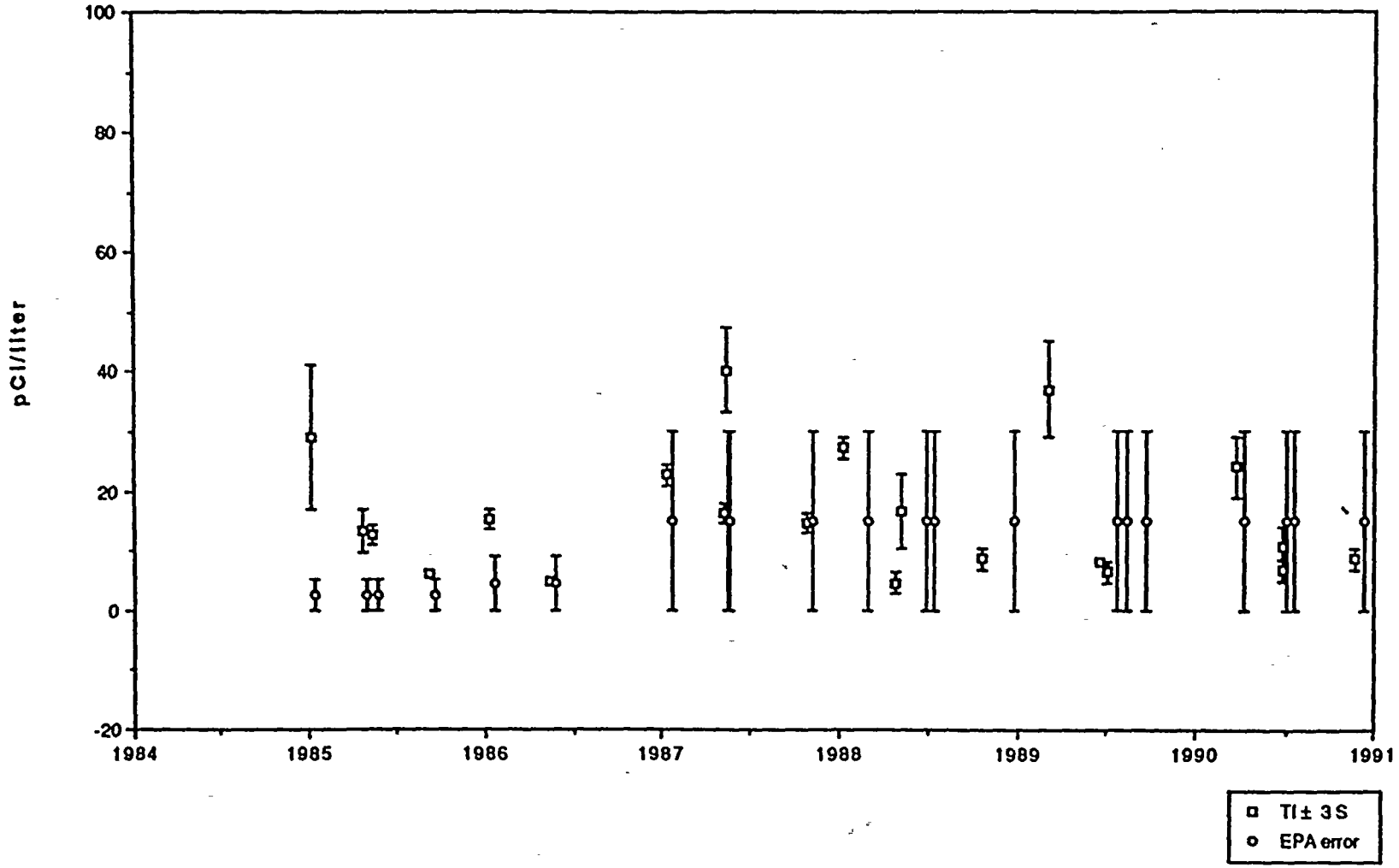
# US EPA CROSS CHECK PROGRAM

## STRONTIUM-89 IN WATER (pg. 1)



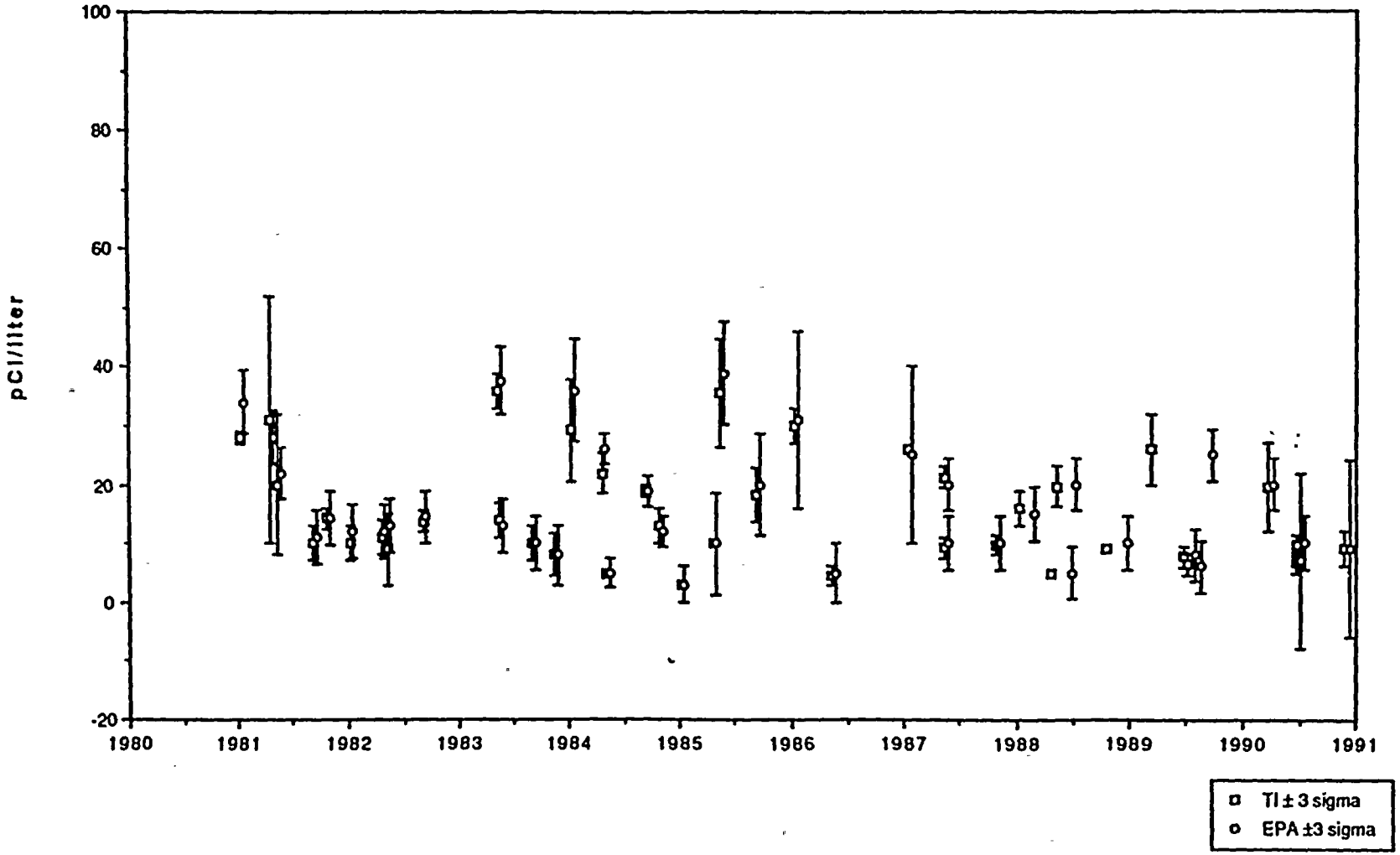
# US EPA CROSS CHECK PROGRAM

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

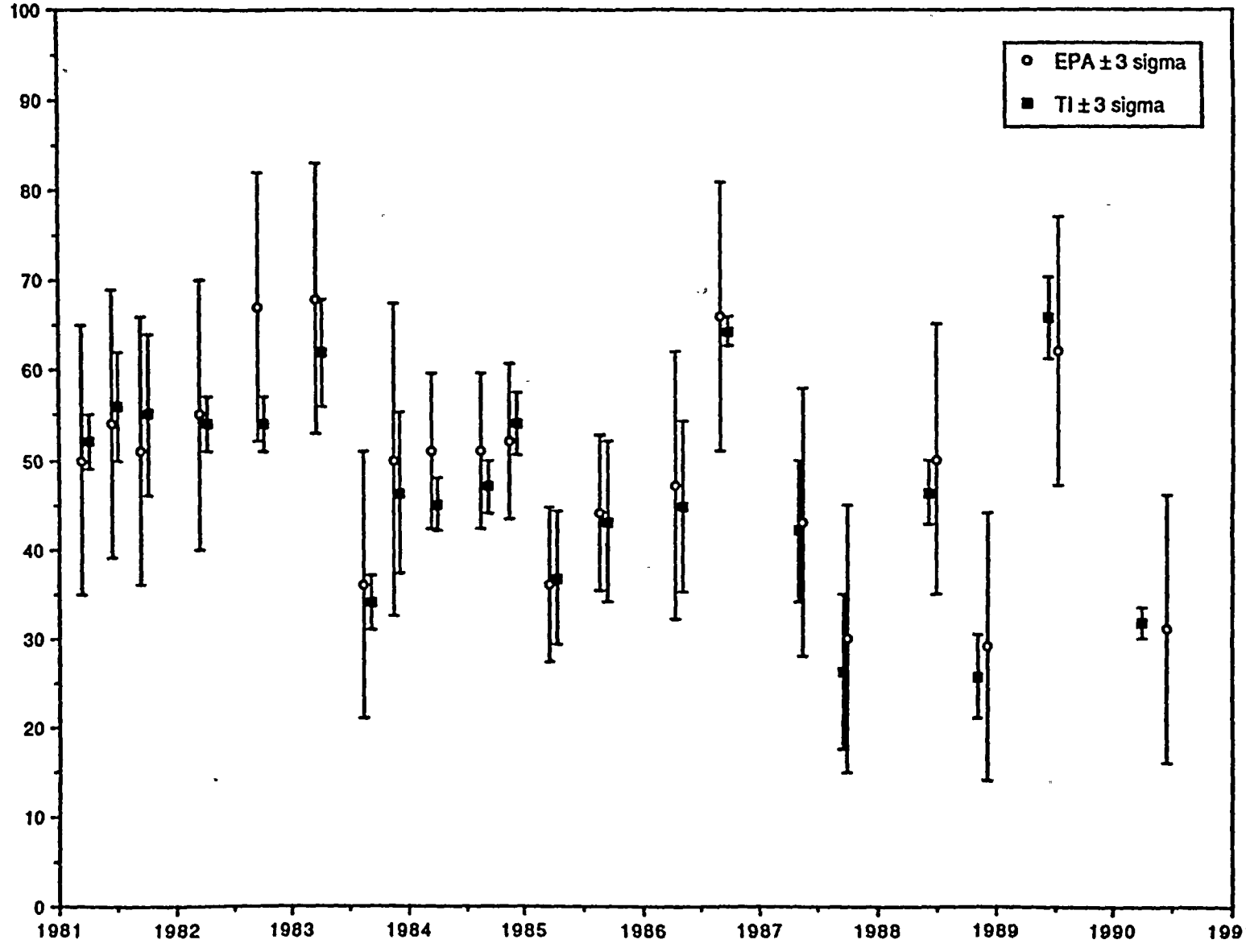


# US EPA CROSS CHECK PROGRAM

## STRONTIUM-90 IN WATER



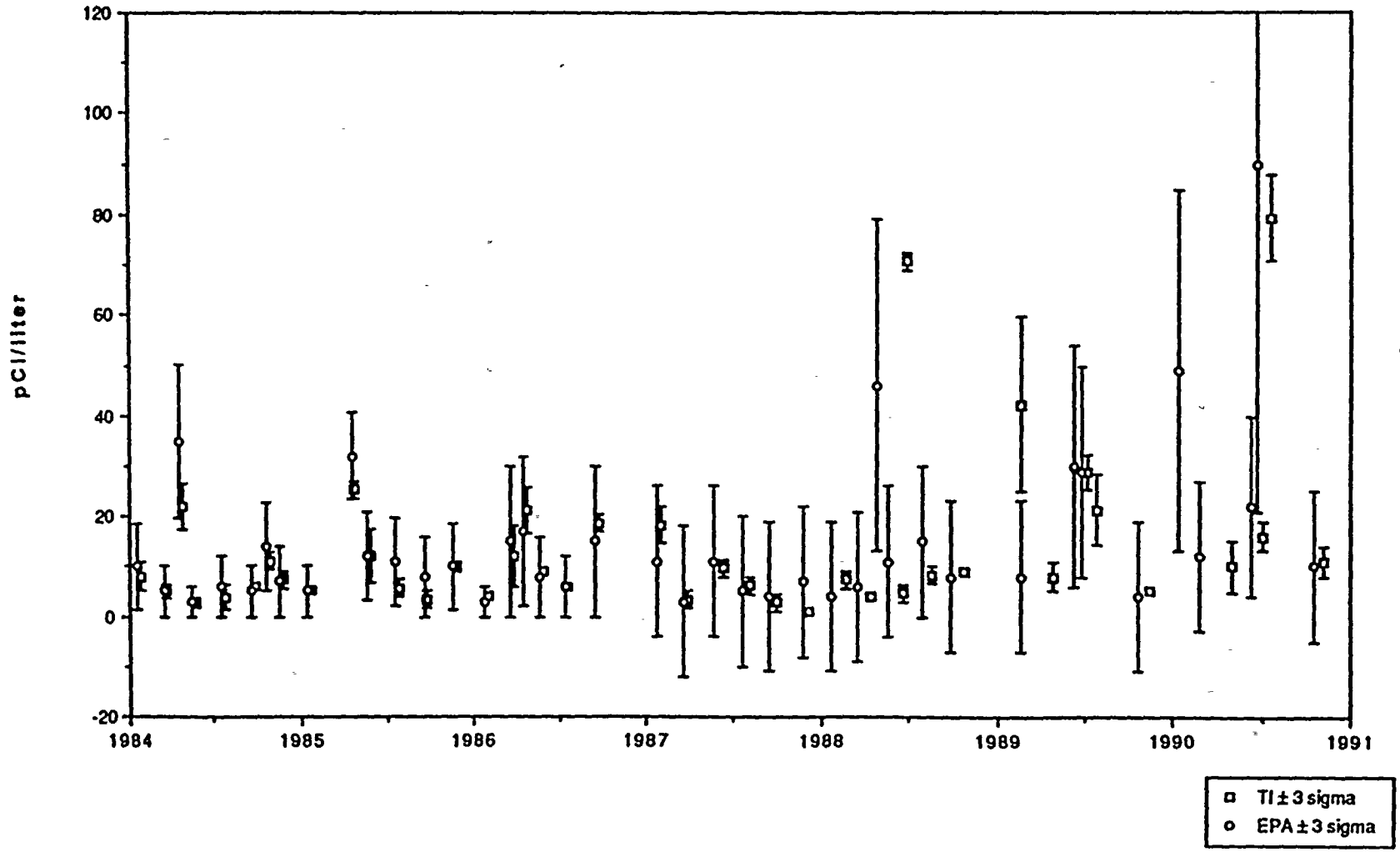
# US EPA CROSS CHECK PROGRAM
## GROSS BETA IN AIR PARTICULATES




* 08/25/89 EPA test invalid.

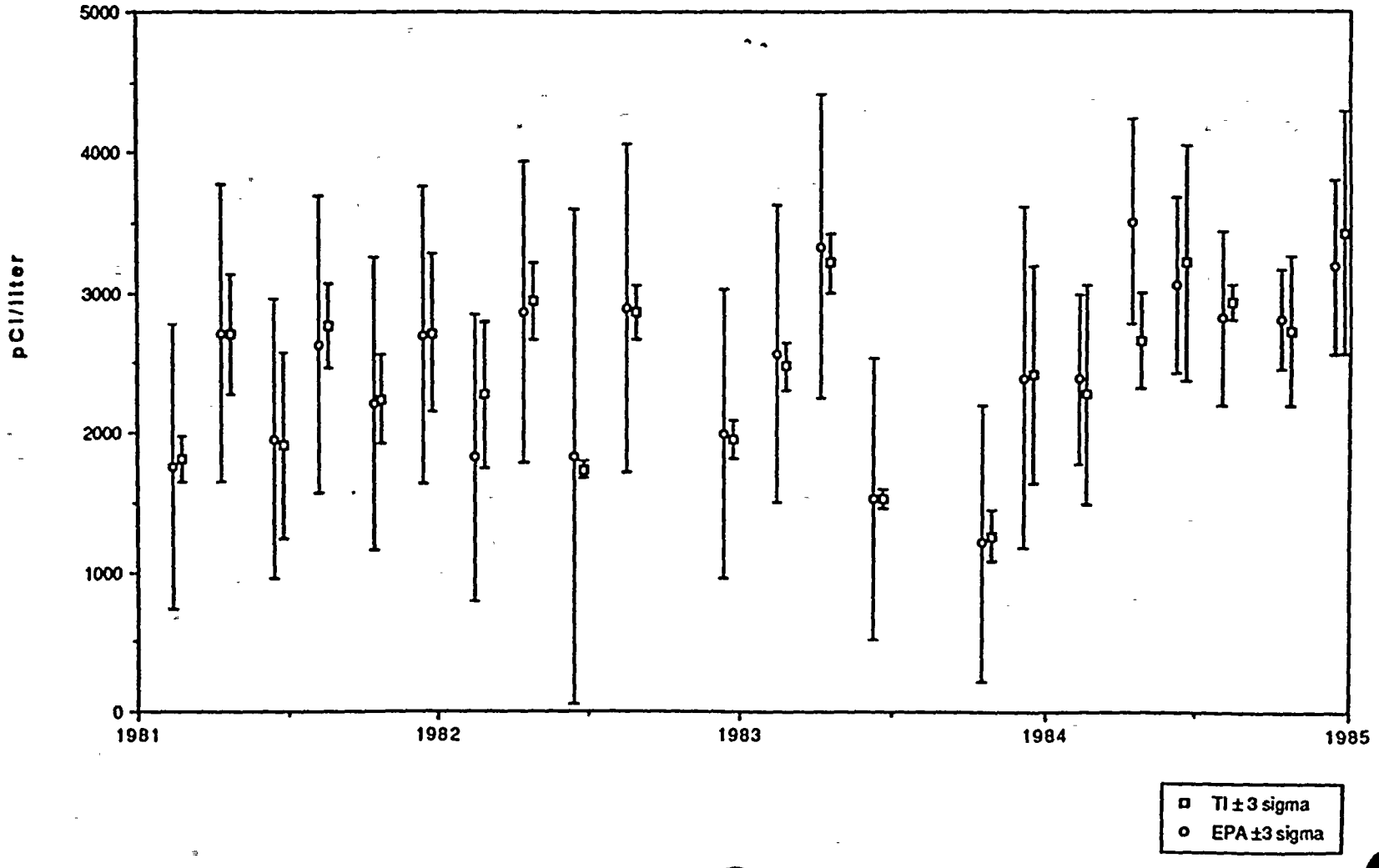
# US EPA CROSS CHECK PROGRAM

## GROSS ALPHA IN WATER



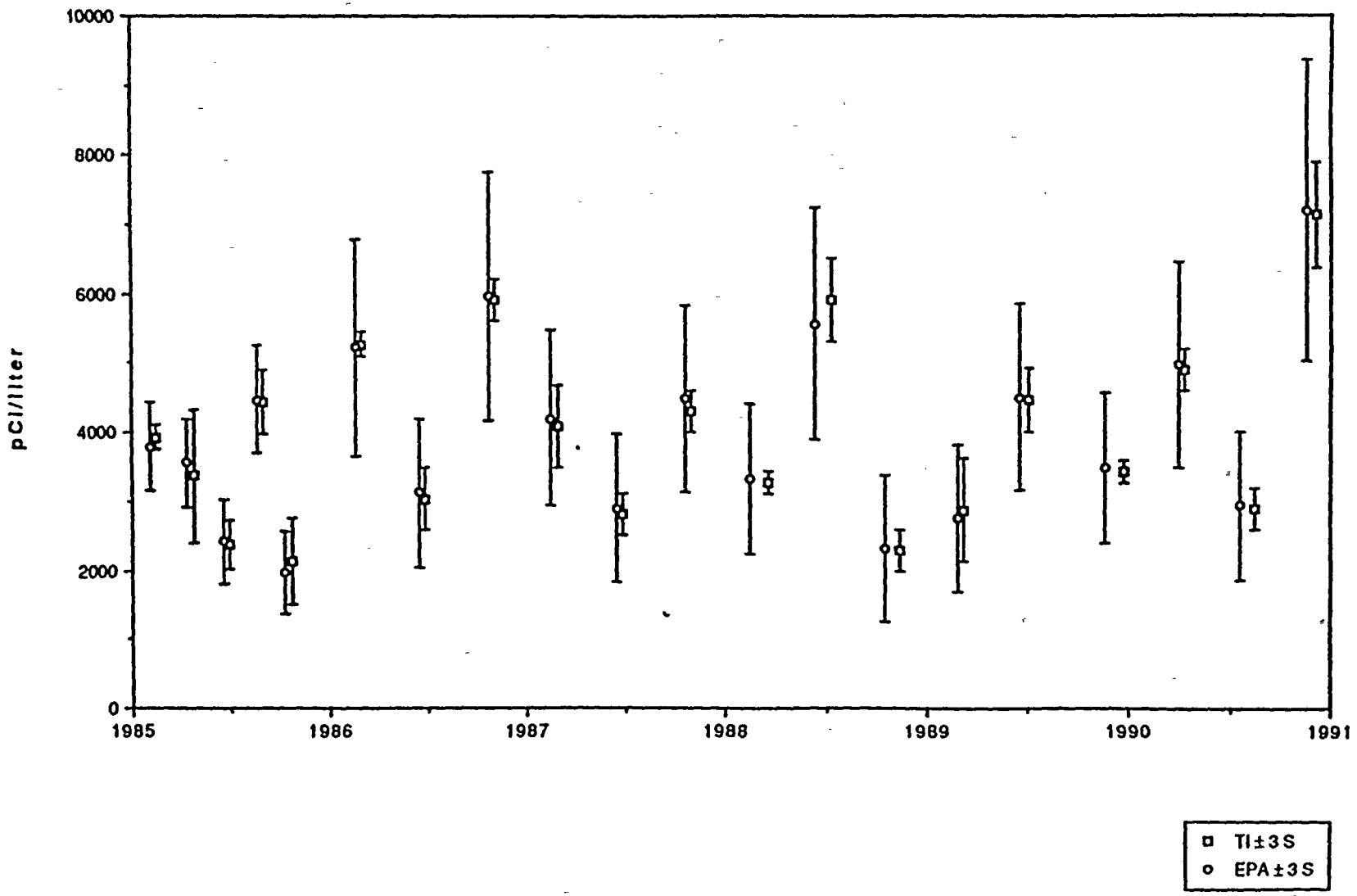
# US EPA CROSS CHECK PROGRAM

## TRITIUM IN WATER (pg. 1)



# US EPA CROSS CHECK PROGRAM

## TRITIUM IN WATER (pg. 2)



# APPENDIX E
# REMP SAMPLING AND ANALYTICAL EXCEPTIONS

## PROGRAM EXCEPTIONS

REMP deviations for 1990 are listed at the end of this appendix. Where possible, the causes of the deviations have been corrected to prevent recurrence.

## REMP EXCEPTIONS FOR SCHEDULED SAMPLING AND ANALYSIS DURING 1990

| Station | Description | Date of Sampling | Reason(s) for Loss/ Exception |
|---|---|---|---|
| All | Air Particulate | 04/23/90 | Samples inadvertently lost at the laboratory. |
| A-2 | Air Iodine | 10/22/90 | LLD not met due to low sample volume. Unit removed for repairs. |
| Coloma | Air Particulate | 08/20/90 | Electrical malfunction; Sampler found not running. |
| Dowagiac | Air Particulate/ Air Iodine | 12/31/90 | Electrical malfunction; LLD not met due to low sample volume. Unit sent for repairs. |
| OFS-6 | TLD | Second Qtr. | TLD, wire cage and entire telephone pole missing at time of TLD exchange. |
| L-2, L-3 L-4, L-5 | Surface Water | 01/11/90 | Sample not available due to ice on shoreline. |
| N/A | Drinking Water | 01/12/89 through 06/15/89 | Analytical lab used an LLD of 2 pCi/l for I-131 analyses. Maximum LLD required by T/S is 1 pCi/l. |

# APPENDIX F
# 1990 LAND USE CENSUS

## APPENDIX F
## SUMMARY OF THE 1990 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 1990 Land Use Census. The following is a summary of the 1990 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.

In 1990 there were no additions and five deletions from the list of area milk farms. None of the deleted milk farms were involved in the Cook Plant milk sampling program.

The closest milk farm in each land sector was unchanged for 1990. A table identifying these milk farms is included at the end of this Appendix. The location of the closest milk animal also remains unchanged for 1990.

### Residential Survey

The residential survey is performed to identify the closest residence to the plant in each land sector. The closest residences in each sector were unchanged for 1990. A table identifying each residence is included at the end of this appendix.

### 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 in the land sector where it is estimated that the maximum concentration of plant related radionuclides would occur. The broadleaf analytical results for 1990 were <LLD.

**Well Census**

A residential well survey was performed in 1990 to monitor the groundwater aquifer north and south of the Cook Plant for radionuclides and to identify wells in the vicinity of the plant used to supply water for human consumption.

The well survey was performed in the communities of Rosemary Beach and Livingston Hills located directly north and south of the plant respectively. These are the closest communities to the Cook Plant. Results of the survey are summarized on the table and maps at the end of this appendix.

Communities to the east of the plant were not involved in the well census due to the fact that they are located greater than a mile from the plant center and are upstream of the prevailing east to west groundwater flow.

Eight of the thirty-seven residences in the Rosemary Beach community were identified as having wells used to supply water for human consumption. These residences are indicated on the Rosemary Beach Map. Gamma spectrometry, iodine, and tritium analyses were performed for each sample. The results were all <LLD.

The Livingston Hills community consists of eight residences. Each residence obtains its drinking water from the Lake Township Municipal Water System. Inactive wells are located at each residence. None of the inactive wells are currently operational. Two of the inactive wells, Malmstadt and Scupham, were temporarily repaired for the purpose of obtaining groundwater samples. These residences are identified on the Livingston Hills Map. Duplicate samples were obtained from each well. The gamma spectrometry, iodine, and tritium results for the Malmstadt samples were <LLD. The gamma spectrometry and iodine results for the Scupham

samples were <LLD. The tritium results for the Scupham samples were <LLD and 350 pCi/liter. (See attached Table).

An additional well has been established offsite between the plant and Livingston Hills to facilitate future groundwater sampling in this area for the purpose of long-term monitoring of the aquifer (see attached map). Initial gamma spectrometry, iodine, and tritium analyses were all <LLD.

A swamp water sample was obtained to represent standing ground water that may be utilized for animal consumption. Initial gamma spectrometry, iodine, and tritium analyses were all <LLD.

## Figure 5

## INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Milk and Animal Survey

| Sector | Survey Year | Distance Miles | Name | Address |
|---|---|---|---|---|
| A | a | N/A | No milk animals | N/A |
| | b | N/A | No milk animals | N/A |
| B | a | N/A | No milk animals | N/A |
| | b | N/A | No milk animals | N/A |
| C | a | N/A | No milk animals | N/A |
| | b | N/A | No milk animals | N/A |
| D | a | 4.75 | Gerald Totzke | 6744 Totzke Rd., Baroda |
| | b | 4.75 | Gerald Totzke | 6744 Totzke Rd., Baroda |
| E | a | 10.5 | Andrews Univ. | Berrien Springs |
| | b | 10.5 | Andrews Univ. | Berrien Springs |
| [redacted] | 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 | 4.25 | G. G. Shuler & Sons | RFD 1, Snow Rd., Baroda |
| | b | 4.25 | G. G. Shuler & Sons | RFD 1, Snow Rd., Baroda |
| H | a | 5.2 | Norman Zelmer | 11701 S. Gast Rd., Bridgman |
| | b | 5.2 | Norman Zelmer | 11701 S. Gast Rd., Bridgman |
| J | a | 7.8 | Jerry Warmbein | Box 184, Avery Rd., Three Oaks |
| | b | 7.8 | Jerry Warmbein | Box 184, Avery Rd., Three Oaks |
| K | a | 12 | Kenneth Tappan | Rt. 2, Kruger Rd, Three Oaks |
| | b | 12 | Kenneth Tappan | Rt. 2, Kruger Rd, Three Oaks |

[redacted]other sectors are over water.
[redacted]Reporting Year
(b) Year prior to reporting year.

Figure 6

INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT

Residential Land Use Survey

| 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 | 6-4.1 | Rt. #1, Rosemary Rd. |
| B | a | 2 | 2165 | 11-11-0006-0004-09-2 | Iler Drive, Rosemary Beach |
| | b | 2 | 2165 | 6-4.9 | Rt. #1, Rosemary Rd. |
| C | a | 3 | 3093 | 11-11-6800-0028-00-0 | Lake Road, Rosemary Beach |
| | b | 3 | 3093 | 6-28 | Rt. #1, Rosemary Rd. |
| D | a | 4 | 5733 | 11-11-0005-0036-01-8 | 7500 Thorton Drive |
| | b | 4 | 5733 | 5-36 | 7500 Thorton Drive |
| E | a | 5 | 5631 | 11-11-0005-0009-07-0 | 7927 Red Arrow Highway |
| | b | 5 | 5631 | 5.25.5 | 7927 Red Arrow Highway |
| F | a | 6 | 5392 | 11-11-0008-0015-03-1 | 8197 Red Arrow Highway |
| | b | 6 | 5392 | 8-10.3 | 3900 Livingston Rd. |
| G | a | 7 | 3728 | 11-11-0007-0013-01-4 | Livingston Road |
| | b | 7 | 3728 | 7-4 | 4212 Livingston Rd. |
| H | a | 8 | 4944 | 11-11-8600-0004-00-1 | Wildwood |
| | b | 8 | 4944 | 7-7+8 | Wildwood Subdivision (8700 Red Arrow Hwy.) |
| J | a | 9 | 3366 | 11-11-0007-0010-02-3 | Livingston Hills |
| | b | | 3366 | 7-1 0.3 | 4600 W. Livingston Rd. Livingston Hills Subdivision) |
| K | a | 10 | 3090 | 11-11-0007-0010-03-1 | Livingston Hills |
| | b | 10 | 3090 | 7-10.3 | 4600 W. Livingston Rd. (Livingston Hills Subdivision) |

(1) All other sectors are over water.
(a) Reporting Year
(b) Year prior to reporting year.
* Specific property numbers as listed on the tax rolls were used to identify houses. Previous year's report used lot numbers. The lot numbers remained the same.
** House #6 was incorrectly addressed the previous year. All other address changes are minor modifications reflecting updated address format.

**Figure 7**

**INDIANA MICHIGAN POWER COMPANY - DONALD C. COOK NUCLEAR PLANT**

Offsite Well Survey

Results in units of pCi/l

| Well | Date | H-3 | I-131 | Gamma Spec |
|---|---|---|---|---|
| **ROSEMARY BEACH** | | | | |
| Armstrong | 08/29/90 | < 200 | < 0.2 | < LLD |
| Burke | 08/29/90 | < 200 | < 0.2 | < LLD |
| Halstead | 08/29/90 | < 100 | < 0.2 | < LLD |
| Tengerstrom | 08/31/90 | < 100 | < 0.1 | < LLD |
| Scott | 08/31/90 | < 100 | < 0.1 | < LLD |
| Cone | 09/11/90 | < 100 | < 0.2 | < LLD |
| Mc Clean | 09/19/90 | < 200 | < 0.2 | < LLD |
| Maracich | 09/19/90 | < 200 | < 0.2 | < LLD |
| **LIVINGSTON HILLS** | | | | |
| Swamp Water | 09/10/90 | < 200 | < 0.1 | < LLD |
| Malmstadt | 09/26/90 | < 100 | < 0.1 | < LLD |
| Duplicate | 09/26/90 | < 200 | < 0.1 | < LLD |
| Scupham | 11/12/90 | < 200 | < 0.2 | < LLD |
| Duplicate | 11/12/90 | 350 | < 0.2 | < LLD |
| New Well | 11/29/90 | < 100 | < 0.1 | < LLD |
| Duplicate | 11/29/90 | < 200 | < 0.2 | < LLD |

Figure 8

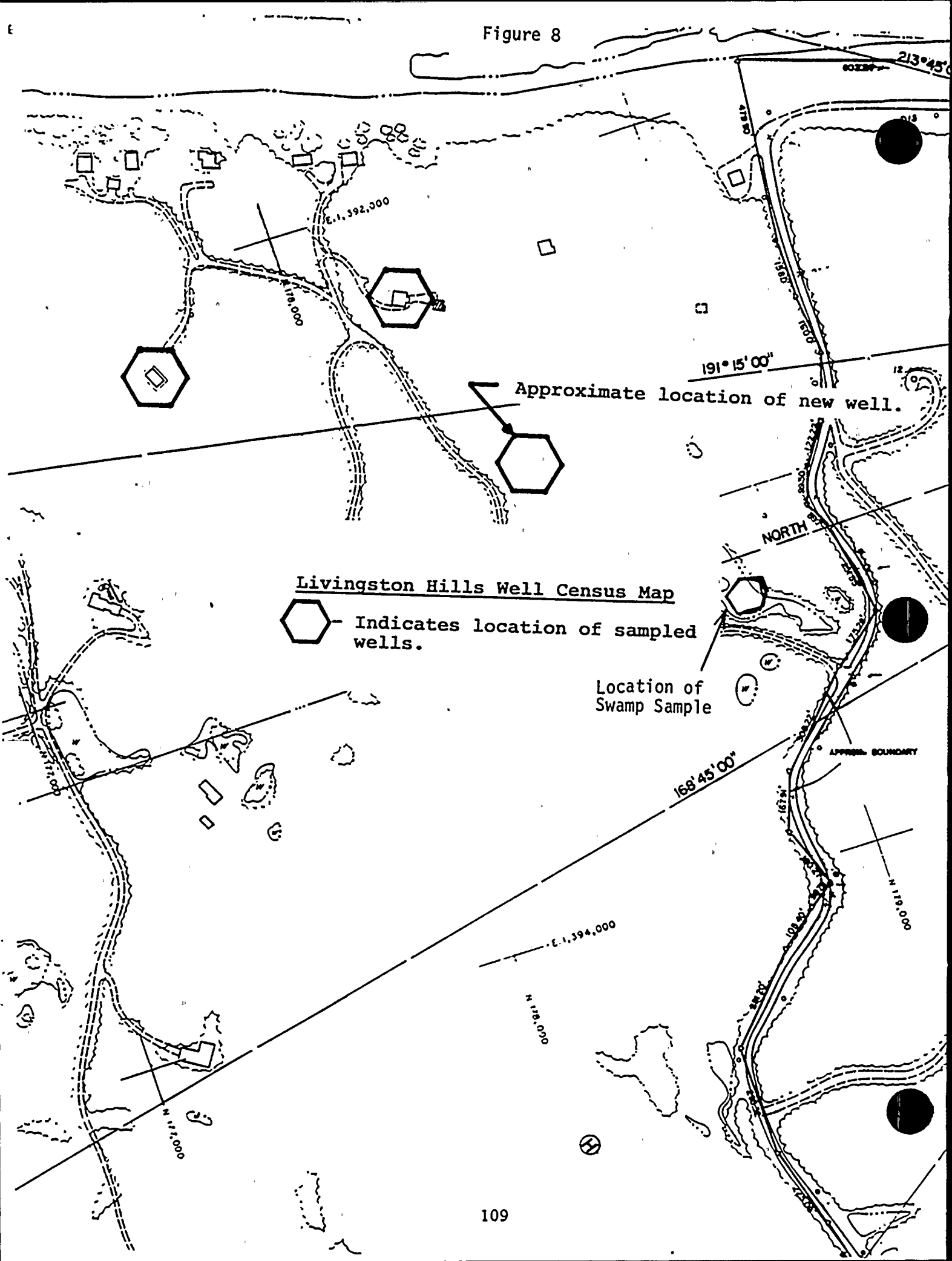
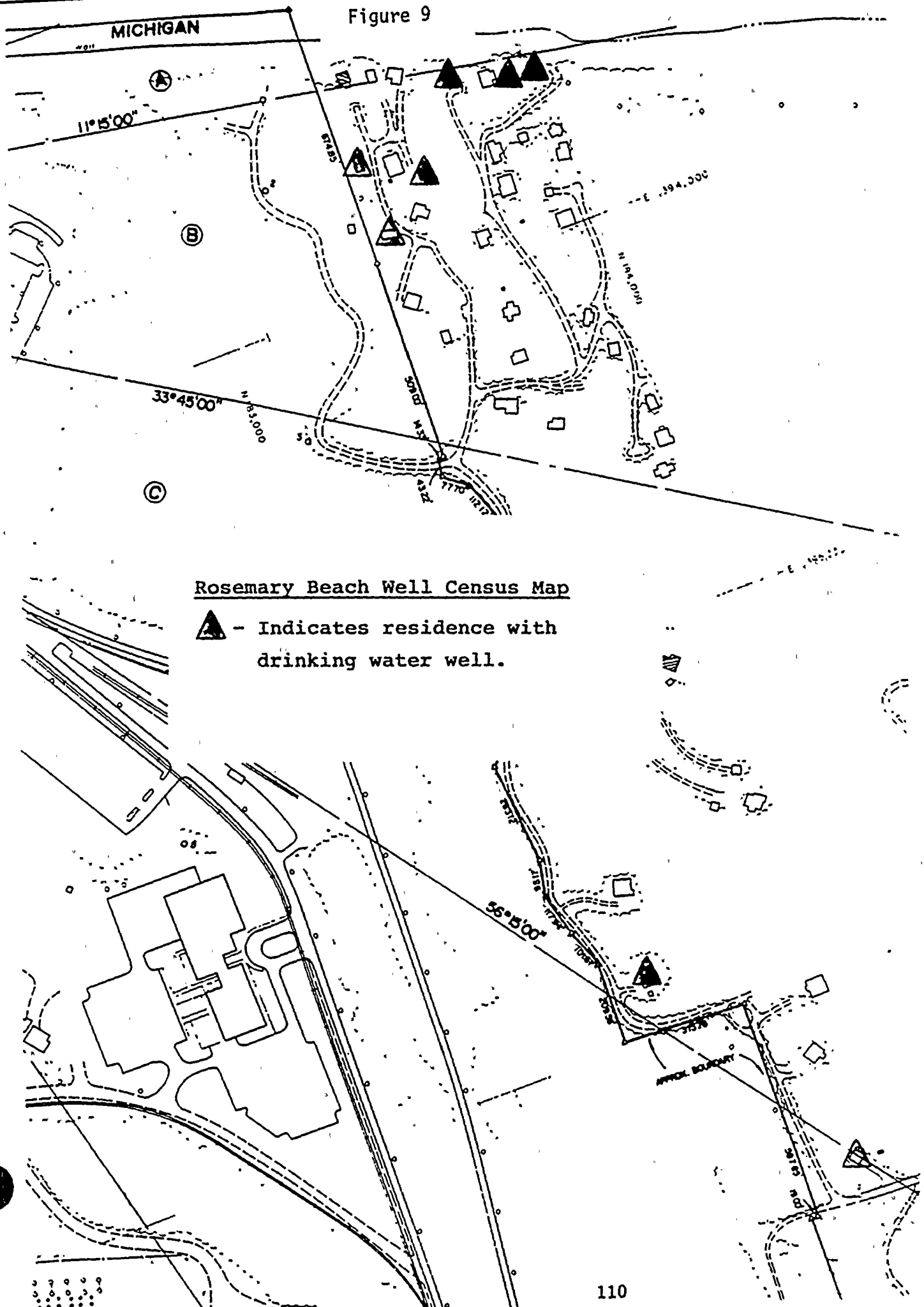

Approximate location of new well.
Livingston Hills Well Census Map
Indicates location of sampled wells.
Location of Swamp Sample
191° 15' 00"
168° 45' 00"
NORTH
E. 1,392,000
E. 1,394,000
N 178,000
N 119,000
N 177,000

Figure 9


MICHIGAN
11°15'00"
33°45'00"
56°8'00"
Rosemary Beach Well Census Map
▲ - Indicates residence with drinking water well.

# APPENDIX G
# SUMMARY OF THE PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

## SUMMARY OF THE PREOPERATIONAL RADIOLOGICAL MONITORING PROGRAM

A preoperational radiological environmental monitoring program was performed for the Donald C. Cook Nuclear Plant from August 1971 until the initial criticality of Unit 1 on January 18, 1975. The analyses of samples collected in the vicinity of the nuclear power plant were performed by Eberline Instrument Corporation. The summary of the preoperational program presented in this appendix is based on the seven semi-annual reports covering the period. The purpose of this summary is to provide a comparison of the radioactivity measured in the environs of the plant during the pre-start up of Unit 1 and the radioactivity measured in 1990.

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

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

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

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

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

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

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

The discussion that follows is for the various sample media collected and analyzed in both the preoperational period and in 1990. Analyses, such as strontium-89 and strontium-90 in milk and air

particulates performed during the preoperational but not required in 1990, 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 BLIND DUPLICATE SAMPLE PROGRAM

## SUMMARY OF THE BLIND DUPLICATE SAMPLE PROGRAM

The Plant procedure for implementing the blind duplicate sampling program was revised in 1990. The procedure revision was performed to allow for the preparation and use of spiked samples in the duplicate sample program. Analysis comparisons using samples with detectable activity, as referenced in Regulatory Guide 4.15, are a more useful indicator of an analytical lab's performance.

Ten duplicate analyses were performed in 1990. The samples and results are listed in the attached table. Nine of the samples were within acceptable limits. The duplicate TLD sample fell outside the acceptable limits. A comparison was subsequently made between the onsite, offsite, and control group TLD's.

## BLIND DUPLICATE SAMPLE PROGRAM - 1990

| Collection Date | Sample Type | Location | Isotopes/ Units | Routine Sample | Blind Duplicate (a) | Acceptable Limits |
|---|---|---|---|---|---|---|
| 04/06/90 | Milk | Warmbein | Gamma-K-40 pCi/liter | 1240 ± 120 | 1230 ± 120 | 1120-1360 |
| 04/22/90 (First Qtr.) | TLD-Control | Env. Supr. Office | Direct Radiation mR/std month | 10.8 ± 0.2 | 8.3 ± 0.3 (b) | 10.6-11.0 |
| 05/06/90 | Groundwater | Well - #5 | H-3 pCi/liter | 700 ± 100 | 650 ± 90 | 600-800 |
| 11/03/90-11/09/90 | Airborne | N/A | Gross Beta pCi/m3 | .014 ± .001 | .014 ± .001 | .013-.015 |
| 11/08/90-11/13/90 | Waterborne | N/A | I-131 pCi/liter | < .2 | < .4 | N/A |
| 10/05/90-11/17/90 | Waterborne | N/A | H-3 pCi/liter | < 200 | 110 ± 50 | N/A |
| 10/14/90-11/20/90 | Waterborne | N/A | Gamma Isotopic (c) | All nuclides = <LLD | All nuclides = <LLD | N/A |
| 11/12/90 | Groundwater | 1A | H-3 - pCi/liter | 1500 ± 400 | 1100 ± 100 | 1100 ± 1900 |
| 11/12/90 | Groundwater | 12 | H-3 - pCi/liter | 2700 ± 400 | 2700 ± 100 | 2300 ± 3100 |
| 11/12/90 | Groundwater | 11 | H-3 - pCi/liter | 1000 ± 400 | 710 ± 100 | 600 ± 1400 |

(a) All blind samples were within acceptable limits unless otherwise noted.
(b) Blind sample not within acceptable limits.
(c) Samples with detectable activity were within acceptable limits. The lab has been instructed to perform future duplicate analyses using samples with detectable activity.

# APPENDIX I
# SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

## SUMMARY OF THE SPIKE AND BLANK SAMPLE PROGRAM

The following tables list the blanks and spiked water samples analyzed during 1990 for the Teledyne Isotopes In-house Quality Assurance Program. Analysis date is analogous to collection date to identify weekly analysis of samples.

One analysis for gross beta activity was reported outside the specified acceptable ranges. No documented corrective action was taken because in accordance with Section 9.1 of our Quality Control Manual (IWL-0032-365), the acceptance criteria for a particular analysis "is within 3 standard deviations of the EPA one sigma, one determination as specified in the Environmental Radioactive Laboratory Studies Program EPA-600/4-81-004, Table 3, Page 8". For gross beta activity below 100 pCi/l the control level at which corrective action must be taken is ± 15 pCi/l. The quality assurance department operationally investigates gross beta spike results which exceed the one standard deviation, one determination levels (± 5 pCi/l), because of previous experience in reporting results within that level.

# Teledyne Isotopes In-House Spiked Sample Results

## 1990 - Water

| Analysis | Spike Levels (pCi/l) | Acceptable Range (pCi/l) |
|---|---|---|
| Gross Alpha | 11 ± 5 | 6 - 16 |
| Gross Beta | 21 ± 5 | 16-26 |
| Gamma (Eu-154) | 1.4 ± 0.2 E 05 | 1.2 - 1.6 E 05 |
| H-3 (G) | 2.7 ± 0.3 E 03 | 2.4 - 3.0 E 03 |

### GROSS ALPHA

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88267 | 01/03/90 | 1.1 ± 0.2 E 01 |
| 88268 | 01/10/90 | 1.1 ± 0.2 E 01 |
| 88269 | 01/17/90 | 1.4 ± 0.2 E 01 |
| 88270 | 01/24/90 | 1.5 ± 0.2 E 01 |
| 88271 | 01/31/90 | 1.4 ± 0.2 E 01 |
| 92203 | 02/07/90 | 1.6 ± 0.2 E 01 |
| 99204 | 02/14/90 | 1.5 ± 0.2 E 01 |
| 99205 | 02/21/90 | 1.5 ± 0.2 E 01 |
| 92206 | 02/28/90 | 1.6 ± 0.2 E 01 |
| 95348 | 03/07/90 | 1.1 ± 0.2 E 01 |
| 95349 | 03/14/90 | 1.3 ± 0.2 E 01 |
| 95350 | 03/21/90 | 1.5 ± 0.2 E 01 |
| 95351 | 03/28/90 | 1.2 ± 0.1 E 01 |
| 97594 | 04/04/90 | 1.1 ± 0.2 E 01 |
| 97595 | 04/11/90 | 1.5 ± 0.2 E 01 |
| 97596 | 04/18/90 | 1.5 ± 0.2 E 01 |
| 97597 | 04/25/90 | 1.2 ± 0.2 E 01 |
| 00652 | 05/02/90 | 1.2 ± 0.2 E 01 |
| 00653 | 05/09/90 | 1.3 ± 0.2 E 01 |
| 00654 | 05/16/90 | 1.4 ± 0.2 E 01 |
| 00655 | 05/23/90 | 7.6 ± 1.3 E 00 |
| 00988 | 05/30/90 | 1.2 ± 0.2 E 01 |
| 04157 | 06/06/90 | 1.1 ± 0.2 E 01 |
| 04158 | 06/13/90 | 1.4 ± 0.2 E 01 |
| 04159 | 06/20/90 | 1.1 ± 0.2 E 01 |
| 04160 | 06/27/90 | 1.2 ± 0.2 E 01 |
| 06920 | 07/05/90 | 9.1 ± 1.6 E 00 |
| 06921 | 07/11/90 | 9.1 ± 1.6 E 00 |
| 06922 | 07/18/90 | 1.2 ± 0.2 E 01 |
| 06923 | 07/25/90 | 1.0 ± 0.2 E 01 |

## GROSS ALPHA (Cont.)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 09691 | 08/01/90 | 1.1 ± 0.2 E 01 |
| 09692 | 08/08/90 | 9.6 ± 1.5 E 00 |
| 09693 | 08/15/90 | 1.2 ± 0.2 E 01 |
| 09694 | 08/22/90 | 1.4 ± 0.2 E 01 |
| 09695 | 08/29/90 | 1.3 ± 0.2 E 01 |
| 13338 | 09/05/90 | 1.3 ± 0.2 E 01 |
| 13339 | 09/12/90 | 1.3 ± 0.2 E 01 |
| 13340 | 09/19/90 | 1.2 ± 0.2 E 01 |
| 13341 | 09/26/90 | 1.3 ± 0.2 E 01 |
| 15855 | 10/03/90 | 1.3 ± 0.2 E 01 |
| 15856 | 10/10/90 | 1.1 ± 0.2 E 01 |
| 15857 | 10/17/90 | 1.2 ± 0.2 E 01 |
| 15858 | 10/24/90 | 1.1 ± 0.2 E 01 |
| 15859 | 10/31/90 | 1.3 ± 0.2 E 01 |
| 18566 | 11/07/90 | 1.4 ± 0.2 E 01 |
| 18567 | 11/14/90 | 1.2 ± 0.2 E 01 |
| 18568 | 11/21/90 | 1.2 ± 0.2 E 01 |
| 18569 | 11/28/90 | 1.2 ± 0.2 E 01 |
| 21047 | 12/05/90 | 1.3 ± 0.2 E 01 |
| 21048 | 12/12/90 | 1.1 ± 0.2 E 01 |
| 21049 | 12/19/90 | 1.3 ± 0.2 E 01 |
| 21050 | 12/26/90 | 1.3 ± 0.2 E 01 |

## GROSS BETA

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88262 | 01/03/90 | 1.7 ± 0.1 E 01 |
| 88263 | 01/10/90 | 1.7 ± 0.1 E 01 |
| 88264 | 01/17/90 | 1.7 ± 0.1 E 01 |
| 88265 | 01/24/90 | 1.9 ± 0.1 E 01 |
| 88266 | 01/31/90 | 2.0 ± 0.1 E 01 |
| 92199 | 02/07/90 | 1.7 ± 0.1 E 01 |
| 92200 | 02/14/90 | 1.8 ± 0.1 E 01 |
| 92201 | 02/21/90 | 1.9 ± 0.1 E 01 |
| 92202 | 02/28/90 | 2.0 ± 0.1 E 01 |
| 95344 | 03/07/90 | 1.8 ± 0.1 E 01 |
| 95345 | 03/14/90 | 1.8 ± 0.1 E 01 |
| 95346 | 03/21/90 | 2.0 ± 0.1 E 01 |
| 95347 | 03/28/90 | 1.6 ± 0.1 E 01 |

## GROSS BETA (Cont.)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 97590 | 04/04/90 | 1.6 ± 0.1 E 01 |
| 97591 | 04/11/90 | 1.7 ± 0.1 E 01 |
| 97592 | 04/18/90 | 1.8 ± 0.1 E 01 |
| 97593 | 04/25/90 | 1.8 ± 0.1 E 01 |
| 00647 | 05/02/90 | 1.7 ± 0.1 E 01 |
| 00648 | 05/09/90 | 1.7 ± 0.1 E 01 |
| 00649 | 05/16/90 | 1.9 ± 0.1 E 01 |
| 00650 | 05/23/90 | 1.9 ± 0.1 E 01 |
| 00651 | 05/30/90 | 1.8 ± 0.1 E 01 |
| 04153 | 06/06/90 | 2.0 ± 0.1 E 01 |
| 04154 | 06/13/90 | 2.0 ± 0.1 E 01 |
| 04155 | 06/20/90 | 1.7 ± 0.1 E 01 |
| 04156 | 06/27/90 | 1.7 ± 0.1 E 01 |
| 06916 | 07/05/90 | 1.9 ± 0.1 E 01 |
| 06917 | 07/11/90 | 2.0 ± 0.1 E 01 |
| 06918 | 07/18/90 | 1.7 ± 0.1 E 01 |
| 06919 | 07/25/90 | 1.7 ± 0.1 E 01 |
| 09686 | 08/01/90 | 1.8 ± 0.1 E 01 |
| 09687 | 08/08/90 | 1.8 ± 0.1 E 01 |
| 09688 | 08/15/90 | 1.9 ± 0.1 E 01 |
| 09689 | 08/22/90 | 1.8 ± 0.1 E 01 |
| 09690 | 08/29/90 | 1.6 ± 0.1 E 01 |
| 13334 | 09/05/90 | 1.7 ± 0.1 E 01 |
| 13335 | 09/12/90 | 1.3 ± 0.1 E 01 |
| 13336 | 09/19/90 | 2.0 ± 0.1 E 01 |
| 13337 | 09/26/90 | 2.0 ± 0.1 E 01 |
| 15850 | 10/03/90 | 1.8 ± 0.1 E 01 |
| 15851 | 10/10/90 | 2.0 ± 0.1 E 01 |
| 15852 | 10/17/90 | 2.0 ± 0.2 E 01 |
| 15853 | 10/24/90 | 1.9 ± 0.1 E 01 |
| 15854 | 10/31/90 | 2.1 ± 0.1 E 01 |
| 18562 | 11/07/90 | 2.1 ± 0.2 E 01 |
| 18563 | 11/14/90 | 1.9 ± 0.1 E 01 |
| 18564 | 11/21/90 | 2.0 ± 0.1 E 01 |
| 18565 | 11/28/90 | 1.8 ± 0.1 E 01 |
| 21043 | 12/05/90 | 1.7 ± 0.1 E 01 |
| 21044 | 12/12/90 | 2.0 ± 0.1 E 01 |
| 21045 | 12/19/90 | 2.0 ± 0.1 E 01 |
| 21046 | 12/26/90 | 1.8 ± 0.1 E 01 |

## GAMMA (Eu-154)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88292 | 01/03/90 | 1.46 ± 0.15 E 05 |
| 88293 | 01/10/90 | 1.44 ± 0.14 E 05 |
| 88294 | 01/17/90 | 1.45 ± 0.15 E 05 |
| 88295 | 01/24/90 | 1.39 ± 0.14 E 05 |
| 88296 | 01/31/90 | 1.46 ± 0.15 E 05 |
| 92223 | 02/07/90 | 1.44 ± 0.14 E 05 |
| 92224 | 02/14/90 | 1.43 ± 0.14 E 05 |
| 92225 | 02/21/90 | 1.40 ± 0.14 E 05 |
| 92226 | 02/28/90 | 1.40 ± 0.14 E 05 |
| 95368 | 03/07/90 | 1.43 ± 0.14 E 05 |
| 95369 | 03/14/90 | 1.41 ± 0.14 E 05 |
| 95370 | 03/21/90 | 1.46 ± 0.15 E 05 |
| 95371 | 03/28/90 | 1.37 ± 0.14 E 05 |
| 97614 | 04/04/90 | 1.40 ± 0.14 E 05 |
| 97615 | 04/11/90 | 1.37 ± 0.14 E 05 |
| 97616 | 04/18/90 | 1.42 ± 0.14 E 05 |
| 97617 | 04/25/90 | 1.47 ± 0.15 E 05 |
| 00676 | 05/02/90 | 1.43 ± 0.14 E 05 |
| 00677 | 05/09/90 | 1.44 ± 0.14 E 05 |
| 00678 | 05/16/90 | 1.43 ± 0.14 E 05 |
| 00679 | 05/23/90 | 1.45 ± 0.15 E 05 |
| 00680 | 05/30/90 | 1.42 ± 0.14 E 05 |
| 04177 | 06/06/90 | 1.40 ± 0.14 E 05 |
| 04178 | 06/13/90 | 1.43 ± 0.14 E 05 |
| 04179 | 06/20/90 | 1.43 ± 0.14 E 05 |
| 04180 | 06/27/90 | 1.44 ± 0.14 E 05 |
| 06940 | 07/05/90 | 1.42 ± 0.14 E 05 |
| 06941 | 07/11/90 | 1.41 ± 0.14 E 05 |
| 06942 | 07/18/90 | 1.41 ± 0.14 E 05 |
| 06943 | 07/25/90 | 1.44 ± 0.14 E 05 |
| 09716 | 08/01/90 | 1.45 ± 0.15 E 05 |
| 09717 | 08/08/90 | 1.44 ± 0.14 E 05 |
| 09718 | 08/15/90 | 1.42 ± 0.14 E 05 |
| 09719 | 08/22/90 | 1.35 ± 0.14 E 05 |
| 09720 | 08/29/90 | 1.38 ± 0.14 E 05 |
| 13358 | 09/05/90 | 1.46 ± 0.15 E 05 |
| 13359 | 09/12/90 | 1.22 ± 0.12 E 05 |
| 13360 | 09/19/90 | 1.41 ± 0.14 E 05 |
| 13361 | 09/26/90 | 1.33 ± 0.13 E 05 |
| 15880 | 10/03/90 | 1.38 ± 0.14 E 05 |
| 15881 | 10/10/90 | 1.38 ± 0.14 E 05 |
| 15882 | 10/17/90 | 1.44 ± 0.14 E 05 |
| 15883 | 10/24/90 | 1.42 ± 0.14 E 05 |
| 15884 | 10/31/90 | 1.40 ± 0.14 E 05 |

## GAMMA (Eu-154) (Cont.)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 18586 | 11/07/90 | 1.39 ± 0.14 E 05 |
| 18587 | 11/14/90 | 1.42 ± 0.14 E 05 |
| 18588 | 11/21/90 | 1.44 ± 0.14 E 05 |
| 18589 | 11/28/90 | 1.35 ± 0.14 E 05 |
| 21067 | 12/05/90 | 1.45 ± 0.15 E 05 |
| 21068 | 12/12/90 | 1.42 ± 0.14 E 05 |
| 21069 | 12/19/90 | 1.43 ± 0.14 E 05 |
| 21070 | 12/26/90 | 1.40 ± 0.14 E 05 |

## TRITIUM - (H-3)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88277 | 01/03/90 | 2.7 ± 0.2 E 03 |
| 88278 | 01/10/90 | 2.7 ± 0.1 E 03 |
| 88279 | 01/17/90 | 2.6 ± 0.1 E 03 |
| 88280 | 01/24/90 | 2.9 ± 0.1 E 03 |
| 88281 | 01/31/90 | 2.8 ± 0.1 E 03 |
| 92211 | 02/07/90 | 2.6 ± 0.1 E 03 |
| 92212 | 02/14/90 | 2.9 ± 0.1 E 03 |
| 92213 | 02/21/90 | 2.7 ± 0.1 E 03 |
| 92214 | 02/28/90 | 2.5 ± 0.1 E 03 |
| 95356 | 03/07/90 | 2.7 ± 0.1 E 03 |
| 95357 | 03/14/90 | 2.6 ± 0.1 E 03 |
| 95358 | 03/21/90 | 2.8 ± 0.1 E 03 |
| 95359 | 03/28/90 | 2.8 ± 0.1 E 03 |
| 97602 | 04/04/90 | 2.7 ± 0.1 E 03 |
| 97603 | 04/11/90 | 2.8 ± 0.1 E 03 |
| 97604 | 04/18/90 | 2.5 ± 0.1 E 03 |
| 97605 | 04/25/90 | 2.8 ± 0.1 E 03 |
| 00661 | 05/02/90 | 2.7 ± 0.1 E 03 |
| 00662 | 05/09/90 | 2.7 ± 0.2 E 03 |
| 00663 | 05/16/90 | 2.6 ± 0.1 E 03 |
| 00664 | 05/23/90 | 2.8 ± 0.1 E 03 |
| 00665 | 05/30/90 | 2.7 ± 0.1 E 03 |
| 04165 | 06/06/90 | 2.5 ± 0.1 E 03 |
| 04166 | 06/13/90 | 2.5 ± 0.1 E 03 |
| 04167 | 06/20/90 | 2.4 ± 0.2 E 03 |
| 04168 | 06/27/90 | 2.5 ± 0.1 E 03 |
| 06928 | 07/05/90 | 2.6 ± 0.1 E 03 |
| 06929 | 07/11/90 | 2.5 ± 0.1 E 03 |
| 06930 | 07/18/90 | 2.4 ± 0.1 E 03 |
| 06931 | 07/25/90 | 2.7 ± 0.1 E 03 |
| 09701 | 08/01/90 | 2.4 ± 0.1 E 03 |

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

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 09702 | 08/08/90 | 2.4 ± 0.1 E 03 |
| 09703 | 08/15/90 | 2.7 ± 0.1 E 03 |
| 09704 | 08/22/90 | 2.5 ± 0.1 E 03 |
| 09705 | 08/29/90 | 2.4 ± 0.1 E 03 |
| 13346 | 09/05/90 | 2.4 ± 0.1 E 03 |
| 13347 | 09/12/90 | 2.6 ± 0.1 E 03 |
| 13348 | 09/19/90 | 2.5 ± 0.1 E 03 |
| 13349 | 09/26/90 | 2.6 ± 0.1 E 03 |
| 15865 | 10/03/90 | 2.6 ± 0.1 E 03 |
| 15866 | 10/10/90 | 2.5 ± 0.1 E 03 |
| 15867 | 10/17/90 | 2.5 ± 0.1 E 03 |
| 15868 | 10/24/90 | 2.5 ± 0.1 E 03 |
| 15869 | 10/31/90 | 2.5 ± 0.1 E 03 |
| 18574 | 11/07/90 | 2.7 ± 0.1 E 03 |
| 18575 | 11/14/90 | 2.4 ± 0.1 E 03 |
| 18576 | 11/21/90 | 2.4 ± 0.2 E 03 |
| 18577 | 11/28/90 | 2.6 ± 0.1 E 03 |
| 21055 | 12/05/90 | 2.6 ± 0.1 E 03 |
| 21056 | 12/12/90 | 2.8 ± 0.1 E 03 |
| 21057 | 12/19/90 | 2.7 ± 0.1 E 03 |
| 21058 | 12/26/90 | 2.7 ± 0.1 E 03 |

# Teledyne Isotopes In-House Blanks Sample Results

## 1990 - Water

### GROSS ALPHA

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88257 | 01/03/90 | L. T. 7. E-01 |
| 88258 | 01/10/90 | L. T. 6. E-01 |
| 88259 | 01/17/90 | L. T. 5. E-01 |
| 88260 | 01/24/90 | L. T. 6. E-01 |
| 88261 | 01/31/90 | L. T. 5. E-01 |
| 92195 | 02/07/90 | L. T. 5. E-01 |
| 92196 | 02/14/90 | L. T. 7. E-01 |
| 92197 | 02/21/90 | L. T. 3. E-01 |
| 92198 | 02/28/90 | L. T. 6. E-01 |
| 95340 | 03/07/90 | L. T. 6. E-01 |
| 95341 | 03/14/90 | L. T. 6. E-01 |
| 95342 | 03/21/90 | L. T. 4. E-01 |
| 95343 | 03/28/90 | L. T. 4. E-01 |
| 97586 | 04/04/90 | L. T. 4. E-01 |
| 97587 | 04/11/90 | L. T. 6. E-01 |
| 97588 | 04/18/90 | L. T. 5. E-01 |
| 97589 | 04/25/90 | L. T. 4. E-01 |
| 00594 | 05/02/90 | L. T. 6. E-01 |
| 00595 | 05/09/90 | L. T. 6. E-01 |
| 00596 | 05/16/90 | L. T. 4. E-01 |
| 00597 | 05/23/90 | L. T. 4. E-01 |
| 00598 | 05/30/90 | L. T. 8. E-01 |
| 04149 | 06/06/90 | L. T. 4. E-01 |
| 04150 | 06/13/90 | L. T. 4. E-01 |
| 04151 | 06/20/90 | L. T. 6. E-01 |
| 04152 | 06/27/90 | L. T. 5. E-01 |
| 06912 | 07/05/90 | L. T. 4. E-01 |
| 06913 | 07/11/90 | L. T. 7. E-01 |
| 06914 | 07/18/90 | L. T. 7. E-01 |
| 06915 | 07/25/90 | L. T. 7. E-01 |
| 09681 | 08/01/90 | L. T. 4. E-01 |
| 09682 | 08/08/90 | L. T. 6. E-01 |
| 09683 | 08/15/90 | L. T. 5. E-01 |
| 09684 | 08/22/90 | L. T. 4. E-01 |
| 09685 | 08/29/90 | L. T. 5. E-01 |

## GROSS ALPHA (Cont.)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 13330 | 09/05/90 | L. T. 5. E-01 |
| 13331 | 09/12/90 | L. T. 8. E-01 |
| 13332 | 09/19/90 | L. T. 4. E-01 |
| 13333 | 09/26/90 | L. T. 4. E-01 |
| 15845 | 10/03/90 | L. T. 5. E-01 |
| 15846 | 10/10/90 | L. T. 4. E-01 |
| 15847 | 10/17/90 | L. T. 4. E-01 |
| 15848 | 10/24/90 | L. T. 4. E-01 |
| 15849 | 10/31/90 | L. T. 6. E-01 |
| 18558 | 11/07/90 | L. T. 6. E-01 |
| 18559 | 11/14/90 | L. T. 4. E-01 |
| 18560 | 11/21/90 | L. T. 7. E-01 |
| 18561 | 11/28/90 | L. T. 4. E-01 |
| 21039 | 12/05/90 | L. T. 6. E-01 |
| 21040 | 12/12/90 | L. T. 6. E-01 |
| 21041 | 12/19/90 | L. T. 4. E-01 |
| 21042 | 12/26/90 | L. T. 5. E-01 |

## GROSS BETA

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88257 | 01/03/90 | L. T. 8. E-01 |
| 88258 | 01/10/90 | L. T. 9. E-01 |
| 88259 | 01/17/90 | L. T. 8. E-01 |
| 88260 | 01/24/90 | L. T. 7. E-01 |
| 88261 | 01/31/90 | L. T. 7. E-01 |
| 92195 | 02/07/90 | L. T. 7. E-01 |
| 92196 | 02/14/90 | L. T. 7. E-01 |
| 92197 | 02/21/90 | L. T. 7. E-01 |
| 92198 | 02/28/90 | L. T. 8. E-01 |
| 95340 | 03/07/90 | L. T. 7. E-01 |
| 95341 | 03/14/90 | L. T. 8. E-01 |
| 95342 | 03/21/90 | L. T. 8. E-01 |
| 95343 | 03/28/90 | L. T. 7. E-01 |
| 97586 | 04/04/90 | L. T. 8. E-01 |
| 97587 | 04/11/90 | L. T. 7. E-01 |
| 97588 | 04/18/90 | L. T. 8. E-01 |
| 97589 | 04/25/90 | L. T. 7. E-01 |
| 00594 | 05/02/90 | L. T. 8. E-01 |
| 00595 | 05/09/90 | L. T. 7. E-01 |
| 00596 | 05/16/90 | L. T. 6. E-01 |
| 00597 | 05/23/90 | L. T. 7. E-01 |
| 00598 | 05/30/90 | L. T. 8. E-01 |

## GROSS BETA (Cont.)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 04149 | 06/06/90 | L. T. 7. E-01 |
| 04150 | 06/13/90 | L. T. 7. E-01 |
| 04151 | 06/20/90 | L. T. 8. E-01 |
| 04152 | 06/27/90 | L. T. 7. E-01 |
| 06912 | 07/05/90 | L. T. 8. E-01 |
| 06913 | 07/11/90 | L. T. 7. E-01 |
| 06914 | 07/18/90 | L. T. 8. E-01 |
| 06915 | 07/25/90 | L. T. 8. E-01 |
| 09681 | 08/01/90 | L. T. 8. E-01 |
| 09682 | 08/08/90 | L. T. 7. E-01 |
| 09683 | 08/15/90 | L. T. 8. E-01 |
| 09684 | 08/22/90 | L. T. 7. E-01 |
| 09685 | 08/29/90 | L. T. 8. E-01 |
| 13330 | 09/05/90 | L. T. 8. E-01 |
| 13331 | 09/12/90 | L. T. 8. E-01 |
| 13332 | 09/19/90 | L. T. 7. E-01 |
| 13333 | 09/26/90 | L. T. 8. E-01 |
| 15845 | 10/03/90 | L. T. 8. E-01 |
| 15846 | 10/10/90 | L. T. 8. E-01 |
| 15847 | 10/17/90 | L. T. 1. E 00 |
| 15848 | 10/24/90 | L. T. 7. E-01 |
| 15849 | 10/31/90 | L. T. 8. E-01 |
| 18558 | 11/07/90 | L. T. 8. E-01 |
| 18559 | 11/14/90 | L. T. 7. E-01 |
| 18560 | 11/21/90 | L. T. 7. E-01 |
| 18561 | 11/28/90 | L. T. 8. E-01 |
| 21039 | 12/05/90 | L. T. 8. E-01 |
| 21040 | 12/12/90 | L. T. 8. E-01 |
| 21041 | 12/19/90 | L. T. 9. E-01 |
| 21042 | 12/26/90 | L. T. 8. E-01 |

## TRITIUM - (H-3)

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 88287 | 01/03/90 | L. T. 2. E 02 |
| 88288 | 01/10/90 | L. T. 2. E 02 |
| 88289 | 01/17/90 | L. T. 1. E 02 |
| 88290 | 01/24/90 | L. T. 2. E 02 |
| 88291 | 01/31/90 | L. T. 1. E 02 |
| 92219 | 02/07/90 | L. T. 2. E 02 |
| 99220 | 02/14/90 | L. T. 1. E 02 |
| 92221 | 02/21/90 | L. T. 1. E 02 |
| 92222 | 02/28/90 | L. T. 1. E 02 |

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

| TI # | Analysis Date | Activity (pCi/l) |
|---|---|---|
| 95364 | 03/07/90 | L. T. 1. E 02 |
| 95365 | 03/14/90 | L. T. 2. E 02 |
| 95366 | 03/21/90 | L. T. 2. E 02 |
| 95367 | 03/28/90 | L. T. 2. E 02 |
| 97610 | 04/04/90 | L. T. 1. E 02 |
| 97611 | 04/11/90 | L. T. 2. E 02 |
| 97612 | 04/18/90 | L. T. 2. E 02 |
| 97613 | 04/25/90 | L. T. 1. E 02 |
| 00671 | 05/02/90 | L. T. 1. E 02 |
| 00672 | 05/09/90 | L. T. 2. E 02 |
| 00673 | 05/16/90 | L. T. 1. E 02 |
| 00674 | 05/23/90 | L. T. 1. E 02 |
| 00675 | 05/30/90 | L. T. 1. E 02 |
| 04713 | 06/06/90 | L. T. 2. E 02 |
| 04714 | 06/13/90 | L. T. 1. E 02 |
| 04175 | 06/20/90 | L. T. 1. E 02 |
| 04176 | 06/27/90 | L. T. 2. E 02 |
| 06936 | 07/05/90 | L. T. 2. E 02 |
| 06937 | 07/11/90 | L. T. 1. E 02 |
| 06938 | 07/18/90 | L. T. 1. E 02 |
| 06939 | 07/25/90 | L. T. 1. E 02 |
| 09711 | 08/01/90 | L. T. 1. E 02 |
| 09712 | 08/08/90 | L. T. 1. E 02 |
| 09713 | 08/15/90 | L. T. 2. E 02 |
| 09714 | 08/22/90 | L. T. 1. E 02 |
| 09715 | 08/29/90 | L. T. 1. E 02 |
| 13354 | 09/05/90 | L. T. 2. E 02 |
| 13355 | 09/12/90 | L. T. 1. E 02 |
| 13356 | 09/19/90 | L. T. 2. E 02 |
| 13357 | 09/26/90 | L. T. 1. E 02 |
| 15875 | 10/03/90 | L. T. 2. E 02 |
| 15876 | 10/10/90 | L. T. 2. E 02 |
| 15877 | 10/17/90 | L. T. 1. E 02 |
| 15878 | 10/24/90 | L. T. 1. E 02 |
| 15879 | 10/31/90 | L. T. 2. E 02 |
| 18582 | 11/07/90 | L. T. 1. E 02 |
| 18583 | 11/14/90 | L. T. 1. E 02 |
| 18584 | 11/21/90 | L. T. 2. E 02 |
| 18585 | 11/28/90 | L. T. 1. E 02 |
| 21059 | 12/05/90 | L. T. 1. E 02 |
| 21064 | 12/12/90 | L. T. 2. E 02 |
| 21065 | 12/19/90 | L. T. 2. E 02 |
| 21066 | 12/26/90 | L. T. 2. E 02 |

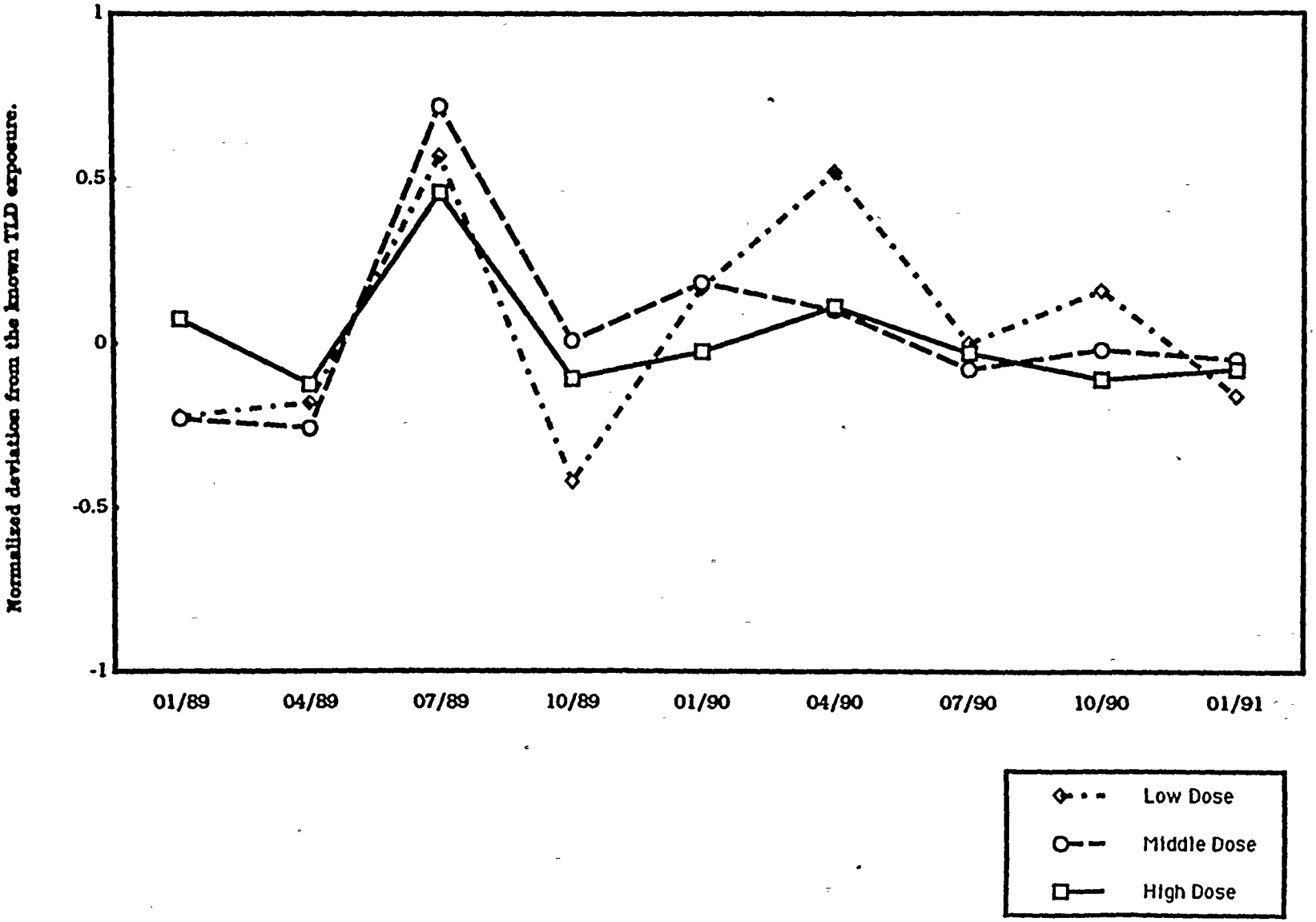
# APPENDIX J
# TLD QUALITY CONTROL PROGRAM

## TLD QUALITY CONTROL PROGRAM

Teledyne Isotopes performs an in-house quality assurance testing program for the environmental TLD laboratory. On a quarterly basis the QA manager exposes groups of TLDs to three different doses using a known cesium-137 exposure rate. Typical exposures are between 20 and 80 mR. The TLDs are readout on each of the three Model 8300 Readers in the environmental TLD laboratory and the calculated results are reported to the QA manager. The QA manager evaluates the results and writes a report discussing the performance of the labs. For 1990 all results were within the requirements of Regulatory Guide 4.13, Section C. The standard deviations were less than 7.5% and the variations from the known were less than 30%. The accompanying graphs show the normalized deviations of the measured doses to the exposure doses for each of the three readers.

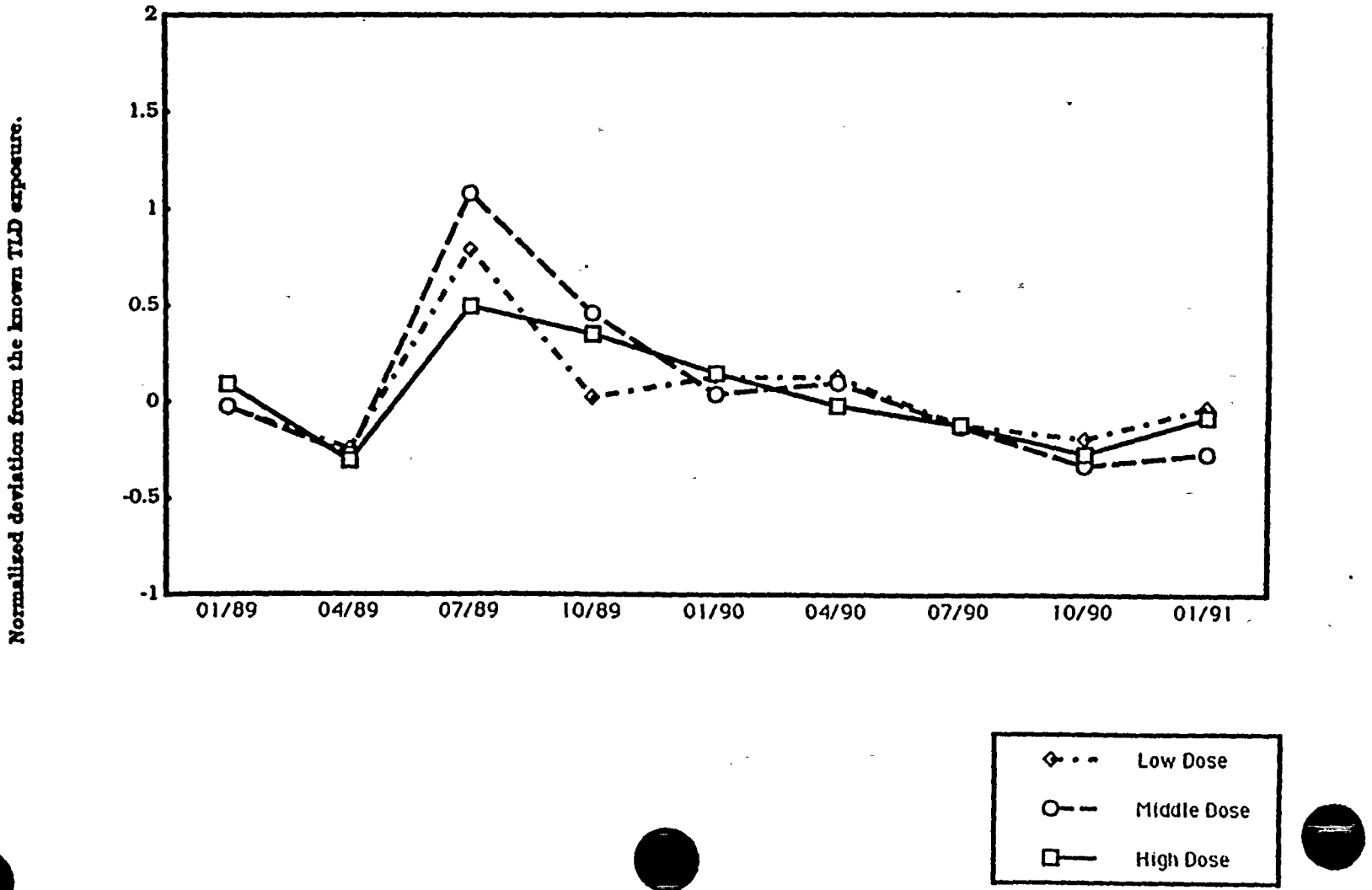
# QUALITY CONTROL - TLDS

## TLD READER 205



# QUALITY CONTROL - TLDs

## TLD READER 211



# QUALITY CONTROL - TLDs

## TLD READER 242